



The Effect of Environmental Design on Reducing Nursing and Medication Errors in Acute Care Settings

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Abstract

The Problem

It has been estimated that approximately 44,000 Americans die in hospitals each year as a result of preventable medical errors (Kohn et al., 2000a). The estimated national costs of adverse events in the United States is 37.6 billion dollars, while the national costs of preventable adverse events has been estimated to be 17 billion dollars (Kohn et al., 2000b). Physical environment is an important component in the acute care setting that can directly impact patient safety, nursing and medication errors, as well as contribute to staff fatigue, stress and burnout resulting in errors.

Methods

This study examines this issue in the medical-surgical units with multiple methods that include:

- Literature Review and Analysis (204 empirical and 148 non-empirical journal articles, books, book chapters and reports were reviewed and analyzed. Among these 352 items, 112 were specifically on nursing and medication errors).
- Survey on Nursing Staff in Four Hospitals in the Pacific Northwest
- Focus Groups with Nursing, Administration and Pharmacy Staff Members
- Site Visits to Three Selected Facilities that have implemented Design for Enhanced Patient Safety and Reduction of Errors

Key Findings and Conclusions

The review and analysis demonstrated that the following environmental variables contribute to work place errors: spatial design, micro-environmental design, ergonomics, noise levels, lighting, color, heating, ventilation, and air conditioning. Staffing levels, age and health of workers were among non-environmental variables associated with workplace errors. These variables contributed to errors through workers' fatigue, stress, disruptions, distractions, and other mediating factors. Ten major design recommendations are given based on the findings of the study. For example, the authors suggest finding a balance between patient accessibility and a reduction of disruptions. In addition, standardization and automation are emphasized.

Table of Contents

With over 30 pages of literature review and empirical analysis content, *The Effect of Environmental Design on Reducing Nursing and Medication Errors in Acute Care Settings* provides a comprehensive review of a very important issue. The reader will also find over 20 graphs that showcase the evidence. In addition, more than 25 images present a visual reference for the issues discussed.

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Executive Summary

It has been estimated that approximately 44,000 Americans die in hospitals each year as a result of preventable medical errors (Kohn et al., 2000a). The estimated national costs of adverse events in the United States is 37.6 billion dollars, while the national costs of preventable adverse events has been estimated to be 17 billion dollars (Kohn et al., 2000b). Physical environment is an important component in the acute care setting that can directly impact patient safety, nursing and medication errors, as well as contribute to staff fatigue, stress and burnout resulting in errors. However, there is no comprehensive review of the literature in this area; also, empirical studies linking the physical environment and errors in hospitals are very scarce.

This study examines this issue in the medical-surgical units with multiple methods that include:

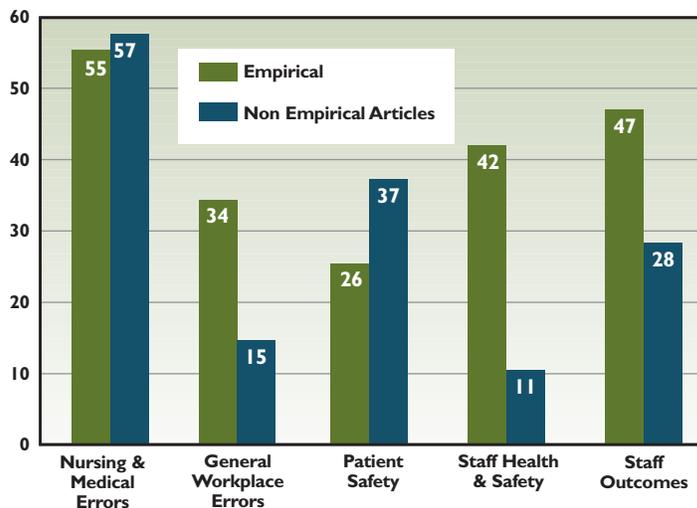
- Literature Review and Analysis
- Survey on Nursing Staff in Four Hospitals in the Pacific Northwest
- Focus Groups with Nursing, Administration and Pharmacy Staff Members
- Site Visits to Three Selected Facilities that have implemented Design for Enhanced Patient Safety and Reduction of Errors

Highlights of the Literature Review and Analysis

In order to gain an understanding on the environmental factors related to nursing efficiency, nursing and medication errors and other outcomes, an extensive review of literature was conducted in the area of nursing and medication errors in healthcare environments and other work places, staff efficiency, staff safety, staff burnout and other staff outcomes, infection control and patient outcomes. The research questions that guided this review and analysis are:

1) What are the effects of environmental variables on nursing and medication errors, nurses' efficiency, and quality of patient care in medical-surgical nursing units?

Figure 1: Number of literature items reviewed and analyzed in the various substantive areas



2) What are the effects of environmental variables on nurses' job satisfaction, health and safety in medical-surgical nursing units?

In total, 204 empirical (evidence-based) and 148 non-empirical (descriptive and conceptual) journal articles, books, book chapters and reports were reviewed and analyzed. Among these 352 items, 112 were specifically on nursing and medication errors. A breakdown of the reviewed items by substantive areas is provided in Figure 1.

Nurses' work in the acute care environment is physically and psychologically intense with much scope for burnout, stress, and error. Crowded, acoustically ineffective and poorly designed nursing stations and other healthcare staff work spaces within the hospital add to staff stress and may increase the risk of medical errors. Nursing errors and efficiency can be conceptualized at two levels, "active failures" and "latent conditions" (Reason, 2000). "Active failures" can be attributed to human cognition and limitations of memory and thought process. "Latent conditions" refer to failures resulting from decisions made by the management and architects. Examples include: physical environmental factors such as noise, lighting, color, temperature and layout and design and organizational factors such as time pressure, stress, fatigue, work overload, lack of privacy, etc. These issues highlight that the design of nurses' work environments (physical, organizational and social/psychological) need to be supportive of the nature of their work, and responsive to their particular needs.

To identify the environmental/architectural factors that affect nursing and medication errors, nurses' job performance/satisfaction, patient and staff safety, we reviewed and analyzed findings from the literature in the following four substantive areas:

- i) Errors in the workplace (both healthcare and non-healthcare settings)
- ii) Hospital design and environmental variables related to staff health and safety
- iii) Hospital design and environmental variables related to patient safety
- iv) Health care facility management, design and environmental variables related to staff outcomes – job satisfaction and effectiveness of nursing professionals.

In this executive summary, we highlight issues from the literature on error in the healthcare, as well as non-healthcare settings. Discussion on the other three sections is provided in the literature review document.

In acute care settings, errors often occurred in physician ordering and nursing administration. The most common medication errors are prescription/medication ordering errors, dispensing errors, errors in administration, and errors in the medication record. Dispensing errors are associated with a high prescription volume, being overworked, fatigue, interruptions, and drugs that look alike or sound alike (Hodgkinson, Koch, & Nay, 2006). The literature examining the effects of environmental variables on errors in acute care setting is limited. However, there have been some significant studies on error in non-healthcare work places and these have implications for healthcare settings. Though our focus was on environmental factors, we also reviewed some pertinent literature on non-environmental factors as environmental factors in combination with organizational and other factors lead to nursing, medication and other types of error in acute care settings. To get a broader contextual picture of why errors (especially latent error/failure) occur, we need to have an understanding of all the factors involved in the process.

Our review demonstrated that the following environmental variables contribute to work place errors:

- Noise levels
- Lighting
- Color
- Ergonomics/Furniture/ Equipment
- Heating, Ventilation and Air Conditioning
- Design/layout

The non-environmental variables associated with workplace errors include:

- Fatigue/long work hours
- Staffing levels
- Stress
- Faulty judgment
- Age of worker

Environmental Factors

Noise is Distracting and Disrupts Concentration, and is Highly Likely to Contribute Towards Error

The effects of noise on health outcomes, as well as work performance, are contingent upon several factors including the nature of the noise and the type of work task involved. There are two types of negative effect of noise on performance: 1) Effects of unpredictable noise are more severe on job performance than those of predictable noise, 2) Any negative effect of noise increases with task complexity (Leather, Beale & Sullivan, 2003). The interaction of unpredictable noise and high task complexity result in increased error in calculation, tracking and monitoring tasks, slower learning of new materials and poorer recall and memorization (Sundstrom, 1986). Loud, unexpected and unfamiliar noises may create a distraction, which could disrupt performance. When individuals are repeatedly distracted, overload may occur, which results in ignoring low-priority inputs. Noises may also block sounds which provide useful feedback, such as alarms on machines (Sundstrom, 1987).

Noise is problematic in a healthcare setting partially because there are a variety of sources of noise, many of which are loud (Ulrich, Lawson, & Martinez, 2003 as cited in Ulrich, Zimring, Quan, Joseph, & Choudhary, 2004). Sources of noise include telephones, staff voices, trolleys, and paging systems, among others. A higher degree of noise-induced stress was associated with higher levels of burnout for nurses (Topf & Dillon, 1988). Room occupancy affects noise levels. Noise levels are lower in private rather than multi-occupancy rooms (Ulrich et al., 2004).

These research findings on occupational noise highlights that one has to take into account the full context of each work setting (e.g., the type of work, type of noise, duration of noise, duration of work task, workers own health status, organizational factors etc.) to understand what type of effect noise may have on different groups of workers in that setting. Suggestions to improve the acoustics in a space include use of sound absorption materials like batts, acoustic panels, partition-

ing large spaces into smaller work spaces or partitioning off noisy areas, and creation of quiet areas with the work setting for specific tasks (Banbury & Berry, 2005). In healthcare settings, sound-absorbing ceiling tiles, single-bed rather than multibed rooms, and the reduction of noise sources may help in noise reduction (Neumann & Ruga, 1995; Ulrich et al., 2004).

Inadequate Lighting (either too bright or too dark) Can Impede Task Performance

Performance of tasks which involve visual discrimination of details declines when lighting levels are not bright enough (Sundstrom & Sundstrom, 1986). Control over the degree of lighting helps individuals perform tasks more effectively (Ebben, 2001). Lighting levels can affect healthcare staff effectiveness in performing critical tasks. Higher lighting levels are recommended to reduce medication error (Buchanan et al., 1991). On the other hand, glare from excess light, wrongly directed light and reflective surfaces cause reduction in visibility and discomfort in the work settings (Abdou, 1997; Kroemer & Kroemer, 2001; Ruck, 1989a). Research and examples of work places where people are productive demonstrates that the incorporation of natural daylight helped increase worker performance (Abdou, 1997; Brill, Margulis, Konar & Bosti, 1984; Sundstrom, 1987). To improve lighting in healthcare settings, surfaces that reduce glare should be used, and patients and workers should be exposed to natural daylight (Mroczek, Mikitarian, Vietra, & Rotarius, 2005; Shumaker & Reizemstein, 1982; Weber, 1995). In addition, being as the average age of nurses is increasing, bright work surface illumination levels (1500-2000 lx) may be necessary to reduce errors in dispensation and to aid in paper-based tasks (Ulrich & Barach, 2006).

Different Color Schemes Invoke Certain Responses; If the Color Scheme is not Suited to the Task On Hand, Errors May Result

Color impacts mood, satisfaction, motivation, and performance (Stone, 2003). In particular, warm colors, such as red, focus people outward and increase their awareness and alertness regarding their environment. Cool colors, such as blue and green, focus people inward enabling them to focus on mental and visual tasks (Wineman, 1979).

Color affects an employee's accuracy. More errors were made in the white office than in the green or red offices. Working in the red office was associated with reduced confusion (Kwallek & Lewis, 1990). The color of the environment may affect the perceptions of other environmental factors. A noisy environment, therefore, may be perceived as less noisy in cooler colors such as blue or green, whereas noise levels may be exaggerated in a red or yellow environment (Tofle, Schwarz, & Max-Royale, 2004). Similar effects have been noted with regards to the temperature of the environment. Guidelines have been suggested with regards to color in healthcare facilities. Stimulating colors should be used in the recreation areas and lounges. Cool colors should be used to promote relaxation in quiet or secluded rooms (Mahnke, 1996). For sub-acute care and rehabilitation, Leibrock (2000) suggests that intense colors should be used for accents and contrast to improve visual organization. Malkin (1982, 1992) suggests that red and yellow colors should be used in a setting where creativity and socialization are desired. Green and blue colors should be used in areas that require concentration and visual acuity. Cool colors also promote less distraction and more opportunity to concentrate on difficult tasks, and may thus be beneficial to nurses.

Inadequate Workstation Design and Tasks with Poor Ergonomics are Associated with the Development of Musculoskeletal Disorders and Higher Absenteeism Levels, and May be Related to Lower Levels of Patient Care and Increased Error Rates

Common ailments, such as sciatica, hernia, arthritis, muscular tension, and fatigue, may originate following irregular motions and maintaining a certain posture for prolonged periods of time. Tasks with poor ergonomics are associated with higher absenteeism levels, and may result in reduction or poor quality patient care in acute care settings (Janowitz et al., in press). For workers who stand for long periods of time, such as nurses, a prolonged stationary posture may result in some of these ailments and affect their work performance (Franco & Fusetti, 2004). The design of their work environment should help to reduce some of these ailments. For instance, their workstation should be designed so that there is sufficient space for the nurses' feet to enable movement close to the counter (Kroemer & Kroemer, 2001).

Relationships between the components incorporated in the design are critical to efficiency. Nurses need communication links that combine auditory, visual, or tactile components. There are no empirical studies looking at the ergonomics, design, communication and equipment in patient care areas of hospitals. However, designers (and experts in this field) recommend control links that include access and use of a bedside computer, movement links in areas where nursing staff can survey a patient and have the option controlling an apparatus by foot movements at the same time (Carayon et al., 2003). Further, Carayon et al. (2003) offer various recommendations to improve ergonomic design in healthcare facilities. To minimize perception time, both visual and tactile discrimination should be maximized through the use of the appropriate size, color, and texture of materials. To minimize decision time, for instance, patient headboards could have blood pressure cuffs and suction cups on both sides of the bed and different alarm sounds could be associated with different medical devices. To optimize the nurses' opportunity for movement, the equipment should be located in an area which enables easy access. Finally, to minimize the need for human strength, the use of mechanical devices should be used, such as beds that move from side to side or gurneys that enable a patient to have an X-ray without being transferred to an X-ray table.

To improve the way nurses handle patients, proper furniture and equipment are necessary. Beds, tables, trolleys, and wheelchairs, for instance, should be suitable, available, and maintained. As well, nurses should be properly trained with regards to equipment usage and storage (Hignett & Richardson, 1995). With regards to equipment and technology, various attempts have been made to reduce medication errors. Computerized physician order entry can improve the efficiency of care on intensive care units and reduce medication errors. The installation of an automated computer controlled device stored directly on nursing units (Medstation Rx) was associated with fewer medication errors (Borel & Rascati, 1995; Schwarz & Brodowy, 1995).

Poor Ventilation Systems and Excessive Thermal Environments May Compromise an Individual's Health and Lead to Stress and Negative Task Performances

Ventilation is critical to the functioning of an acute care facility. Ulrich et al. (2004) suggest that adequate ventilation and its maintenance are necessary to ensure the safety of staff and patients. Existing studies (Lundstrom, Pugliese, Bartley, Cox, & Guthier, 2002; Menzies, Fanning, Yuan, &

FitzGerald, 2000) on ventilation in hospitals do not deal specifically with error; they do demonstrate that the health of nurses (and patients) is affected by ventilation. If their health is compromised, so might their ability to adequately care for their patients, which may result in increased errors.

Mental performance is associated with the temperature of the office. Mental performance deteriorates with higher room temperatures (25 degrees Celsius for people who are un-acclimatized to the environment and 30-35 degree C for those who are acclimatized) (Kroemer & Kroemer, 2001). Prolonged exposure to heat will result in reduced performance of tasks since arousal levels will fall to below normal levels, distraction levels increase, and muscular activity becomes impaired (Sundstrom, 1987; Sundstrom & Sundstrom, 1986)

Productivity increases when workgroups are kept small and well-integrated, sources of distraction are kept to a minimum, and the design of the work setting is comfortable, safe, and healthy (Leaman & Bordass, 2000). Personal control over environmental variables also aids in improving an individual's performance and job satisfaction (Leaman & Bordass, 2000; Lee & Brand, 2005).

Single-Occupancy Rooms Can Reduce Errors

Single-occupancy rooms have also been associated with better communication among staff, reduced need for patient transfers, fewer medication errors, and decreased infection rates (Chaudhury et al., 2006; Page, 2004). Quality of care was also perceived as being greater since nurses were better able to respond to the emotional and physical needs of the patients (Janssen, Harris, Soolsma, Klein, & Seymour, 2001).

Non-environmental/Organizational Variables

Working Long Hours Contributes to Fatigue, Resulting in Slowed Reaction Time, Reduced Attention to Detail, Compromised Problem Solving, and Errors of Omission

Shift-work affects an individual's ability to sleep. Shift workers in non-healthcare (e.g., air traffic controllers) settings were found to sleep more, feel greater confusion, fatigue, and decreased vigor when working night shifts (Luna, French & Mitcha, 1997).

Working long hours has detrimental effects on patient care. Error rates were found to be three times higher when nurses worked shifts lasting 12.5 hours or more (Rogers, Hwang, Scott, Aiken & Dinges, 2004).

Negative effects of fatigue include slowed reaction time, reduced attention to detail, compromised problem solving, and errors of omission (Institute of Medicine, 2004; Krueger, 1994; Page, 2004). People working shift work (especially night shift) report impaired job performance, administration error, sleep disturbances, fatigue, and a greater likelihood of injuries (e.g., needle stick injuries) and accidents, incorrect operation of medical equipment, increased errors, in particular drug administration errors, due to sleepiness (Krueger, 1994; Page, 2004; Suzuki, Ohida, Kaneita, Yokoyama, & Uchiyama, 2005).

Stressors in the Work Environment Include Time Pressures, Deadline Pressures, an Uneven Distribution of Resources, and a Heavy Work Volume

Errors caused by work overload, faulty judgment, and a stressful experience led to a lack of confidence and increased anxiety in nurses (Meurier, Vincent & Palmer, 1997). Some negative effects of stress include anxiety, depression, increased blood pressure, reduced immune function, and sleeplessness (Barach & Dickerman, 2006). Stress healthcare workers experience is associated with the constricted use of common-sense solutions to safety, the widespread use of beginners in their field including residents and interns, the fact that little has been done to reduce sources of human error, and the shift of clinical care to an ambulatory setting (Amalberti, Auroy, Berwick & Barach 2005). Job rotation and job sharing can help reduce one's exposure to a high stress job for long periods of time.

More Errors Occur When Staffing Levels are Insufficient and Due to Faulty Judgement

Staffing levels are associated with the occurrence of adverse events. Research has demonstrated a relationship between low staffing levels and a higher number of medication errors and wound infections occurrence (Hall, Doran, & Pink, 2004). Patient falls are also more likely to occur when staff levels are low (Whitman, Kim, Davidson, Wolf, & Wang, 2002; Unruh, 2003; Yang, 2003). Lack of knowledge regarding the use of drugs as well as incomplete, illegible, or verbal prescriptions can also lead to errors (Leape, Bates, Cullen, Cooper, Demeacao, Gallivan, et al., 1995; Tissot, Cornette, Demoly, Jacquet, Barale, & Capellier, 1999).

Leadership Amongst Those in Authority, as well as the Implementation of an Error Reporting System, Can Reduce the Occurrence of Errors

Successes in other industries, such as chemical, material manufacturing, and defense, have demonstrated that reporting errors has improved safety. Systems of error reporting enable both staff members and those in leadership positions to learn from the mistakes and help prevent future similar errors from occurring. Healthcare is a "system that is highly complex and tightly interrelated" (Barach & Dickerman, 2006). The safety profile of an organization, including healthcare, is measured by "reporting on the number of adverse events over a time interval" (Amalberti, Auroy, Berwick, & Barach, 2005, p. 757). One of the main barriers in improving patient safety is the lack of awareness amongst those in healthcare regarding the extent to which errors occur daily in acute care facilities (Kohn, Corrigan, & Donaldson, 2000). Unfortunately, people working in healthcare have been afraid of reporting errors due to fear of reprimand and fear of losing the respect of colleagues (Paparella, 2005). Furthermore, when dealing with errors, healthcare professionals tend to look at individual patients rather than the system itself. Attention should be shifted to the system to prevent all patients from receiving inadequate service (Barach & Moss, 2001).

Various strategies have been suggested to reduce the occurrence of errors (Benner, Sheets, Uris, Malloch, Schwed, & Jamison, 2002; Hodgkinson, Koch, Nay, & Nichols, 2006; Kohn et al., 2000; McClanahan, Goodwin, & Houser, 2000):

- One method is to reduce people's reliance on their memory. Recollection from memory regarding tasks that need to be performed and than manner in which they are performed is

flawed. Through the use of protocols and checklists, people are able to use aids when making decisions, thus reducing the potential for error

- A second strategy to reduce errors is to improve access to information. Healthcare professionals should have access to patient information, including medications and therapies, at the point of care. This can be achieved by having pharmacists available on nursing units as well as placing lab reports at the patient's bedside, among other approaches.
- A third strategy which can improve patient care is the use of error-proof processes
- Standardizing tasks is another method through which errors can be reduced. By implementing routine processes, people are able to familiarize themselves with the manner in which a task should be performed. The practice gained at performing tasks in a routine manner will help reduce opportunities for errors.
- A final strategy which can aid in error reduction is reducing the number of hand-offs that occur. By eliminating numerous transfers of material and information, the potential for error decreases

Leadership is an administrative aspect which is critical to error prevention (Leape & Berwick, 2000). Patient safety should be a central focus for corporate leaders. This includes evaluating the hospital design as well as incorporating safety goals among the corporate business plans (Kohn et al., 2000). Accidents often occur through a combination of human error and through faulty systems. By correcting system design failures, the institution is creating an environment in which patient safety is central (Kohn et al., 2000).

Tables 1-4 in Appendix A provide a summary of the key variables, issues and references related to error in acute care and general work settings. It includes empirical (evidence-based) and non-empirical (expert opinion and anecdotal information) articles for both environmental and non-environmental variables (in both healthcare and non-healthcare settings) and uses a 'star' system to denote the quality and quantity of articles/chapters in each area with higher number of stars indicating more articles and research has been conducted in a particular area. Additionally, Table 2 in Appendix B provides a summary of the various activities, errors and design aspects associated with the different spaces in a medical-surgical nursing unit.

Summary of Empirical Study

The empirical portion of the study was divided into three sections:

a) Survey with Nursing Staff

We conducted a cross-sectional survey with nursing staff members. The sampling frame for this study included nurses working in four hospitals in Pacific Northwest region of the United States: Providence Portland, Providence St. Vincent (Portland), Providence Newburg (Oregon), and Swedish Hospital (Seattle). The sample comprised of 84 nurses. Questionnaires administered to nursing staff focused on nursing unit design, the medication room, errors and adverse events, job performance and satisfaction, and demographic information. The questionnaire is included in Appendix F.

b) Focus Groups with Key Personnel Addressing Design and Error Issues

Focus groups interviews were conducted at three facilities: Swedish Hospital, Providence Portland, and Providence St. Vincent. Staff members from these hospitals, including nurse managers, pharmacists, administrative personnel and risk managers participated in these focus groups. Discussions centered on facility design, medication administration, and causes of errors. The results from the focus group sessions are included in the study narrative section. It follows the results from the survey. The focus group discussion guide is provided in Appendix G.

c) Site Visits to Acute Care Settings that have Incorporated Design Features to Enhance Patient Safety and Reduction of Errors

Three hospitals that have been noted in literature as implementing environmental changes to improve patient safety and reduce error were selected for the site visits. These hospitals are: Bronson Methodist Hospital, Barbara Ann Karmanos Cancer Center, and St. Joseph's Hospital. Interviews were conducted with key staff members of these hospitals. These interviews focused on facility design and its impact on patient safety and errors. Additionally, the environmental changes were photographically documented. Summary of the facility visit interviews is also included in the study narrative section. It follows the focus group findings.

Summary of Results from Survey with Nursing Staff in Selected Hospitals in Oregon and Washington

Nursing Units and Stations

Most nurses in this study worked in units with centralized nursing stations. Environmental characteristics that were noted as *helpful* in nursing units (in their facilities) included:

- Hand washing and disinfection locations and protocols¹
- Storage space for dirty supplies
- The location of the medication room
- Medication dispensation method (automated system)

Environmental factors noted as *neither helpful nor problematic* included furniture type and arrangement, lighting and location of storage rooms. Environmental factors identified as *problematic* (especially in their own hospitals) included:

- Space for clean supplies
- Availability of space in the charting area
- Patient surveillance opportunity
- Noise levels in patient care unit
- Privacy in the nursing stations
- Nursing station layout
- Walking distances to patient rooms
- The size of the medication room
- Heating and cooling systems
- Visibility to all areas of the nursing unit

Many of these issues (e.g., noise, layout, walking distance, patient surveillance opportunity, etc.) were identified as important environmental elements in literature (see literature review section).

Medication Room and Errors

The majority of participants preferred a central location of the medication room close to the nursing station and were happy with the location of medication room if it was centrally located in their particular nursing unit. Some problems identified for medication rooms were: inappropriate location as it was too far away from most functions in the unit, lack of space or very limited space.

All hospitals studied had automatic medication dispensation systems. The main benefits of an automated system were as follows: there is less chance of an error occurring, they are more efficient, tracking of medications and users, readily available meds, no narcotic counts, better organization, and it being safer for patients. Some drawbacks noted included waiting times (i.e., waiting in queue to get the medication), medications not being there when needed and a slow response time when ordering medication. Overall, most participants felt that the automated medication dispensation method has somewhat reduced medication errors in their hospitals.

The study participants stated that most types of medication errors rarely occurred in their units. Some of these (rarely occurring) errors include IV medication rates being too slow or too fast, the wrong concentration or dosage of medication delivered in the IV, the wrong route of administration, wrong medication administration, and wrong medication delivered due to the misidentification of a patient. The nurses noted some environmental factors that contribute to these errors (though they cautioned us that this was not a common phenomenon):

- The location of the med. room
- Inadequate size of the med. room
- Problematic organization of medical supplies
- High levels of noise
- Poor lighting in the med. room.

Some non-environmental factors noted include unreadable or missing medication labels, medication not being documented, lack of supplies and calculation errors.

Correlations for Medication Errors

Individual correlations were conducted between the frequency of medication errors and factors contributing to medication errors to determine if any significant relationships existed. One has to interpret these results keeping in mind that the sample size was very small (N=84) and the observations by the nursing staff were in context of their own work sites. Additionally, errors occurring due to environmental factors were rare.

- *For the error of missed doses of medication*, significant relationships were found with the following environmental factors: Problematic organization of medical supplies, high level of noise and poor lighting in the medication room.
- *Wrong time of medication administration* was associated with several environmental factors including location and inadequate size of medication room.
- *Medication errors of having the IV medication rate going too slow or too fast, having the wrong concentration of medication delivered in the IV, wrong route of medication administration, and wrong medication administration* were significantly associated with the following environmental

factors: location and inadequate size of medication room, poor lighting and high noise and problematic organization of medical supplies.

- *Similarly, having the wrong medication delivered due to misidentification of the patient was significantly associated with all but one of the above factor, which was the location of the medication room.*

Some additional correlations were run between physical environmental issues and errors:

- *Nursing unit design was significantly associated with the frequency of medication errors and factors contributing to medication errors.*
- *Staff and organizational issues leading to nursing errors were significantly associated with physical environmental issues leading to nursing errors. (see the narrative section of the survey more detailed information and tables on these correlations).*

Documentation Errors

The participants stated that documentation errors occurred rarely in their unit. Some infrequently occurring errors include documenting in the wrong patient chart and charting procedures or medications before they were completed. Though environmental factors did not commonly contribute to documentation error, on rare occasions some environmental factors that contribute to these errors include:

- Location of the charting space
- Small or inadequate size of the charting space
- Poor lighting
- High levels of noise
- *Correlations for documentation errors*

The points mentioned in medication error section about sample size and data holds true for the interpretation of these correlations too. Individual correlations were conducted to determine if an association existed between the frequency of documentation errors and environmental factors contributing to documentation errors. All documentation errors (mentioned above) were significantly associated with location of charting space, small or inadequate size of charting space, poor lighting and high level of noise

Nursing Errors

Various environmental factors are seen as very important causes leading to nursing errors. These include:

- Lack of privacy in the nurses' work area
- Inappropriate space layout in the nursing unit
- Insufficient space for documentation for charting
- Lack of space in the medication room
- High noise levels
- Faulty medication dispensation equipment
- Problematic location of the nursing station

Inappropriate location of the medication room was not seen as very important by some participants, but was seen as somewhat important by other participants. Inadequate lighting in the medication room also received mixed results. Inadequate lighting in the nursing station, faulty ventilation systems, non ergonomic furniture, and inadequate break room were not seen as problematic and the study participants did not think they contributed to nursing errors.

The study participants noted some non-environmental variables that lead to nursing errors and these included poor training of health professionals, overwork and stress of health professionals, high nurse to patient ratio, health professionals not working together as a team, poor handwriting by health professionals and lack of computerized medical records. One has to keep in mind that the hospital staff in focus group interviews noted that the non-environmental factors as more frequent causes of error than environmental factors, though they noted that environmental factors should not be overlooked.

Ranking of Environmental and Non-Environmental Solutions that Contributes to Reduction of Error

Ranking of Environmental Solutions (ranking of 1 to 5, with 1 being the best solution)

- Appropriate medication dispensation equipment (First)
- Sufficient space for documentation for charting (First)
- Reduced noise levels in the nursing unit (Second & Fifth)
- Appropriate location of the medication room (Second & Fifth)
- Adequate privacy in the work space (Second & Fifth)
- Appropriate lighting in the nursing station (Third)
- Adequate space in the medication room (Third)
- Appropriate location of nursing station (Fourth and Fifth)
- Ergonomic furniture, provision of break room for staff, adequate lighting in med. room, appropriate layout in nursing unit, appropriate HVAC system and floor (all ranked Fifth)

Ranking of Solutions to Staff and Organizational Issues

The *number one* solution was increasing the number of nurses per unit. Better training of health professionals was also among the top solutions as it was ranked *first* by 17 participants and ranked *second* by 18 participants. Reducing the number of work hours of nurses and using automated medication dispensation systems were both ranked *third* by a large number of participants. More use of computers instead of paper records for drug orders and medical tests was ranked both *third* and *fifth*. Also ranking *fifth* was more use of computerized medical records and requiring hospitals to develop systems to avoid medical errors.

Job Performance and Satisfaction

For the most part, participants stated that the physical working conditions help a great deal in affecting the manner in which they perform their job. In terms of job stress, most participants somewhat agreed when asked if they felt emotionally drained from work, felt used up at the end

of the workday and felt tired when getting up in the morning to face another day on the job. They disagreed with all the other stress and burnout options (see survey narrative section for all the options).

On a positive note, participants agreed when asked if they can effectively solve the problems that arise from work, if they effectively contribute to what the hospital does, and if they feel confident that they are effective at getting things done. Participants also agreed when asked about feeling good at their job, feeling exhilarated when accomplishing something at work and having accomplished many worthwhile things in their job.

Correlations Between Job Stress and Error

Correlations were run between job stress and variables pertaining to medication errors to determine if any significant relationships exist. The points mentioned in medication error section about sample size and data holds true for the interpretation of these correlations too. For each of the following variables, an overall average score was calculated and used. None of the correlations were significant. The variables used for correlations were as follows: the frequency of medication errors, the factors contributing to medication errors, staff and organizational issues causing medication errors, environmental issues causing medication errors, and nursing unit design.

Recommended Design Principles to Reduce Nursing and Medical Errors

Integrating the major issues identified in the literature and the key findings from the empirical study, we propose the following design principles:

Balance Between Patient Accessibility and Reduction of Disruptions

Decentralized nurses' station can provide greater visibility and accessibility to the patient rooms. However, the tradeoff is reduced communication/consultation between staff members. On the other hand, open-plan nurses' stations (especially centralized ones) are highly problematic for interruptions and disruptions from various sources. There is no easy answer to the issue of advantages and disadvantages of centralized vs. decentralized nurses' stations. In terms of layout of the main nurses' station, the key design aspect provide work spaces that allow flexibility in terms of visibility/accessibility to the patients and at the same time provide reduced interruptions from co-workers and noise disruptions. A combination of open-counter work spaces with adjacent small work rooms with doors is helpful in having the flexibility for staff to minimize interruptions as necessary by the tasks. Within the open-counter work area, certain portion could be enclosed to reduce disruptions from noise and reduce interruptions, but allowing visual connection with the hallways.

Accessibility of patient information at the bedside is helpful in reducing errors during order entry, data entry, etc. Among the different locations of computer-based charting, the computer-on-wheels in the patient room allows flexibility in terms of direct data access and entry at the bedside. However, this (or charting just outside the patient room) does not provide seating for staff (lack of seating during charting was pointed out as a contributing factor in staff fatigue in this study).

Therefore, a seated charting area within the patient room or next to the patient will be helpful in reducing fatigue/stress during accessibility of information in close proximity to the patient.

Standardization

Standardization of layouts/structure, equipments and procedures can potentially reduce nursing and medication errors, increase efficiency and avoid delays.

Patient room: identical bed orientation, location and design of sink, faucets, hand sanitizers, location and design of storage cabinet, windows (location, number and size), location of electrical and gas outlets, location of lights, type of lighting, bed controls, call lights, furniture, family sleeping arrangement.

Patient bathroom: arrangement, dimensions, non-slip protection areas, sinks, showers, toilets, emergency call lights.

Nurses' Station: Layout, arrangement of equipments, accessibility to patient rooms, and furniture.

Automation

Automation can substantially streamline the system of medication prescription, storage, dispensation, preparation and administration. There are several areas where automation could reduce errors. Areas where automation are recommended and worth considering: computerized physician order entry (CPOE) allowing access to evidence based practice at point of ordering, order verification, medication storage (Pyxis machine, refrigerator, other), dispensation, preparation, administration (bar coding), documentation of med effects, ordering of materials/supplies, movement of materials/supplies, etc.

Minimize Staff Fatigue

Noise Reduction

Noise reduction is a critical component in minimizing fatigue and stress among staff members. The specific design aspects in regard to noise reduction include: nursing unit layout (number of beds, centralized vs. decentralized nurses' station), type of flooring (carpeting, rubber or other flooring with appropriate sound absorption and maintenance parameters), single patient rooms, sound insulation in walls between patient rooms, high sound absorbent ceiling tiles, elimination of overhead paging system, reduced noise in telemetry alarm system and timing of shift change.

Decentralized Medication Rooms

Decentralized medication rooms or individual patient medication cabinets can reduce the length and amount of walking necessary for nurses. Walking to and from patient rooms and medication room/nurses' station is an important factor contributing to staff fatigue. Pods with 8-12 patient rooms having own medication room can reduce walking related fatigue as well as errors taking place in centralized medication room serving 30+ patients.

Medication rooms need ample work surface for medication preparation and other desk tasks by multiple staff members at the same time.

Positive Staff Break Room

Rejuvenating staff break room is an overlooked issue in nursing unit design. Staff break room's location needs be close to the nursing unit, yet provide a distinctly calming atmosphere. Access to nature, either through views, incorporation of landscaping or physical access to garden can be a powerful method in providing staff a rejuvenating break time that can help reduce the negative effects of fatigue and stress of the nursing unit.

Promote a Culture of Safety

In order to develop as self-sustaining mechanism that will monitor, report and act upon nursing and medication errors, it is critical that there is an organizational culture of safety in place. At this point, most of the facilities have voluntary reporting of errors. This process needs to be emphasized by creating an active agenda for non-punitive error reporting and identifying methods to prevent or minimize errors. Built-in mechanism to track errors, possible errors, stress and fatigue, and identification of possible environmental correlates will help maximize the benefits of positive environmental design features.

Interview with Principal Investigators

Click here to play a 4:43 minute audio interview with the principal investigators. If the link does not play automatically, you will need to open through a media player such as Windows Media Player, Quick Time, or RealPlayer.

¹ The percentage and frequency of participants for each category is provided in the report in the empirical study results. All tables and figures related to the data are also included in that document.

A Review and Analysis of the Literature

Overview

Nurses' work in the acute care environment is physically and psychologically intense with much scope for burnout, stress, and error. Crowded, acoustically ineffective, and poorly designed nursing stations and other healthcare staff work spaces within the hospital add to staff stress and may increase the risk of medical errors. Ulrich et al. (2004) have argued that reduction of staff stress [and error] by ergonomic interventions, as well as environmental considerations (such as air quality, acoustics, lighting, etc.) can have significant impact on staff health. It can also influence staff efficiency and contribute toward patient safety. It is claimed (e.g., Harrison, 2004; McCarthy, 2004; Reiling et al., 2003; Rollins, 2004; Scott, 2004) that specific environmental conditions such as type of lighting (artificial versus natural lighting), degree of lighting in nurses' workspace, and thermal condition in work area, affect performance (e.g., artificial lighting producing the effect of feeling drained and tired, inadequate lighting leading to medication error). Research has demonstrated that high noise levels in acute care environments are detrimental to work performance (e.g., Topf & Dillon, 1988). Design and functioning of hospitals have a major impact on recruitment and retention of nurses (e.g., Scott, 2004). Additionally, it has been noted that hospitals often lack functional staff break rooms that would allow nurses to rest and relax during break times. Though nursing staff spend a significant amount of time at their work settings working both day and night shifts, often they are not consulted in decisions regarding their work environments, and this can contribute to feelings of demoralization.

The turnover rate is high in nursing, and there is ample evidence (e.g., Lu et al., 2005) of nurses' dissatisfaction with their jobs. Nurses' job satisfaction is not only important in terms of their job efficiency and productivity, but also in terms of how it affects patient outcomes and satisfaction. Studies (e.g., Adamson, Kenny, & Wilson-Barnett, 1995; Aikin et al., 2001; Tovey & Adams, 1999) on job satisfaction and nursing turnover rate have mainly focused on workload, managerial support, and working climate. Less attention has been given to environmental and hospital-design factors affecting job satisfaction and performance.

Further, nursing errors and efficiency can be conceptualized at two levels, active failures and latent conditions (Reason, 2000). Active failures can be attributed to human cognition and limitations of memory and thought process. Latent conditions refer to failures resulting from decisions made by the management and architects. Examples include time pressure, stress, fatigue, and physical factors such as noise, lack of privacy, temperature, etc. These issues highlight that the design of nurses' work environments needs to be supportive of the nature of their work and responsive to their particular needs. However, a limited number of studies have examined the effects of environmental factors on nursing staff health, effectiveness, errors, and job satisfaction.

To gain an understanding on the type and quantity of literature on environmental factors related to nursing efficiency, error, and other outcomes, an extensive review of literature in the area of

healthcare design, error in the workplace, hospital management, staff efficiency, staff safety, staff burnout and other staff outcomes, infection control, and patient outcomes was conducted.

The research questions that guided this review were:

- 1) What are the effects of physical environmental variables on nursing errors, nurses' efficiency, and quality of patient care in medical/surgical nursing units?
- 2) What are the effects of physical environmental variables on nurses' job satisfaction, health, and safety in medical/surgical nursing units?

To address the research questions and facilitate the review and analysis process, the articles and chapters reviewed were divided into four categories:

- i) *Errors in the workplace (both healthcare and non-healthcare settings)* - Review of literature on error in healthcare setting and non-healthcare setting. Main focus of this review is environmental factors (e.g., acoustics, lighting, color, ergonomics/furniture, heating/ventilation/air conditioning, and layout and design) relationship to errors (mainly latent errors). However, literature related to some relevant non-environmental factors (e.g., fatigue, work hours, staffing level, stress, etc.) was also reviewed as these factors are often related to environmental conditions in acute care settings.
- ii) *Hospital design and environmental variables related to staff health and safety* – Review of literature on hospital design (e.g., nurses' station layouts, nurses' circulation paths) and environmental variables (e.g., air quality, noise, light, ventilation, etc.), and their effect on health and safety issues of healthcare professionals (especially nursing staff).
- iii) *Hospital design and environmental variables related to patient safety* – Review of literature on patient safety issues including medication errors, infection control (e.g., location and number of sinks and hand-cleaner dispensers in patient care areas) and falls prevention to identify linkages among hospital design, environmental features, and staff job performance as they relate to patient safety issues.
- iv) *Healthcare facility management, design, and environmental variables related to staff outcomes - job satisfaction and effectiveness of nursing professionals* – Literature on nursing professionals' job satisfaction, job-related stress, staff retention and turnover rates, nursing behavioral and organizational factors; human factors analysis related to nursing were reviewed to determine whether environmental factors play any role in nurses' job performance and satisfaction.

The articles in each category were subdivided into empirical and non-empirical articles. Articles that presented primary data and findings from a research project were grouped under the “empirical” subcategory. Articles and chapters that were either review of other studies, prescriptive in nature, or covered general descriptive information were grouped under the “non-empirical” subcategory.

Within the non-empirical section, the articles were further subdivided into expert opinion and anecdotal information. Articles that were written by experts in the field of healthcare design and workplace errors were grouped under the expert opinion section, and the remaining non-empirical articles were grouped under anecdotal information section.

Literature Review Method

Several strategies were used to identify potential studies/articles for the review. First, a keyword search of relevant databases was conducted. Table 1 provides a list of the databases searched and the keywords used during this search process.

Table 1: Databases and keywords used for identification of related literature.

Database	Keywords
EBSCO	Nursing error; nursing station layout, hospital design, acute care, job satisfaction & nursing, burnout & nurses, falls incidence
ABI/Inform	Nursing error; nursing station layout, hospital design, acute care, job satisfaction & nursing, burnout & nurses, falls incidence
PsycINFO	Nursing error; nursing station layout, hospital design, acute care, job satisfaction & nursing, burnout & nurses, falls incidence
Medline	Nursing efficiency & hospitals, nursing station layout, nursing roles, nursing unit design, job satisfaction & nursing, staff/patient safety in hospitals
Ageline	Nursing station layout, nursing unit design, falls incidence & prevention, job satisfaction & nursing, burnout & nursing
Web of Science	Nursing error; nursing efficiency, nursing station layout, nursing station design, nursing unit design, hospital management, job satisfaction & nursing, burnout & nursing, operating costs & hospitals
Social Science Citation Index	Nursing error; nursing efficiency, nursing station layout, nursing station design, nursing unit design, hospital management, job satisfaction & nursing, burnout & nursing, operating costs & hospitals
EMBASE	Nursing efficiency in hospitals, nursing roles, nursing station layout, nursing stations, nursing unit design, nursing & infection control, acute care design, acute care hospital design, acute care & nursing & safety, job satisfaction & nursing, falls incidence, operating costs and hospitals
Pubmed	Nursing efficiency in hospitals, nursing roles, nursing station layout, nursing stations, acute care design, acute care hospital design, acute care & nursing & safety, operating costs & hospitals
Worldcat	Nursing error; nursing station layout, acute care, nursing & job satisfaction, infection control & nursing, staff safety & hospitals, patient safety, healthcare design
JSTOR	Nursing error; nursing efficiency, healthcare facility design, nursing unit design, infection control & hospitals, job satisfaction & nursing, falls incidence, hospital management, nursing station layout

Second, potential studies were identified by a systematic review of issues of relevant journals/magazines in the area of healthcare design, management, nursing research, and infection control.

Following is a list of journals and magazines searched for relevant articles:

Nursing, Hospital, and Healthcare

Advances in Nursing Science, American Journal of Nursing, Applied Nursing Research, British Journal of Nursing, Critical Care Nursing Quarterly, International Journal of Nursing Studies, Journal of Advanced Nursing, Journal of Gerontological Nursing, Journal of Nursing Management, Journal of Professional Nursing, Medical-Surgical Nursing Journal, Nursing Inquiry, Nursing Research, Nursing Science Quarterly, Research in Nursing, Pediatric Nursing, American Journal of Infection Control, Journal of Hospital Infection, American Journal of Medical Quality, American Journal of Critical Care, Annals of Emergency Medicine, Critical Care Medicine, Health Affairs, Healthcare Forum Journal, Health Facilities Management, Health Services Management, Hospital and Healthcare Network, Hospital Topics, Hospital and Health Services Administration, Journal of the American Medical Association, Journal of Healthcare Management, Managed Healthcare Executive, Quality Management in Health Care.

Architecture and Design

Journal of Healthcare Design, Hospital Design, Journal of Healthcare Interior Design, Journal of Architectural and Planning Research

Social, Psychological and Behavioral Issues

Social Science and Medicine, Journal of Environmental Psychology, Environment and Behavior, Health and Place, Environmental Design Research Association's Conference Proceedings.

Others

The Gerontologist, Journal of Gerontology (Psychological and Social Sciences), Journal of Applied Behavioral Science, Journal of Social Behavior and Personality, Journal of Occupational Psychology, Journal of Social Psychology, Applied Ergonomics.

The literature search demonstrated that many articles on the relationship of design to healing and innovations in hospital design are dated 1980 and later, so this timeframe was chosen for the systematic journal searches. However, relevant articles dealing with nursing units/stations and nurses' work environment dating earlier than 1980 were also included in the review. Finally, reference lists were inspected for articles included in this review that dealt directly with nursing work environmental issues. In each case, articles and chapters that were potentially relevant were collected and assessed for appropriateness. The findings from the literature review are presented in an annotated bibliography format that provides a summary of key issues from each article or chapter (see Appendix A). The bibliography of all articles is presented in Appendix B, at the end of this report.

Annotations of the empirical articles included the following categories:

- Focus of the study
- Research design
- Sample information and site
- Findings
- Implications of findings as it relates to environmental issues

Annotations of the non-empirical articles included the following categories:

- Focus of the article/chapter
- Type of healthcare facility
- Recommendations for healthcare settings
- Implications of findings as it relates to environmental issues

Errors in the General Workplace

Pathophysiology of Errors

Error, failures, and catastrophes occur in different types of work settings including hospitals, nursing homes, nuclear power plants, chemical installations, ferries and other public transportation systems, as well as the air and spacecraft industry. In the IOM report *To Err Is Human*, error is defined as “the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim” (Kohn, Corrigan, & Donaldson, 2000c, p. 54). Error is also “the condition of being wrong in conduct or judgment” (Canadian Oxford Paperback Dictionary, 2000, p. 323). Errors occur due to gaps and mistakes in the information processing within the underlying mechanisms of the cognitive system of the human brain. Memory is stored in one’s schema. Actions that take place are specified by a large number of schemas that are organized in a hierarchical control structure (Norman, 1981). The order in which actions are triggered is central to how the intended action is performed. When information needed to perform an action is unavailable, a slip may occur. A slip also occurs if a schema is triggered at the wrong time (Norman, 1981). Slips result in an individual doing something or saying something that was unintended. Some of the factors associated with slips are fatigue, time pressures, and interruptions (Massachusetts Medical Society, 2003). When a person fails to retrieve information from memory, a lapse occurs. Mistakes occur when the intended actions do not achieve the desired outcomes (Reason, 1990).

Furthermore, errors occur when a situation is falsely classified. In other words, the person performs the correct action for a situation, but the situation is not correct (Norman, 1981). Two forms of errors have been identified by Reason (1990). The first is an *error of execution*. In this instance, an action does not proceed as it was intended. The second form is *error of planning*, where the action originally intended is not correct. These errors are often not the result of a single individual, but rather they result from problems within the system. Most work environments function as complex and integrated systems. When failures or faults occur in these complex systems, it is usually due to “the adverse conjunction of a large number of causal factors, each one

necessary but singly insufficient to achieve the catastrophic outcome (Reason, 1990, p. 475). There are two ways in which humans can contribute to the breakdown of complex systems (Kohn et al., 2000c; McClanahan, Goodwin, & Houser, 2000; Reason, 1990, Reason, 1997; Reason, 2004): a) active errors/failures and b) latent errors/failures (see Figure 1).

Active Errors/Failures

An *active error* is one that is caused by the person on the frontline (e.g., control room operator, train driver, pilots, air traffic controllers, etc.). The adverse effect of an *active error* is immediate. However, post-failure investigations demonstrate that frontline operators are “rarely the principal instigators of system breakdown. Their part is often to provide just those local triggering conditions necessary to manifest systemic weaknesses created by fallible decisions made earlier in the organizational and managerial spheres” (Reason, 1990, p. 475). Thus, the following type of error/failure is very important.

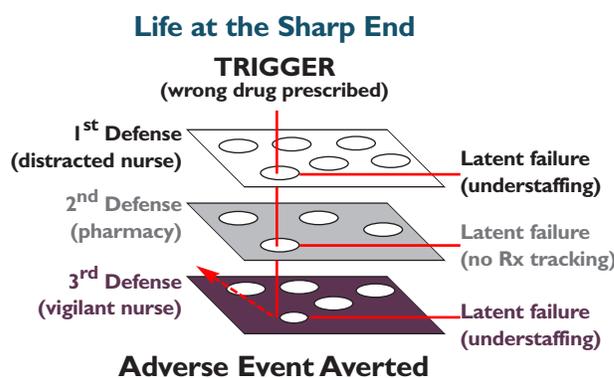


Figure 1: Human error triggers and management

Source: Reason, J. (2000). Human error: Models and management. *British Medical Journal*, 320, 768-770.

Latent Errors/Failures

A *latent error*, on the other hand, is not in the control of a frontline person. Instead, these errors result from factors such as poor design, bad management decision, poorly structured organizations, and faulty maintenance (Kohn et al., 2000c). Latent errors are the most dangerous because they can remain unrecognized for periods of time and can result in various active errors. Focusing on identifying and fixing latent errors within the system can improve

the functionality of the system and prevent future errors while also increasing safety.

There are two approaches that deal with the problem of human error. The first is a traditional person-centered approach that focuses on errors from the person on the frontline. It views the unsafe act as arising from uncharacteristic mental processes such as inattention, negligence, recklessness, and forgetfulness (Reason, 2000). A problem with this approach is that it focuses on the individual and isolates the individual from the system. By not focusing on the system, the same error may occur again with different individuals. Therefore, reporting measures are necessary to identify mishaps, near misses, and incidents to uncover error traps. The second approach is a systems approach, which suggests that, even in the best organizations, errors are likely to occur because humans are fallible (Reason, 2000). In other words, errors are a consequence of the system rather than the individual. Thus, when errors occur, it is important to understand what defenses failed in the system, rather than focus on the individual who made the error: “When a similar set of conditions repeatedly provokes the same kind of error in different people it is clear that we are dealing with an error prone situation rather than with error prone, careless, or incompetent individuals” (Reason, 1997, as cited in Reason, 2004, p. ii29). The center of the systems approach, then, is to understand the mechanisms in the system that led to error, thereby eliminating the

potential for the same error to occur in the future. High-reliability organizations using the systems approach anticipate the worst scenarios and are prepared to deal with adverse events, should they occur (Reason, 2000).

Workplace Errors

Both environmental and non-environmental variables may contribute to the occurrence of errors and adverse events in both healthcare and non-healthcare workplaces. The environmental variables are mostly latent factors. In the error-related section, we reviewed literature from both healthcare and non-healthcare work settings. There have been some significant studies on error in the non-healthcare workplaces, and these have implications for healthcare settings. Though our focus was on environmental factors, we also reviewed some pertinent literature on non-environmental factors, as environmental factors, in combination with organizational and other factors, lead to nursing, medication, and other types of error in acute care settings. To get a holistic picture of why errors (especially latent error/failure) occur, we have to have an understanding of all the factors involved in the process.

Environmental Variables (as identified in literature) That Contribute to Workplace Errors Are:

- Noise levels
- Lighting
- Color
- Ergonomics/furniture/equipment
- Heating, ventilation, and air conditioning
- Design/layout

Non-Environmental Variables (as identified in literature) Associated with Errors Include:

- Fatigue/long work hours
- Staffing levels
- Stress
- Faulty judgment
- Age of worker

In the following section, we discuss findings from studies in non-healthcare work environmental settings, highlighting some of the environmental and non-environmental factors associated with errors/mistakes and productivity to identify implications for healthcare settings. Studies related to errors and causes of error in medical/healthcare settings follow after this discussion.

Errors in Acute Care Environments

Environmental Variables

Noise/Acoustics

Occupational noise (unwanted sound) has been linked to a range of negative health effects beyond the obvious relationship with hearing loss (Kryter, 1994). In industrial settings, studies have demonstrated that noise exposure has been related to a different health-related indicators including self-reported fatigue (Leather et al, 2003). Noise is detrimental to performance and leads to worker errors and slips. McDonald and Ronayne (1989) demonstrated that blue-collar workers ($n = 901$) experience psychological distress through occupational noise exposure. In this study, adverse events were rarely reported when noise levels were below 70 dB, but became more frequent when noise levels exceeded 85 dB.

Banbury and Berry (1998) in a study of office workers ($n = 180$) found that office noise could disrupt performances on arithmetic and memory tasks. Specifically, participants performed significantly poorer in situations where office noise was present compared to situations where noise was not present. Hygge and Knez (2001) demonstrated in their research ($n = 128$) that an attention task was performed faster when noise was not present, but at a lower accuracy rate than when noise was present. Noise disturbances have also been found to impair concentration. In an office situation, telephones left ringing at vacant posts were associated with the greatest disruption to concentration (Banbury & Berry, 2005). Similarly, it was determined in another study that the most bothersome noises for office workers are ringing phones, people talking, and the hum of ventilation systems (Brill, Margulis, Konar, & BOSTI, 1984). Sundstrom et al. (1994) conducted a survey of office workers' ($n = 1,442$) satisfaction and discovered that job satisfaction declined in those workers who experienced increase in noise from telephones ringing and piped-in background music. These noise-related findings have implications for acute care settings. Bothersome noise in hospitals may affect the concentration of frontline staff and result in medication and other errors.

Additionally, research has also demonstrated that negative effect of noise in combination with other work characteristics (e.g., type of work, organizations factors, etc.) may exacerbate worker health condition and work performance (Leather et al, 2003). A study on pregnant workers demonstrated that pregnancy complications under noisy work conditions were increased with additional demand of shift work (Nurminen & Kurppa, 1989). This finding has implications for nursing and healthcare staff in acute care setting who do shift work and are exposed to occupational noise.

Leather et al. (2003) state that the effects of noise on health outcomes, as well as work performance, are contingent upon several factors including the nature of the noise and the type of work task involved. They documented two types of negative effect of noise on performance (based on their review of laboratory experiments): 1) effects of unpredictable noise are more severe on job performance than those of predictable noise and 2) any negative effect of noise increases with task complexity. "It is the interaction of unpredictable noise and high task complexity which has

been found to result in increased error in calculation, tracking and monitoring tasks, slower learning of new materials and poorer recall and memorization" (Sundstrom, 1986, as cited in Leather et al. 2003, p. 214). These findings have implications for nursing work (that includes tracking and monitoring patients, need for recall of information, and learning of new materials) in acute care settings. Nursing work is complex in nature, and acute care settings are often exposed to both predictable and unpredictable noise. There is the potential for nursing error due to exposure to noise (especially if it is unpredictable).

Based on his review of noises in the working environment, Sundstrom (1987) suggests that noises may affect performance for various reasons. Noise that is loud enough may initially create arousal in an individual, but the arousal only lasts until the person becomes adapted to it. Depending on the task, the brief sensation of arousal may be beneficial or detrimental. Loud, unexpected, and unfamiliar noises may create a distraction, which could disrupt performance for tasks requiring short-term retention of information. Similarly, motor tasks and tasks of vigilance have suffered with irregular noise. When individuals are repeatedly distracted, overload may occur, which results in ignoring low-priority inputs. Noises may also block sounds that provide useful feedback, such as alarms on machines. This is critical to nurses because, if background noise levels are excessively distracting or loud, nurses may not be able to hear the sounds of patient equipment, thereby impeding patient care. Additionally, based on their study, Kjellberg et al. (1996) argue that individual characteristics and other contextual issues in the work environment are important in determining subjective responses to noise.

These research findings on occupational noise highlight the notion that one has to take into account the full context of each work setting (e.g., the type of work, type of noise, duration of noise, duration of work task, workers' health status, etc.) to understand what type of effect noise may have on different groups of workers in that setting. Based on study findings, suggestions to improve the acoustics in a space include use of sound absorption materials like batts, acoustic panels, partitioning large spaces into smaller work spaces or partitioning off noisy areas, and creation of quiet areas with the work setting for specific tasks (Banbury & Berry, 2005).

Lighting

Lighting levels can often affect performance at work. Specifically, lighting affects visibility, which, in turn, affects how well a task is performed (Abdou, 1997). In particular, performance of tasks that involve visual discrimination of details declines when lighting levels are not bright enough (Sundstrom & Sundstrom, 1986). For difficult tasks, increased intensity of lighting for tasks involving visual discrimination improves performance (Sundstrom, 1987). As well, performance increases with added light for undemanding tasks, but "each increment in brightness of light brings less benefit, and the benefits are smallest for the least difficult tasks" (Sundstrom & Sundstrom, 1986, p. 93). Other research has shown that too much light in the workplace results in visual discomfort, while not enough light is related to longer task time and increased errors (Abdou, 1997). The most common negative effect of poorly designed lighting design on an individual's health is eyestrain. Optimal lighting levels depend on the task at hand, the individual, and the objects that need to be

seen. For an office environment, recommended levels of illumination range from 500 to 1000 lx and can be even higher if there are numerous dark surfaces (Kroemer & Kroemer, 2001). Overall illumination should be between 200 and 500 lx if light-emitting displays (such as cathode ray tubes (CRTs) on computers) are present (Kroemer & Kroemer, 2001). Age does impact lighting levels, as older adults require brighter lighting to accurately perform a task (Sundstrom, 1987).

Greater illumination increases the probability of seeing hazards and reducing accidents (Abdou, 1997). This has implications for nursing because if proper lighting is available for their tasks, the likelihood of errors, such as incorrect medication doses, is reduced. Illumination levels also impact performance. Hygge and Knez (2001), in an empirical study ($n = 128$), found that long-term recall was better in 1,500 rather than 300 lx (illumination levels).

Glare is often a source of discomfort. Glare occurs when the source of light is much brighter than the environment to which the eyes are adjusted (Kroemer & Kroemer, 2001). If the light source is wrongly directed, it causes a reduction in visibility from reflected glare (Ruck, 1989a). Furthermore, the closer the light source is to an individual's center of vision, the worse the glare (Abdou, 1997).

Control over the degree of lighting helps individuals perform tasks more effectively (Ebben, 2001). Greater control with lighting was associated with greater workplace satisfaction in an empirical study by Marans and Yan (1989). Furthermore, Veitch and Newsham (2000) found that office employees ($n = 120$) believed that control over their physical environment, including lighting, contributes to their well-being. In this study, however, performance scores did not differ amongst individuals given control over lighting and individuals who were not given control.

Inconsistent results have been obtained regarding the effect that lighting, in particular fluorescent lighting, has on an individual's mood and performance. In an empirical study with 96 participants, Knez (1995) found that luminance levels that accounted for a positive mood (cool-white fluorescent lamps and low illuminance (300 lx) or warm-white fluorescent lamps and high illuminance (1,500 lx)), were optimal for problem-solving and free-recall tasks. The opposite was true in conditions that induced a negative mood. This study suggests that mood valences and cognitive performances of individuals vary as a function of the individuals' reactions to the indoor lighting. Veitch (1997) on the other hand, found that providing subjects ($n = 208$) with information about lighting or the fluorescent lamp itself affected mood or performance.

Research and examples of workplaces where people are productive demonstrates that the incorporation of natural daylight helped increase worker performance. Daylight adds a sense of spaciousness to a room and is related to improved physical and mental well-being (Abdou, 1997). Having windows enables individuals to have a view of the outside, thereby providing a source of stimulation (Sundstrom, 1987). Working conditions also appear better when windows are provided (Brill, Margulis, Konar, & BOSTI, 1984). In windowless environments such as factories, employees have complained of headaches and general depression and are more prone to becoming ill. Additionally, absenteeism and vandalism have increased (Ruck, 1989b). Decreased productivity and efficiency are often a result of job dissatisfaction and depression, which are related to the presence

of windows in the office environment (Abdou, 1997). As noted by Abdou (1997), “light comfort functions both as a predictor of morale and worker performance and combines both the quality of artificial light and daylight in the workspace” (p. 131).

Associated with natural daylight is the view people have from their windows. Individuals with only a view of built components, such as buildings, were found to have higher levels of job stress than other individuals. In addition, people who had a view of nature, such as trees, had higher levels of job satisfaction than individuals with views of built components or no outdoor views at all (Kaplan, Talbot, & Kaplan, 1988, as cited in Bechtel & Churchman, 2002). Further discussion on this is in the following section on healthcare settings.

Color

Color impacts mood, satisfaction, motivation, and performance (Stone, 2003). In particular, warm colors, such as red, focus people outward and increase their awareness and alertness regarding their environment. Empirical studies have demonstrated that cool colors, such as blue and green, focus people inward enabling them to focus on mental and visual tasks (Wineman, 1979). Levy’s (1984) study illustrated that red is associated with anger, tension, and vigor, whereas blue has been associated with relaxation. Similarly, Mahnke’s (1996) review of the literature suggests that red is stimulating, yellow is tensing and raises motor activity, blue is calming and increases the ability to concentrate, and green balances heterogeneous tendencies. Preferred office colors tend to be blues and greens and lighter colors (Brill, Margulis, Konar, & BOSTI, 1984).

Color affects an employee’s accuracy. In a study ($n = 222$ university students) comparing red, white, and green office colors, more errors were made in the white office than in the other two colors, though participants did find the white color to be the least distracting. Working in the red office was associated with reduced confusion (Kwallek & Lewis, 1990). Thus, even though a preference was exhibited for a white office, this color was associated with the poorest performance. This study indicates that color preferences may not have a positive affect on worker productivity. Stone (2003) found that when participants (undergraduate students, $n = 128$) performed a low-demand task in a blue environment, error rates were higher over time than in a red environment. This may have occurred because of the calming nature of the color blue and the boredom levels associated with the task. Individuals may have performed better in the red environment because the stimulation of the color may have offset the boredom levels (Stone, 2003). Opposing results were found by Stone and English (1998), who measured mood levels in addition to environment color and task performance. Undergraduate students ($n = 112$) in this study performing both an actual and perceived low-demand task, which created the greatest levels of hostility, in a blue environment had lower errors than individuals in a red environment. The calming nature of the blue environment may have countered the high level of hostility produced by the task, leading to fewer errors than the red environment.

On the other hand, when a high-demand task, which created the lowest levels of hostility, was performed in the red environment, it was perceived as a moderate level task and fewer errors occurred than in the blue environment. The stimulation of the red environment appeared to have

benefited the participants for the high-demand task (Stone & English, 1998). In addition, the blue environment appeared to allow individuals to focus more on the task at hand, which led to more extreme ratings of the task demand. The red environment, on the other hand, drew an individual's attention away from the task, thereby moderating the ratings of task demand (Stone & English, 1998).

The color of the environment may affect the perceptions of other environmental factors. Mahnke (1996) noted, "stimulation of the senses, brightness, and loudness are associated with the most active effect of warm colors, and the reverse for cool colors" (as cited in Tofle, Schwarz, & Max-Royale, 2004, p. 13). A noisy environment, therefore, may be perceived as less noisy in cooler colors such as blue or green, whereas noise levels may be exaggerated in a red or yellow environment (Tofle et al., 2004). Similar effects have been noted with regard to the temperature of the environment. When the wall colors were light-blue, individuals were cold when the temperature was 75 degrees F, whereas when the walls were painted orange, individuals were too hot at 75 degrees F (Clark, 1975). The correct choice of color, therefore, can aid in reducing the negative perceptions of environmental stimuli.

Ergonomics, Furniture and Equipment

Workstation design influences physical well-being as well as performance. Individuals can work effectively and comfortably if their workstations provide convenient and accessible places for equipment, supplies, and materials (Sundstrom, 1987). Common ailments, such as sciatica, hernia, arthritis, muscular tension, and fatigue, may originate following irregular motions and maintaining a certain posture for prolonged periods of time (Franco & Fusetti, 2004). For workers who stand for long periods of time, such as nurses, a prolonged stationary posture may be responsible for their physical conditions (Franco & Fusetti, 2004). Individuals who work for long periods of time on computers are also likely to experience physical problems. The design of the workplace, working postures, and prolonged use of the computer mouse are some factors related to an increased risk of developing upper-extremity musculoskeletal disorders (Faucett & Rempel, 1996; Fogleman & Brogmus, 1995).

In addition, the more time spent on a computer task, the more likely individuals are to experience postural discomfort. In particular, Liao and Drury (2000) noted in their study of 6 college students, that as discomfort and fatigue increased, so too did postural shifts. Interestingly, in one study of 70 office workers, workstation adjustments resulted in improvements in the physical health of individuals, but additional stress management training did not result in increased improvements (Feuerstein, Nicolas, Huang, Dimberg, Ali, & Rogers, 2004).

Arm work has been associated with breathing patterns. Specifically, in Cerny and Ucer's (2004) empirical study of 6 individuals performing exercise tasks with their arms and legs, arm work was found to alter the ventilatory response to work. In other words, sensations of breathlessness were generally greater for arm, as opposed to leg, work. Increased breathing frequency, concomitant with a decrease in end-expiration lung volume suggests that arm work restricts movement of the chest wall and increases expiratory muscle recruitment. These same muscles are used to support

the body during upright work tasks, such as those that a nurse performs. Thus, the increased muscle recruitment interferes, at a certain level, with the ability to perform work tasks involving the upper body.

The relationship between an individual and workstation depends on many factors: the components of the workstation such as the chair and desk, the details of each component such as the height of the chair and desk, the difference in importance of the components based on the job requirements, the manner in which the individual utilizes the workstation, the fit between the workstation and the individual's body, and the worker's training and ability (Sundstrom & Sundstrom, 1986).

In most workplaces, including health environments, computers are common work equipments.

The display screens of computers may also affect worker performance. In a study of 10 participants for whom visual display unit work is an important part of their daily work, when CRT computer displays were compared to liquid crystal displays (LCD), the LCD technology was related to increased accuracy (Menozzi, Napflin, & Kreuger, 1999). The LCD technology, therefore, may be superior and result in less visual strain in the workplace.

Suggested improvements to the workstation include using chair adjustments, having an adjustable workstation if more than one individual will be using it, and having a workstation that is deep enough to place a keyboard directly in front of the computer monitor (Schulze, 2000).

The furniture should also be designed in a manner that enables free-flowing motion. People should be able to move freely among comfortable poses (Kroemer & Kroemer, 2001). Furthermore, individuals should keep their wrists straight and should not cross their legs while typing. Glare, dust, and room temperature should also be controlled (Schulze, 2000).

Training with regard to ergonomics is beneficial to employees as well. Huang, Robertson, & Chang (2004) demonstrated that, after receiving training, office employees ($n = 89$) were able to transfer their knowledge to their workplace. They rearranged their workspaces to support the demands of their jobs. In addition, satisfaction regarding the design of their workplace increased their ability to use the available space effectively and organize their material efficiently. By changing the design of their workstations, individuals perceived they had control over their environment. Control has been associated with improved physical health and performance (Karasek & Theorell, 1990).

Heating, Ventilation and Air Conditioning Systems

Air quality is associated with performance and physical well-being. In one study, individuals ($n = 227$) who found their thermal environment unacceptable with regard to the temperature they were experiencing, were more likely than individuals who found their thermal environments acceptable to experience headaches, dry eyes, nose irritation, an irritated throat, and a sense of tiredness (Melikov, Pitchurov, Naydenov, & Langkilde, 2005). Furthermore, individuals who were bothered by the uncomfortable room temperatures were more willing to accept excessive

warmth than excessive coldness. Finally, almost half of the participants were dissatisfied with the air quality in their environment and consistently requested increased air movement.

Air quality is affected by the mechanisms that provide air circulation. Improperly stalled mechanical equipment can lead to the growth and distribution of bacteria and fungi in the air (Bechtel & Churchman, 2002). Air quality, in particular, air pollution, can create annoyance and dissatisfaction with the environment. Brill, Margulis, Konar, & BOSTI (1984) noted that air quality, measured as being either too smoky or smelly, is a problem for 10% of workers. Stress may also result if the air pollutant is seen as a hazard (Sundstrom & Sundstrom, 1986). Poor air quality may also lead to sick building syndrome symptoms, which include headaches, tiredness, sore throat, irritability, skin rashes, and dry eyes, among other symptoms (Bechtel & Churchman, 2002).

Thermal comfort in an environment varies as a function of the level of physical activity performed as well as the amount of clothing a person wears. Higher levels of physical activity and greater amounts of clothing are associated with a lowered temperature at which individuals are comfortable (Kroemer & Kroemer, 2001; Fanger, 1972, as cited in Sundstrom & Sundstrom, 1986). In addition, individuals vary at the temperature level with which they feel comfortable. The core temperature of the body is 37 degrees C. If the core temperature changes by approximately 2 degrees C, the functions of the body and its ability to perform tasks are negatively affected (Kroemer & Kroemer, 2001). A healthy body will “naturally respond to a cold environment by making its skin surface colder, and to a hot environment by making the skin warmer” (Kroemer & Kroemer, 2001, p. 238).

Mental performance is associated with the temperature of the office. For an individual who is not acclimatized to the environment, mental performance deteriorates with higher room temperatures starting at about 25 degrees C. For an individual who is acclimatized, the threshold increases to 30 or 35 degrees C (Kroemer & Kroemer, 2001). Prolonged exposure to heat will result in reduced performance of tasks since arousal levels will fall to below normal levels, distraction levels increase, and muscular activity becomes impaired (Sundstrom, 1987; Sundstrom & Sundstrom, 1986). Sundstrom (1987) does note that, in laboratory research, mental tasks have generally been unaffected by heat, but performance on motor tasks, vigilance, and dual tasks has suffered. The effect of cold air has not been addressed as extensively, but it has been noted that, if offices are too cold and the body core temperature drops below 35 degrees C, mental performance is reduced and nervous coordination is affected (Kroemer & Kroemer, 2001).

Associated with the thermal environment is the amount of humidity in the air. In a German office, humidity exceeding the 90th percentile had a significant protective effect on low skin hydration (Brasche, Bullinger, Schwab, Gebhart, Herzog, & Bischof, 2004). Poor skin symptoms in this study were associated with the need to work with poor software longer than four hours per day as well as unfavourable job characteristics.

Design and Layout

Building and office design impacts performance and satisfaction. Marans & Spreckelmeyer (1982a), in an empirical study of employees at the federal office building in Ann Arbor, Michigan, determined that people with greater control over their environment were more satisfied than individuals with less control. As well, individuals in private office spaces were more satisfied than individuals in open or pool arrangements. It was noted that important predictors of satisfaction with the office environment are the amount of workspace an individual has, the type of workstation, and the department in which the station is located. Noise levels, movement from individuals and equipment, and air quality were factors associated with evaluations of overall ambience in an office building (Marans & Spreckelmeyer, 1982b). Poor conversational and visual privacy also contributed to poor office evaluations (Spreckelmeyer, 1987).

Buildings that have a high functional capacity are able to meet the needs of the users. As building size increases, operational complexity increases, creating a likelihood of failure (Leaman & Bordass, 2000). Productivity increases when workgroups are kept small and well-integrated, sources of distraction are kept to a minimum, and the design of the work setting is comfortable, safe, and healthy (Leaman & Bordass, 2000). Personal control over environmental variables also aids in improving an individual's performance and job satisfaction (Leaman & Bordass, 2000; Lee & Brand, 2005).

Non-Environmental Variables

Fatigue/Long Work Hours

Fatigue is a result of inadequate rest, sleep loss, continuous physical or mental activity, or non-standard work schedules (Page, 2004). Fatigue results in a feeling of tiredness and a diminished capacity to work (Page, 2004). Shift work affects an individual's ability to sleep. In the aviation industry, crewmembers ($n = 74$) working three to four days on short-haul flights were found to sleep less and have greater difficulty falling asleep while on trips (Gander, Gregory, Graeber, Connell, Miller, & Rosekind, 1998a). Crewmembers did not regain sleep lost during their trips after two days of having returned. Crewmembers ($n = 32$) working long-haul flights had shorter sleep episodes during layovers and greater sleep loss was associated with night flights (Gander, Gregory, Graeber, Connell, Miller, & Rosekind, 1998b). Both crewmembers working on short-haul and long-haul flights reported experiencing physical symptoms such as headaches, congested nose, and back pain. Air traffic controllers ($n = 13$) were found to sleep more, feel greater confusion, fatigue, and decreased vigor when working night shifts (Luna, French, & Mitcha, 1997).

Stress

Performance and productivity are associated with health, well-being, and quality of work life. A review of the literature demonstrated that potential stressors to the work environment include time pressures, deadline pressures, an uneven distribution of resources, and a heavy work volume (Sutherland & Cooper, 2000). Additional sources of stress include threats to an individual's freedom, autonomy, and decision making (Sutherland & Cooper, 2000).

To reduce stressors in the workplace, both the organization and the individual should be involved. Job rotation and job sharing can help reduce one's exposure to a high stress job for long periods of time. Preventative stress management strategies consist of leadership skills training, time management, and assertiveness training (Sutherland & Cooper, 2000).

Age of Worker

Age is associated with reactions to errors. Older workers were found to have a more emotional reaction to their errors in computer-based work and were less likely to correct their errors without support (Birdi & Zapf, 1997). Older workers were also less likely to ask supervisors or colleagues for assistance (Birdi & Zapf, 1997).

The previous section outlined the impact of both environmental and non-environmental variables on errors in the general workplace. Noise, lighting, color, heat, air quality, design, fatigue, stress, and age were found to have impacts on performance and satisfaction.

In the following section, the focus of the discussion turns to the variables that affect error and error reduction in the healthcare environment.

Error in Healthcare Settings

Medical errors may result in a patient experiencing an adverse event. According to the IOM report *To Err is Human*, adverse events occur when a patient suffers an injury that is not due to the patient's condition, but rather from a medical intervention (Kohn et al., 2000a). In the Harvard Medical Practice study, the estimated incidence of adverse events was 3.7%, and most resulted in minor impairment (Brennan, Leape, Laird, Hebert, Localio, Lawthers, et al., 1991). Adverse events due to negligence occurred in 1% of cases, and negligence was higher among those over the age of 64 (Brennan et al., 1991). Of the adverse events that occurred, drug complications were the most common (Leape, Brennan, Laird, Lawthers, Localio, Barnes, et al., 1991).

Patients may also die from experiencing an adverse event. Based on studies that have been conducted in both Colorado and Utah, it has been estimated that approximately 44,000 Americans die in hospitals each year as a result of preventable medical errors (Kohn, Corrigan, Donaldson, 2000b). The estimated national costs of adverse events in the United States is \$37.6 billion, while the national costs of preventable adverse events has been estimated to be \$17 billion (Kohn et al., 2000a).

Adverse drug events have been studied extensively. According to records kept by PHICO during the late 1990s, one-fourth of claims filed involved allergic or adverse reactions to medication (Benjamin & Pendrak, 2003). Medication errors typically involve missed doses, dose errors, route errors, and duplicate errors (Bates, Boyle, Vander Vliet, Schneider, & Leape, 1995a; Davydov, Caliendo, Mehl, & Smith, 2004; Leape, Bates, Cullen, Cooper, Demenaco, Gallivan, et al., 1995). Antibiotics and analgesics are most commonly involved in drug errors, and common reactions to adverse drug events include nausea, dizziness, fever, renal failure, confusion, and arrhythmia (Bates et al., 1995a; Bates, Leape, Cullen, Laird, Petersen, Small, et al., 1995b; Classen, Pestonik, Evans, Lloyd,

& Burke, 1997). Errors often occurred in physician ordering and nursing administration. In Australia, it has been noted that the most common medication errors are prescription/medication ordering errors, dispensing errors, errors in administration, and errors in the medication record (Hodgkinson, Koch, & Nay, 2006). Contributing factors to adverse drug events include a lack of knowledge regarding the drug along with a lack of patient information (Leape et al., 1995). Dispensing errors are associated with a high prescription volume, being overworked, fatigue, interruptions, and drugs that look alike or sound alike (Hodgkinson et al., 2006). On an intensive care unit, adverse events were associated with a lack of standardization of protocols for preparation and administration, inappropriate use of medical devices, incomplete, illegible, or verbal prescriptions, and not having a pharmacist present (Tissot, Cornette, Demoly, Jacquet, Barale, & Capellier, 1999). The incidence of adverse events was found to be the highest in medical intensive care units followed by surgical intensive care units and medical and surgical general care units (Bates et al., 1995b). Adverse drug events need to be documented and evaluated, as documentation can provide information regarding the events that result in patient discomfort. Accurate documentation facilitates knowledge of the drug and whether the risks of prescribing the drug outweigh the benefits (Nebeker, Barach, & Samore, 2004).

The remainder of this section will discuss in greater depth the causes of error as well as solutions that have been identified that aid in the reduction of error in the medical environment. As noted by Ulrich, Quan, Zimring, & Joseph (2004), the literature examining the effects of environmental variables is limited and, thus, the review is restricted.

Environmental Variables

Noise

Ulrich et al. (2004) conducted an extensive review of literature on healthcare settings and physical environments. Their team identified more than 130 references that discussed noise in hospital settings. A majority of these dealt with the effect of noise on patients. Some of the studies, however, offer insight on the impact noise has on the nursing efficiency. According to the World Health Organization guidelines, acceptable levels for continuous background noise in patient rooms are 35 dB. Night-time peak noise levels should not exceed 40 dB (Berglund, Lindvall, & Schwela, 1999). Noise levels, however, increasingly exceed these recommended levels. Blomkvist et al. (2005), for instance, report that noise produced by medical equipment as well as staff reach 70 dB to 75 dB levels when measured at the patient's head. Similarly, equipment such as X-ray machines produced noise levels exceeding 90 dB. Hodge and Thompson (1990) noted that peak sound levels recorded during surgery could interfere with the concentration of staff members as well as prevent reliable communication among staff members.

Noise is problematic in a healthcare setting partially because there are a variety of sources of noise, many of which are loud (Ulrich, Lawson, & Martinez, 2003, as cited in Ulrich et al., 2004). Sources of noise include telephones, staff voices, trolleys, and paging systems, among others. Another reason for high noise levels is that environmental surfaces reflect rather than absorb noise (Ulrich et al., 2004). Nurses ($n = 100$) reported that sounds produced by telephones, the

beeping of monitors, and alarms in equipment were annoying (Topf & Dillon, 1988). In addition, a higher degree of noise-induced stress was associated with higher levels of burnout (Topf & Dillon, 1988).

Room occupancy affects noise levels. Noise levels are lower in private rather than multi-occupancy rooms (Ulrich et al., 2004). Hilton (1985) conducted an empirical study ($n = 25$) comparing three hospitals of various sizes. Noise levels were found to be quieter in smaller hospitals compared to a larger hospital. Patients were relatively satisfied with noise levels, except for those who were in the recovery room of a large hospital. Single-occupancy rooms were also found to have lower noise levels than multiple-occupancy rooms. Similarly, Press Ganey (2003) (as cited in Ulrich et al., 2004), which obtained data from 2,122,439 patients, noted that patients in private rooms were more satisfied with the noise levels in the room than patients in double-occupancy rooms.

Patients are highly sensitive to hospital sounds due to the pain suffered, the nature of their illness, or their lack of control over the sounds (Hosking & Haggard, 1999; Shumaker & Reizemstein, 1982). Excess noise can elevate a patient's blood pressure and heart rate and can result in sleep loss (Cys, 1999; Topf, 1985; Blomkvist et al., 2005). Similarly, excess noise can increase the amount of stress experienced by patients (Ulrich, 2003). Infants exposed to high levels of background noise may suffer from an interference with the development of frequency discrimination as well as sound pattern recognition (Graven, 1997). In an empirical study involving 150 male surgery patients, Topf (1985) discovered that objective noise, greater noise-induced stress, and greater sensitivity of the person to noise were positively related to greater exercised control over noise. Greater control over noise was exercised by patients who had a greater sensitivity to the noise regardless of the level of objective noise. In other words, sensitivity to noise is a large predictor of the use of coping strategies over hospital noise.

Sound-attenuating surfaces can help reduce the amount of noise produced. Sound-absorbing ceiling tiles, single-bed rather than multi-bed rooms, and the reduction of noise sources may help in noise reduction (Neumann & Ruga, 1995; Ulrich et al., 2004). Blomkvist et al. (2005) found that, when sound-absorbing ceiling tiles replaced sound-absorbing tiles, patients slept better, reported lower levels of stress, and felt nurses provided better care. Similarly, carpeted hallways can keep noise to a minimum and having music available for patients can help reduce stress (Lowers, 1999; Neumann & Ruga, 1995; Weber, 1995). For instance, with the introduction of a sound environment with specially designed music, staff members experienced reduced sound level in the ward as well as a less stressful environment (Thorgaard, Ertmann, Hansen, et al., 2005). As well, the majority of patients were satisfied with the music environment and experienced greater relaxation.

Though most of the data reported on noise is based on the experience of patients, one may infer that staff members react similarly to noise levels. Excessive noise levels may result in physical ailments, such as increased stress, among nurses, which could, in turn, affect their performance and errors. Within a noisy environment, people become less interpersonally engaged, cognition is impeded, and people tend to seek simple solutions to complex tasks (Grumet, 1993). Similarly, as noted earlier, excessive noise levels in the operating room were found to impair concentration and

communication among staff members (Hodge & Thompson, 1990). This may be true on the general ward as well, which can impair the care given to patients and result in the occurrence of errors.

Lighting

Lighting levels can affect staff effectiveness in performing critical tasks. Buchanan et al. (1991) evaluated the impact of three different illumination levels on the dispensing errors of pharmacists. In general, errors were reduced when lighting levels were high. Medication levels at 450 lx were 3.8%, whereas they decreased to 2.6 % when illumination levels increased to 1,500 lx.

Lighting levels are also associated with depression. Bright lights have been found to improve health outcomes including depression, sleep, agitation, and length of stay in patients suffering from dementia and seasonal affective disorders (Ulrich et al., 2004). For instance, in a study of 174 psychiatric inpatients hospitalized for depression, the average length of stay was shorter in patients staying in brighter rooms than those staying in darker rooms (16.9 days versus 19.5 days) (Beauchem & Hays, 1996).

The amount of sunlight in a patient's room affects a patient's psychosocial health, quantity of analgesic medication used, and the cost of pain medication (Walch et al., 2005). Specifically, patients undergoing elective surgery who were exposed to an increased intensity of sunlight experienced less perceived stress, less pain, and took less medication per hour and reduced medication costs than patients recovering in the dim side of the ward.

Associated with sunlight is a patient's view. Ulrich (1984) studied 46 patients who had undergone a cholecystectomy. Patients either had a view of trees or a view of a brown brick wall. Patients with a view of trees had a shorter length of stay in the hospital and took a smaller amount of analgesics between their second and fifth days of treatment. Those with a view of trees also received more positive comments from the nurses. Similarly, bipolar patients assigned to brighter eastern-facing rooms had a shorter hospital stay than patients in west-facing rooms (Benedetti et al., 2001).

Among staff ($n = 730$) in a redesigned hospital with greater lighting, the majority felt that the increase in natural light had a positive impact on their work life (Mroczek, Mikitarian, Vietra, & Rotarius, 2005). Even though windows produced glare, most employees still preferred to be located near a window. The inclusion of windows aid in buffering the effects of job stress and contribute to job satisfaction.

To improve lighting, surfaces that reduce glare should be used, and patients should be exposed to natural daylight (Shumaker & Reizemstein, 1982; Weber, 1995). Indirect lighting diffuses light and assists in creating a natural effect (Lowers, 1999). Adequate lighting is necessary for a nurse to perform tasks required for patient care. In addition, being as the average age of nurses is increasing, bright work surface illumination levels (1,500-2,000 lx) may be necessary to reduce errors in dispensation and to aid in paper-based tasks (Ulrich & Barach, 2006).

Color

Relatively little information exists regarding the impact of color on staff performance. In a long-term care setting, changes were made to the color of doors and walls in the patient room and hallways. Based on the changes made, the undesired behavior of patients, with the exception of patients wandering into the bedrooms of others, decreased. Patients also stayed longer in activity areas. Staff and family members felt that the environment was less institutional and more cheerful than before. Cueing out, or minimizing attention by eliminating color cues, appeared to effectively reduce undesired behavior among elderly patients (Hightower, Thomas, Stone, Brinkley, & Brown, 1995). Similar results were obtained by Cooper, Mohide, and Gilbert (1990) (as cited in Tofle et al., 2004). They found that cueing out is effective in reducing undesired behaviors, but they did note that, for the elderly, color coding did not help them function. Instead, combining color coding with sensory cues might be more effective.

People respond to different colors in different ways. Specifically, "different colors arouse different feelings and emotions and activate the organism to a different degree" (Gerard, 1958, as cited in Tofle et al., 2004, p. 17). In addition, the whole organism, including muscle, autonomic, and brain function, responds to color. Finally, the response to color is related to the physical and psychological characteristics of the individual, and it goes beyond individual differences (i.e., people from the same culture may have similar responses).

Tofle et al. (2004) conducted an extensive review of the literature pertaining to healthcare settings. Color is central in the interior design of a facility. Specifically, color "has the power to enhance or devastate architectural volumes, emphasize objects in space and create tensions or calmness in interior space" (Tofle et al., 2004, p. 32). They note, however, that "the literature of studies of color use in healthcare environments is fragmented and inconclusive" (Tofle et al., 2004, p. 36). Based on their review, however, some general patterns and recommendations can be derived. For instance, they note that white and green colors are generally associated with a healthcare environment. Though facilities use the color white to promote cleanliness, it has become associated with a sterile, or unfriendly, institutional setting. Green is often used in a healthcare environment because it reduces glare under light and has a neutralizing effect, but the color green has been noted to appear institutional.

Tofle et al. (2004) found some general agreements regarding guidelines for color in healthcare environments. They note that the effect of color in a healthcare environment can either be positive or negative. In addition, high contrast colors help to clarify and define forms, edge changes, volumes, and planes. Monotony, or too much of one color, may be harmful. Since the after image of red is blue-green, a blue-green color should be used in surgical rooms. In addition, color distortion may occur with the elderly, and, thus, they may require greater illumination (4 to 5 ? times more) to distinguish a figure from the background. Finally, color impacts room size in that cool colors recede and warm colors advance room size.

Other guidelines have been suggested with regard to color in healthcare facilities. Mahnke (1996), for instance, suggests that a facility should have a dignified and respectful appearance as well as be

attractive, and color specifications should play a psychological and aesthetic role. Designers should eliminate the institutional look of psychiatric hospitals and should use color to incorporate a homelike atmosphere (Mahnke, 1996). Warm colors stimulate the senses, while the reverse occurs with cool colors. Therefore, stimulating colors should be used in the recreation areas and lounges. In addition, cool colors should be used to promote relaxation in quiet or secluded rooms.

For sub-acute care and rehabilitation, Leibrock (2000) suggests that intense colors should be used for accents and contrast to improve visual organization. In addition, bright yellow colors should be avoided as they may become annoying. Furthermore a monochromatic color scheme may be perceived as institutional and can contribute to sensory deprivation. To create a relaxing environment, cool tones should be used.

Malkin (1982, 1992) suggests that red and yellow colors should be used in a setting where creativity and socialization are desired. Green and blue colors should be used in areas that require concentration and visual acuity. Cool colors are also appropriate in environments with agitated, anxious, and hypertensive individuals. Cool colors also promote less distraction and more opportunity to concentrate on difficult tasks, and may, thus, be beneficial to nurses. As Tofle et al. (2004) note, contradictions exist with the use of the color white. White has been demonstrated to create a feeling of luminosity and clarity as well as enhance the ability to focus. White colors, however, have also been associated with a monotonous environment, which cause sensory deprivation. White walls also cause glare, which can impede performance.

These guidelines regarding color scheme suggest that, if the incorrect color is chosen, behavior may be negatively affected. Thus, nurses may be more prone to errors in environments in which the color is ill-suited.

Ergonomics, Furniture and Equipment

Ergonomics is important to create the optimal working conditions for workers to perform their tasks efficiently and safely (Carayon, Alavardo, & Hundt, 2003). According to Kroemer & Kroemer (2001), who review ergonomic elements of design, designing a new workspace or revising an existing workspace involves examining what nurses need regarding space, identifying specifications and the range of possible options by a design team, evaluating possible solutions, and implementing the design. Relationships between the components incorporated in the design are critical to efficiency. Nurses may be interested in communication links such as those that are auditory, visual, or tactile. Control links, which may include access and use of a bedside computer, are also important. Finally, movement links, such as having the ability to survey a patient or the ability to control an apparatus by foot movements, might be critical in certain areas (Carayon et al., 2003). Being as nurses spend a great deal of time standing, their workstation should be designed to meet this requirement. For instance, sufficient space is needed for the nurses' feet to enable movement close to the counter (Kroemer & Kroemer, 2001).

Carayon et al. (2003) offer various recommendations to improve ergonomic design in healthcare facilities. To minimize perception time, both visual and tactile discrimination should be maximized

through the use of the appropriate size, color, and texture of materials. To minimize decision time, for instance, patient headboards could have blood pressure cuffs and suction cups on both sides of the bed and different alarm sounds could be associated with different medical devices. To optimize the nurses' opportunity for movement, the equipment should be located in an area that enables easy access. Finally, to minimize the need for human strength, the use of mechanical devices should be used, such as beds that move from side to side or gurneys that enable a patient to have an X-ray without being transferred to an X-ray table.

Hospital employees have many tasks that are physically demanding, and, thus, they are prone to work-related musculoskeletal disorders (Janowitz, Gillen, Ryan et al., in press). It has been reported that 92% of nurses working in geriatric settings have experienced an injury (Collins & Owen, 1996). Nurses ($n = 21$) in an empirical study by Hui et al. (2001) reported that turning, showering, and transferring patients were the most physically demanding tasks performed. Tasks with poor ergonomics are associated with higher absenteeism levels and may be related to lower levels of patient care (Janowitz et al., in press). Poor ergonomics, then, may also result in increased errors amongst nurses.

To improve the way nurses handle patients, proper furniture and equipment are necessary. Beds, tables, trolleys, and wheelchairs, for instance, should be suitable, available, and maintained. As well, nurses should be properly trained with regard to equipment usage, and storage should also be available and accessible. Furthermore, hoists and lifting aids were recommended amongst nurses (Hignett & Richardson, 1995).

Facilities have been successful at implementing ergonomic changes. For instance, at Summit Medical Center in Hermitage, Tennessee, the order-entry facility was isolated from other functions in the inpatient pharmacy to improve the manner in which processing occurred. Ergonomic changes included eliminating crowding, cramping, poor lighting, and disorganization. Larger monitors were purchased and placed lower so the eyes would be directed downward. In addition, ergonomic chairs with multiple adjustments and lumbar support were used. Diffused lighting in the ceiling and indirect lighting by each workstation were installed. Computerized digital-scanning devices were also installed. Overall, employees were satisfied with the changes made (Cronk, 2002).

With regard to equipment and technology, various attempts have been made to reduce medication errors. The installation of an automated computer-controlled device stored directly on nursing units (Medstation Rx) was associated with fewer medication errors (Borel & Rascati, 1995; Schwarz & Brodowy, 1995). Furthermore, the installation of Medstation Rx led to improvements in the administration of medication as scheduled (Shirley, 1999). A drawback of Medstation Rx is lineup during busy times (Borel & Rascati, 1995). Medication errors, including ordering, transcription, and dispensing errors, decreased with the use of a physician computer order entry system (Bates, Leape, Cullen, Laird, Petersen, Teich, et al., 1998). Similarly, Ali et al. (2005) noted that computerized physician order entry can improve the efficiency of care on intensive care units. Hodgkinson et al. (2006) noted that computerized physician order entry, combined with clinical decision support systems, may be effective in reducing errors. Flaws discovered with the computer

order entry system include incorrect patient selection, wrong medication selection, and sending medications to the wrong room (Koppel, Metlay, Cohen, Abaluck, Localio, Kimmel, et al., 2005). Regarding intravenous errors, intravenous infusion pumps with drug libraries were ineffective in reducing errors due to the ability of nurses to override alerts and the lack of usage of the drug library (Rothschild, Keohane, Cook, Orav, Burdick, Thompson, et al., 2005).

Heating, Ventilation, and Air Conditioning Systems

Ventilation is critical to the functioning of an acute care facility. As Nightingale (1859) noted, ventilation is critical to a patient's health - it should be kept pure without causing the patient chills. Furthermore, Nightingale (1859) suggested that air from windows is freshest and that hospitals should have the proper number of windows.

Ventilation was determined as a critical factor in the spread of severe acute respiratory syndrome (SARS) among healthcare workers in a hospital in China. Infection rates were significantly higher on the wards with the worst ventilation, whereas infection rates were significantly lower on the ward with good ventilation. In other wards, when the ratio of area of ventilation windows to volume of the room was higher (i.e., ventilation was good), the number of infected healthcare workers was smaller and infection rates became lower (Jiang, Huang, Xilong, Jinfeng, Wei, et al., 2003).

Menzies, Fanning, Yuan, & FitzGerald (2000) studied the impact of ventilation on infection control and tuberculin levels. Based on a sample of 4,525 healthcare workers, it was determined that a relationship exists between deficiencies in ventilation and tuberculin conversion among staff in hospitals working in non-isolation rooms. Specifically, the risk for tuberculin conversion was greater in non-isolation rooms with less than an average of 2 air exchanges per hour. In addition, inadequate ventilation of patient rooms was significantly associated with tuberculin conversion among staff members. Furthermore, inadequate ventilation of bronchoscopy rooms was significantly associated with tuberculin conversions among respiratory therapists.

Ventilation also impacts the health of patients. Negative outcomes for patients are associated with poor ventilation. Furthermore, room location and the design and location of air intakes and exhaust vents are critical determinants in transmission of airborne contaminants (Lundstrom, Pugliese, Bartley, Cox, & Guthrie, 2002). In an empirical study addressing the spread of methicillin-resistant *Staphylococcus aureus* (MRSA), contaminated dust in the ventilation system was the source of MRSA in patients acquiring the infection during their stay (Kumari, Haji, Keer, Hawkey, Duncanson, & Flower, 1998). Thorough cleaning of the ventilation system and the entire ward terminated the outbreak. According to the *Guidelines for Environmental Infection Control in Health-care Facilities*, patients with airborne infectious diseases should be placed in isolation rooms with proper ventilation to prevent the spread of infection (Schulster & Chinn, 2003). Ulrich et al. (2004) suggest that adequate ventilation and its maintenance are necessary to ensure the safety of staff and patients.

Although these studies do not specifically address errors, they demonstrate that the health of nurses is affected by ventilation. If their health is compromised, so might their ability to adequately care for their patients, which may result in increased errors.

Layout/Patient Room Design

The built environment should be convenient and accessible and should enable patients to connect with staff members, be conducive to the patients' sense of well-being, be safe and secure, and foster connections to the outside world (Lowers, 1999). Single-occupancy rooms have been found to improve patient outcomes when compared to multiple-occupancy rooms. Single-occupancy rooms have also been associated with better communication among staff, reduced need for patient transfers, fewer medication errors, and decreased infection rates (Page, 2004). In a maternity ward, equipment and supplies were easier to access in a single-occupancy room. In addition, privacy was greater and noise levels were reduced. Quality of care was also perceived as being greater since nurses were better able to respond to the emotional and physical needs of the patients (Janssen, Harris, Soolsma, Klein, & Seymour, 2001).

St. Joseph's Community Hospital in West Bend, Wisconsin, incorporated failure modes and effects analysis to aid in the creation of a design in which patient safety was at the forefront. Based on the analyses, a standardized patient room was utilized. The design of the patient room was single-occupancy and included an in-room sink, charting alcoves with a window, supplies and computers available in the alcoves, carpeted floors, bedside computers, oversized windows, sitting areas, and a close proximity between the bed and bathroom (Reiling & Knutzen, 2003; Reiling, 2002). Benefits of single-occupancy rooms include shortening a patient's length of stay, a reduced risk of acquiring a hospital-borne infection, and the reduced risk of medication errors (Anonymous, 2000). Key to the design of St. Joseph's was the standardization of the patient room in terms of layout, location of supplies, and equipment and furniture since standardization reduces the potential for error by making the environment less stressful (Ford, 2004). Specifically, "standardization of patient care environments and equipment greatly decreases the cognitive load on the nurses, making routine tasks less likely to cause slips and lapses" (Carayon et al., 2003, p. 36).

Similar positive results were obtained at the Barbara Ann Karmanos Cancer Institute in Detroit, Michigan. Medication rooms were expanded to give nurses greater time to think and be less distracted. As well, countertop space was increased, supplies were better organized, undercabinet task lighting was installed, and acoustical panels were used to absorb noise. With this new design, error rates decreased by 30% (Quality Letter for Healthcare Leaders, 2003).

Acuity-adaptable rooms are designed to enable a patient to receive all the care required in one room regardless of their acuity level. Acuity-adaptable rooms are larger in size than the regular patient room, and facilities using this type of room have lower rates of medication errors, patient falls, phlebitis, and procedural and lab errors, as well as shorter lengths of patient stay (Hill-Rom, 2002). The combination of acuity-adaptable rooms and decentralized nursing stations has resulted in improved clinical outcomes, cost and operational efficiency, and patient and staff satisfaction (Hendrich, Fay, & Sorrells, 2002). Similar results were obtained with universal rooms that enable patients to remain in the same room throughout their hospital stay. A reduction in patient transfers has led to reduced medication errors at Clarian Health Partners (Runy, 2004).

Design recommendations to improve patient care by Spreckelmeyer (2004) include the use of a universal room, decentralized patient care, enhanced direct contact between patients and staff through room and unit design, the elimination of sensory distracters in areas where nurses perform detailed tasks, the use of automated computerized medical records, patient social supports, incorporating elements of a natural environment, the need for personal control for each nurse, the need to provide communal spaces where information can be exchanged, and attention to ergonomic details.

Non-Environmental Variables

Fatigue/Long Work Hours

Nurses' long work hours has detrimental effects on patient care. Error rates were found to be three times higher when nurses worked shifts lasting 12.5 hours or more (Rogers, Hwang, Scott, Aiken, & Dinges, 2004). High workload influences decisions to perform various procedures and may lead to a reduction in patient satisfaction (Carayon & Gurses, 2005).

Working long hours contributes to fatigue and affects nursing performance. Negative effects of fatigue include slowed reaction time, reduced attention to detail, compromised problem solving, and errors of omission (Krueger, 1994; Institute of Medicine, 2004; Page, 2004). People working shift work report impaired job performance, sleep disturbances, fatigue, and a greater likelihood of injuries and accidents (Krueger, 1994). Excessive daytime sleepiness is associated with administration errors, needlestick injuries, and incorrect operation of medical equipment (Suzuki, Ohida, Kaneita, Yokoyama, & Uchiyama, 2005). These negative effects are true for residents who work long hours and are sleep deprived (Philibert & Barach, 2002). Working the night shift among nurses is associated with increased errors, in particular drug administration errors, due to sleepiness (Page, 2004; Suzuki et al., 2005).

Stress

Errors caused by work overload, faulty judgment, and a stressful experience led to a lack of confidence and increased anxiety in nurses (Meurier et al., 1997). Some negative effects of stress include anxiety, depression, increased blood pressure, reduced immune function, and sleeplessness (Barach & Dickerman, 2006). As Amalberti, Auroy, Berwick, and Barach (2005) note, the stress healthcare workers experience is associated with four factors. These include the constricted use of common-sense solutions to safety, the widespread use of beginners in their field including residents and interns, the fact that little has been done to reduce sources of human error, and the shift of clinical care to an ambulatory setting. Nurses with more experience develop better ways of managing the error and take appropriate measures to ensure the error is not made again (Meurier et al., 1997).

Faulty Judgment

An error of appropriate judgment occurs when nurses do not use adequate clinical judgment to assess symptoms and interventions. If nurses use faulty logic or utilize an unwarranted intervention, such as giving a patient excess medication, they have failed to evaluate the clinical situation

effectively. A better understanding of the decision-making process is needed to understand what prompts incorrect actions to be taken (Benner et al., 2002; Woods & Doan-Johnson, 2002). When healthcare professionals challenge the limits of their performance, they are at risk of using faulty strategies that could lead to adverse events (Amalberti, Auroy, Berwick, & Barach, 2005). Lack of knowledge regarding the use of drugs as well as incomplete, illegible, or verbal prescriptions can also lead to errors (Leape, Bates, Cullen, Cooper, Demeacao, Gallivan, et al., 1995; Tissot, Cornette, Demoly, Jacquet, Barale, & Capellier, 1999).

Organizational Variables

Staffing Levels

Staffing levels are associated with the occurrence of adverse events. In one study in which staffing levels were low, a higher number of medication errors and wound infections occurred (Hall, Doran, & Pink, 2004). Studies have also demonstrated that patient falls are also more likely to occur when staff levels are low (Whitman, Kim, Davidson, Wolf, & Wang, 2002; Unruh, 2003; Yang, 2003). In addition, higher workloads are associated with increased rates of nosocomial infections and decreased patient satisfaction (Yang, 2003). When staffing levels are improved, adverse events are less likely to occur and patient outcomes are likely to improve (Binnekade, Vromm, de Mol, & de Haan, 2003; Blendon et al., 2002; Hall et al., 2004; Nicklin & McVeety, 2002; Unruh, 2003). For instance, one study illustrated that the utilization of nurses who were not trained in intensive care in an intensive care unit benefited patient care, suggesting that increased staffing can reduce errors (Binnekade et al., 2003). Inexperience among nursing staff in intensive care units, however, was found to have a negative impact on the care delivered to patients. When experienced staff members were available to assist the inexperienced nurses, the effects of errors were reduced (Morrison, Beckmann, Durie, Carless, & Gilles, 2001).

Error Reporting and Reduction

Healthcare is a “system that is highly complex and tightly interrelated” (Barach & Dickerman, 2006). The safety profile of an organization, including healthcare, is measured by “reporting on the number of adverse events over a time interval” (Amalberti, Auroy, Berwick, & Barach, 2005, p. 757). Accurate reporting of nursing errors can improve patient safety. One of the main barriers in improving patient safety is the lack of awareness amongst those in healthcare regarding the extent to which errors occur daily in acute care facilities (Kohn, Corrigan, & Donaldson, 2000b). Unfortunately, people working in healthcare have been afraid of reporting errors due to fear of reprimand and fear of losing the respect of colleagues (Paparella, 2005). Furthermore, when dealing with errors, healthcare professionals tend to look at individual patients rather than the system itself. Attention should be shifted to the system to prevent all patients from receiving inadequate service (Barach & Moss, 2001). Successes in other industries, such as chemical, material manufacturing, and defense, have demonstrated that reporting errors has improved safety. These industries are successful at improving safety because they have implemented systems that enable data to be collected and analyzed. In particular, their systems have focused on reporting near misses, and incentives are provided for voluntary reporting in which confidentiality is ensured (Barach & Small,

2000). Reporting near misses offers many advantages over the reporting of adverse outcomes. In particular, near misses occur more often than adverse events, which allow for quantitative analysis, fewer barriers exist regarding data collection, liability is limited, and patterns of recovery can be studied and improvements can be made for future events (Barach & Small, 2000). Finally, within non-medical industries, progress is tracked and those in leadership acknowledge the necessity of developing a safety culture (Kohn et al., 2000b).

Within the healthcare industry, both Clarian and Spectrum Health Systems have demonstrated that it is possible to create a system in which nurses feel safe to report their errors. Clarian Health Partners of Indiana have implemented a program entitled Safe Passage, in which staff members are provided with the most current information available on patient safety as well as the opportunity to both analyze and learn from their errors. Two-way communication exists between leadership and those providing care. Since this program was implemented, error reporting has increased by 300% in the Clarian facilities. Spectrum Health System implemented a similar program entitled the Good Catch program, which targets identifying hazardous conditions (Paparella, 2005). Systems of error reporting enable both staff members and those in leadership positions to learn from the mistakes and help prevent future similar errors from occurring. The Joint Commission on Accreditation of Health Care Organizations (JCAHO) has instituted a policy to improve patient safety by ensuring healthcare organizations have systems in place to better understand why adverse events occur, what actions can be taken to prevent them, and to demonstrate to JCAHO that a functional process is available for undertaking these actions (Ulrich & Barach, 2006).

Various strategies have been suggested to reduce the occurrence of errors. One method is to reduce people's reliance on their memory. Recollection from memory regarding tasks that need to be performed and the manner in which they are performed is flawed. Through the use of protocols and checklists, people are able to use aids when making decisions, thus reducing the potential for error. For instance, Hodgkinson et al. (2006) report that having two nurses checking medication orders prior to dispensation is associated with a reduction in medication errors. A second strategy to reduce errors is to improve access to information. Healthcare professionals should have access to patient information, including medications and therapies, at the point of care. This can be achieved by having pharmacists available on nursing units as well as placing lab reports at the patient's bedside, among other approaches. Having pharmacists available for consultation has been associated with a decrease in medication errors (Hodgkinson et al., 2006). A third strategy that can improve patient care is the use of error-proof processes. Through the use of constraints, such as those available in computerized systems, people using the systems will be guided through their actions and decisions. Standardizing tasks is another method through which errors can be reduced. By implementing routine processes, people are able to familiarize themselves with the manner in which a task should be performed. The practice gained at performing tasks in a routine manner will help reduce opportunities for errors. A final strategy that can aid in error reduction is reducing the number of hand-offs that occur. By eliminating numerous transfers of material and information, the potential for error decreases (Benner, Sheets, Uris, Malloch, Schwed, & Jamison, 2002; Kohn et al., 2000b, McClanahan, Goodwin, & Houser, 2000).

Leadership is an administrative aspect that is critical to error prevention (Leape & Berwick, 2000). Patient safety should be a central focus for corporate leaders. People at the executive level should be involved in all facets of patient safety. This includes evaluating the hospital design as well as incorporating safety goals among the corporate business plans (Kohn et al., 2000b). Patient safety is the responsibility of everyone involved in healthcare. Patient safety should be instilled in those providing healthcare through the use of messages and aims clearly conveyed to staff members. Accidents often occur through a combination of human error and through faulty systems. By correcting system design failures, the institution is creating an environment in which patient safety is central (Kohn et al., 2000b).

Teamwork is also essential to patient care. Teamwork is vital to patient safety and reduced errors since teams make fewer mistakes than individuals working on their own (Amalberti et al. 2005; Small & Barach, 2002). Training should be provided for the team of individuals who are expected to work together. When members of the team are familiar with each other, confidence increases as team members can anticipate each other's needs, creating a calm working environment (Silén-Lipponen, Tossavainen, Turunen, & Smith, 2005). Knowledge is also diffused among team members as a result of collaborative decision making and good management, among other factors (Silén-Lipponen et al., 2005). Patients should be considered as part of the team so that attention is paid to their preferences, their knowledge of their condition, and the treatments they receive (Kohn et al., 2000b).

Simulation training may also benefit patients. Medical simulation techniques include robotic technologies, cognitive science, and advanced computer and robotics technologies (Ulrich & Barach, 2006; Small & Barach, 2002). These simulation techniques allow for training in a realistic situation without ever harming a patient (Streufert, Satish, & Barach, 2001). According to Small and Barach (2002), a fundamental ethical drive in healthcare exists to “(1) allow medical trainees to learn without putting patients at risk; (2) introduce new procedures more safely whereby experienced providers are the learners; (3) adopt new methods to help shape and modify provider behaviors and attitudes; (4) systematically train and test to more relevant, inclusive core competency standards including team skills, professionalism, and systems thinking across the continuum of a provider's career; (5) improve knowledge retention; and (6) continuously improve medical education and training” (p. 1476).

Errors can also be prevented if hospitals anticipate the unexpected. Taking a proactive approach is beneficial to patient care. The use of technological advances facilitates the prevention of errors. For instance, computerized order entry helps in identifying medication errors, and bar coding can help to positively identify and detect misidentified patients. Furthermore, should an error occur, a process of recovery should be in place. Errors should be made visible and intercepted whenever possible, before harm occurs. Through simulation training, models or virtual reality is used to practice tasks in lifelike circumstances. Feedback is provided and healthcare providers are trained in the event that an error occurs (Kohn et al., 2000b).

The Literature Review Table provides a list of the articles related to error in work settings. It includes both empirical and non-empirical (expert opinion and anecdotal information) articles for both environmental and non-environmental variables (in both healthcare and non-healthcare settings) and uses a star system to denote the quality and quantity of articles/chapters in each area with a higher number indicating more articles and research has been conducted in a particular area.

Hospital Design and Environmental Variables Related to Staff Health and Safety

In this section, research related to staff safety including issues of infection control is discussed. Both environmental and non-environmental factors are covered here. This review included studies that deal with non-environmental variables to highlight that staff safety and health issues should take into consideration both environmental and non-environmental factors to generate effective solutions and outcomes.

Environmental Variables

Noise

Noise levels are critical to creating an environment that is conducive to promoting staff health and safety. Bayo, Bayo, & Garcia (1995), in their study of 295 healthcare workers, determined that the main noise sources outside the hospital included road traffic, human voices, aircraft noise, and sirens. Noise sources within the hospital were produced by employees, patients, hospital devices, and visitors. Participants in this study felt that the majority of the noise produced was from within the hospital, and noise levels were found to be well above those suitable for a healthcare facility. These excessive noise levels were found to negatively affect patients more so than healthcare workers. Similarly, Topf and Dillon (1988) studied 100 nurses with regard to noise-induced stress and burnout. They found that the most disturbing noises were produced by telephones, alarms on equipment, and the beeping of patient-monitoring devices. Furthermore, a greater degree of noise-induced stress was associated with higher levels of burnout among nurses. High noise levels, therefore, can negatively impact both patients and healthcare workers, thereby compromising patient care. With regard to specific unit design, Shepley and Davies (2003) compared noise levels between a rectangular design and a circular design. Though nurses walked less on the circular units, noise levels were not found to significantly differ between the two designs.

Ergonomics

Staff perceptions of safety within the hospital influence the adoption of safe work practices (Gershon, Karkashian, Grosch, Murphy, Escamilla-Cejuda, Flanagan, et al., 2000). Nurses spend a great deal of time physically caring for patients, and without proper ergonomic design, nurses may experience physical ailments. A proactive approach, in which nurses were made aware of activities that were most likely to lead to patient falls, led to a significant decrease in the number of falls (Brady, Chester, Pierce, Salter, Schreck, & Radziewicz, 1993). Yassi et al. (2004) reviewed compensa-

tion records of employees at eight facilities and found physical workload and staffing levels were associated with time-loss injury rates and self-reported pain, burnout, health, and job satisfaction. Interestingly, employees at facilities with the lowest quartile time-loss injury rates had better staffing levels, fewer injuries, less pain, and better self-reported health. Furthermore, managers at facilities with lowest quartile time-loss injury are likely to have an engaged workplace, a substantive philosophy of care, and concrete policies and practices. The organizational culture of the workplace, therefore, significantly impacts employee performance and health.

Garg and Owen (1992) introduced ergonomic devices (e.g., walking belts, shower chairs, and hoists) in a nursing facility to determine if these devices aided in reducing injuries among nursing assistants ($n = 92$). Most assistants reacted positively to utilizing the devices and perceived physical stresses after introducing the devices were very low. In addition, fewer patient transfers occurred after introducing the devices, and there was a profound decrease in lost and restricted workdays among the employees. Other factors that affect nurses' compliance with safety-related behaviors include the commitment and support of safety programs among senior management, the absence of barriers to safe work practices, and the cleanliness and orderliness of the facility (Lundstrom, Pugliese, Bartley, Cox, & Guither, 2002).

Ventilation

In terms of ward features, proper ventilation is critical to the health of staff members. Menzies et al. (2000) studied the ventilation systems in Canadian acute care facilities and tested healthcare workers ($n = 4,525$) for tuberculin. The design of the hospital had an impact on ventilation systems in that non-isolation patient rooms that were an average of 57 years old had inadequate ventilation. Patient rooms that were an average of 33 years old, on the other hand, had adequate ventilation. Inadequate ventilation was significantly associated with rates of tuberculin conversion among staff members. Furthermore, though most hospitals had a current policy of testing workers for tuberculosis upon being hired, fewer than half of the workers had been tested. This finding is concerning in that staff members may be inadvertently subjecting patients and other staff members to an increased risk of tuberculin conversion. Similar results were obtained by Jiang et al. (2003) in their study of SARS in China ($n = 4$). Infection rates of SARS were significantly higher on wards with poor ventilation. It has been noted that the location of the patient room and the design and location of air intakes and exhaust vents are critical determinants in the transmission of airborne contaminants (Lundstrom, Pugliese, Bartley, Cox, & Guither, 2002). Thus, when ventilation is not adequate, staff members are more vulnerable to acquiring infections.

Non-Environmental Variables

Infection Control and Hand Hygiene

The spread of infection within hospitals is influenced by nursing behaviors. Implicit in reducing infection rates is compliance among staff regarding hand hygiene. In a review of 423 published articles regarding hand hygiene, Larson (1988) found that once infections begin, they are often spread by the contaminated hands of staff. Furthermore, compliance with handwashing is related to significant decreases in nosocomial infections (Larson, 1988). However, in a study monitoring physicians

during their rounds, it was found that physicians have poor compliance with hand decontamination (O'Malley, Varadharajan, & Lok, 2005). Similar results were found by Pittet, Mourouga, & Perneger (1999) who observed healthcare workers regarding their handwashing practices. They found that the average compliance with handwashing was 48%. Compliance was also lower in surgical and intensive care units, though nurses were found to have better compliance than other healthcare workers. Contributing factors to poor compliance are understaffing and high workloads.

Various measures have been suggested to improve compliance regarding hand hygiene. Mixed results have been obtained regarding increasing the number of sinks within the facilities. Kaplan and McGuckin (1986) found that handwashing increased when more sinks were available. Whitby and McLaws (2004), on the other hand, found that the increased availability of sinks did not significantly increase handwashing compliance among staff members. Factors that have been found to improve handwashing compliance are alcohol-based products (Cohen, Saimon, Cimiotti, & Larson, 2003; Gould, 1994; Gould & Ream, 1993), additional training on infection control (Gould, 1994; Gould & Ream, 1993), and whether senior staff members comply with hand hygiene (Lankford, Zembower, Trick, Hacek, Noskin, & Peterson, 2003). By emphasizing the importance of handwashing and standard precautions for infection control, an outbreak of MRSA ended in one facility (Emery, Nennig, & Gold, 2005). In addition to hand hygiene, other methods of reducing MRSA include meticulous cleaning of equipment and hospital rooms and the use of gowns and disposable aprons (McCaughey, 2005).

Education regarding the importance of handwashing and the negative implications of poor hand hygiene are critical to increasing compliance (Arikan, Ozgultekin, Tulunay, Turan, Oral, & Rosenthal, 2005; Elliott, 1992; Pittet, 2004). Lockhart (2005) noted that the presence of a 24-hour/day infection control staff, which helped to educate staff regarding hand hygiene, as well as VRE policies, helped reduce levels of VRE. Educational campaigns, along with the installation of alcohol-based dispensers, however, were found to be ineffective in increasing handwashing compliance (Muto, Sistrom, & Farr, 2000).

The Literature Review Table provides a list of the articles related to staff health and safety. It follows a similar format as Table 1 and uses the star system to denote the quality and quantity of articles/chapters for each factor.

Hospital Design and Environmental Variables Related to Patient Safety

Adverse Events

Patients may experience an adverse event while hospitalized. Adverse events are complications and injuries patients suffer that may result in death, disability, or prolonged hospital stay (Baker, Norton, Flintoft, Blais, Brown, & Cox et al., 2004). These events are not due to the illness, but rather to healthcare management. Hospitals with higher patient acuity levels have a greater number of adverse events (Unruh, 2003). Patients in isolation were also found to experience longer

patient stays and higher rates of adverse events than patients who were not in isolation (Stelfox, Bates, & Redelmeir, 2003). Finally, a trend exists toward the more frequent occurrence of adverse events in teaching hospitals (Baker et al., 2004).

The physical environment impacts patient outcomes. Patients tend to perceive the hospital as a cold, frightening place (McCarthy, 2004). A healing environment is one that incorporates elements of nature, soothing colors, natural light, and pleasant sounds (Stichler, 2001). The following section reviews environmental and non-environmental variables that impact patient safety and patients' perceptions of the healing environment.

Environmental Variables

Noise

Often, hospitals are noisy, and excess levels of noise can increase anxiety, pain perception, and sleep deprivation among patients as well as increase a patient's stay (Cabrera & Lee, 2004; Ulrich, Zimring, Quan, Joseph, & Choudhary, 2004). Nightingale (1859) noted that unnecessary noise, intermittent noise, and sudden, sharp noises can create excitement in a patient and can harm the patient's recovery. In addition, noise control is important for the recovery of patients since tolerance of noise is lower during illness (Hosking & Haggard, 1999). Nicklin and McVeety (2002) in their study of 22 teaching hospitals in Canada, found that nurses ($n = 503$) felt the healthcare environment posed serious risks for patients. With regard to noise, nurses felt that overcrowding within hospitals led to excess noise levels and decreased privacy for patients. Shepley (2002) conducted a study in which a neonatal intensive care unit was redesigned. The original design consisted of six small rooms that accommodated up to five babies in each room. The new design included an open unit that was divided into bays of six baby stations. The redesigned unit, in comparison to the old unit, was rated positively by both families and healthcare workers ($n = 39$) and had lower noise levels.

Suggestions to reduce noise levels include introducing music. Since music has been demonstrated to reduce anxiety prior to and during surgery, Cabrera and Lee (2004) have suggested the use of a sound control center to reduce noise levels as well as assist in reducing pain levels. As well, carpeted surfaces, sound-absorbing ceiling tiles, and sound-attenuating surfaces have been suggested to reduce noise levels (Lowers, 1999; Rollins, 2004; Shumaker & Reizemstein, 1982; Ulrich, Zimring, Quan, Joseph, & Choudhary, 2004). The use of private rooms instead of multi-occupancy rooms may also aid in reducing noise levels (Ulrich et al., 2004).

Lighting

Poor lighting can cause discomfort among patients (Shumaker & Reizemstein, 1982). Adequate lighting within the healthcare environment, on the other hand, is beneficial to both staff and patients. Access to natural light and better lighting in general can reduce stress and improve patient safety (Rollins, 2004). Shepley (2002), for instance, noted in her study of neonatal intensive care units that the use of natural light positively impacted the patients and family members. In designing patient rooms, therefore, natural light should be included in the rooms, and patients and their visitors should control the intensity of lighting to meet their individual needs (Stichler, 2001).

Indirect lighting diffuses light and creates a more natural effect (Lowers, 1999).

Ventilation

Adequate ventilation and its maintenance are necessary to ensure the safety of staff and patients (Ulrich et al., 2004). Proper ventilation can help alleviate stress and improve patient outcomes as well as prevent nosocomial infections (Rollins, 2004). According to the *Guidelines for Environmental Infection Control in Health Care Facilities*, heating, ventilation, and air conditioning filters should be properly installed and maintained. Furthermore, patients diagnosed with or suspected of having an airborne infectious disease should be placed in isolation rooms that receive numerous air changes per hour and are under negative pressure (Sehulster & Chinn, 2003). Brady (2005) further noted that, to reduce the risk of nosocomial infection in neonatal intensive care units, positive pressure ventilation should be in place. As well, isolation rooms with negative pressure should be available.

Kumari et al. (1998) investigated the spread of MRSA within a facility on the east coast of England. Contaminated dust in the ventilation system was the source of MRSA in patients acquiring the infection during their stay. Thorough cleaning of the ventilation system and the entire ward terminated the outbreak. This study signifies the importance of maintaining proper ventilation to prevent infection among staff and patients.

New healthcare facilities are incorporating improved ventilation systems into their designs to assist in improving patient care. Children's Hospital in San Diego, California, for instance, is opening a convalescent care hospital, which is designed to promote long-term care for permanently disabled children. The air ventilation system will be improved, and it is expected that fewer respiratory infections will occur (Bilchik, 2002).

Design/Layout

Patient perceptions of both their rooms and nurses impact their satisfaction regarding quality of care. Gotlieb (2002, 2000) studied the effects of patient hospital rooms on patient satisfaction with their nurses as well as their hospital stay. It was determined that, the more positively patients evaluate their rooms, the greater their satisfaction with both their nurses and the hospital (Gotlieb, 2002; 2000).

The design of patient rooms is also associated with patient falls. Most falls occur in the patient's bedroom, usually when a patient attempts to get out of bed unassisted (Ulrich & Barach, 2006). In particular, bedroom falls occur at the edge of patient beds while that patient is returning from or attempting to get to the bathroom. Flaws in design that can contribute to falls include poor placement of rails, slippery floors, narrow door openings, and incorrect furniture heights (Ulrich & Barach, 2006). When nursing staff were dispersed and placed in closer proximity to patient rooms, patient falls declined by 75% in the cardiac critical care unit at Methodist Hospital in Indianapolis, Indiana (Barach & Dickermann, 2006).

Acuity-adaptable rooms also appear to affect patient satisfaction. These rooms offer patients control of lighting, temperature, and privacy and are generally found on decentralized nursing units.

Hendrich, Fay, and Sorrells (2002, 2004) found that patient transfers decreased by more than 90% on a unit with acuity-adaptable rooms. In addition, overall patient days per bed have increased since the patient is not required to move. These units have also been found to improve patient safety as patient falls and medication errors have decreased and patient satisfaction has increased (Hendrich, Fay, & Sorrells, 2004; 2002).

Barbara Ann Karamanos Cancer Institute has renovated areas within the hospital to be patient-centered. Medical rooms were made larger and an emphasis was placed on lighting and acoustics. A decrease has occurred in the use of pain medication on these units as well as a decrease in medication errors (Bilchik, 2002). Similarly, Chaim Sheba Medical Center in Tel-Hashomer, Israel, used a psychoenvironmental approach to its design incorporating space, daylight, and fresh air. Patients are not overcrowded, and staff can easily observe patient living areas. Both patients and staff react positively toward the classical daylight and fresh air (Gross, Sasson, Zarhy, & Zohar, 1998). St. Joseph's Community Hospital in West Bend, Wisconsin, used standardized patient rooms in its design of the new facility. Safety-driven principles were developed to minimize the occurrence of serious adverse events such as patient falls and operative/postoperative complications. Some of these design principles include visibility of patients by staff members, automation where possible, immediate accessibility of information, and noise reduction (Reiling, Breckbill, Murphy, McCullough, & Chernos, 2003; Reiling, Berry, Parker, & Coile Jr., 2004).

Infection control is also affected by design. Dettenkofer et al. (2004) reviewed 17 studies that looked at the impact of design on infection control and found that the number of beds on intensive care units impacts infection control. Specifically, patients on intensive care units with more than 11 beds were at a higher risk of acquiring a nosocomial infection than patients on intensive care units with fewer than 6 beds. In addition, rates of nosocomial infection increased when a 5th bed was added to a 4-bed open ward. Similarly, Kibbler, Quick, & O'Neill (1998) found that, when 4-bedded bays were increased to 5-bedded bays, infection rates for MRSA increased. Therefore, having more patients on a ward increases infection rates and can prolong a patient's stay. McCarthy (2004) suggests that single rooms should replace multi-patient rooms to increase patient privacy and reduce rate of nosocomial infections.

Stichler (2001) offers some design guidelines with regard to healthcare facilities. He suggests that healing environments improve one's connection with nature, culture, and people and promote a positive awareness of one's self. Universal rooms can accommodate patients and family members as well as provide increased storage for equipment. Furthermore, a balance must be achieved between the need for staff to view patients and respect for the patients' privacy. Furnishings used in the rooms and on the ward should be comfortable and durable. Barach and Dickerman (2006) note that goals for designing a facility with regard to patient safety include reducing the risk of injury to both patients and staff, removing or minimizing hazards, and educating designers in the complexity of promoting safety within the healthcare environment.

Non-Environmental Variables

Infection Control and Hand Hygiene

Patient safety is affected by infection control measures. Pneumonia, urinary tract infections, surgical-site infections, and bloodstream infections account for approximately 80% of all nosocomial infections (Burke, 2003). Factors that contribute to hospital-acquired infections include poor handwashing compliance among staff, inadequate ventilation, and overcrowding (O'Connell & Humphreys, 2000).

Various factors have been identified in reducing infection rates. Isolation rooms are critical for reducing the spread of infection (O'Connell & Humphreys, 2005; Schulster & Chinn, 2003; Ulrich et al., 2004). The most critical factor for reducing infections, however, is handwashing (Brady, 2005; O'Connell & Humphreys, 2000; Page, 2004; Ulrich et al., 2004). Though recommendations include increasing the availability of handwashing sinks, a few studies have demonstrated that the greater availability of handwashing facilities did not increase compliance (Preston, Larson, & Stamm, 1981; Vietri, Dooley, Davis, Longfield, Meier, & Whelen, 2004). Units that are understaffed also have lower compliance rates regarding handwashing (Ulrich et al., 2004). Compliance with handwashing did improve when senior staff members engaged in this behavior (Dettenkofer, Seegers, Antes, Motschall, Schumacher, & Daschner, 2004). On intensive care units, handwashing sinks in each patient room was also found to reduce infection rates on these units (Ulrich et al., 2004).

The Literature Review Table provides a list of the articles related to patient health and safety. It follows a similar format as Table 1 and uses the star system to denote the quality and quantity of articles/chapters for each factor.

Healthcare Facility Management, Design, and Environmental Variables Related to Staff Outcomes

The physical environment impacts nurses' and other healthcare staff members' job performance. As will be discussed in the next section, various environmental and non-environmental variables significantly impact job satisfaction as well as efficiency.

Environmental Variables

Noise

Noise is one aspect of the environment that can negatively affect both staff and patients. Noise levels within the hospital are produced by staff, visitors, patients, and hospital devices, such as telephones, alarms on equipment, and the beeping of patient-monitoring devices (Bayo, Garcia, & Garcia, 1995; Topf & Dillon, 1988). When noise levels are high, the sleep patterns of patients may be disrupted and communication between patients and staff is made difficult (Rabinowitz, 2005). In their study of the impact of noise on burnout ($n = 100$), Topf and Dillon (1988) found that disturbing noise levels promoted noise-induced stress, which, in turn, was associated with higher levels of burnout among critical care nurses. Hodge and Thompson (1990) conducted a study within

an operating room and found that the loudest noises occurred during the preparation period of surgery. Loud noise levels during surgery could also hamper communication among the medical staff as well as their concentration levels. Noise levels, then, can interfere with completing important tasks and can increase the risk of error.

Lighting

Lighting is an important environmental feature that impacts a nurse's performance. Nightingale (1859) noted that lighting is one critical element of the hospital environment. Exposure to daylight not only benefits patients, but it also has positive effects on staff. As exposure to daylight increases, nurses are less likely to experience stress and dissatisfaction with their jobs, reducing their levels of burnout (Alimoglu & Donmez, 2005). Exposure to artificial lights, on the other hand, has a negative effect, as nurses find them to be very draining (Scott, 2004). It would appear, therefore, that nurses function more effectively in an environment with minimal artificial lighting and in an environment that facilitates the use of natural daylight.

Ventilation

One other critical element of the hospital environment mentioned by Nightingale (1859) is ventilation, which is very important in terms of infection control. As noted in previous sections, adequate ventilation (i.e., the installation of a HEPA filter and the use of negative air pressure rooms) helps to minimize the spread of infection among both staff and patients (Noskin & Petersen, 2001). Without adequate ventilation, nurses are at an increased risk of acquiring an infection, which in turn, could affect their job performance.

Wayfinding and Design

Wayfinding is another critical element of the hospital environment. Wayfinding is of particular importance because if patients or staff members have difficulties orienting themselves within the facility, they may become frustrated and disoriented, which, in turn, may lead to them experiencing stress (Carpman & Grant, 1993; Moeser, 1988). Furthermore, when a hospital is redesigned, the staff needs to learn new routes to make their way around the facility, which can also lead to anxiety and stress (Christensen, unpublished). If staff experience stress, absenteeism rates may increase and their ability to take care of patients may decline.

Access to space within the hospital affects nurses' perceptions of their workplace. A study conducted by Halford and Leonard (2003) in two National Health Service Hospitals in England found that nurses had the least access to space among staff members within their hospitals. Their spatial confinement to their wards often led nurses to have a strong spatial identification with their ward while having negative feelings toward other spaces within the hospital. Through this lack of space and their sense of territoriality, their nursing identities are formed. Additionally, a lack of space was associated with the impression that the hospital did not care about its nurses and generated stress among nurses. Opportunities are also limited to relax and relieve themselves of their anxieties.

Specific nursing units affect job satisfaction and burnout. Sochalski (2001) noted that medical-surgical nurses, in comparison to nurses on other units, reported lower levels of quality of care, higher

numbers of tasks left undone at the end of a shift, and high levels of emotional exhaustion. Furthermore, nurses working in acute medicine have higher levels of emotional exhaustion than nurses working in accident and emergency (Gillespie & Melby, 2003). Forensic psychiatric nurses in Australia report higher levels of job satisfaction than nurses in mainstream services (Happell, Martin, & Pinikahana, 2003). These nurses are generally more satisfied with their independence, quality of care, responsibility, and the opportunities given to them to discuss work. Among mental health nurses, stressors that lead to burnout include conflict with co-workers, inadequate resources, work setting, and issues with management (Taylor & Barling, 2004). Finally, nurses working in dermatology have lower levels of emotional exhaustion than those working in other specialties (Renzi, Tabolli, Ianni, DiPietro, & Puddu, 2005).

Non-Environmental Variables

Staffing and Workload

Evident across studies is the notion that nurses are generally dissatisfied with their jobs. Job satisfaction among nurses is dependent upon numerous factors. One critical factor is workload. Staff shortages have contributed to increased stress levels among nurses, since workload levels have increased (Jenkins & Elliott, 2004; McVicar, 2003; Olofsson, Bengtsson, & Brink, 2003). Furthermore, nurses feel that higher workloads interfere with patient care (Shaver & Lacey, 2003). Sochalski (2004) discovered that nurses with fewer patients rated the quality of care they provided higher than nurses with a greater number of patients assigned to them. As the number of patients per nurse increases, dissatisfaction increases (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Jenkins & Elliot, 2004). When workloads are balanced, greater time is spent in patient care (Upenieks, 1998).

Time is also an issue associated with job satisfaction. Nurses feel they do not have enough time to both complete their tasks and spend time with their patients (Bowers, Luring, & Jackson, 2001). During their shifts, nurses pass medications, monitor patients, chart and create documentation, and interact with physicians, among other activities (Bowers, Luring, & Jackson, 2001). Upenieks (1998) found that registered nurses spend approximately 30% of their time in direct patient care. Nurses feel frustrated because they do not have enough time in their shifts to take care of patients and complete administrative tasks (Bowers et al, 2001; Olofsson, Bengtsson, & Brink, 2003). Their frustration reduced their levels of satisfaction with their jobs.

Staff shortages have been noted as affecting job satisfaction. The nursing shortage stems from concerns with the educational system, societal influences, and economic factors. An improvement in the work environment, such as better pay and recognition of a nurse's qualities, may help attract potential nurses as well as retain existing nurses (Andrews & Dziegielewski, 2005). Furthermore, federal funding should be provided for nursing education, a compensation and benefits package should be implemented, staff effectiveness should be measured, and ergonomic technology should be adopted to reduce the risk of injury (Joint Commission of Accreditation of Healthcare Organizations, 2002). Recruitment strategies have been weakened, however, by issues with foreign-born nurses and an increase in older registered nurses entering the workforce (Hendrich, 2006). The addition of trained, non-professional staff to assist registered nurses may help increase morale

among nurses. Hospital costs may also be reduced as the length of patient stay may decrease and fewer errors are likely to occur (Tuttas, 2003). The greater use of temporary-agency registered nurses increases the operational costs of hospitals, whereas hospitals are likely to have lower operating costs with a more experienced nursing staff (Bloom, Alexander, & Nuchols, 1997). Finally, staff members satisfied with their work environment are likely to remain in their jobs, and, thus, the hospital is able to save money on recruiting nurses (Amos, Hu, & Herrick, 2005). Hendrick (2006) notes, "a stable, adequate staff maximizes opportunities for nurses to attend to patients, complete their work, derive work satisfaction, and provide safe, quality care" (p. 4).

Education and Experience

Education is another factor that contributes to job satisfaction. Nurses with higher education levels, and, thus, higher qualifications, may have elevated expectations for their position. If hospitals are not willing to meet these expectations, dissatisfaction may occur (Cavanagh, 1992). Related to education is experience. Nurses with less experience tend to suffer higher levels of stress and are less confident in their abilities (Ernst, Messmer, Franco, & Gonzalez, 2004; McVicar, 2003). As stress levels increase, job satisfaction decreases (Hoffman & Scott, 2003; Norbeck, 1985). In a study conducted in South Carolina, however, nurses with greater experience, who felt they were not getting adequate recognition for their work and who did not experience autonomy, were less satisfied with their jobs (Ma, Samuels, & Alexander, 2003). When nurses are not satisfied in their positions, absenteeism, turnover, and burnout are likely to occur (Kalliath & Morris, 2002; Lu, While, & Barriball, 2005; Ma et al., 2003). When, on the other hand, nurses feel their opinions are being taken into account, they have more positive attitudes regarding their work and are thus more satisfied (Lane, Prestholdt, & Matthews, 1991). Furthermore, when nurses find their work meaningful, they are less likely to experience burnout and patient satisfaction increases (Leiter, Harvie, & Frizzell, 1998; Vahey, Aiken, Sloane, Clarke, & Vargas, 2004).

Benefits

Staff benefits are also related to job satisfaction. When nurses are satisfied with their pay and are committed to their organization, they are less likely to leave their jobs (Cavanagh, 1992; Lum, Kervin, Clark, Reid, & Sirola, 1998). By not leaving, a more stable working environment is created, which may positively influence patient care. Other factors influencing satisfaction are lack of acknowledgement from supervisors (Olofsson et al., 2003), relationships with other staff members, coping with the emotional needs of both patients and their families, shift working, and lack of rewards (McVicar, 2003).

Nurses' satisfaction in their jobs affects patient satisfaction. Patients report higher satisfaction levels on units where nurses have higher levels of personal accomplishment and lower than average levels of emotional exhaustion (Vahey, Aiken, Sloane, Clarke, & Vargas, 2004). Patients on units where nurses find their work meaningful also have higher satisfaction levels. Patients on units where nurses expressed an intention to leave, however, were less satisfied with their care (Leiter, Harvey, & Frizzell, 1998). When organizational factors, such as being overloaded, having difficult patients, and lack of teamwork, and personal factors, such as personal problems and cultural background, interfere with the quality of care provided to patients, productivity suffers (McNeese-Smith, 2001).

The Literature Review Table provides a list of the articles that deal with the effects of environmental and non-environmental factors on staff outcomes and the supporting articles. It follows a similar format as Table I and uses the star system to denote the quality and quantity of articles/chapters for each factor.

Conclusion

Based on the literature reviewed, it is clear that both environmental and non-environmental variables affect the occurrence of errors in the general workplace and in acute care settings. Specifically,

- Noise is distracting and disrupts concentration, resulting in errors.
- Inadequate lighting (either too bright or too dark) can impede task performance.
- Different color schemes invoke certain responses; if the color scheme is not suited to the task on hand, errors may result.
- Inadequate workstation design results in reduced comfort and the development of musculoskeletal disorders. Tasks with poor ergonomics are associated with higher absenteeism levels and may be related to lower levels of patient care and increased error rates.
- Computerized physician order entry can improve the efficiency of care on intensive care units and reduce medication errors.
- Poor ventilation systems and excessive thermal environments may compromise an individual's health and lead to stress and negative task performances.
- Design, in particular single-occupancy room design in acute care settings, can lead to a reduction of errors.
- Working long hours contributes to fatigue, resulting in slowed reaction time, reduced attention to detail, compromised problem solving, and errors of omission.
- Stressors in the work environment include time pressures, deadline pressures, an uneven distribution of resources, and a heavy work volume.
- Lack of knowledge and faulty judgement can lead to errors.
- More errors occur when staffing levels are insufficient and nurses are inexperienced.
- Leadership amongst those in authority, as well the implementation of an error-reporting system, can reduce the occurrence of errors.

A few other general issues about the other three sections could be pointed out in conclusion. Most of the empirical literature on workspace design on nurses' job performance has focused on noise, lighting, ventilation, and wayfinding. There is evidence on the negative impact of noise, artificial lighting, improper or inadequate ventilation, and disorienting layouts of nursing units. Also, there is literature on the pros and cons of various nursing-unit configurations. Some of the key issues in nursing-unit design are travel distance, patient visibility, distribution of support space, flexibility, patient room design, and visual linkage with outdoors. Less information is available on the effect of

different workspace design and environmental features, such as size and layout of nurses' station, privacy, task lighting, visual access, access to support spaces, etc.

Also, the impact of patient room issues, such as patient room configurations, layout of furniture and sink, relationship between the patient room vis-à-vis the nursing-unit design, visual access from nurses' station and hallways, etc., have not been addressed adequately in the empirical literature. Nurses' efficiency, potential for errors, stress levels, and overall job satisfaction will be affected by a myriad of these design issues and their combinations.

Potential conflicts between various tasks such as privacy needed for charting and the opportunity for surveillance on patients need to be looked at as we examine the effect of design on efficiency and errors. A participatory planning and design process involving the nursing staff at various levels of hierarchy might be helpful toward understanding of the real-life demands of the jobs and identifying environmental sources of stress, frustration, and conflicts. Finally, effective design needs to occur with organizational and regulatory commitment for flexibility in how nursing units are operated in terms of number of staff, staff training, and required communication patterns between staff, workload, and overall culture of the workplace

References

- Abdou, O. A. (1997, September). Effects of luminous environment on worker productivity in building spaces. *Journal of Architectural Engineering*, 124-132.
- Aiken, L., Clarke, S., Sloane, D. Sochalski, J., Busse, R., Clarke, H., Giovannetti, P., Hunt, J., Rafferty, A., & Shamian, J. (2001). Nurses' reports on hospital care in five countries. *Health Affairs*, 20(3), 43-53.
- Alimoglu, M. K., & Donmez, L. (2005). Daylight exposure and the other predictors of burnout among nurses in a university hospital. *International Journal of Nursing Studies*, 42, 549-555.
- Amalberti, R., Auroy, Y., Berwick, D., & Barach, P. (2005). Five system barriers to achieving ultrasafe health care. *Annals of Internal Medicine*, 142, 756-764.
- American Institute of Architects. (2001). *Guidelines for design and construction of hospital and healthcare facilities*. Dallas, TX: Facilities Guideline Institute.
- Amos, M. A., Hu, J., & Herrick, C. A. (2005). The impact of team building on communication and job satisfaction of nursing staff. *Journal for Nurses in Staff Development*, 21(1), 10-16.
- Andrews, D. R., & Dziegielewska, S. F. (2005). The nurse manager: Job satisfaction, the nursing shortage and retention. *Journal of Nursing Management*, 13, 286-295.
- Arikan, O. A., Ozgultekin, A., Tulunay, M., Turan, G., Oral, M., & Rosenthal, V. D. (2005). Effect of education and performance feedback on handwashing in two hospitals in Istanbul and Ankara. *American Journal of Infection Control*, 33(5), E75.
- Baker, G. R., Norton, P. G., Flintoft, V., Blais, R., Brown, A., Cox, J. et al. (2004). The Canadian adverse events study: The incidence of adverse events among hospital patients in Canada. *Canadian Medical Association Journal*, 170(11), 1678-1686.
- Banbury, S., & Berry, D. C. (1998). Disruption of office-related tasks by speech and office noise. *British Journal of Psychology*, 89, 499-517.

- Banbury, S. P., & Berry, D. C. (2005). Office noise and employee concentration: Identifying causes of disruption and potential improvements. *Ergonomics*, 48(1), 25-37.
- Barach, P., & Berwick, D. M. (2003). Patient safety and reliability of health care systems. *Annals of Internal Medicine*, 138(12), 997-998.
- Barach, P., & Dickerman, K. N. (2006, February). *Hospital design promoting patient safety*. Paper presented at the American Society for Healthcare Engineering International Conference, San Diego, CA.
- Barach, P., & Moss, F. (2001). Delivering safe health care. *British Medical Journal*, 323, 585-586.
- Barach, P., Satish, U., & Streufert, S. (2001). Healthcare assessment and performance: Using simulation. *Simulation & Gaming*, 32(2), 147-155.
- Barach, P., & Small, S. (2000a). Reporting and preventing medical mishaps: Lessons from non-medical near miss reporting systems. *British Medical Journal*, 320, 759-763.
- Barach, P., & Small, S. (2000b). How the NHS can improve safety and learning. *British Medical Journal*, 320, 1683-1684.
- Bayo, M.V., Garcia, A. M., & Garcia, A. (1995). Noise levels in an urban hospital and workers' subjective responses. *Archives of Environmental Health*, 50(3), 247-251.
- Benner, P., Sheets, V., Uris, P., Malloch, K., Schwed, K., & Jamison, D. (2002). Individual, practice, and system causes of errors in nursing: A taxonomy. *Journal of Nursing Administration*, 32(10), 509-523.
- Blendon, R. J., DesRoches, C. M., Brodie, M., Benson, J. M., Rosen, A. B., Schneider, E., Altman, D. E., Zapert, K., Herrmann, M. J., & Steffenson, A. E. (2002). Patient safety: Views of practicing physicians and the public on medical errors. *New England Journal of Medicine*, 347(24), 1933-1940.
- Bloom, J. R., Alexander, J. A., & Nuchols, B. A. (1997). Nurse staffing patterns and hospital efficiency in the United States. *Social Sciences Medicine*, 44(2), 147-155.
- Bobrow, M. (1978). The evolution of nursing space planning for efficient operation. In L. G. Redstone (Ed.), *Hospitals and healthcare facilities* (pp. 43-54). NY: McGraw Hill Book Company.
- Bobrow, M. & Thomas, J. (2000). Inpatient care facilities. In Kobus, R. et al., *Building type basics for healthcare facilities* (pp. 131-192). New York: John Wiley & Sons.
- Borel, J. M., & Rascati, K. L. (1995). Effect of an automated, nursing unit-based drug-dispensing device on medication errors. *American Journal of Health-System Pharmacy*, 52, 1875-1879.
- Bowers, B. J., Lauring, C., & Jacobson, N. (2001). How nurses manage time and work in long-term care. *Journal of Advanced Nursing*, 33(4), 484-491.
- Brady, M.T. (2005). Health care-associated infections in the neonatal intensive care unit. *American Journal of Infection Control*, 33(5), 268-275.
- Brady, R., Chester, F. R., Pierce, L. L., Salter, J. P., Schreck, S., & Radziewicz, R. (1993). Geriatric falls: Prevention strategies for the staff. *Journal of Gerontological Nursing*, 19(9), 26-32.
- Brennan, T.A., Leape, L. L., Laird, N. M., Hebert, L., Localio, R., Lawthers, A. G. et al. (1991). Incidence of adverse events and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. *The New England Journal of Medicine*, 324(6), 370-376.
- Brill, M., Margulis, S. T., Konar, E., & BOSTI. (1984). *Using office design to increase productivity*. Buffalo, NY: Workplace Design and Productivity, Inc.
- Burgio, L., Engel, B., Hawkins, A. McCorick, K., Scheve, A. (1990). A descriptive analysis of nursing staff behaviors in a teaching nursing home: Differences among NAs, LPNs and RNs. *The Gerontologist*, 30, 107-112.

- Burke, J. P. (2003). Infection control: A problem for patient safety. *New England Journal of Medicine*, 348(7), 651-656.
- Cabrera, I., & Lee, M. (2000). Reducing noise pollution in the hospital setting by establishing a department of sound: A survey of recent research on the effects of noise and music in health care. *Preventative Medicine*, 30, 339-345.
- Carayon, P., Alvarado, C. J., & Hundt, A. S. (2003). *Reducing workload and increasing patient safety through work and work-space design*. Madison WI: Center for Quality and Productivity Improvement.
- Carayon, P., & Gurses, A. P. (2005). A human factors engineering conceptual framework of nursing workload and patient safety in intensive care units. *Intensive and Critical Care Nursing*, 21, 284-301.
- Carpman, J. R., & Grant, M. A. (1993). *Design that cares: Planning health facilities for patients and visitors 2nd edition*. San Francisco, CA: Jossey-Bass.
- Cavanagh, S. J. (1992). Job satisfaction of nursing staff working in hospitals. *Journal of Advanced Nursing*, 17, 704-711.
- Cawood, C. (1993). Nursing units and common staffing problems. In D. K. Hamilton (Ed.) *Unit 2000: Patient beds for the future. A nursing unit design symposium* (pp. 103-109). Houston: Watkins Carter Hamilton Architects, Inc.
- Chaudhury, H., Mahmood, A. & Valente, M. (2005). Advantages and disadvantages of single vs. double occupancy patient rooms in acute care environments: A review and analysis of the literature. *Environment and Behavior*, 37(6), 760-786.
- Chaudhury, H., Mahmood, A. & Valente, M. (2006, August). Nurses' preference for single versus multi-occupancy patient rooms in acute care environments: An exploratory comparative assessment. *Applied Nursing Research*, 18(3).
- Christensen, K. E. An impact analysis framework for calculating the costs of staff disorientation in hospitals. Hospital Orientation Project. Wayfinding in Hospital Environments: A school of Architecture and Urban Planning Report Series. Unpublished manuscript, University of California, Los Angeles.
- Cohen, B., Saiman, L., Cimiotti, J., & Larson, E. (2003). Factors associated with hand hygiene practices in two neonatal intensive care units. *Pediatric Infectious Disease Journal*, 22(6), 494-499.
- Dettenkofer, M., Seegers, S., Antes, G., Motschall, E., Schumacher, M., & Daschner, F. D. (2004). Does the architecture of hospital facilities influence nosocomial infection rates? A systematic review. *Infection Control and Hospital Epidemiology*, 25(1), 21-25.
- Ebben, J. M. (2001). Let there be appropriate light. *HE Solutions*, 37-40.
- Emery, S., Nennig, M., & Gold, D. (2005). Control of a methicillin-resistant *Staphylococcus aureus* (MRSA) cluster in critical care by reinforcing hand hygiene and standard precautions. *American Journal of Infection Control*, 33(5), E53-E54.
- Ernst, M., Messmer, P. R., Franco, M., & Gonzalez, J. L. (2004). Nurses' job satisfaction, stress, and recognition in a pediatric setting. *Pediatric Nursing*, 30, 219-227.
- Fisher, S. (1982). Design reduces nurses' walking, encourages patients to visit with each other. *American Health Care Association Journal*, 8(2), 40-43.
- Franco, G., & Fusetti, L. (2004). Bernardino Ramazzini's early observations of the link between musculoskeletal disorders and ergonomic factors. *Applied Ergonomics*, 35, 67-70.
- Gadbois, C., Bourgeois, P., Goeh-Akue-Gad, M. M., Guillaume, J., & Urbain, M. A. (1992). Hospital design and the temporal and spatial organization of nursing activity. *Work & Stress*, 6(3), 277-291.
- Garg, A., & Owen, B. (1992). Reducing back stress to nursing personnel: An ergonomic intervention in a nursing home. *Ergonomics*, 35(11), 1353-1375.
- Gershon, R. R. M., Karkashian, C. D., Grosch, J. W., Murphy, L., Escamilla-Cejudo, A., Flanagan, P. A., Bernacki, E., Kasting, C., & Martin, L. (2000). Hospital safety climate and its relationship with safe work practices and workplace exposure incidents. *American Journal of Infection Control*, 28(3), 211-221.

- Gillespie, M., & Melby, V. (2003). Burnout among nursing staff in accident and emergency and acute medicine: A comparative study. *Journal of Clinical Nursing*, 12, 842-851.
- Girard, N. E. (1978). Room clusters facilitate nursing care. *Modern Healthcare*, 8, 46-47.
- Gotlieb, J. (2000). Understanding effects of nurses, patients' hospital rooms, and patients' perception of control in the perceived quality of a hospital. *Health Marketing Quarterly*, 18(1/2), 1-14.
- Gotlieb, J. (2002). Understanding the effects of nurses on the process by which patients develop hospital satisfaction. *Holistic Nursing Practice*, 17(1), 49-60.
- Gould, D. (1994). Nurses' hand decontamination practice: Results of a local study. *Journal of Hospital Infection*, 28, 15-30.
- Gould, D., & Ream, E. (1993). Assessing nurses' hand decontamination performance. *Nursing Times*, 89(25), 47-50.
- Greenberg, L. A. (2000). Planning a nurse station for clinical function. (Herman Miller for Healthcare). <http://www.hermanmiller.com/healthcare>
- Gross, R., Sasson, Y., Zarhy, M., & Zohar, J. (1998). Healing environment in psychiatric hospital design. *General Hospital Psychiatry*, 20, 108-114.
- Hall, L. M., Doran, D., & Pink, G. H. (2004). Nurse staffing models, nursing hours, and patient safety outcomes. *Journal of Nursing Administration*, 34(1), 41-45.
- Hamilton, D. K. (1993). (Ed.) *Unit 2000: Patient beds for the future*. Bellaire, TX: Watkins Carter Hamilton Publications.
- Happell, B., Martin, T., & Pinikahana, J. (2003). Burnout and job satisfaction: A comparative study of psychiatric nurses from forensic and a mainstream mental health service. *International Journal of Mental Health Nursing*, 12, 39-47.
- Harrison, S. (2004). Bad hospital design leads to poor staff performance. *Nursing Standard*, 18(46), 7.
- Hendrich, A., Fay, J., & Sorrells, A. (2002, September). Acuity-adaptable patient rooms and decentralized nursing stations—A winning combination. *Healthcare Design*, 11-13.
- Hendrich, A., Fay, J., & Sorrells, A. K. (2004). Effects of acuity-adaptable rooms on flow of patients and delivery of care. *American Journal of Critical Care*, 13(1), 35-45.
- Hignett, S., & Richardson, B. (1995). Manual handling human loads in a hospital: An exploratory study to identify nurses' perceptions. *Applied Ergonomics*, 26(3), 221-226.
- Hodge, B., & Thompson, J. F. (1990). Noise pollution in the operating theatre. *Lancet*, 335 (8694), 891-894.
- Hodgkinson, B., Koch, S., Nay, R., & Nichols, K. (2006). Strategies to reduce medication errors with reference to older adults. *International Journal of Evidence Based Healthcare*, 4, 2-41.
- Hoffman, A. J., & Scott, L. D. (2003). Role stress and career satisfaction among registered nurses by work shift patterns. *Journal of Nursing Administration*, 33(6), 337-342.
- Hosking, S., & Haggard, L. (1999). Departmental components of the average hospital. In S. Hosking and L. Haggard, *Healing the hospital environment: Design, management and maintenance of healthcare premises* (pp.53-82). London: Routledge.
- Institute of Medicine (IOM) (2004). *Keeping patients safe: Transforming the work environment of nurses*. Washington, DC: National Academy Press.
- Janowitz, I. L., Gillen, M., Ryan, G., Rempel, D., Trupin, L., Swig, L. et al. (in press). Measuring the physical demands of work in hospital settings: Design and implementation of an ergonomics assessment. *Applied Ergonomics*, 1- 18.
- Janssen, P. A., Harris, S. J., Soolsma, J., Klein, M. C., & Seymour, L. C. (2001, September). Single room maternity care: The nursing response. *Birth*, 28(3), 173-179.

- Jenkins, R., & Elliott, P. (2004). Stressors, burnout and social support: Nurses in acute mental health settings. *Journal of Advanced Nursing*, 48(6), 622-631.
- Jiang, S., Huang, L., Xilong, C., Jinfeng, W., Wei, W. et al. (2003). Ventilation of wards and nosocomial outbreak of severe acute respiratory syndrome among healthcare workers. *Chinese Medical Journal*, 116(9), 1293-1297.
- Joint Commission of Accreditation of Healthcare Organizations (JCAHO) (2002). *Healthcare at the crossroad: Strategies for addressing the evolving nursing crisis*. Oakbrook Terrace, IL: Joint Commission of Accreditation of Healthcare Organizations
- Kalliath, T., & Morris, R. (2002). Job satisfaction among nurses. *Journal of Nursing Administration*, 32(12), 648-654.
- Kaplan, L. M., & McGuckin, M. (1986). Increasing handwashing compliance with more accessible sinks. *Infection Control*, 7(8), 408-410.
- Kibbler, C. C., Quick, A., & O'Neill, A. M. (1998). The effect of increased bed numbers on MRSA transmission in acute medical wards. *Journal of Hospital Infection*, 39, 213-219.
- Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (2000). *To err is human: Building a safer health system*. Washington, D.C.: National Academy Press.
- Kroemer, K. H. E., & Kroemer, A. D. (2001). *Office ergonomics*. London: Taylor & Francis Ltd.
- Krueger, G. P. (1994). Fatigue, performance, and medical error. In M. S. Bogner (Ed.) *Human error in medicine* (pp. 311-326). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Kumari, D. N., Haji, T. C., Keer, V., Hawkey, P. M., Duncanson, V., & Flower, E. (1998). Ventilation grilles as a potential source of methicillin-resistant *Staphylococcus aureus* causing an outbreak in an orthopaedic ward at a district general hospital. *The Journal of Hospital Infection*, 39(2), 127-133.
- Kwallek, N., & Lewis, C. M. (1990). Effects of environmental color on males and females: A red or white or green office. *Applied Ergonomics*, 21(4), 275-278.
- Lane, I. M., Prestholdt, P. H., & Mathews, R. C. (1991). Organizational factors associated with beliefs of nurses that influence turnover. *Journal of Organizational Behavior*, 12(7), 641-649.
- Lankford, M. G., Zembower, T. R., Trick, W. E., Hacek, D. M., Noskin, G. A., & Peterson, L. R. (2003). Influence of role models and hospital design on hand hygiene of health care workers. *Emerging Infectious Diseases*, 9(2), 217-223.
- Larson, E. (1988). A causal link between handwashing and risk of infection? Examination of evidence. *Infection Control*, 8, 28-36.
- Leaman, A., & Bordass, B. (2000). Productivity in buildings: The killer variables. In D. Clemence-Croom (Ed.), *Creating the productive workplace* (pp. 165-191). London: Spon Press.
- Leather, P., Beale, D., & Sullivan, L. (2003). Noise, psychosocial stress and their interaction in the workplace. *Journal of Environmental Psychology*, 23, 213-222.
- Leape, L. L. (1994). Error in medicine. *Journal of the American Medical Association*, 272(23), 1851-1857.
- Leape, L. L. (2000). Institute of Medicine medical error figures are not exaggerated. *Journal of the American Medical Association*, 284(1), 95-97.
- Leape, L. L., Bates, D., Cullen, D., Cooper, J., Demenaco, H., Gallivan, T., Hallisey, R., Ives, J., Laird, N., Laffel, G., Nemeskal, R., Peterson, L., Porter, K., Servi, S., Shea, B., Small, S., Sweitzer, B., Thompson, B., & Vander Vleit, M. (1995). Systems analysis of adverse drug events. *Journal of the American Medical Association*, 274(1), 35-43.
- Leape, L. L., & Berwick, D. M. (2000). Safe health care: Are we up to it? *British Medical Journal*, 320, 725-726.

- Leape, L. L., & Berwick, D. M. (2005). Five years after *To Err Is Human*: What have we learned? *Journal of the American Medical Association*, 293(19), 2384-2389.
- Leape, L. L., Berwick, D. M., & Bates, D. W. (2002). What practices will most improve patient safety? *Journal of the American Medical Association*, 288(4), 501-507.
- Leape, L. L., Brennan, T. A., Laird, N., Lawthers, A. G., Localio, R., Barnes, B. A. et al. (1991). The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *The New England Journal of Medicine*, 324(6), 377-384.
- Leape, L. L., Woods, D. D., Hatlie, M. J., Kizer, K. W., Schroeder, S. A., & Lundberg, G. D. (1998). Promoting patient safety by preventing medical error. *Journal of the American Medical Association*, 280(16), 1444-1447.
- Lee, S. Y., & Brand, J. L. (2005). Effects of control over office workspace on perceptions of the work environment and work outcomes. *Journal of Environmental Psychology*, 25, 323-333.
- Leibrock, C. A. (2000). Inpatient hospitals: General hospitals (Chapter 13). In C. Leibrock, *Design details for health: Making the most of interior design's healing potential* (pp.231-256). New York: John Wiley & Sons, Inc.
- Leiter, M. P., Harvie, P., & Frizzell, C. (1998). The correspondence of patient satisfaction and nurse burnout. *Social Science and Medicine*, 47, 1611-1617.
- Lockhart, J. (2005). The healthcare-associated training calendar: An innovative approach to infection control education. *American Journal of Infection Control*, 33(5), E69.
- Lu, H., While, A. E., & Barriball, K. L. (2005). Job satisfaction among nurses: A literature review. *International Journal of Nursing Studies*, 42, 211-227.
- Lum, L., Kervin, J., Clark, K., Reid, F., & Sirola, W. (1998). Explaining nursing turnover intent: Job satisfaction, pay satisfaction, or organizational commitment? *Journal of Organizational Behavior*, 19(3), 305-320.
- Luna, T. D., French, J., & Mitcha, J. L. (1997). A study of USAF air traffic controller shiftwork: Sleep, fatigue, activity, and mood analyses. *Aviation, Space, and Environmental Medicine*, 68(1), 18-23.
- Lundstrom, T., Pugliese, G., Bartley, J., Cox, J., & Guither, C. (2002). Organizational and environmental factors that affect worker health and safety and patient outcomes. *American Journal of Infection Control*, 30(2), 93-106.
- McCarthy, M. (2004). Healthy design. *The Lancet*, 364, 405-406.
- McCaughy, B. (2005, June 6). Coming Clean, *The New York Times*, p. A19.
- McClanahan, S., Goodwin, S. T., & Houser, F. (2000). A formula for errors: Good people + bad systems. In P.L. Spath (Ed.) *Error regulation in health care: A systems approach to improving patient safety*, (pp. 1-15). San Francisco, CA: Jossey-Bass.
- McNeese-Smith, D. K. (2001). Staff nurse views of their productivity and nonproductivity. *Health Care Management Review*, 26(2), 7-19.
- McVicar, A. (2003). Workplace stress in nursing: A literature review. *Journal of Advanced Nursing*, 44(6), 633-642.
- Ma, C., Samuels, M. E., & Alexander, J. W. (2003). Factors that influence nurses' job satisfaction. *Journal of Nursing Administration*, 33(5), 293-299.
- Mahnke, F. (1996). *Color, Environment, and Human Response*. New York: Van Nostrand Reinhold.
- Malkin, J. (1982). *The design of medical and dental facilities*. New York: Van Nostrand Reinhold Co.
- Malkin, J. (1992). *Hospital interior architecture: Creating healing environments for special patient populations*. New York: Van Nostrand Reinhold Co.

- Marans, R. W., & Spreckelmeyer, K. F. (1981). *Evaluating built environments: A behavioral approach*. Ann Arbor, MI: Institute for Social Research & Architectural Research Laboratory.
- Maslach, C., & Jackson, S. E. (1986). *Maslach burnout inventory. Research edition manual*. Palo Alto, CA: Consulting Psychologists Press.
- Menzies, D., Fanning, A., Yaun, L., & FitzGerald, J. M. (2000). Hospital ventilation and risk for tuberculosis infection in Canadian health care workers. *Annals of Internal Medicine*, 133(10), 779-789.
- Meurier, C. E., Vincent, C. A., & Parmar, D. G. (1997). Learning from errors in nursing practice. *Journal of Advanced Nursing*, 26, 111-119.
- Miller, R. L., & Swensson, E. S. (1995). The patient care unit (Chapter 9) New directions in hospital and healthcare facility design (pp.177-208). New York: McGraw-Hill, Inc.
- Moeser, S. D. (1988). Cognitive mapping in a complex building. *Environment and Behavior*, 20(1), 21-49.
- Mroczek, J., Mikitarian, G., Vieira, E. K., & Rotarius, T. (2005). Hospital design and staff perceptions: An exploratory analysis. *The Health Care Manager*, 24(3), 233-244.
- Muto, C. A., Siström, M. G., & Farr, B. M. (2000). Hand hygiene rates unaffected by installation of dispensers of a rapidly acting hand antiseptic. *American Journal of Infection Control*, 28(3), 273-276.
- Nicklin, W., & McVeety, J. E. (2002). Canadian nurses' perceptions of patient safety in hospitals. *Canadian Journal of Nursing Leadership*, 15(3), 11-21.
- Nightingale, F. (1859). *Notes on nursing: What it is and what it is not*. London: John W. Parker & Son.
- Norbeck, J. S. (1985). Perceived job stress, job satisfaction, and psychological symptoms in critical care nursing. *Research in Nursing & Health*, 8(3), 253-259.
- Noskin, G. A., & Petersen, L. R. (2001). Engineering infection control through facility design. *Emerging Infectious Diseases*, 7(2), 354-357.
- O'Connell, N. H., & Humphreys, H. (2000). Intensive care unit design and environmental factors in the acquisition of infection. *Journal of Hospital Infection*, 45, 255-262.
- O'Malley, A., Varadharajan, V., & Lok, S. (2005). Hand decontamination by medical staff in general medical wards. *Journal of Hospital Infection*, 59, 369-376.
- Olofsson, B., Bengtsson, C., & Brink, E. (2003). Absence of response: A study of nurses' experience of stress in the workplace. *Journal of Nursing Management*, 11, 351-358.
- Page, A. (Ed.). (2004). Work and workspace design to prevent and mitigate errors. In *Keeping patients safe: Transforming the work environment of nurses* (pp. 226-285). Washington, D.C.: The National Academies Press.
- Paparella, S. (2005). A safe haven for nurses to report medication errors? Clarian and Spectrum health systems prove it is possible. *Journal of Emergency Nursing*, 31(4), 373-375.
- Pittet, D., Mourouga, P., & Perneger, T. V. (1999). Compliance with handwashing in a teaching hospital. *Annals of Internal Medicine*, 130(2), 126-130.
- Preston, G. A., Larson, E. L., & Stamm, W. E. (1981). The effect of private isolation rooms on patient care practices, colonization and infection in an intensive care unit. *The American Journal of Medicine*, 70, 641-645.
- Rabinowitz, P. M. (2005). Is noise bad for your health? *The Lancet*, 365, 1908-1909.
- Reason, J. (2000). Human error: Models and management. *British Medical Journal*, 320, 768-770.
- Reason, J. (1997). *Managing the risks of organizational accidents*. Brookfield, VT: Ashgate.

- Reason, J. (1990). *Human Error*. Cambridge: Cambridge University Press.
- Redstone, L. G. (Ed.) (178). *Hospitals and healthcare facilities*. NY: McGraw- Hill Book Co.
- Reiling, J. (2002). Designing a safe hospital. *Center for the Study of Healthcare Management*. www.hsr.umn.edu/mha/center/4220.pdf
- Reiling, J., & Bauer, A. (2002). The impact of facility design on patient safety. *Focus on Patient Safety*, 5(3), 3-4.
- Reiling, J., Berry, L. L., Parker, D., Coile Jr., R. C., et al. (2004). Facility design focused on patient safety/reply. *Frontiers of Health Services Management*, 21(1), 41-51.
- Reiling, J., Breckbill, C., Murphy, M., McCullough, S., & Chernos, S. (2003, May-June). Facility designing around patient safety and its effect on nursing. *Nursing Economic\$,* 21(3), 143-147.
- Reiling, J., & Knutzen, B. L. (2003). FMEA – the cure for medical errors. *Quality Progress*, 36(8), 67-71.
- Renzi, C., Tabolli, S., Ianni, A., Di Pietro, C., & Puddu, P. (2005). Burnout and job satisfaction comparing healthcare staff of a dermatological hospital and general hospital. *Journal of the European Academy of Dermatology and Venereology*, 19, 153-157.
- Reynolds, D. M., Johnson, M. H., Longe, R. L. (1978). Medication delivery time requirements in centralized and decentralized unit dose drug distribution systems. *American Journal of Hospital Pharmacy*, 35(8), 941-943.
- Rogers, A. E., Hwang, W., Scott, L. D., Aiken, L. H., & Dinges, D. F. (2004). The working hours of hospital staff nurses and patient safety. *Health Affairs*, 23(4), 202-212.
- Rollins, J. A. (2004). Evidence-based hospital design improves health care outcomes for patients, families, and staff. *Pediatric Nursing*, 30(4), 338-339.
- Rubin, H. (1997). The relationship between environmental design and patient medical outcomes. *Journal of Healthcare Design*, 9, 13-14.
- Ruck, N. (1989a). Luminous environment. In N. Ruck (Ed.), *Building design and human performance* (pp. 40-59). New York, NY: Van Nostrand Reinhold Co.
- Schwarz, H. O., & Brodowy, B. A. (1995). Implementation and evaluation of an automated dispensing system. *American Journal of Health-System Pharmacy*, 52, 823-828.
- Scott, H. (2004). Working environments have a direct impact on care. *British Journal of Nursing*, 13(15), 893.
- Seeyle, A. (1982). Hospital ward layout and nurse staffing. *Journal of Advanced Nursing*, 7, 195-201.
- Sehulster, L., & Chinn, R. Y. W. (2003). *Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)*, 52(RR-10), 1-44.
- Shaver, K. H., & Lacey, L. M. (2003). Job and career satisfaction among staff nurses: Effects of job setting and environment. *Journal of Nursing Administration*, 33(3), 166-172.
- Shepley, M. M., & Davies, K. (2003). *Nursing unit configuration and its relationship to noise and nurse walking behavior: An AIDS/HIV unit case study*. Retrieved 11/26/2004, from http://www.aia.org/aah_a_jrnl_0401_article4
- Shumaker, S. A., & Pequegnat, W. (1989). Hospital design, health providers, and the delivery of effective health care. In E. H. Zube & G. T. Moore (Eds.), *Advances in environment, behavior, and design, Vol. 2* (pp. 161-199). New York: Plenum.
- Shumaker, S. A. & Reizemstein, J. E. (1982). Environmental factors affecting inpatient stress in acute care hospitals. In G. Evans (Ed.), *Environmental stress* (pp. 179-223). Cambridge, London: Cambridge University Press.
- Sochalski, J. (2001). Quality of care, nurse staffing, and patient outcomes. *Policy, Politics, & Nursing Practice*, 2(1), 9-18.

- Sochalski, J. (2004). Is more better? The relationship between nurse staffing and the quality of nursing care in hospitals. *Medical Care*, 42(2), 1167-1173.
- Spreckelmeyer, K. (2004, June 1). Ten design recommendations to improve environmental quality of nursing units. *Environmental Quality of Nursing Units*, 1-6.
- Spreckelmeyer, K. F. (1987). Environmental norms in the work place. *Design Methods and Theories*, 21(4), 723-730.
- Stelfox, H. T., Bates, D. W., & Redelmeir, D. A. (2003). Safety of patients isolated for infection control. *Journal of the American Medical Association*, 290(14), 1899-1905.
- Stichler, J. F. (2001). Creating healing environments in critical care units. *Critical Care Nursing Quarterly*, 24(3), 1-20.
- Stone, N. J. (2003). Environmental view and color for a simulated telemarketing task. *Journal of Environmental Psychology*, 23, 63-78.
- Stone, N. J., & English, A. J. (1998). Task type, posters, and workspace color on mood, satisfaction, and performance. *Journal of Environmental Psychology*, 18, 175-185.
- Sturdavant, M. (1960). Intensive nursing service in circular and rectangular units. *Hospitals, JAHA*, 34(14), 46-48, 71-78.
- Sundstrom, E. (1987). Work environments: Offices and factories. In D. Stokols & I. Altman (Eds.), *Handbook of Environmental Psychology* (pp. 733-782). New York: Wiley.
- Sundstrom, E., & Sundstrom, M. G. (1986). *Work places: The psychology of the physical environment in offices and factories*. Cambridge: Cambridge University Press.
- Sundstrom, E., Town, J. P., Rice, R. W., Osborn, D. P., & Brill, M. (1994). Office noise, satisfaction, and performance. *Environment and Behavior*, 26(2), 195-222.
- Suzuki, K., Ohida, T., Kaneita, Y., Yokoyama, E., & Uchiyama, M. (2005). Daytime sleepiness, sleep habits and occupational accidents among hospital nurses. *Journal of Advanced Nursing*, 52(4), 445-453.
- Taylor, B., & Barling, J. (2004). Identifying sources and effects of career fatigue and burnout for mental health nurses: A qualitative approach. *International Journal of Mental Health Nursing*, 13, 117-125.
- Tissot, E., Cornette, C., Demoly, P., Jacquet, M., Barale, F., & Capellier, G. (1999). Medication errors at the administration stage in an intensive care unit. *Intensive Care Medicine*, 25, 353-359.
- Tofle, R. B., Schwarz, B., & Max-Royale, A. (2004). *Color in healthcare environments: A monograph reference guide*.
- Topf, M. & Dillon, E. (1988). Noise-induced stress as a predictor of burnout in critical care nurses. *Heart Lung*, 17(5), 567-574.
- Tradewell, G. B. (1993). Contemporary nursing unit configuration. In D. K. Hamilton (Ed.) *Unit 2000: Patient beds for the future. A nursing unit design symposium* (pp. 191-215). Houston: Watkins Carter Hamilton Architects, Inc.
- Trites, D. K., & Schwartz, N. W. (1967). Nursing or clerking. *Nursing Outlook*, 55-56.
- Trites, D. K., Galbraith, F. D. Jr., Leckwart, J. F., & Sturdavant, M. (1968). Radial nursing units prove best in controlled study. *Modern Hospital*, 112(4), 94-99.
- Trites, D. K., & Schwartz, N. W. (1967). Nursing or clerking. *Nursing Outlook*, 55-56.
- Tuttas, C. A. (2003). Decreasing nurse staffing costs in a hospital setting: Development and support of core staff stability. *Journal of Nursing Care Quality*, 18(3), 226-240.
- Tyson, G. A., Lambert, W. G., & Beattie, L. (2002). The impact of ward design on the behaviour, occupational satisfaction and well-being of psychiatric nurses. *International Journal of Mental Health Nursing*, 11, 94-102.

- Tyson, G.A, Lambert, W. G., & Beattie, L. (1995). The quality of psychiatric nurses' interaction with patients: An observational study. *International Journal of Nursing Studies*, 32, 49-58.
- Ulrich, R., & Barach, P. (2006, February). *Designing safe healthcare facilities—What are the data and where do we go from here?* Paper presented at the Healthcare Environments Research Summit 2006, Atlanta, GA.
- Ulrich, R., Zimring, C., Quan, X., Joseph, A., & Choudhary, R. (2004). *The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity*. Report to the Center for Health Design for the Designing the 21st Century Hospital Project.
- Unruh, L. (2003). Licensed nurse staffing and adverse events in hospitals. *Medical Care*, 41(1), 142-152.
- Upenieks, V.V. (1998). Work sampling: Assessing nursing efficiency. *Nursing Management*, 29(4), 27-29.
- Vahey, D. C., Aiken, L. H., Sloane, D. M., Clarke, S. P., & Vargas, D. (2004). Nurse burnout and patient satisfaction. *Medical Care*, 42(2), 1157-1166.
- Verderber, S., & Fine, D. J. (2000). Reinventing the patient room. In S. Verderber & D. Fine, *Healthcare architecture in an era of radical transformation* (pp. 195-222). New Haven, CT: Yale University Press.
- Vietri, N. J., Dooley, D. P., Davis, C. E. Jr., Longfield, J. N., Meier, P.A., & Whelen, A. C. (2004). The effect of moving to a new hospital facility on the prevalence of methicillin-resistant *Staphylococcus aureus*. *American Journal of Infection Control*, 32, 262-267.
- Weber, D. O. (1995, March-April). Environments that heal. *The Healthcare Forum Journal*, 38(2), 42.
- Whitby, M., & McLaws, M. L. (2004). Handwashing in healthcare workers: Accessibility of sink location does not improve compliance. *Journal of Hospital Infection*, 58, 247-253.
- Whitman, G. R., Kim, Y., Davidson, L. J., Wolf, G. A., & Wang, S. (2002). The impact of staffing on patient outcomes across specialty units. *Journal of Nursing Administration*, 32(12), 633-639.
- Williams, M.A. (1988). The physical environment and patient care. *Annual Review of Nursing Research*, 6, 61-84.
- Wineman, J. D. (1979). Color in environmental design: Its impact on human behavior. *Environmental Design Research Association*, 10, 436-439.
- Yang, K. (2003). Relationships between nurse staffing and patient outcomes. *Journal of Nursing Research*, 11(3), 149-157.
- Yassi, A., Cohen, M., Cvitkovich, Y., Park, I. H., Ratner, P.A., Ostry, A. S., Village, J., & Pollack, N. (2004). Factors associated with staff injuries in intermediate care facilities in British Columbia, Canada. *Nursing Research*, 53(2), 87-98.

Empirical Study

In the empirical portion of this study, we collected, analyzed, and interpreted information on staffs' perception of medication and documentation error, job performance, and satisfaction in acute-care settings. Additionally, we visited key hospitals that have implemented design features that deal with patient safety and medical errors.

This study was divided into three sections:

- a) Survey with nursing staff utilizing a structured questionnaire
- b) Focus groups with key personnel dealing with error-related issues (e.g., nurse manager, charge nurse, care aide, pharmacist, risk manager, and administrative staff)
- c) Site visits to acute-care environments that have incorporated design features to enhance patient safety and reduction of errors

Survey with Nursing Staff

Participants

Our research team conducted cross-sectional surveys with nursing staff members, and the sampling frame for this study included nurses working in the Pacific Northwest region of the United States (Portland and Seattle). The sample comprised of 84 nurses, 16 worked at Providence Portland, 22 worked at Providence St. Vincent (Portland), 4 worked at Providence Newburg (Portland), and 42 worked at Swedish Hospital (Seattle). The majority of participants were female (N = 80, 95.2%). Most participants fell within the age range of 26-55 (N = 71, 84.5%). Regarding job designation, the majority of participants were staff nurses (N = 53, 63.1%), followed by charge nurses (N = 24, 28.6%). Few nurses worked as clinical coordinators (N = 3, 3.6%), nurse's aides (N = 2, 2.4%), or float nurses (N = 2, 2.4%). Most nurses have been working in their place of employment for an average of 11.3 years and have approximately 16 years of experience in their profession.

Procedures

The survey questionnaires were mailed to an administrative contact person in each hospital who distributed the surveys among nursing staff in different medical-surgical units. The survey questionnaire took between 30 and 45 minutes to complete. A cover letter was included on the questionnaire detailing the purpose of this study. Once questionnaires were complete, they were collected by the same contact person and mailed back to the researchers. All the participants in this study were remunerated with a gift card.

Measures

Questionnaires administered to nursing staff focused on nursing-unit design, the medication room, errors and adverse events, job performance and satisfaction, and demographic information.

Demographic Information

Participants were asked to provide their gender and age. They were also asked to select their job designation from a variety of choices including nurse manager, charge nurse, staff nurse, nurse aide, clerk, and other. The participants were requested to specify the amount of time they had worked at their current hospital and the number of years experience they had in their profession.

Nursing Units

Participants were asked whether certain environment characteristics in their nursing units were helpful or problematic in their work performance. Items included nursing-station layout, availability of space in the charting area, and walking distance to patient rooms, among others. Questions were based on a 5-point Likert scale ranging from problematic to helpful.

Medication Room and Errors

Participants were asked to identify activities related to medication ordering, storage, dispensation preparation and administration, as well as the location of these activities. There was a series of questions regarding the medication room, including the appropriateness of its location, the size, and organization of the room. Questions were also included regarding the benefits and drawbacks of an automated medication dispensation system.

Errors/Adverse Events

Participants were asked a series of questions regarding the medication errors that occur more or less frequently, as well as factors that contribute to these errors. Documentation errors and factors contributing to these errors were also addressed. A 5-point Likert scale was used, ranging from rarely to very frequently. Some items of this scale were adapted from the National Medical Practice Survey (Blendon, et al., 2002).

Questions also focused on staff and organizational issues, as well as physical environmental issues that lead to nursing errors. Items that were included are poor training of health professionals, high nurse-to-patient ratio, inadequate lighting, and inappropriate space layout of the nursing unit, among others. Participants were also asked to rank order the top five solutions regarding both staff and organizational issues and physical environmental issues that could prevent nursing errors and increase efficiency. Sample items include better training of health professionals; increasing the number of nurses per unit; an appropriate heating, cooling, and ventilation system; and adequate privacy in the workspace.

Job Performance and Satisfaction

The 17-item scale for job stress and burnout was used in this study. This scale was adapted from the Maslach Burnout Inventory (Maslach & Jackson, 1986). Items include feeling emotionally drained from work, becoming less enthusiastic about work, and feeling burned out from work. A 5-point Likert scale was used with ranks ranging from disagree to agree.

Results

Nursing Units

When asked what type of nursing station participants worked at, 48 (57.1%) nurses stated they worked in a centralized nursing station, while 7 (8.3%) stated they worked in a decentralized nursing station. Twenty-nine participants failed to respond to this question. Environmental characteristics seen as helpful for nurses include hand-washing and disinfection locations and protocols (N = 36, 43.4%). Environmental characteristics seen as somewhat helpful include storage space for dirty supplies (N = 26, 31.3%), the location of the medication room (N = 28, 34.1%), and the medication dispensation method (N = 28, 34.6%).

Environmental characteristics noted to be neither helpful nor problematic include the design of the furniture in the nursing station (N = 28, 33.7%), the arrangement of furniture (N = 35, 42.7%), lighting (N = 26, 31.3%), and the location of the storage area (N = 26, 31.7%) (see Table S1).

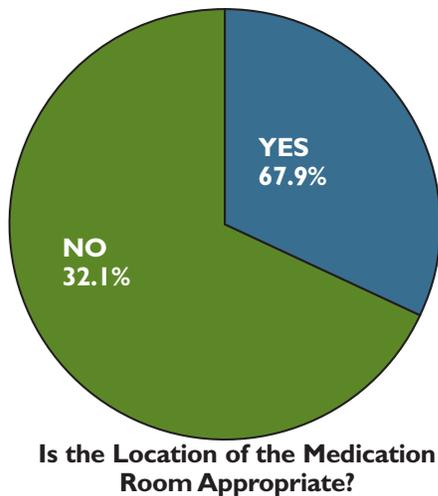
Most environmental characteristics were rated as somewhat problematic and include storage

Table S1: Problematic and Helpful Environmental Characteristics in the Nursing Unit

(Figures in Percent)	Helpful	Somewhat Helpful	Neither Helpful nor Problematic	Somewhat Problematic	Problematic
Nursing station layout	20.7	18.3	20.7	31.7	8.5
Availability of space in charting area	13.3	18.1	8.4	34.9	25.3
Design of furniture in nursing station	12.0	15.7	33.7	26.5	12.0
Arrangement of furniture in nursing station	12.2	9.8	42.7	28.0	7.3
Privacy in nursing station	7.2	12.0	15.7	26.5	38.6
Walking distance to patient rooms	19.3	16.9	18.1	28.9	16.9
Visibility to all areas of the nursing unit	12.2	7.3	6.1	36.6	37.8
Patient surveillance/monitoring	14.8	14.7	17.3	28.4	24.7
Storage space for clean supplies	12.0	21.7	21.7	27.7	16.9
Storage space for dirty supplies	6.0	31.3	22.9	19.3	20.5
Location of storage area (clean and dirty)	14.6	26.8	31.7	15.9	11.0
Location of medication room	20.7	34.1	20.7	12.2	12.2
Size of medication room	7.5	20.0	23.8	27.5	11.3
Medication dispensation method	27.2	34.6	16.0	17.3	4.9
Hand-washing and disinfection locations and protocols	43.4	26.5	16.9	2.4	10.8
Noise level/acoustics	7.2	15.7	20.5	34.9	21.7
Lighting in the space	22.9	25.3	31.3	14.5	6.0
Heating and cooling	2.4	21.7	27.7	33.7	14.5

space for clean supplies (N = 23, 27.7%), nursing-station layout (N = 26, 31.7%), availability of space in the charting area (N = 29, 34.9%), walking distances to patient rooms (N = 24, 28.9%), patient surveillance (N = 23, 28.4%), the size of the medication room (N = 22, 27.5%), noise levels (N = 29, 34.9%), and heating and cooling systems (N = 28, 33.7%). Problematic environmental characteristics include privacy in the nursing stations (N = 32, 38.6%) and visibility to all areas of the nursing unit (N = 31, 37.8%).

Figure S1: Appropriateness of Location of the Medication Room



Medication Room and Errors

The majority of participants felt the location of the medication room is appropriate for the nursing unit (N = 55, 67.9%) (see Figure S1). Those participants who felt the location is appropriate mainly did so because they felt it was in a central location (N = 37, 82.2%) (see Figure S2). Those who felt the location was not appropriate (N = 26, 32.1%) did so because the location was too far away (N = 6, 22.2%), there was not enough room (N = 5, 18.5%), or they did not have a room at all (N = 5, 18.5%) (see Figure S3).

Few participants (N = 16, 20.5%) felt there was a better location for a medication room within the nursing unit. Of these participants, most preferred a location close to the nursing station (N = 7, 35.0%). With regard to the size of the medication room, the majority of participants felt the room was just right (N = 36, 48.6%), while others felt the room was too small (N = 33, 44.6%). Few thought the room was too large (N = 5, 6.8%). Most participants found the organization of medication and supplies helpful (N = 57, 74.0%) and found the supplies organized and easy to locate (N = 58, 76.3%). Most participants also found the medication room was in a quiet location (N = 51, 68.0%).

With regard to an automated medication dispensation method, 67 participants (81.7%) stated they had one on their unit. Most dispensation units are located in the medication room (N = 26, 41.3%) or around the nurses' station (N = 17, 27.0%) (see Figure S4).

The main benefit of an automated medication dispensation system is the reduced possibility of an error occurring (N = 32, 25.6%). Other benefits include it being more timely (N = 21, 16.8%), tracking of medications and users (N = 14, 11.2%), readily available meds (N = 15, 12.0%), no narcotic counts (N = 10, 8.0%), better organization (N = 7, 5.6%), and it being safer for patients (N = 7, 5.6%) (see Table S2).

Some of the main drawbacks of an automated medication dispensation system include waiting times (N = 20, 24.4%), medications not being there when needed (N = 14, 17.1%), and a slow response time when ordering new medications (N = 14, 17.1%) (see Table S3).

Errors/Adverse Events

Figure S2: Why the Location of the Medication Room is Appropriate

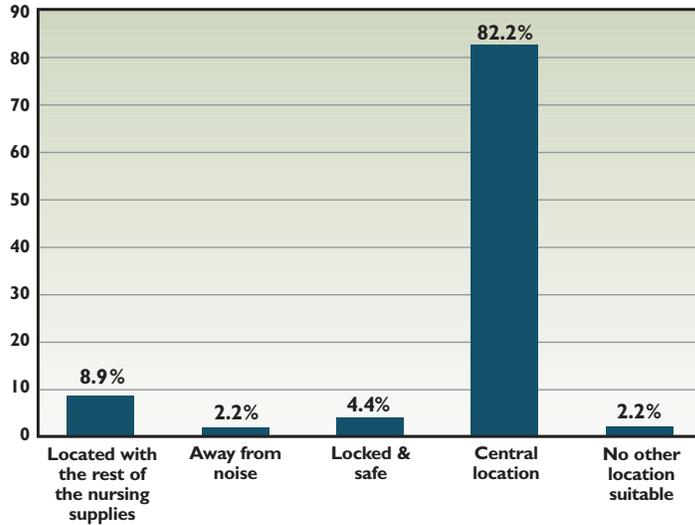
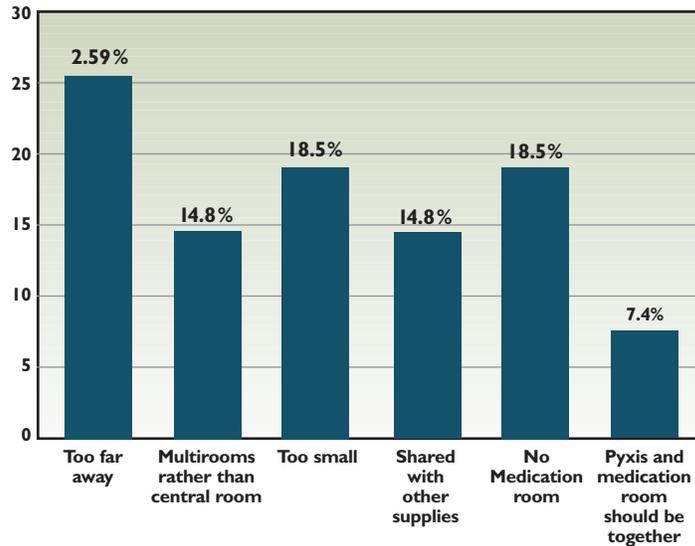


Figure S3: Why the Location of the Medication Room is Not Appropriate



Most medication errors were found to rarely occur. These include IV medication rates being too slow or too fast (N = 40, 47.6%), the wrong concentration or dosage of medication delivered in the IV (N = 56, 66.7%), the wrong route of administration (N = 61, 72.6%), wrong medication administration (N = 56, 66.7%), and wrong medication delivered due to the misidentification of a patient (N = 58, 69.0%). An error that occurs neither rarely nor frequently is the wrong time of medication administration (N = 23, 27.4%). One error that occurs somewhat frequently, on the other hand, is missed doses of medication (N = 24, 28.9%). Interestingly, 20 (24.1%) participants felt this error rarely occurred (see Table S4).

Figure S4: Location of Medication Dispensation Unit

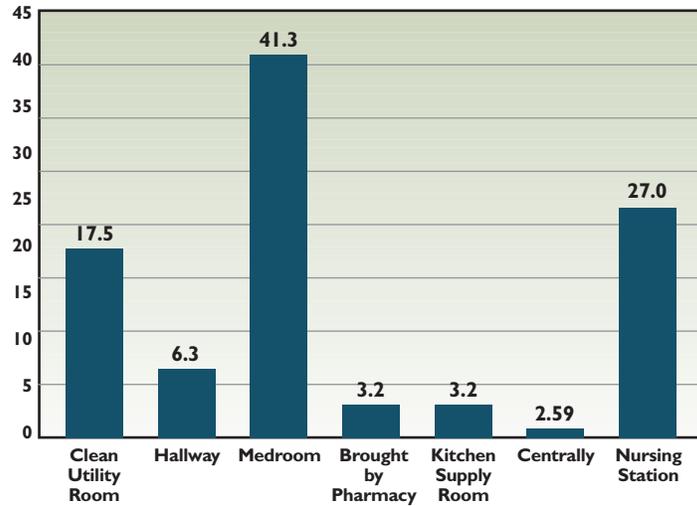


Table S2: Benefits of an Automated Medication Dispensation System

Benefits	Percentage
Less chance for error	25.6
More timely	16.8
Readily available medications	12.0
Tracking of medications and users	11.2
Narcotic counts	8.0
Safer for patients	5.6
More organized	5.6
Patient checks	4.0
Easy access	2.4
Better documentation	1.6
More accountability	1.6
Privacy	1.6
Fewer medications missing	0.8
No physical signing off of medications	0.8
Frees up pharmacist	0.8
Drugs programmed under generic and brand names	0.8
No benefits	0.8

Table S3: Drawbacks of an Automated Medication Dispensation System

Drawbacks	Percentage
Waiting times	24.4
Medication not there when needed	17.1
Slow response time when ordering new medications	17.1
Stocked incorrectly	7.3
Wrong medications easily dispensed	6.1
Staff may not think as much	4.9
Location of machine	4.9
Pharmacy slow to supply out-of-stock medications	3.7
No override feature	2.4
System failure	2.4
Need to verify correct medication and dosage entered in system	1.2
Able to take medications before needed	1.2
Patient information not entered in timely manner by Pyxis technician	1.2
Waiting for repairs	1.2
Reconciling medications difficult if narcotic count incorrect	1.2
Locating generic drugs	1.2
Error on pharmacy entries	1.2
Less contact with pharmacist	1.2

Table S4: Frequency of Occurrence of Medication Error

(Figures in Percent)	Very Frequently	Somewhat Frequently	Neither Frequently nor Rarely	Somewhat Often	Rarely	Don't Know
Missed doses of medication	2.4	28.9	21.7	18.1	24.1	4.8
Wrong time of medication administration	4.8	22.6	27.4	19.0	20.2	6.0
IV medication rate too slow or too fast	3.6	9.5	22.6	4.8	47.6	11.9
Wrong concentration or dosage of medication delivered in IV	0.0	4.8	9.5	4.8	66.7	14.3
Wrong route of medication administration	0.0	0.0	9.5	3.6	72.6	14.3
Wrong medication administered	0.0	0.0	15.5	3.6	66.7	14.3
Wrong medication delivered due to misidentification of patient	0.0	0.0	7.1	1.2	69.0	22.6

Overall, most participants felt that the automated medication dispensation method has somewhat reduced medication errors (N = 46, 56.1%).

All of the factors asked of participants as contributing to medication errors rarely contributed to an error. These include the location of the medication room (N = 50, 60.2%), inadequate size of the medication room (N = 50, 59.5%), problematic organization of the medical supplies (N = 46, 54.8%), high levels of noise (N = 38, 45.8%), poor lighting in the medication room (N = 53, 63.1%), unreadable or missing medication labels (N = 49, 58.3%), medication not being documented (N = 29, 34.5%), lack of supplies (N = 42, 50.6%), and calculation errors (N = 43, 52.4%) (see Table S5).

Table S5: Factors that Contribute to Medication Errors

(Figures in Percent)	Very Frequently	Somewhat Frequently	Neither Frequently nor Rarely	Somewhat Often	Rarely	Don't Know
Location of medication room	2.4	2.4	14.5	2.4	60.2	18.1
Small or inadequate size of medication room	1.2	1.2	17.9	1.2	59.5	19.0
Problematic organization of medical supplies	1.2	3.6	13.1	10.7	54.8	16.7
High level of noise	9.6	10.8	13.3	45.8	15.7	
Poor lighting in med room	1.2	2.4	17.9	0.0	63.1	15.5
Medication label unreadable or missing	3.6	6.0	11.9	4.8	58.3	15.5
Medication not documented on medication administration record	6.0	15.5	13.1	20.2	34.5	10.7
Lack of supplies (IV pumps, pill-slicer)	4.8	8.4	10.8	14.5	50.6	10.8
Calculation errors (incorrect conversion, incorrect calculation)	1.2	4.9	17.1	9.8	52.4	14.6

Most documentation errors were also found to rarely occur. These include documenting in the wrong patient chart (N = 55, 66.3%) and charting procedures or medications before they were completed (N = 39, 47.0%). A documentation error that was found to occur rarely (N = 24, 28.9%) or somewhat often (N = 23, 27.7%) is the omission of or partial information input in patient charts or records (see Table S6). Factors that rarely contribute to these errors include the location of the charting space (N = 31, 36.9%), small or inadequate size of the charting space (N = 28, 33.7%), poor lighting (N = 54, 64.3%), and high levels of noise (N = 28, 33.3%) (see Table S7).

Table S6: Frequency of Documentation Error

(Figures in Percent)	Very Frequently	Somewhat Frequently	Neither Frequently nor Rarely	Somewhat Often	Rarely	Don't Know
Documenting in wrong patient's chart	1.2	3.6	12.0	7.2	66.3	9.6
Omission or partial information input in charts/records	6.0	22.9	7.2	27.7	28.9	7.2
Charting procedures or medications before they were completed	3.6	8.4	12.0	12.0	47.0	16.9

Table S7: Factors that Contribute to Documentation Errors

(Figures in Percent)	Very Frequently	Somewhat Frequently	Neither Frequently nor Rarely	Somewhat Often	Rarely	Don't Know
Location of charting space	4.8	11.9	14.3	17.9	36.9	14.3
Small or inadequate size of charting space	6.0	19.3	14.5	15.7	33.7	10.8
Poor lighting	1.2	1.2	16.7	4.8	64.3	11.9
High level of noise	10.7	9.5	15.5	21.4	33.3	9.5

Other types of nursing errors that were identified as occurring by a few participants include omissions or late medication administration (N = 4, 11.8%), leaving medication at the patient bedside (N = 3, 8.8%), running IV bags when they are not placed on volumetric pumps (N = 3, 8.8%), transcription errors (N = 3, 8.8%), and confusion regarding protocols (N = 3, 8.8%) (see Table S8).

Various factors are seen as very important causes leading to nursing errors. These include poor training of health professionals (N = 41, 50.0%), overwork and stress of health professionals (N = 59, 70.2%), high nurse-to-patient ratio (N = 56, 66.7%), health professionals not working together as a team (N = 42, 50.0%), and poor handwriting by health professionals (N = 53, 63.1%). A factor seen as somewhat important causes leading to errors is a lack of computerized medical records (N = 37, 44.6%). Poor supervision of health professionals was not seen as a very important cause (N = 35, 42.7%). Interestingly, breach-of-infection precautions was not seen as very important by some nurses (N = 28, 33.3%), but was seen as being very important (N = 28, 33.3%) or somewhat important (N = 21, 25.0%) by other nurses. A similar pattern was obtained for high staff turnover, in that 28 (33.7%) participants felt this was somewhat important, 23 (27.7%) felt this was very important, while 25 (30.1%) participants felt this was not very important. Overall though, both breach-of-infection precautions and high staff turnover were seen as important rather than unimportant in contributing to nursing errors (see Table S9).

Table S8: Other Types of Nursing Errors

Types of Nursing Errors	Percentage (N = 22)
Omissions/late or wrong medication	11.8
Leaving medication at the patient's bedside	8.9
Transcription errors	8.9
Confusion regarding protocols	8.9
Running of IV bags when not placed on volumetric pumps	8.9
Delayed treatments	5.9
Not charting when medication given or procedure performed	5.9
Lack of knowledge	5.9
Missing care due to lack of time	2.9
Neglecting patient needs	2.9
Giving patient medications during sleep hours	2.9
Time not entered when new medications written on MAR	2.9
Lack of documentation	2.9
Missed dressing changes	2.9
Patient history not recorded	2.9
Lab errors	2.9
Not identifying patient properly	2.9
Improper application of equipment	2.9
Not completing Medicare form at discharge	2.9
Breast milk given to wrong patient	2.9

Table S9: Staff and Organizational Issues Leading to Nursing Errors

Staff and Organizational Issues (Figures in Percent)	Very Important	Somewhat Important	Not Very Important	Not at all Important
Poor training of health professionals	50.0	29.3	17.1	3.7
Overwork, stress, or fatigue of health professionals	70.2	27.4	2.4	0.0
High nurse-to-patient ratio	66.7	26.2	4.8	2.4
Health professionals not working together or not communicating as a team	50.0	39.3	9.2	1.2
Poor supervision of health professionals	17.1	30.5	42.7	9.8
Poor handwriting by health professionals	63.1	29.8	7.1	0.0
Lack of computerized medical records	21.7	44.6	25.3	8.4
High staff turnover	27.7	33.7	30.1	8.4
Breach-of-infection precautions	33.3	25.0	33.3	8.3

Few physical environmental issues were seen as not important in leading to nursing errors. These include inadequate lighting in the nursing station (N = 37, 44.0%), faulty ventilation systems (N = 39, 46.4%), non-ergonomic furniture (N = 36, 42.9%), and inadequate breakroom (N = 26, 31.0%). Factors seen as either very important or somewhat important in leading to nursing errors consist of lack of privacy in the nurses' work area (N = 51, 60.9%), inappropriate space layout in the nursing unit (N = 54, 61.9%), insufficient space for documentation for charting (N = 66, 78.6%), lack of space in the medication room (N = 46, 57.5%), high noise levels (N = 49, 59.0%), faulty medication dispensation equipment (N = 43, 51.2%), and the problematic location of the nursing station (N = 50, 59.5%). Inappropriate location of the medication room was not seen as very important by some participants (N = 27, 33.8%), but was seen as somewhat important by other participants (N = 23, 28.8%). Inadequate lighting in the medication room also received mixed results in that some participants (N = 25, 31.6%) found this to be not at all important, whereas other participants (N = 22, 27.8%) found lighting to be somewhat important in leading to nursing errors (see Table S10).

Table S10: Physical Environmental Issues Leading to Nursing Errors

Staff and Organizational Issues (Figures in Percent)	Very Important	Somewhat Important	Not Very Important	Not at all Important
Inadequate lighting in nursing station	8.3	28.6	44.0	19.0
Faulty heating, cooling, and ventilation system in nursing unit	8.3	22.6	46.4	22.6
Non-ergonomic furniture in nursing station	10.7	27.4	42.9	19.0
Lack of privacy in nurses' work area	29.8	31.0	28.6	10.7
Inappropriate space layout in the nursing unit	27.4	34.5	31.0	7.1
Insufficient space for documentation for charting/record keeping	39.3	39.3	14.3	7.1
Inadequate break room/lack of break room	26.2	20.2	31.0	22.6
Inappropriate location of medication room	23.8	28.8	33.8	13.8
Lack of space in medication room	18.8	38.8	27.5	15.0
Inadequate/inappropriate lighting in medication room	16.5	27.8	24.1	31.6
High noise level/acoustical problems in nursing unit	27.7	31.3	24.1	16.9
Faulty medication dispensation equipment	29.8	21.4	26.2	22.6
Problematic location of nursing station	20.2	39.3	23.8	16.7

When asked to rank possible solutions to staff and organizational issues, the number one solution was increasing the number of nurses per unit (N = 35, 47.9%). Better training of health professionals was also among the top solutions as it was ranked first by 17 participants (26.2%) and ranked second by 18 participants (27.7%). Reducing the number of work hours of nurses (N = 19, 32.8%) and using automated medication dispensation systems (N = 15, 26.3%) were both ranked third by a large number of participants. More use of computers instead of paper records for drug orders and medical tests was ranked both third (N = 16, 24.6%) and fifth (N = 14, 21.5%). Also ranking fifth was more use of computerized medical records (N = 22, 35.5%) and requiring hospitals to develop systems to avoid medical errors (N = 16, 25.0%) (see Table S11).

Table SI 1: Ranking of Solutions for Staff and Organizational Issues

Staff and Organizational Issues	Rank (Percentage)				
	1	2	3	4	5
Increasing the number of nurses per unit	47.9	15.1	13.7	11.0	9.6
Better training of health professionals	26.2	27.7	13.8	15.4	12.3
Reducing work hours of nurses to avoid fatigue-related errors	10.3	19.0	32.8	22.4	10.3
Automated medication dispensation system	12.3	19.3	26.3	17.5	19.3
More use of computers instead of paper records	10.8	18.5	24.6	20.0	21.5
More use of computerized medical records	11.3	14.5	19.4	16.1	35.5
Requiring hospitals to develop systems to avoid medical errors	12.5	15.6	20.3	20.3	25.0

The top ranked solution to physical environmental issues is appropriate medication dispensation equipment (N = 20, 35.7%). Also ranked as a top solution is sufficient space for documentation for charting (N = 18, 28.6%). Other factors that ranked among the top solutions include reduced noise levels in the nursing unit, appropriate lighting in the nursing station, adequate privacy in the work space, appropriate space layout in the nursing unit, adequate space in the medication room, and appropriate location of the medication room (see Table SI2).

Table SI2: Ranking of Solutions for Physical Environmental Issues

Staff and Organizational Issues	Rank (Percentage)				
	1	2	3	4	5
Appropriate medication dispensation equipment	35.7	14.3	16.1	19.6	10.7
Sufficient space for documentation for charting	28.6	23.8	9.5	19.0	15.9
Reduced level of noise in nursing unit	10.9	28.3	15.2	10.9	28.3
Appropriate location of medication room	15.8	23.7	18.4	7.9	23.7
Adequate privacy in workspace	17.8	22.2	13.3	15.6	22.2
Appropriate lighting in nursing station	9.4	3.1	34.4	18.8	18.8
Adequate space in medication room	8.6	5.7	30.6	14.3	22.2
Appropriate location of nursing station	19.1	12.8	14.9	21.3	21.3
Ergonomic furniture in nursing station	13.3	10.0	13.3	23.3	30.0
Break room providing adequate opportunity for rest	14.6	14.6	14.6	17.1	29.3
Adequate lighting in medication room	16.1	16.1	6.5	19.4	25.8
Appropriate space layout in nursing unit	23.4	12.8	21.3	17.0	25.5
Appropriate heating, cooling, and ventilation system	10.3	13.8	13.8	20.7	24.1
Appropriate flooring	10.0	15.0	15.0	10.0	20.0

Job Performance and Satisfaction

For the most part, participants stated that the physical working conditions help a great deal in affecting the manner in which they perform their job (N = 26, 36.6%). In terms of job stress, most participants somewhat agreed when asked if they felt emotionally drained from work (N = 27, 32.5%), felt used up at the end of the workday (N = 32, 38.6%), and felt tired when getting up in the morning to face another day on the job (N = 28, 34.1%). Most participants disagreed, however, when asked if they felt burned out from their work (N = 24, 29.6%) or if they had become less interested in their work since starting their job (N = 39, 47.0%). Participants also disagreed when asked if they have become less enthusiastic about their work (N = 30, 36.6%), if they just wanted to do their job and not be bothered (N = 39, 47.0%), if they have become more cynical about their work (N = 42, 51.2%), and if they doubted the significance of their work (N = 48, 58.5%). Mixed results were obtained when participants were asked whether working all day is a real strain.

On a positive note, participants agreed when asked if they can effectively solve the problems that arise from work (N = 47, 57.3%), if they effectively contribute to what the hospital does (N = 54, 64.3%), and if they feel confident that they are effective at getting things done (N = 55, 65.5%). Participants also agreed when asked about feeling good at their job (N = 68, 81.9%), feeling exhilarated when accomplishing something at work (N = 47, 56.0%), and having accomplished many worthwhile things in their job (N = 54, 64.3%) (see Table S13).

Table S13: Job Performance and Burnout

(Figures in Percent)	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree
I feel emotionally drained from my work	22.9	32.5	22.9	14.5	7.2
I feel used up at the end of the workday	30.1	38.6	12.0	14.5	4.8
I feel tired when I get up in the morning and have to face another day on the job	13.4	34.1	17.1	17.1	18.3
Working all day is really a strain for me	9.0	23.1	24.4	20.5	23.1
I can effectively solve the problems that arise in my work	57.3	29.3	7.3	4.9	1.2
I feel burned out from my work	4.9	21.0	22.2	22.2	29.6
I feel I am making an effective contribution to what this hospital does	64.3	25.0	8.3	1.2	1.2
I have become less interested in my work since I started this job	1.2	10.8	18.1	22.9	47.0
I have become less enthusiastic about my work	1.2	15.9	14.6	31.7	36.6
In my opinion, I am good at my job	81.9	13.3	3.6	0.0	1.2
I feel exhilarated when I accomplish something at work	56.0	29.8	13.1	1.2	0.0
I have accomplished many worthwhile things in this job	64.3	26.2	7.1	2.4	0.0
I just want to do my job and not be bothered	1.2	14.5	18.1	19.3	47.0

I have become more cynical about whether my work contributes anything	3.7	11.0	18.3	15.9	51.2
I doubt the significance of my work	1.2	4.9	11.0	24.4	58.5
At my work, I feel confident that I am getting things done	65.5	25.0	4.8	2.4	2.4

Correlations

Individual correlations were conducted between the frequency of medication errors and factors contributing to medication errors to determine if any significant relationships existed. For the error of missed doses of medication, significant relationships were found with the following factors: problematic organization of medical supplies ($r = 0.24, p < 0.05$), high level of noise ($r = 0.32, p < 0.01$), poor lighting in the medication room ($r = 0.28, p < 0.05$), missing or unreadable medication labels ($r = 0.28, p < 0.05$), medication not being documented on the administration record ($r = 0.44, p < 0.01$), lack of supplies ($r = 0.45, p < 0.01$), and calculation errors ($r = 0.43, p < 0.01$).

Wrong time of medication administration was associated with several factors including location of medication room ($r = 0.22, p < 0.05$), small or inadequate size of the medication room ($r = 0.22, p < 0.05$), unreadable medication labels ($r = 0.32, p < 0.01$), medication not being documented ($r = 0.49, p < 0.01$), lack of supplies ($r = 0.38, p < 0.01$), and calculation errors ($r = 0.37, p < 0.01$).

Medication errors of having the IV medication rate going too slow or too fast, having the wrong concentration of medication delivered in the IV, wrong route of medication administration, and wrong medication administration were significantly associated with all contributing factors. Similarly, having the wrong medication delivered due to misidentification of the patient was significantly associated with all but one factor, which was the location of the medication room (see Table S14).

Table S14: Correlation Matrix for Frequency and Causes of Medication Errors

Factors Contributing to Medication Errors	Medication Errors						
	Missed doses of med.	Wrong time of med.	IV med. rate too slow or too fast	Wrong concentration or dosage of med. delivered in IV	Wrong route of med. admin.	Wrong med. administered	Wrong med. delivered due to misidentification of patient
Location of medication room	0.20	0.22*	0.37**	0.24*	0.36**	0.42**	0.22
Small or inadequate size of medication room	0.14	0.22*	0.39**	0.34**	0.46**	0.49**	0.35**
Problematic organization of medical supplies	0.24*	0.21	0.35**	0.28**	0.38**	0.47**	0.37**
High level of noise	0.33**	0.15	0.34**	0.32**	0.36**	0.31**	0.39**
Poor lighting in med room	0.28*	0.19	0.41**	0.41**	0.42**	0.37**	0.42**
Medication label unreadable or missing	0.28*	0.32**	0.38**	0.51**	0.58**	0.34**	0.46**
Medication not documented	0.44**	0.49**	0.33**	0.39**	0.44**	0.31**	0.41**
Lack of supplies	0.45**	0.38**	0.49**	0.39**	0.40**	0.42**	0.40**
Calculation errors	0.43**	0.37**	0.30**	0.55**	0.53**	0.36**	0.50**

[*] Significance at the 0.05 level [**] Significance at the 0.01 level

Individual correlations were also conducted to determine if an association existed between the frequency of documentation errors and factors contributing to documentation errors. All documentation errors were significantly associated the contributing factors (see Table S15).

Table S15: Correlation Matrix for Documentation Errors

Factors Contributing to Documentation Errors	Documentation Errors		
	Documenting in wrong patient's chart	Omission of input of partial information in charts/records	Charting procedures or medications before completed
Locating of charting space	0.50**	0.39**	0.47**
Small or inadequate size of charting space	0.49**	0.48**	0.55**
Poor lighting	0.54**	0.38**	0.47**
High level of noise	0.38**	0.50**	0.46**

[**] Significance at the 0.01 level

To determine if job stress was related to age, experience in the profession, and the amount of time employed at the hospital, the overall average of the items on the job stress scale was calculated. Positive items on the scale were reverse coded, thus, higher scores were associated with greater burnout. A one-way analysis of variance was conducted to determine if there were any significant differences between the age categories, but significant differences were not found ($F = 0.36, p = 0.84$). A correlation was run between the average score for job stress and experience in the profession, but again, a significant relationship was not found ($r = -0.20, p = 0.06$). Finally, a correlation was run between the amount of time employed at the current hospital and the mean score for job stress. A significant relationship was not found ($r = -0.14, p = 0.21$).

Correlations were also run between job stress and variables pertaining to medication errors to determine if any significant relationships exist. For each of the following variables, an overall average score was calculated and used. Significant results were not obtained when job stress was correlated with the frequency of medication errors ($r = 0.15, p = 0.19$), the factors contributing to medication errors ($r = 0.09, p = 0.41$), staff and organizational issues causing medication errors ($r = -0.18, p = 0.11$), environmental issues causing medication errors ($r = -0.11, p = 0.32$), and nursing-unit design ($r = -0.11, p = 0.34$). Nursing-unit design was, however, significantly associated with the frequency of medication errors ($r = -0.22, p < 0.05$) and factors contributing to medication errors ($r = -0.24, p < 0.05$). Finally, staff and organizational issues leading to nursing errors were significantly associated with physical environmental issues leading to nursing errors ($r = 0.66, p < 0.01$).

b) Focus Groups Were Conducted at Three Facilities: Swedish Hospital, Providence Portland, and Providence St. Vincent. Staff members from the hospital, including nurses, pharmacists, and risk managers, participated. Discussions centered on facility design, medication administration, and causes of errors.

c) Facility Visits Were Done in Three Acute-Care Settings in United States that have incorporated design features for enhances patient safety and reduction of error. Interviews

were conducted with key members of Bronson Methodist Hospital, Barbara Ann Karmanos Cancer Center, and St. Joseph's Hospital. Interviews focused on facility design and its impact on patient safety and errors.

Focus Groups Findings

Focus groups were conducted in three hospitals (Swedish Medical Center, Providence St. Vincent Hospital, and Providence Portland Hospital) in conjunction with the collection of survey data to better understand the process of medication dispensation in relation to medication errors. Factors in the nursing station area and patient rooms, which contribute to nursing performance, efficiency, and nursing/medication errors, were explored. The participants were nursing staff (nurse managers, charge nurses, unit clerk, and care aides), administrative staff, and pharmacists.

Medication Dispensation

Medication Room

The general consensus was that the medication room location within the nursing unit is the most important criterion for reducing nurses' fatigue and errors. The staff preferred multiple decentralized medication rooms throughout the floor, as opposed to central medication rooms, because they can save time and reduce the potential for errors as the nurses go back and forth between the med room and patient rooms. In the new tower at Providence Portland, there will be decentralized medication rooms serving every eight patient rooms. This is hoped to substantially reduce the walking time needed between the medication room and the patient rooms, and, consequently, the potential for fatigue and errors.

Automated Dispensation

With regard to the Pyxis machine, participants preferred the machine to be located in a closed versus an open area. This is due to the fact that, in an open area, people stand in line and block doorways. Other negative aspects of the Pyxis in an open area are the distractions and the noise levels. As well, space is unavailable to draw medications, and working space to look up the patient and drug is nonexistent. Without workspace, nurses are handling too many things at once and, thus, the potential for error exists.

When asked about medications and supplies, participants preferred that these be in separate rooms, especially if the rooms are small in size. Also, when multiple activities are taking place in one location, the area becomes congested, distractions are likely to occur, and noise levels tend to be high. Some participants stated that, if the room was large enough, having both medications and supplies in a single room is feasible and desirable. This is due to the fact that, occasionally, the nurse has several items to get for one patient, such as medications and toiletries. By combining the medication and supply rooms, nurses can reduce the number of trips they make between the supply room and patient room.

Medication Delivery

The handling of medication passes through various hands from the time it leaves the pharmacy until the medication reaches the patient, and, thus, the potential for error is at several points. In one facility, for instance, medications arrive in the nursing unit by one of two means. One manner in which they arrive is through a runner, who works out of the pharmacy. The runner loads medications onto a cart from the pharmacy and then drops off the medications in the back room where the Pyxis machine is located. In this scenario, oral medications as well as IV medications are grouped together, which becomes a problem because nurses do not look for the oral medications among the IV medications. A second manner in which medications arrive to the nursing unit is through a tube system that is situated at the nursing station. This is problematic due to the fact the nurses' station tends to be chaotic and any one person, who is not necessarily a nurse, may retrieve the medication and misplace it. The medication should be placed in the Pyxis machine, but this is not always the case, and replacement orders are placed when the medication is not found.

In addition, the potential for error increases in double-occupancy patient rooms because medications for each patient may be placed in the incorrect drop-down bin, which may result in the patient receiving the incorrect medication. There appears to be no consistency within the hospital itself as to where the different types of medications should be located, and, therefore, medications are frequently misplaced, leading to an increased potential for error. Another facility is moving their medication dispensation to a Pyxis profile in which 90 to 95% of medications will be obtained through the Pyxis machine. Exceptions include specific medications such as inhalers and eye drops, which will be delivered to the nursing unit through the tube system. The Pyxis profile will not allow nurses to select drugs that are not on the patient profile, which is aimed at reducing the potential for error.

Nursing Unit Design

It was noted that the pod design decreases fatigue amongst nurses and keeps nurses closer to their patients. Unit design is influenced by patient acuity. For instance, a circular nursing station was preferred amongst nurses on units with high-acuity patients. This design facilitates visibility, which is critical to the care of high-acuity patients. Open areas were preferred in intensive-care units because, even though noise is a factor, patients can be monitored from the nursing station. In general, nurses preferred unit layout in which they have a visual link to the patients, but have audio privacy. Small alcoves within the nursing station were found to be beneficial because nurses can communicate with other staff members regarding patients while still maintaining low noise levels within the nursing unit. Nursing units closed off with Plexiglas were also found to be beneficial due to high patient visibility with low levels of noise.

Computerized Charting

Computerized charting was found to have both positive and negative features. In general, nurses preferred computers mounted outside the patient room in the current design of their hospitals. In one facility, computers are mounted in the patient's room, but nurses chart with their backs

toward the patient. Patients then complain that nurses are turned away from them. As well, nurses are constantly interrupted by patients who communicate with them while they are trying to complete their charting. Nurses prefer to be facing patients at eye level while charting, in particular if the computers are mounted in the patient rooms. Nurses do complain of having to stand while charting and would prefer to chart while seated. Nurses enjoyed using computers on wheels (COWs) as this allows them to move the computer within the room (and outside the room) as needed.

Patient Rooms

With regard to patient-room design, participants overwhelmingly preferred single over double-occupancy rooms. The main reasons for this preference were privacy, safety, and reduced errors. With regard to specific features in the room, nurses felt that accessibility to a sink, either outside or inside the patient room, is necessary. Bathrooms should be located so that it has the shortest distance for a patient to reach from the bed. Patients should not have to walk to the front of the bed where they can get tangled in their IV or oxygen lines. In terms of wall panels, it was found that horizontal wall panels are at one level, which enables nurses to see everything right away. Vertical wall panels, however, appear less clinical. Consistency among the patient rooms received mixed support. Participants felt that consistency would reduce fatigue, inefficiencies, and errors. Consistency, however, was not thought to make any significant difference if rooms are all single-occupancy.

Environmental Factors that Contribute to Nursing and Medication Errors

- Having the Pyxis machine outside the medication room
- Nursing-unit design (large units require more walking contributing to staff fatigue versus small pods that require less walking)
- Inability to see patient rooms from the nurses' station
- Lack of adequate work space in the medication room
- Inadequate and inappropriate storage of supplies
- Inadequate lighting in hallways can effect charting errors outside the patient rooms
- Constant interruptions and high noise levels in charting areas
- Congestion in medication rooms
- Double-occupancy patient rooms
- Long nursing shifts (12-hours)
- Having the nurses' station too close to the waiting room
- Location of sinks in the patient rooms
- Poor charting space in the hallways outside the patient rooms
- Lack of seating in the patient room for charting
- Poorly designed break room
- Carrying multiple medications for different patients at one time

Environmental Changes that May Effect Reduction of Nursing and Medication Errors:

- Medication rooms should be decentralized (with more Pyxis machines) on the nursing unit.
- Medication rooms need ample work surface for medication preparation and other desk tasks.
- The potential for error increases in double-occupancy rooms since medications for each patient may be placed in the incorrect drop-down bin.
- Pod design with decentralized med room and nursing station decreases fatigue amongst nurses and keeps nurses closer to their patients.
- In medical-surgical units, nurses' station with a visual link to the patients, but with audio privacy and reduced noise.
- Single-occupancy rooms in terms of reducing medication administration-related errors.
- Quiet workspace, but close to the main nurses' station.
- Improved lighting in the nurses' station and hallways.
- Reduced work hours to 8- to 10-hours shifts.
- Changing the sink location to the front of the room
- Locating the nurses' station away from visiting rooms.
- Streamlining the medication dispensing system.
- Individual bins for every patient.
- Larger labels on supply Pyxis
- Consistency in design of nursing units.
- An adequately designed break room
- Staff participation in the design process.
- Standardization of patient rooms.
- Having doctors chart orders through a computer to reduce transcription errors.
- Medication delivery to each patient room.
- Bedside computer charting.
- Bar coding for patient identification.

Selected Facility Visits

Site visits were conducted at three selected hospitals that have either conducted new construction or renovation to increase patient safety and reduce medication/nursing errors. These sites were:

- Bronson Methodist Hospital, Kalamazoo, Michigan
- Barbara Ann Karmanos Cancer Center, Detroit, Michigan
- St. Joseph's Hospital, West Bend, Wisconsin

The site visits included interviews with key administrative and nursing staff members and the pharmacist to gather information about the design features in the nursing units and their experience in the effect of the environment on patient safety, staff fatigue, efficiency, and nursing/medication errors. Highlights of the interviews and guided tours of the nursing units are presented here.

Bronson Methodist Hospital

Interviews with Christine Rosey (Pharmacist) and Richard A. Van Enk, Ph.D. (Director, Infection Control & Epidemiology)

Bronson Methodist Hospital is located in Kalamazoo, Michigan, and offers multiple services for all populations including children, women, and men through specialties such as the Stroke Center, the Chest Pain Center, and BirthPlace. The facility contains 343 licensed beds, and all rooms are private.

In terms of pharmacy design, in general, the pharmacist is not pleased with the design, which includes inefficient shelving systems. To process medication orders, the pharmacist enters the order and the technician fills the order and places it on the counter. After a period of time, the pharmacist will check everything and send the medications to the various units. Difficulty exists in verifying the order with the actual label once more before the medications are distributed. The pharmacy environment is also very distracting. Pharmacists and technicians must cope with the telephone constantly ringing while trying concentrate on placing an order. To minimize distractions, as much automation as possible is used. The most common mistake is to place returned medications in the wrong bin. Someone may grab the medication from the bin thinking it is the one he or she needs, when, in fact, it was placed on the wrong shelf. Through verification, however, the pharmacist and technician should discover that the medication is incorrect. There needs to be a better shelving system for stocking medications that allow: a) easier visual and physical accessibility to the medications, b) clustered organization of shelving system to reduce the high stimulation of information, and c) reduced distraction from the other activities that are conducted in the pharmacy.

Computerized physician order entry, to be implemented in the near future, was seen as a highly positive feature in reduction of errors. If the computerized system is developed correctly, and includes evidence-based medicine, guidelines, and recommendations for patients, it can drive therapy in the right direction and reduce significant errors during prescription and filling orders. Satellite pharmacies were also seen as beneficial because pharmacists could talk to a patient or nurse face to face to make an informed decision. This is an important consideration for future facility design. Although a central pharmacy will be needed, satellite locations on different floors would allow pharmacists to easily interact with nurses on the floors for verification and validation of the medications prescribed.

Bronson's new facility consists of all private patient rooms. This is found to be a highly positive change at two levels. First, as the option of giving another patient in the room the wrong medication does not exist, confusion and errors in medication administration in the patient rooms have significantly been reduced. Second, there was a study conducted at Bronson documenting the effect of single rooms on nosocomial infection rates. This study's findings collected from the princi-

pal investigator of the study, Richard A. Van Enk, Ph.D., director, infection control and epidemiology, are summarized here.

Bronson Methodist Hospital replaced its predominantly semiprivate-room facility with a new facility using nearly all private rooms. Its recent study determined whether the use of private rooms would result in a significant reduction in nosocomial infections compared to the previous semiprivate-room design. The old hospital complex consisted of three contiguous but separately constructed buildings containing 307 staffed inpatient beds comprising adult medical/surgical, adult critical care, maternal/child, and pediatric general and critical-care units. For the purpose of the study, outpatient and short-stay (less than 24 hours) rooms and procedure rooms such as operating rooms were not part of the analysis. The adult medical/surgical and all the general pediatric beds in the old facility (222 beds) were semiprivate rooms (two patient beds per room). Approximately 72% of the old facility inpatient rooms were semiprivate. The new facility consists of 287 inpatient rooms, all of which are private with the exception of the neonatal intensive-care unit. The NICU beds comprise approximately 15% of current staffed beds, leaving 85% of the hospital (181 beds) with private rooms. The new facility merged four critical-care units into two; the cardiac and medical intensive-care units were merged, and the trauma care/burn and surgical intensive-care units were merged.

The total hospital infection rate declined by 11% after the opening of the private-room facility, but this reduction did not reach statistical significance ($p = 0.076$). When time series analysis was used to remove a significant 12-month seasonal variability in infections, the difference between infection rates in the semiprivate and private environments was significant ($p = 0.007$). When infection data were analyzed by hospital unit, the cardiac surgery, mother/baby, and medical intensive-care units showed significant reductions in infection rates. By infection class, pneumonia, lower respiratory tract, and reproductive tract infections significantly declined in the new facility. The study demonstrated that provision of care to the same patient population using the same healthcare personnel in a facility consisting of private rooms showed a significant reduction in nosocomial infection rates compared to a semiprivate-room hospital environment.

Barbara Ann Karmanos Cancer Center

Interviews with Dore Shepherd (Director), Stephen Smith (Pharmacist), and Nanci Burrows (Director of Customer Relations and RN Recruitment/Retention)

The Barbara Ann Karmanos Center, located in Detroit, Michigan, is the first independent cancer center in Michigan. Previously part of the Detroit Medical Center, it became the Karmanos Cancer Center through the financial support of Peter Karmanos, whose wife Barbara Ann was diagnosed with breast cancer in 1996. The hospital currently has 94 beds and is licensed to have 124 beds. In September 2006, construction began for a new building scheduled to open in the spring of 2008, where the goal is to have all private rooms. Currently, every unit varies in terms of double- and single-occupancy rooms.

Medication rooms have been renovated in this facility. Original designs were extremely small to service 48 patients on the units, and, thus, have been redesigned. Because nurses spend a great deal of time preparing medications, the room was expanded to include more countertops as well as vibrant and stimulating colors. Simple features, such as a clock and telephone, were also added. According to the center's study, medication errors in the newly designed medication rooms have been reduced by 30%. The main reasons attributable to this change can be given to adequate floor and counter space for multiple staff to work in the medication room, higher level of lighting, and a positively stimulating visual environment.

Medication Prescription, Delivery, Preparation, and Administration

Medication orders originate with a manual form filled out by a physician. The unit clerk, who reads and enters the order, then handles the order. A carbon copy of the order is placed in a drop box, where a technician comes periodically throughout the day to retrieve them. The orders are then brought to the pharmacy, where the technician interprets what was handwritten and enters the order into the system, which does not interact with that of the nurses. The pharmacy then dispenses the orders based on what the technician has entered.

To determine if medication errors have occurred, midnight shift nurses obtain computer printouts of medication administration records (MAR) for each patient from the pharmacy. Nurses must then compare what the technician has entered into the system with the medication that the physician ordered. Mistakes are often a result of human entry, and, if errors are found, the nurses write them down and return to the pharmacy to rectify the error. To increase perceptions, lighting was doubled in the medication room, where nurses tend to review the patient records. Within this facility, a culture exists to discover and report errors before they reach the patient so that something may be done about the process that facilitated the error.

A large portion of medication errors is caused by prescriptions, and there is not one way to improve this. Within the last two years, the facility has segregated prescribing errors to the vice president of medical affairs, who speaks to the physician directly regarding the error. Some causes of prescription errors include poor handwriting and incomplete orders. Computerized physician order entry is being considered within the facility, and interim steps, including standardized spreadsheets on the intranet, have been implemented.

An involuntary system is used to report medication errors. A centralized computer system is used to report the errors, and staff members know it is nonpunitive. Through tertiary looks at medication variance rates, it has been noticed that significant differences do not exist between the various floors, regardless of design. A relationship does not exist either between staffing levels (current) and medication errors.

A trend exists toward centralization, mainly to reduce costs. However, having pharmacists on the various floors is beneficial. They are able to answer questions and reiterate processes, which benefits the patient. Pyxis profiles are positive as well. Through interfacing, the pharmacist is able to review and approve the order, and, once approved, nurses are able to get medications immediately from the cabinet.

The design of the pharmacy depends upon its services and how medications are delivered to the patient. Flexibility is key in this hospital due to a higher outpatient population than inpatient population. Multiple people work on the afternoon shifts, and, thus, activities can be segregated. On the midnight shift, only one person is working, and, thus, the design should be flexible to segregate and reintegrate on the midnight shift.

St. Joseph's Hospital

Interviews with Mike R. Murphy (Vice President, Patient Care Services), Mary Beth Miranda (Quality and Research Project Specialist), and Mark R. Selle (Pharmacist)

St. Joseph's Hospital in West Bend, Wisconsin, opened as an 80-bed facility in August 2005. The hospital emphasizes safe, high-quality patient-centered care. Concepts central to the design include automation, standardization and advanced technology. All rooms are private, and the environment is designed to promote patient safety and reduce fatigue for staff, patients, and family members through the use of natural light, views of nature, and soothing colors.

An emphasis was placed on noise reduction. The guidelines of the World Health Organization were used, with an emphasis on keeping noise levels in the lower decibel ranges. Sound meters were also used for every design feature in the new hospital.

Staff's ability to see patients was also critical in the design as was the availability of information at the patient's bedside. Patients' involvement in their care is another important element, and, with a full ethics system in place, patients will have all information available at their bedside enabling them to become much more involved in questioning their care.

The EPIC computer system for records was implemented and includes electronic medication administration records, a bar-coding system, automated scheduling, and automated registration. It is a flexible system that is responsive to the individual needs of the organization. Physician computerized order entry will become part of EPIC in the near future.

Standardization

A key element of the design at St. Joseph's is standardization, in which all the rooms are designed to be identical, rather than mirror images of each other. The patient rooms are all single-handed to reduce any potential confusion that may arise in finding the gas and power outlets and other equipment. Although it was initially thought that standardization of patient rooms that will not share gas and power supplies from a shared headwall will increase capital cost, in reality, the facility was able to realize cost savings through more off-site elements brought in for installation. Each patient room is divided into a clinical side and family side, and every patient area has a computer on wheels. There are two separate vertical headwalls within the room to ensure that oxygen is available on both sides. Storage room was limited because materials have to be discarded once the patient is discharged. A unique feature of the room is the location of the bathroom, which is on the headwall to reduce the travel distance between the bed and the bathroom. The patient can use handrails to walk on his or her own to the bathroom.

Another feature of the patient room is the adjacent nurse alcove. There is very little movement necessary for the staff between the patient room and storage facility, because medications and 80 – 90% of the supplies are located in the alcove. Each alcove includes a 7-drawer configuration server, and every drawer contains the same items in each hospital location. Some customization was allowed within the overall standardization for units that did not need certain items in their drawers. Nurses seem to be generally happy with the alcove setup because there is a tremendous amount of shielding from distractions when in the alcove, enabling them to focus on patient care. Medication errors have been greatly reduced through the use of the alcove. If a nurse is mixing medications in the alcove, it is only for one specific patient, thereby reducing the potential for error.

To minimize fatigue for nurses, a focus is placed on trying to keep patient acuity levels the same. Patients are assigned in areas, which are in close proximity for nurses. As well, the patient chart stays in the alcove to reduce the amount of time spent looking for the chart. In this facility, the nurses' station is centralized, but most of the supplies are decentralized. Thus, very little activity occurs at the central nurses' station. Walking distances have also not been an issue due to the decentralization. Nurses appear to be walking less to care for a specific patient, but they are walking more to care for multiple rooms. A negative aspect of the decentralization is that staff members almost have to consciously seek other staff members to render another opinion.

With regard to handwashing, a sink was strategically positioned in the patient rooms so patients can see if the staff members have washed their hands. Patients are also encouraged to ask staff members if they have washed their hands. Some safety features within the patient room include a heat panel above the window to ensure the comfort of patients and visitors. The heat panel also eliminates condensation, which is a medium for mold and bacteria in the winter. Windows are triple-paned, which reduces noise, in particular, that of helicopters landing. Other aspects of standardization include consistent lighting, red lights flaring, and the same brand of monitors used throughout the facility.

Ergonomics also played an important role in the facility's design. For example, the location of the recliner in the patient room was considered. The traditional location is next to the patient's bed, but staff members had to bend and lean when they were on the family side of the bed. Shortening the length of the couch and putting the recliner next to the couch solved the problem. Ergonomics was also considered when making lighting and flooring choices. An integral blind is located on the alcove door and, at nighttime, the blind can be closed and the nurses can use the bright, internal lighting.

Pharmacy Activities and Design Issues

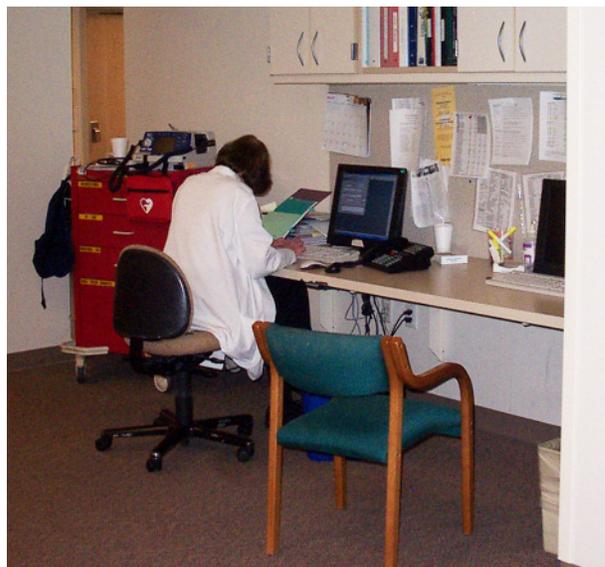
With regard to the pharmacy, orders are placed directly with the wholesaler rather than the manufacturer. The advantage of this method is that medications can be ordered close to six times a week, and the product is received the next day. As well, smaller quantities can be ordered. Once an order is placed, a manual process of reviewing the order with the stock is used. Stickers are applied to the medications, which are then placed on shelves. To distribute medications, a cart is used. Checks are made to determine if a bar code is on the product. For safety purposes, using the manufacturer's bar code has an advantage. If a pharmacist puts the wrong

Bronson Methodist Hospital, Kalamazoo, Michigan



Left: The location of hand-washing sink was not next to the entry door but rather on the footwall. This location does not provide the easiest access to the sink. The faucets for cold and hot water are separate requiring more touching of the surfaces and potential for spreading of bacteria. The sink itself and the countertop are of one color (not enough visual contrast), which is not recommended for aging eyes.

Below: The window provides visual access to the bed space and allows easier surveillance for staff. In the new unit (under construction), Bronson will install full glass areas without the divisions to allow greater visual linkage.



Decentralized staff work area allows easy access to the patient rooms, but is affected by the noise and other distractions from the hallways – potentially contributing to fatigue/errors.



The central nurses' station has open workspaces and is affected by surrounding noise and traffic. The positive aspect of the workspace was the different counter heights that allow some privacy for staff and work surfaces for a standing nurse.

Bronson Methodist Hospital, Kalamazoo, Michigan (cont.)



The landscape murals were considered by staff as providing a calming effect in the unit. A number of staff felt that murals with natural scenes can help reduce the stress and fatigue.

Bronson Methodist Hospital, Kalamazoo, Michigan (cont.)



Top and Bottom: The landscape seating area next to the food court was pointed out as a popular space for staff during breaks. Many staff members walk fairly long distances to come to this area in order to connect with nature and reduce fatigue. It was pointed out that staff break rooms on the floors could greatly benefit from easy access to garden areas in terms of reducing the fatigue and stress levels.

St. Joseph's Hospital, West Bend, Wisconsin



The storage organization in the pharmacy was considered somewhat inefficient in terms of access to the different medications and potentially contributing to errors in picking the right medication.



This shelving unit in the pharmacy was also considered somewhat inefficient in terms of access to the medications on the top and bottom shelves. Also, it was commented that the stimulation of reading the labels of medications could be reduced with smaller shelving units with fewer medications to look at in any given storage unit. Such a shelving unit would potentially implicate on a larger pharmacy.



St. Joseph's Hospital, West Bend, Wisconsin (cont.)

Vertical gas and power outlet panels were standardized in design and color to minimize confusion and ease of usage. Also, it was thought that vertical panels looked less institutional than horizontal ones.



The bathroom provides continuous handrail from the bedside (see left photo). The objective of locating the bathroom at the headwall was to reduce the distance between the bed and toilet and also to provide handrail support.



St. Joseph's Hospital, West Bend, Wisconsin (cont.)

Standardized staff alcove next to each patient room provides a seated charting area with visual access to the bed.



The nurse server has supplies that are standardized throughout the unit for easy access and reduction of errors. The top drawers are used for medications specific to the patient. Staff commented that individual medication drawers have reduced possibilities of medication errors.



St. Joseph's Hospital, West Bend, Wisconsin (cont.)

The computer on wheels (COW) in each patient room is intended to collect patient information near the bedside. Once the Computerized Physical Ordered Entry system is in place, the physician is expected to input prescription requests at the bedside. It is hoped that this will allow significant reduction of errors and paperwork.



The sink is located just next the entrance as a cue to staff for handwashing. A hands-free faucet was provided to reduce spread of infection by reducing contact with surfaces. The visual contrast between the sink and counter is a positive design feature for nursing staff members who are aging.

St. Joseph's Hospital, West Bend, Wisconsin (cont.)



Above: The nurses' station is kept entirely open for greatest visual access to the hallways.



Left: The adjacent workrooms (doors on the right side of top photo) provide some privacy from the hallway traffic noise. Also, each workspace has vertical divisions to provide territorial demarcation and privacy.

St. Joseph's Hospital, West Bend, Wisconsin (cont.)



Top: The hallways have limited overhead lighting to reduce sensory stimulation. The walls have alternating colors to provide some visual break in the long hallways. Due to the inclusion of the nurse alcoves with each patient room, the overall length of the hallway is considerably longer. This is a potential reason for increased walking for staff.

Bottom: As the door between the alcove and patient room is the one most used, the hallway door to the patient room is kept closed. This situation does not provide opportunity for natural surveillance of patients for staff walking along the hallway.

St. Joseph's Hospital, West Bend, Wisconsin (cont.)

The patient has a view of the staff working in the nurse alcove. This is potentially a positive aspect for the patient to be able to have visual and auditory contact with a staff member.



The nurse has the option of closing the door to achieve privacy and reduce interruptions from the patient, if needed, during deskwork.



Barabara Ann Karmanos Cancer Center, Detroit, MI

Environmental changes in the medication rooms included increased lighting, sound-absorbing tiles, and pastel colors on the walls. These changes have resulted in reduced noise in the medication room and an overall positively stimulating ambiance, in turn, reducing the rate of medication errors.



Barabara Ann Karmanos Cancer Center, Detroit, MI (cont.)



The nurses' station was redesigned to provide a combination of auditory privacy maintaining visual linkage with the hallways and patient rooms. The glassed areas have reduced noise levels and have potentially fewer distractions from the hallway traffic and equipment. However, this section of the nurses' area does not provide the privacy that a separate vestibule or room might have provided. Also, the lack of private workspaces that have doors make confidential conversations challenging in this nurses' station.

References

- Abdou, O. A. (1997, September). Effects of luminous environment on worker productivity in building spaces. *Journal of Architectural Engineering*, 124-132.
- Adamson, B., Kenny, D., & Wilson-Barnett, J. (1995). The impact of perceived medical dominance on the workplace satisfaction of Australian and British nurses. *Journal of Advanced Nursing*, 21, 172-183.
- Agency for Healthcare Research and Quality. (2003, March). *The effect of health care working conditions on patient safety*. Summary, Evidence Report/Technology Assessment: Number 74. AHRQ Publication No. 03-E024. Rockville, MD. <http://www.ahrq.gov/clinic/epc-sums/worksum.htm>
- Aiken, L. H., Clarke, S. P., Cheung, R. B., Douglas, D. M., Silber, J. H. (2003). Educational levels of hospital nurses and surgical patient mortality. *Journal of the American Medical Association*, 290(12), 1617-1623.
- Aiken, L. H., Clarke, S. P., Sloane, D. M., Sochalski, J., & Silber, J. H. (2002). Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *Journal of the American Medical Association*, 288(16), 1987-1993.
- Aiken, L. H., Clarke, S. P., Sloane, D. M., & Sochalski, J. A., (2001). An international perspective on hospital nurses' work environments: The case for reform. *Policy, Politics, & Nursing Practice*, 2(4), 255-263.
- Aiken, L., Clarke, S., Sloane, D. Sochalski, J., Busse, R., Clarke, H., Giovannetti, P., Hunt, J., Rafferty, A., & Shamian, J. (2001). Nurses' reports on hospital care in five countries. *Health Affairs*, 20(3), 43-53.
- Ali, N. A., Mekhjian, H. S., Kuehn, P. L., Bentley, T. D., Kumar, R., Ferketich, A. K., & Hoffmann, S. P. (2005). Specificity of computerized physician order entry has a significant effect on the efficiency of workflow for critically ill patients. *Critical Care Medicine*, 33(1), 110-114.
- Alimoglu, M. K., & Donmez, L. (2005). Daylight exposure and the other predictors of burnout among nurses in a university hospital. *International Journal of Nursing Studies*, 42, 549-555.
- Allen, C., & Jones, J. (2002). Acute wards: Problems and solutions. *Psychiatric Bulletin*, 26, 458-459.
- Amalberti, R., Auroy, Y., Berwick, D., & Barach, P. (2005). Five system barriers to achieving ultrasafe health care. *Annals of Internal Medicine*, 142, 756-764.
- American Institute of Architects. (2001). *Guidelines for design and construction of hospital and healthcare facilities*. Dallas, TX: Facilities Guideline Institute.
- Amos, M. A., Hu, J., & Herrick, C. A. (2005). The impact of team building on communication and job satisfaction of nursing staff. *Journal for Nurses in Staff Development*, 21(1), 10-16.
- Andrews, D. R., & Dziegielewska, S. F. (2005). The nurse manager: Job satisfaction, the nursing shortage and retention. *Journal of Nursing Management*, 13, 286-295.
- Anonymous. (2000, January). Hospitals discover cost efficiency of private rooms. *Executive Solutions for Healthcare Management*, 3(1), 7-8.
- Arikan, O. A., Ozgultekin, A., Tulunay, M., Turan, G., Oral, M., & Rosenthal, V. D. (2005). Effect of education and performance feedback on handwashing in two hospitals in Istanbul and Ankara. *American Journal of Infection Control*, 33(5), E75.
- Baker, G. R., Norton, P. G., Flintoft, V., Blais, R., Brown, A., Cox, J., et al. (2004). The Canadian adverse events study: The incidence of adverse events among hospital patients in Canada. *Canadian Medical Association Journal*, 170(11), 1678-1686.
- Banbury, S., & Berry, D. C. (1998). Disruption of office-related tasks by speech and office noise. *British Journal of Psychology*, 89, 499-517.
- Banbury, S. P., & Berry, D. C. (2005). Office noise and employee concentration: Identifying causes of disruption and potential improvements. *Ergonomics*, 48(1), 25-37.
- Barach, P., & Berwick, D. M. (2003). Patient safety and reliability of health care systems. *Annals of Internal Medicine*, 138(12), 997-998.
- Barach, P., & Dickerman, K. N. (2006, February). *Hospital design promoting patient safety*. Paper presented at the American Society for Healthcare Engineering International Conference, San Diego, CA.
- Barach, P., & Moss, F. (2001). Delivering safe health care. *British Medical Journal*, 323, 585-586.
- Barach, P., Satish, U., & Streufert, S. (2001). Healthcare assessment and performance: Using simulation. *Simulation & Gaming*, 32(2), 147-155.

- Barach, P., & Small, S. (2000a). Reporting and preventing medical mishaps: Lessons from non-medical near miss reporting systems. *British Medical Journal*, 320, 759-763.
- Barach, P., & Small, S. (2000b). How the NHS can improve safety and learning. *British Medical Journal*, 320, 1683-1684.
- Bates, D. W., Boyle, D. L., Vander Vliet, M. B., Schneider, J., & Leape, L. (1995). Relationship between medication errors and adverse drug events. *Journal of General Internal Medicine*, 10, 199-205.
- Bates, D. W., Leape, L. L., Cullen, D. J., Laird, N., Petersen, L. A., Small, S. D., et al. (1995). Incidence of adverse drug events and potential adverse drug events. *Journal of the American Medical Association*, 274(1), 29-34.
- Bates, D. W., Leape, L. L., Cullen, D. J., Laird, N., Petersen, L. A., Teich, J. M. et al. (1998). Effect of computerized physician order entry and a team intervention on prevention of serious medical errors. *Journal of the American Medical Association*, 280(15), 1311-1316.
- Bayo, M.V., Garcia, A. M., & Garcia, A. (1995). Noise levels in an urban hospital and workers' subjective responses. *Archives of Environmental Health*, 50(3), 247-251.
- Bechtel, R. & Churchman, A. (2002). *Handbook of Environmental Psychology*. New York: J. Wiley & Sons.
- Bell, C., Graven, S., Shepley, M., Rubin, H., & Ulrich, R. (1997). Pre-symposium workshop: Panel Discussion. *Journal of Healthcare Design*, 9, 21-24.
- Benedetti, F., Colombo, C., Barbini, B., Campori, E., & Smeraldi, E. (2001). Morning sunlight reduces length of hospitalization in bipolar depression. *Journal of Affective Disorders*, 62(3), 221-223.
- Benjamin, D. M., & Pendrak, R. F. (2003). Medication errors: An analysis comparing PHICO's closed claims data and PHICO's event reporting trending system (PERTS). *Journal of Clinical Pharmacology*, 43, 754-759.
- Benner, P., Sheets, V., Uris, P., Malloch, K., Schwed, K., & Jamison, D. (2002). Individual, practice, and system causes of errors in nursing: A taxonomy. *Journal of Nursing Administration*, 32(10), 509-523.
- Berntsen, K. J. (2004). How far has healthcare come since "to err is human?" Exploring the use of medical error data. *Journal of Nursing Care Quality*, 19(1), 5-7.
- Bilchik, G. S. (2002, July-August). A better place to heal. *Health Forum Journal*, 45(4), 10-15.
- Binnekade, J. M., Vroom, M. B., de Mol, B. A., & de Haan, R. J. (2003). The quality of intensive care nursing before, during, and after the introduction of nurses without ICU training. *Heart & Lung*, 32(3), 190-196.
- Birdi, K. S., & Zapf, D. (1997). Age differences in reactions to errors in computer based work. *Behaviour and Information Technology*, 16(6), 309-319.
- Blendon, R. J., DesRoches, C. M., Brodie, M., Benson, J. M., Rosen, A. B., Schneider, E., Altman, D. E., Zapert, K., Herrmann, M. J., & Steffenson, A. E. (2002). Patient Safety: Views of practicing physicians and the public on medical errors. *New England Journal of Medicine*, 347(24), 1933-1940.
- Blomkvist, V., Eriksen, C. A., Theorell, T., Ulrich, R., & Rasmanis, G. (2005). Acoustics and psychosocial environment in intensive coronary care. *Journal of Occupational and Environmental Medicine*, 62, e1-e8.
- Bloom, J. R., Alexander, J. A., & Nuchols, B. A. (1997). Nurse staffing patterns and hospital efficiency in the United States. *Social Sciences Medicine*, 44(2), 147-155.
- Bobrow, M. & Thomas, J. (2000). Inpatient care facilities. In Kobus, R. et al., *Building type basics for healthcare facilities* (pp. 131-192). New York: John Wiley & Sons
- Booker, J. M. & Roseman, C. (1995). A seasonal pattern of hospital medication errors in Alaska. *Psychiatry Research*, 57, 251-257.
- Boreham, N. C., Shea, C. E., & Mackway-Jones, K. (2000). Clinical risk and collective competence in the hospital emergency department in the UK. *Social Science and Medicine*, 51, 83-91.
- Borel, J. M., & Rascati, K. L. (1995). Effect of an automated, nursing unit-based drug-dispensing device on medication errors. *American Journal of Health-System Pharmacy*, 52, 1875-1879.
- Bowers, B. J., Lauring, C., & Jacobson, N. (2001). How nurses manage time and work in long-term care. *Journal of Advanced Nursing*, 33(4), 484-491.
- Brady, M. T. (2005). Health care-associated infections in the neonatal intensive care unit. *American Journal of Infection Control*, 33(5), 268-275.
- Brady, R., Chester, F. R., Pierce, L. L., Salter, J. P., Schreck, S., and Radziewicz, R. (1993). Geriatric falls: Prevention strategies for the staff. *Journal of Gerontological Nursing*, 19(9), 26-32.
- Brasche, S., Bullinger, M., Schwab, R., Gebhart, H., Herzog, V., & Bischof, W. (2004). Comparison of risk factor profiles concerning self-reported skin complaints and objectively determined skin symptoms in German office workers. *Indoor Air*, 14, 137-143.

- Brennan, T. A., Hebert, L. E., Laird, N. M., Lawthers, A., Thorpe, K. E., Leape, L. L., et al. (1991). Hospital characteristics associated with adverse events and substandard care. *Journal of the American Medical Association*, 265(24), 3265-3269.
- Brennan, T. A., Leape, L. L., Laird, N. M., Hebert, L., Localio, R., Lawthers, A. G. et al. (1991). Incidence of adverse events and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. *The New England Journal of Medicine*, 324(6), 370-376.
- Brill, M., Margulis, S. T., Konar, E., & BOSTI. (1984). *Using office design to increase productivity*. Buffalo, NY: Workplace Design and Productivity, Inc.
- Buntin, J. (2005, August). Plague of errors. *Governing*. <http://governing.com/articles/8med.htm>
- Burgio, L., Engel, B., Hawkins, A., McCorick, K., Scheve, A. (1990). A descriptive analysis of nursing staff behaviors in a teaching nursing home: Differences among Nas, LPNs and RNs. *The Gerontologist*, 30, 107-112.
- Burke, J. P. (2003). Infection control: A problem for patient safety. *New England Journal of Medicine*, 348(7), 651-656.
- Cabrera, I. & Lee, M. (2000). Reducing noise pollution in the hospital setting by establishing a department of sound: A survey of recent research on the effects of noise and music in health care. *Preventative Medicine*, 30, 339-345.
- Carayon, P., Alvarado, C. J., & Hundt, A. S. (2003). *Reducing workload and increasing patient safety through work and workspace design*. Madison WI: Center for Quality and Productivity Improvement.
- Carayon, P., & Gurses, A. P. (2005). A human factors engineering conceptual framework of nursing workload and patient safety in intensive care units. *Intensive and Critical Care Nursing*, 21, 284-301.
- Carpman, J. R., & Grant, M. A. (1993). *Design that cares: Planning health facilities for patients and visitors 2nd edition*. San Francisco, CA: Jossey-Bass.
- Cavanagh, S. J. (1992). Job satisfaction of nursing staff working in hospitals. *Journal of Advanced Nursing*, 17, 704-711.
- Cawood, C. (1993). Nursing units and common staffing problems. In D. K. Hamilton (Ed.) *Unit 2000: Patient beds for the future. A nursing unit design symposium* (pp. 103-109). Houston: Watkins Carter Hamilton Architects, Inc.
- Cerny, F. J., & Ucer, C. (2004). Arm work interferes with normal ventilation. *Applied Ergonomics*, 35, 411-415.
- Christenfeld, R, Wagner, J, Pastva, G. & Acrish, W. P. (1989). How physical settings affect chronic mental patients. *Psychiatric Quarterly*, 60, 253-264.
- Christensen, K. E. (1979). An impact analysis framework for calculating the costs of staff disorientation in hospitals. Los Angeles: School of Architecture and Urban Planning, University of California.
- Christensen, M. (2005). What knowledge do ICU nurses have with regard to the effects of noise exposure in the intensive care unit? *Intensive and Critical Care Nursing*, 21, 199-207.
- Clark, L. (1975). *The ancient art of color therapy*. Old Greenwich, CT: Deving-Adair.
- Classen, D. C., Pestotnik, S. L., Evans, R. S., Lloyd, J. F., & Burke, J. P. (1997). Adverse drug events in hospitalized patients. *Journal of the American Medical Association*, 277(4), 301-305.
- Cronk, J. D. (2002). Ergonomics in an Order Entry Facility. *U.S. Pharmacist*. http://www.uspharmacist.com/index.asp?show=article&page=8_943.htm
- Cohen, B., Saiman, L., Cimiotti, J. & Larson, E. (2003). Factors associated with hand hygiene practices in two neonatal intensive care units. *Pediatric Infectious Disease Journal*, 22(6), 494-499.
- Connolly, C. (2005, June 3). Toyota assembly line inspires improvements at hospital. *Washington Post*, p. A01.
- Cook, A. F., Hoas, H., Guttmanova, K., & Joyner, J. C. (2004). An error by any other name. *American Journal of Nursing*, 104(6), 32-43.
- Cooper, B., Mohide, A., & Gilbert, S. (1989, September). Testing the use of color in a long-term care setting. *Dimensions*, 22-26.
- Costa, G., Sartori, S., Bertoldo, B., Olivato, D., Antonacci, G., Ciuffa, V., Mauli, F. (2005). Work ability in health care workers. *International Congress Series*, 1280, 264-269.
- Davydov, L., Caliendo, G., Mehl, B., & Smith, L. G. (2004). Investigation of correlation between house-staff work hours and prescribing errors. *American Journal of Health-System Pharmacy*, 61, 1130-1134.
- Dawson, D. (2005). The problem of noise and the solution of sound? *Intensive and Critical Care Nursing*, 21, 197-198.

- Dean, B. S., Allan, E. L., Barber, N. D., & Barker, K. N. (1995). Comparison of medication errors in an American and British hospital. *American Journal of Health-System Pharmacy*, 52, 2543-2549.
- Dettenkofer, M., Seegers, S., Antes, G., Motschall, E., Schumacher, M., & Daschner, F. D. (2004). Does the architecture of hospital facilities influence nosocomial infection rates? A systematic review. *Infection Control and Hospital Epidemiology*, 25(1), 21-25.
- Devlin, A. S., & Arneill, A. B. (2003). Health care environments and patient outcomes: A review of literature. *Environment and Behavior*, 35(5), 665-694.
- Duffin, C. (2004, July 14). Mistakes triple on longer shifts, US researchers find. *Nursing Standard*, 18(44), 6.
- Dowdell, E. B. (2004). Pediatric medical errors part 1: The case – A pediatric drug overdose case. *Pediatric Nursing*, 30(4), 328-330.
- Ebben, J. M. (2001). Let there be appropriate light. *HE Solutions*, 37-40.
- Elliott, P. R. A. (1992). Handwashing: A process of judgement and effective decision-making. *Professional Nurse*, 2, 292-296.
- Emery, S., Nennig, M., & Gold, D. (2005). Control of a methicillin-resistant *Staphylococcus aureus* (MRSA) cluster in critical care by reinforcing hand hygiene and standard precautions. *American Journal of Infection Control*, 33(5), E53-E54.
- Ernst, M., Messmer, P. R., Franco, M., & Gonzalez, J. L. (2004). Nurses' job satisfaction, stress, and recognition in a pediatric setting. *Pediatric Nursing*, 30, 219-227.
- Ewens, A. (2003). Changes in nursing identities: Supporting a successful transition. *Journal of Nursing Management*, 11, 224-228.
- Facchinetti, N., Campbell, G., & Jones, D. P. (1999). Evaluating dispensing error detection rates in a hospital pharmacy. *Medical Care*, 37(1), 39-43.
- Faucett, J. & Rempel D. (1996). Musculoskeletal symptoms related to video display terminal use: An analysis of objective and subjective exposure estimates. *American Association of Occupational Health Nurses Journal*, 44, 33-39.
- Feuerstein, M., Nicholas, R. A., Huang, G. D., Dimberg, L., Ali, D., & Rogers, H. (2004). Job stress management and ergonomic intervention for work-related upper extremity symptoms. *Applied Ergonomics*, 35, 565-574.
- Fisher, S. (1982). Design reduces nurses' walking, encourages patients to visit with each other. *American Health Care Association Journal*, 8(2), 40-43.
- Fitzgerald, M., Pearson, A., Walsh, K., Long, L., & Heinrich, N. (2003). Patterns of nursing: A review of nursing in a large metropolitan hospital. *Journal of Clinical Nursing*, 12, 326-332.
- Florin, J., Ehrenberg, A., & Ehnfors, M. (2005). Patients' and nurses' perceptions of nursing problems in acute care setting. *Journal of Advanced Nursing*, 51(2), 140-149.
- Fogleman, M., & Brogmus, G. (1995). Computer mouse use and cumulative trauma disorders of upper extremities. *Ergonomics*, 38(12), 2465-2475.
- Franco, G., & Fusetti, L. (2004). Bernardino Ramazzini's early observations of the link between musculoskeletal disorders and ergonomic factors. *Applied Ergonomics*, 35, 67-70.
- Furnham, A., & Strbac, L. (2002). Music is as distracting as noise: The differential distraction of background music and noise on the cognitive test performance of introverts and extroverts. *Ergonomics*, 45(3), 203-217.
- Gadbois, C., Bourgeois, P., Goeh-Akue-Gad, M. M., Guillaume, J., & Urbain, M. A. (1992). Hospital design and the temporal and spatial organization of nursing activity. *Work & Stress*, 6(3), 277-291.
- Gander, P. H., Gregory, K. B., Graeber, R. C., Connell, L. J., Miller, D. L., & Rosekind, M. R. (1998a). Flight crew fatigue II: Shore-haul fixed-wing air transport operations. *Aviation, Space, and Environmental Medicine*, 69(9), B8-B15.
- Gander, P. H., Gregory, K. B., Graeber, R. C., Connell, L. J., Miller, D. L., & Rosekind, M. R. (1998b). Flight crew fatigue V: Long-haul air transport operations. *Aviation, Space, and Environmental Medicine*, 69(9), B37-B48.
- Gandhi, T. K., Weingart, S. N., Seger, A. C., Borus, J., Burdick, E., Poon, E. G., Leape, L. L., & Bates, D. W. (2005). Outpatient prescribing errors and the impact of computerized prescribing. *Journal of General Internal Medicine*, 20(9), 837-841.
- Garg, A., & Owen, B. (1992). Reducing back stress to nursing personnel: An ergonomic intervention in a nursing home. *Ergonomics*, 35(11), 1353-1375.
- Girard, N. E. (1978). Room clusters facilitate nursing care. *Modern Healthcare*, 8, 46-47.

- Gershon, R. R. M., Karkashian, C. D., Grosch, J. W., Murphy, L., Escamilla-Cejudo, A., Flanagan, P. A., Bernacki, E., Kasting, C., & Martin, L. (2000). Hospital safety climate and its relationship with safe work practices and workplace exposure incidents. *American Journal of Infection Control, 28*(3), 211-221.
- Gillespie, M., Melby, V. (2003). Burnout among nursing staff in accident and emergency and acute medicine: A comparative study. *Journal of Clinical Nursing, 12*, 842-851.
- Grotta, P., Przykucki, J., & Patterson, J. (2005). Prevent transmission: Isolating vancomycin-resistant Enterococci (VRE) and breaking the chain of contagion. *American Journal of Infection Control, 33*(5), E31-E32.
- Gotlieb, J. (2002). Understanding the effects of nurses on the process by which patients develop hospital satisfaction. *Holistic Nursing Practice, 17*(1), 49-60.
- Gotlieb, J. (2000). Understanding effects of nurses, patients' hospital rooms, and patients' perception of control in the perceived quality of a hospital. *Health Marketing Quarterly, 18*(1/2), 1-14.
- Gould, D. (1994). Nurses' hand decontamination practice: Results of a local study. *Journal of Hospital Infection, 28*, 15-30.
- Gould, D., & Ream, E. (1993). Assessing nurses' hand decontamination performance. *Nursing Times, 89*(25), 47-50.
- Graven, S. N. (1997). Clinical research data illuminating the relationship between the physical environment and patient medical outcomes. *Journal of Healthcare Design, 9*, 15-20.
- Greenberg, L. A. (2000). Planning a nurse station for clinical function. <http://www.hermanmiller.com/healthcare>
- Griffiths, P., Edwards, M., Forbes, A., & Harris, R. (2004). Post-acute intermediate care in nursing-led units: A systematic review of effectiveness. *International Journal of Nursing Studies, 42*, 107-116.
- Gross, R., Sasson, Y., Zarhy, M., & Zohar, J. (1998). Healing environment in psychiatric hospital design. *General Hospital Psychiatry, 20*, 108-114.
- Groves, J. E., Lavori, P. W., & Rosenbaum, J. F. (1993, Winter). Accidental injuries of hospitalized patients. A prospective cohort study. *International Journal of Technology Assessment in Health Care, 9*(1), 139-144.
- Grumet, G. W. (1993). Pandemonium in the modern hospital. *New England Journal of Medicine, 328*(6), 433-437.
- Gulak, M. B. (1991). Architectural guidelines for state psychiatric hospitals. *Hospital and Community Psychiatry, 42*, 705-707.
- Halford, S., & Leonard, P. (2003). Space and place in the construction and performance of gendered nursing identities. *Journal of Advanced Nursing, 42*(2), 201-208.
- Hall, L. M., Doran, D., & Pink, G. H. (2004). Nurse staffing models, nursing hours, and patient safety outcomes. *Journal of Nursing Administration, 34*(1), 41-45.
- Hamilton, D. K. (1993). *Unit 2000: Patient beds for the future. A nursing unit design symposium.*
- Happell, B., Martin, T., & Pinikahana, J. (2003). Burnout and job satisfaction: A comparative study of psychiatric nurses from forensic and a mainstream mental health service. *International Journal of Mental Health Nursing, 12*, 39-47.
- Harrison, S. (2004). Bad hospital design leads to poor staff performance. *Nursing Standard, 18*(46), 7.
- Hayward, R. A., & Hofer, T. P. (2001). Estimating hospital deaths due to medical error: Preventability is in the eye of the reviewer. *Journal of the American Medical Association, 286*(4), 415-420.
- Hendrich, A. (2006, February). *Hospital work environments: Implications for nursing practice and patient care quality.* Paper presented at the Healthcare Environments Research Summit 2006, Atlanta, GA.
- Hendrich, A., Fay, J., & Sorrells, A. K. (2004). Effects of acuity-adaptable rooms on flow of patients and delivery of care. *American Journal of Critical Care, 13*(1), 35-45.
- Hendrich, A., Fay, J., & Sorrells, A. (2002, September). Acuity-adaptable patient rooms and decentralized nursing stations-A winning combination. *Healthcare Design, 11*-13.
- Hightower, D. P., Thomas, S. H., Stone, K., Brinkley, S., & Brown, D. F. M. (1995). Red cabin lights impair air medical crew performance of color-dependent tasks. *Air Medical Journal, 14*(2), 75-78.
- Hignett, S., & Richardson, B. (1995). Manual handling human loads in a hospital: An exploratory study to identify nurses' perceptions. *Applied Ergonomics, 26*(3), 221-226.
- Hill-Rom (2002). *The patient room of the future.* Batesville, IN: Author.
- Hightower, D. P., Thomas, S. H., Stone, K., Brinkley, S., & Brown, D. F. M. (1995). Red cabin lights impair air med-

- ical crew performance of color-dependent tasks. *Air Medical Journal*, 14(2), 75-78.
- Hilton, B. A. (1985). Noise in acute patient care areas. *Research in Nursing and Health*, 8, 283-291.
- Hodge, B., & Thompson, J. F. (1990). Noise pollution in the operating theatre. *Lancet*, 335 (8694), 891-894.
- Hodges, V., Sandford, D. & Elzinga, R. (1986). The role of ward structure on nursing staff behaviors: An observational study of three psychiatric wards. *Acta Psychiatrica Scandinavica*, 73, 6-11.
- Hodgkinson, B., Koch, S., Nay, R., & Nichols, K. (2006). Strategies to reduce medication errors with reference to older adults. *International Journal of Evidence Based Healthcare*, 4, 2-41.
- Hoffman, A. J., & Scott, L. D. (2003). Role stress and career satisfaction among registered nurses by work shift patterns. *Journal of Nursing Administration*, 33(6), 337-342.
- Hosking, S. & Haggard, L. (1999). Departmental components of the average hospital. In S. Hosking and L. Haggard, *Healing the hospital environment: Design, management and maintenance of healthcare premises* (pp.53-82). London: Routledge.
- Hosking, S. & Haggard, L. (1999). The human factor. In S. Hosking and L. Haggard, *Healing the hospital environment: Design, management and maintenance of healthcare premises* (pp.159-171). London: Routledge.
- Howell, K., Fontes, D., Hamvas, A., Mathur, A., & Holzmann-Pazgal, G. (2005). Compliance with contact precautions in a neonatal intensive care unit. *American Journal of Infection Control*, 33(5), E132.
- Huang, Y., Roberston, M. M., & Chang, K. (2004). The role of environmental control on environmental satisfaction, communication, and psychological stress: Effects of office ergonomics training. *Environment and Behavior*, 36(5), 617-637.
- Hui, L., Ng, G. Y. F., Yeung, S. S. M., & Hui-Chan, C. W. Y. (2001). Evaluation of physiological work demands and low back neuromuscular fatigue on nurses working in geriatric wards. *Applied Ergonomics*, 32, 479-483.
- Hygge, S., & Knez, S. (2001). Effects of noise, heat and indoor lighting on cognitive performance and self-reported affect. *Journal of Environmental Psychology*, 21, 291-299.
- Institute of Medicine (IOM) (2001). *Crossing the quality chasm: A new health system for the 21st century*. Washington, DC: National Academy Press.
- Institute of Medicine (IOM) (2004). *Keeping patients safe: Transforming the work environment of nurses*. Washington, DC: National Academy Press.
- Jackson, L., & Gleason, J. (2004). Proactive management breaks the fall cycle. *Nursing Management*, 35(6), 37-38.
- Janowitz, I. L., Gillen, M., Ryan, G., Rempel, D., Trupin, L., Swig, L., et al. (in press). Measuring the physical demands of work in hospital settings: Design and implementation of an ergonomics assessment. *Applied Ergonomics*, 1- 18.
- Jenkins, R., & Elliott, P. (2004). Stressors, burnout and social support: Nurses in acute mental health settings. *Journal of Advanced Nursing*, 48(6), 622-631.
- Jiang, S., Huang, L., Xilong, C., Jinfeng, W., Wei, W. et al. (2003). Ventilation of wards and nosocomial outbreak of severe acute respiratory syndrome among health-care workers. *Chinese Medical Journal*, 116(9), 1293-1297.
- Joint Commission of Accreditation of Healthcare Organizations (JCAHO) (2002). *Healthcare at the crossroad: Strategies for addressing the evolving nursing crisis*. Oakbrook Terrace, IL: Joint Commission of Accreditation of Healthcare Organizations
- Jones, R. G. (1988). Experimental study to evaluate nursing staff morale in a high stimulation geriatric psychiatry setting. *Journal of Advanced Nursing*, 13, 352-357.
- Janssen, P. A., Harris, S. J., Soolsma, J., Klein, M. C., & Seymour, L. C. (2001, September). Single room maternity care: The nursing response. *Birth*, 28(3), 173-179.
- Kalliath, T., & Morris, R. (2002). Job satisfaction among nurses. *Journal of Nursing Administration*, 32(12), 648-654.
- Kaplan, L. M., & McGuckin, M. (1986). Increasing hand-washing compliance with more accessible sinks. *Infection Control*, 7(8), 408-410.
- Karasek, R. and Theorell, T. (1990). *Healthy work: stress, productivity, and the reconstruction of working life*. New York: Basic Books.
- Kaushal, R., Bates, D. W., Landrigan, C., McKenna, K. J., Clapp, M., D., Federico, F., & Goldmann, D. A. (2001). Medication errors and adverse drug events in pediatric inpatients. *Journal of the American Medical Association*, 285(16), 2114-2120.
- Kibbler, C. C., Quick, A., & O'Neill, A. M. (1998). The effect of increased bed numbers on MRSA transmission in acute medical wards. *Journal of Hospital Infection*, 39, 213-219.

- Kjellberg, A., Landstrom, U., Tesarz, M., Soderberg, L., & Akerlund, E. (1996). The effects of nonphysical noise characteristics, ongoing task and noise sensitivity on annoyance and distraction due to noise at work. *Journal of Environmental Psychology, 16*, 123-136.
- Knez, I. (1995). Effects of indoor lighting on mood and cognition. *Journal of Environmental Psychology, 15*, 39-51.
- Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (2000a). Errors in health care: A leading cause of death and injury. In *To err is human: Building a safer health system* (pp. 26-47). Washington, D.C.: National Academy Press.
- Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (2000b). Creating safety systems in health care organizations. In *To err is human: Building a safer health system* (pp. 155-201). Washington, D.C.: National Academy Press.
- Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (2000c). Executive summary. In *To err is human: Building a safer health system* (pp. 1-16). Washington, D.C.: National Academy Press.
- Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (2000d). A comprehensive approach to improving patient safety. In *To err is human: Building a safer health system* (pp. 17-25). Washington, D.C.: National Academy Press.
- Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (2000e). Why do errors happen? In *To err is human: Building a safer health system* (pp. 49-68). Washington, D.C.: National Academy Press.
- Koppel, R., Metlay, J., Cohen, A., Abaluck, B., Localio, A. R., Kimmel, S. E., & Strom, B. L. (2005). Role of computerized physician order entry systems in facilitating medication errors. *Journal of the American Medical Association, 293*(10), 1197-1203.
- Kroemer, K. H. E., & Kroemer, A. D. (2001). *Office ergonomics*. London: Taylor & Francis Ltd.
- Krueger, G. P. (1994). Fatigue, performance, and medical error. In M. S. Bogner (Ed.) *Human error in medicine* (pp. 311-326). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Kuhar, P. A., Miller, D. M., Spear, B. T., Ulreich, S. M., & Mion, L. C. (2004). The meaningful retention strategy inventory: A targeted approach to implementing retention strategies. *Journal of Nursing Administration, 34*(1), 10-18.
- Kumari, D. N., Haji, T. C., Keer, V., Hawkey, P. M., Duncanson, V., & Flower, E. (1998). Ventilation grilles as a potential source of methicillin-resistant *Staphylococcus aureus* causing an outbreak in an orthopaedic ward at a district general hospital. *The Journal of Hospital Infection, 39*(2), 127-133.
- Kwallek, N., & Lewis, C. M. (1990). Effects of environmental colour on males and females: A red or white or green office. *Applied Ergonomics, 21* (4), 275-278.
- Lane, I. M., Prestholdt, P. H., & Mathews, R. C. (1991). Organizational factors associated with beliefs of nurses that influence turnover. *Journal of Organizational Behavior, 12*(7), 641-649.
- Lankford, M. G., Zembower, T. R., Trick, W. E., Hacek, D. M., Noskin, G. A., & Peterson, L. R. (2003). Influence of role models and hospital design on hand hygiene of health care workers. *Emerging Infectious Diseases, 9*(2), 217-223.
- Larson, E. (1988). A causal link between handwashing and risk of infection? Examination of evidence. *Infection Control, 8*, 28-36.
- Larson, L. (2003, February). Putting safety in the blueprint: Patient safety is the guiding force for a new hospital. *Trustee, 9*-13.
- Leaman, A., & Bordass, B. (2000). Productivity in buildings: The killer variables. In D. Clemence-Croom (Ed.), *Creating the productive workplace* (pp. 165-191). London: Spon Press.
- Leather, P., Beale, D., & Sullivan, L. (2003). Noise, psychosocial stress and their interaction in the workplace. *Journal of Environmental Psychology, 23*, 213-222.
- Leape, L. L. (1994). Error in medicine. *Journal of the American Medical Association, 272*(23), 1851-1857.
- Leape, L. L. (2000). Institute of medicine medical error figures are not exaggerated. *Journal of the American Medical Association, 284*(1), 95-97.
- Leape, L. L., Bates, D., Cullen, D., Cooper, J., Demenaco, H., Gallivan, T., Hallisey, R., Ives, J., Laird, N., Laffel, G., Nemeskal, R., Peterson, L., Porter, K., Servi, S., Shea, B., Small, S., Sweitzer, B., Thompson, b., & Vander Vleit, M. (1995). Systems analysis of adverse drug events. *Journal of the American Medical Association, 274*(1), 35-43.
- Leape, L. L., & Berwick, D. M. (2000). Safe health care: Are we up to it? *British Medical Journal, 320*, 725-726.
- Leape, L. L., & Berwick, D. M. (2005). Five years after *to err is human*: What have we learned? *Journal of the American Medical Association, 293*(19), 2384-2389.
- Leape, L. L., Berwick, D. M., & Bates, D. W. (2002). What practices will most improve patient safety? *Journal of the American Medical Association, 288*(4), 501-507.

- Leape, L. L., Brennan, T. A., Laird, N., Lawthers, A. G., Localio, R., Barnes, B. A. et al. (1991). The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *The New England Journal of Medicine*, 324(6), 377-384.
- Leape, L. L., Woods, D. D., Hatlie, M. J., Kizer, K. W., Schroeder, S. A., & Lundberg, G. D. (1998). Promoting patient safety by preventing medical error. *Journal of the American Medical Association*, 280(16), 1444-1447.
- Lee, S. Y., & Brand, J. L. (2005). Effects of control over office workspace on perceptions of the work environment and work outcomes. *Journal of Environmental Psychology*, 25, 323-333.
- Lee, T. H. (2002). A broader concept of medical errors. *New England Journal of Medicine*, 347(24), 1965-1967.
- Leibrock, C. A. (2000). Inpatient hospitals: General hospitals (Chapter 13). In C. Leibrock, *Design details for health: Making the most of interior design's healing potential* (pp.231-256). New York: John Wiley & Sons, Inc.
- Leiter, M. P., Harvie, P. & Frizzell, c. (1998). The correspondence of patient satisfaction and nurse burnout. *Social Science and Medicine*, 47, 1611-1617.
- Lesiuk, T. (2005). The effect of music listening on work performance. *Psychology of Music*, 33(2), 173-191.
- Levy, B. I. (1984). Research into the psychological meaning of color. *American Journal of Art Therapy*, 23, 58-62.
- Liao, M. H., & Drury, C. G. (2000). Posture, discomfort and performance in a VDT task. *Ergonomics*, 43(3), 345-359.
- Lockhart, J. (2005). The healthcare-associated training calendar: An innovative approach to infection control education. *American Journal of Infection Control*, 33(5), E69.
- Lowers, J. (1999, August). Improving quality through the built environment. *Quality Letter for Healthcare Leaders*, 11, 2-9.
- Lu, H., While, A. E., & Barriball, K. L. (2005). Job satisfaction among nurses: A literature review. *International Journal of Nursing Studies*, 42, 211-227.
- Lum, L., Kervin, J., Clark, K., Reid, F., & Sirola, W. (1998). Explaining nursing turnover intent: Job satisfaction, pay satisfaction, or organizational commitment? *Journal of Organizational Behavior*, 19(3), 305-320.
- Luna, T. D., French, J., & Mitcha, J. L. (1997). A study of USAF air traffic controller shiftwork: Sleep, fatigue, activity, and mood analyses. *Aviation, Space, and Environmental Medicine*, 68(1), 18-23.
- Lundstrom, T., Pugliese, G., Bartley, J., Cox, J., & Guither, C. (2002). Organizational and environmental factors that affect worker health and safety and patient outcomes. *American Journal of Infection Control*, 30(2), 93-106.
- McCarthy, M. (2004). Healthy design. *The Lancet*, 364, 405-406.
- McCaughey, B. (2005, June 6). Coming Clean, *The New York Times*, p. A19.
- McClanahan, S., Goodwin, S. T., & Houser, F. (2000). A formula for errors: Good people + bad systems. In P. L. Spath (Ed.) *Error reduction in health care: A systems approach to improving patient safety* (pp. 1-15). San Francisco, CA: Jossey-Bass Publishers.
- McCoy, J. M. (2002). Work environments. In R. Bechtel & A. Churchman (Eds.), *Handbook of Environmental Psychology* (pp. 443-460). New York: J. Wiley & Sons.
- McDonald, N., & Ronayne, T. (1989). Jobs and their environment: The Psychological impact of work in noise. *The Irish Journal of Psychology*, 10(1), 39-55.
- McDonald, C. J., Weiner, M., & Hui, S. L. (2000). Deaths due to medical errors are exaggerated in Institute of Medicine report. *Journal of the American Medical Association*, 284(1), 93-94.
- McClanahan, S., Goodwin, S. T., & Houser, F. (2000). A formula for errors: Good people + bad systems. In P. L. Spath (Ed.) *Error regulation in health care: A systems approach to improving patient safety*, (pp. 1-15). San Francisco, CA: Jossey-Bass.
- McManis & Monsalve Associates (2003). Healthy work environments: Striving for excellence volume II.
- McNeese-Smith, D. K. (2001). Staff nurse views of their productivity and nonproductivity. *Health Care Management Review*, 26(2), 7-19.
- McNeese-Smith, D. K. (1999). The relationship between managerial motivation, leadership, nurse outcomes, and patient satisfaction. *Journal of Organizational Behavior*, 20(2), 243-259.
- McVicar, A. (2003). Workplace stress in nursing: A literature review. *Journal of Advanced Nursing*, 44(6), 633-642.
- Ma, C., Samuels, M. E., & Alexander, J. W. (2003). Factors that influence nurses' job satisfaction. *Journal of Nursing Administration*, 33(5), 293-299.
- Mahnke, F. (1996). *Color, Environment, and Human Response*. New York: Van Nostrand Reinhold.

- Malkin, J. (1982). *The design of medical and dental facilities*. New York: Van Nostrand Reinhold Company.
- Malkin, J. (1992). *Hospital interior architecture: Creating healing environments for special patient populations*. New York: Van Nostrand Reinhold Co. Inc.
- Marans, R. W., & Spreckelmeyer, K. F. (1981). *Evaluating built environments: A behavioral approach*. Ann Arbor, MI: Institute for Social Research & Architectural Research Laboratory.
- Marans, R. W., & Spreckelmeyer, K. F. (1982a). Evaluating open and conventional office design. *Environment and Behavior*, 14(3), 333-351.
- Marans, R. W., & Spreckelmeyer, K. F. (1982b). Measuring overall architectural quality: A component of building evaluation. *Environment and Behavior*, 14(6), 652-670.
- Mastromarino, P., Conti, C., Donato, K., Strappini, P. M., Cattaruzza, M. S., & Orsi, G. B. (2005). Does hospital work constitute a risk factor for *Helicobacter pylori* infection? *Journal of Hospital Infection*, 60, 261-268.
- Meehan, T., Bergen, H., & Fjeldsoe, K. (2004). Staff and patient perceptions of seclusion: Has anything changed? *Journal of Advanced Nursing*, 47(1), 33-38.
- Melikov, A., Pitchurov, G., Naydenov, K., & Langkilde, G. (2005). Field study on occupant comfort and the office thermal environment in rooms with displacement ventilation. *Indoor Air*, 15, 205-214.
- Menozi, M., Napflin, U., & Krueger, H. (1999). CRT versus LCD: A pilot study on visual performance and suitability of two display technologies for use in office work. *Displays*, 20, 3-10.
- Menzies, D., Fanning, A., Yaun, L. & FitzGerald, J. M. (2000). Hospital ventilation and risk for tuberculosis infection in Canadian health care workers. *Annals of Internal Medicine*, 133(10), 779-789.
- Meurier, C. E., Vincent, C. A., & Parmar, D. G. (1997). Learning from errors in nursing practice. *Journal of Advanced Nursing*, 26, 111-119.
- Meurier, C. E., Vincent, C. A., & Parmar, D. G. (1998). Nurses' responses to severity dependent errors: A study of the causal attributions made by nurses following an error. *Journal of Advanced Nursing*, 27, 349-354.
- Miller, R. L. & Swensson, E. S. (1995). The patient care unit (Chapter 9) *New directions in hospital and healthcare facility design* (pp.177-208). New York: McGraw-Hill, Inc.
- Milne, D & Day, S. R. (1986). Planning and evaluating innovations in nursing practice by measuring the ward atmosphere. *Journal of Advanced Nursing*, 11, 203-210.
- Moeser, S. D. (1988). Cognitive mapping in a complex building. *Environment and Behavior*, 20(1), 21-49.
- Morrissey, J. (1994, September 19). Cooperative care acutely less costly. *Modern Healthcare*, 181, 32.
- Morrison, A. L., Beckmann, U., Durie, M., Carless, R., Gillies, D. M. (2001). The effects of nursing staff inexperience (NSI) on the occurrence of adverse patient experiences in ICUs. *Australian Critical Care*, 14(3), 116-121.
- Mroczek, J., Mikitarian, G., Vieira, E. K., & Rotarius, T. (2005). Hospital design and staff perceptions: An exploratory analysis. *The Health Care Manager*, 24(3), 233-244.
- Murray, M. D. (2001). Automated medication dispensing devices. In A. J. Markowitz (Ed.) *Making health care safer: A critical analysis of patient safety practices* (pp. 111-117). Rockville, MD: Agency for Healthcare Research and Quality. <http://www.ahrq.gov/clinic/ptsafety/pdf/ptsafety.pdf>
- Muto, C A, Sstrom, M G, & Farr, B M (2000). Hand hygiene rates unaffected by installation of dispensers of a rapidly acting hand antiseptic. *American Journal of Infection Control*, 28(3), 273-276.
- Nebeker, J. R., Barach, P., & Samore, M. H. (2004). Clarifying adverse drug events: A Clinician's guide to terminology, documentation, and reporting. *Annals of Internal Medicine*, 140, 795-801.
- Needham, D. M., Anderson, G., Pink, G. H., McKillop, I., Tomlinson, G. A., & Detsky, A. S. (2003). A province-wide study of the association between hospital resource allocation and length of stay. *Health Services Management Research*, 16, 155-166.
- Nightingale, F. (1859). *Notes on nursing: What it is and what it is not*. London: John W. Parker & Son.
- Nicklin, W., & McVeety, J. E. (2002). Canadian nurses' perceptions of patient safety in hospitals. *Canadian Journal of Nursing Leadership*, 15(3), 11-21.
- Norbeck, J. S. (1985). Perceived job stress, job satisfaction, and psychological symptoms in critical care nursing. *Research in Nursing & Health*, 8(3), 253-259.
- Norman, D. A. (1981). Categorization of action slips. *Psychological Review*, 88(1), 1-15.
- Noskin, G. A., & Petersen, L. R. (2001). Engineering infection control through facility design. *Emerging Infectious Diseases*, 7(2), 354-357.

- O'Connell, N. H., & Humphreys, H. (2000). Intensive care unit design and environmental factors in the acquisition of infection. *Journal of Hospital Infection*, 45, 255-262.
- O'Malley, A., Varadharajan, V., & Lok, S. (2005). Hand decontamination by medical staff in general medical wards. *Journal of Hospital Infection*, 59, 369-376.
- Olds, A. R. (1978). Psychological considerations in humanizing the physical environment of pediatric outpatient and hospital settings. In E. Gellert (Ed.) *Psychosocial aspects of pediatric care* (pp. 111-131). New York: Grune & Stratton, Inc.
- Olofsson, B., Bengtsson, C., & Brink, E. (2003). Absence of response: A study of nurses' experience of stress in the workplace. *Journal of Nursing Management*, 11, 351-358.
- Page, A. (Ed.). (2004). Work and workspace design to prevent and mitigate errors. In *Keeping patients safe: Transforming the work environment of nurses* (pp. 226-285). Washington, D.C.: The National Academies Press.
- Paparella, S. (2005). A safe haven for nurses to report medication errors? Clarian and Spectrum health systems prove it is possible. *Journal of Emergency Nursing*, 31(4), 373-375.
- Payne, N. (2001). Occupational stressors and coping as determinants of burnout in female hospice nurses. *Journal of Advanced Nursing*, 33(3), 396-405.
- Peterson, G. M., Wu, M. S. H., & Bergin, J. K. (1999). Pharmacists' attitudes towards dispensing errors: Their causes and prevention. *Journal of Clinical Pharmacy and Therapeutics*, 24, 57-71.
- Philibert, I., & Barach, P. (2002). Residents' hours of work. *British Medical Journal*, 325, 1184-1185.
- Pierce, R. A., 2nd, Rogers, E. M., Sharp, M. H., & Musulin, M. (1990). Outpatient pharmacy redesign to improve work flow, waiting time, and patient satisfaction. *American Journal of Hospital Pharmacy*, 47(2), 351-356.
- Pittet, D. (2004). The Lowbury lecture: Behaviour in infection control. *Journal of Hospital Infection*, 58, 1-13.
- Pittet, D., Mouroug, P., Perneger, T. V. (1999). Compliance with handwashing in a teaching hospital. *Annals of Internal Medicine*, 130(2), 126-130.
- Preston, G. A., Larson, E. L., & Stamm, W. E. (1981). The effect of private isolation rooms on patient care practices, colonization and infection in an intensive care unit. *The American Journal of Medicine*, 70, 641-645.
- Rabinowitz, P. M. (2005). Is noise bad for your health? *The Lancet*, 365, 1908-1909.
- Raffaello, M., & Maass, A. (2002). Chronic exposure to noise in industry: The effects of satisfaction, stress symptoms, and company attachment. *Environment and Behavior*, 34(5), 651-671.
- Reason, J. (2004). Beyond the organizational accident: The need for "error wisdom" on the frontline. *Quality & Safety in Health Care*, 13, 28-33.
- Reason, J. (2000). Human error: Models and management. *British Medical Journal*, 320, 768-770.
- Reason, J. (1997). *Managing the risks of organizational accidents*. Brookfield, VT: Ashgate.
- Reason, J. (1990). *Human Error*. Cambridge: Cambridge University Press.
- Reiling, J. (2002). Designing a safe hospital. *Center for the Study of Healthcare Management*. www.hsrumn.edu/mha/center/4220.pdf
- Reiling, J., & Bauer, A. (2002). The impact of facility design on patient safety. *Focus on Patient Safety*, 5(3), 3-4.
- Reiling, J., Berry, L. L., Parker, D., Coile Jr, R. C., et al. (2004). Facility design focused on patient safety/reply. *Frontiers of Health Services Management*, 21(1), 41-51.
- Reiling, J., Breckbill, C., Murphy, M., McCullough, S., & Chernos, S. (2003, May-June). Facility designing around patient safety and its effect on nursing. *Nursing Economic\$, 21(3)*, 143-147.
- Reiling, J., & Knutzen, B. L. (2003). FMEA – the cure for medical errors. *Quality Progress*, 36(8), 67-71.
- Reiling, J. G., Knutzen, B. L., Wallen, T. K., McCullough, S., Miller, R., & Chernos, S. (2004). Enhancing the traditional hospital design process: A focus on patient safety. *Joint Commission Journal on Quality and Safety*, 30(3), 115-124.
- Reinerstein, J. L. (2000). Let's talk about error. *British Medical Journal*, 320, 730.
- Renzi, C., Tabolli, S., Ianni, A., Di Pietro, C., & Puddu, P. (2005). Burnout and job satisfaction comparing health-care staff of a dermatological hospital and general hospital. *Journal of the European Academy of Dermatology and Venereology*, 19, 153-157.
- Reynolds, D. M., Johnson, M. H., Longe, R. L. (1978). Medication delivery time requirements in centralized and decentralized unit dose drug distribution systems. *American Journal of Hospital Pharmacy*, 35(8), 941-943.

- Rogers, A. E., Hwang, W., Scott, L. D., Aiken, L. H., & Dinges, D. F. (2004). The working hours of hospital staff nurses and patient safety. *Health Affairs, 23*(4), 202-212.
- Rollins, J. A. (2004). Evidence-based hospital design improves health care outcomes for patients, families, and staff. *Pediatric Nursing, 30*(4), 338-339.
- Rothschild, J. M., Keohane, C. A., Cook, E. F., Orav, E. J., Burdick, E., Thompson, S., et al. (2005). A controlled trial of smart infusion pumps to improve medication safety in critically ill patients. *Critical Care Medicine, 33*(3), 533-540.
- Rubin, H. (1997). The relationship between environmental design and patient medical outcomes. *Journal of Healthcare Design, 9*, 13-14.
- Ruck, N. (1989a). Luminous environment. In N. Ruck (Ed.), *Building design and human performance*, (pp. 40-59). New York, NY: Van Nostrand Reinhold.
- Ruck, N. (1989b). Lighting design. In N. Ruck (Ed.), *Building design and human performance*, (pp. 89-115). New York, NY: Van Nostrand Reinhold.
- Runy, L. A. (2004, May). The patient room: Universal rooms. *Hospitals and Health Networks, 36*-40.
- Salerno, S., Canulla, M., Talamanca, I. F. (2005). Ageing in nursing: A ten year follow up study. *International Congress Series, 1280*, 124-129.
- Santell, J. P., Hicks, R. W., McMeekin, J., & Cousins, D. D. (2003). Medication errors: Experience of the United States Pharmacopeia (USP) Medmarx reporting system. *Journal of Clinical Pharmacology, 43*, 760-767.
- Schwarz, H. O., & Brodowy, B. A. (1995). Implementation and evaluation of an automated dispensing system. *American Journal of Health-System Pharmacy, 52*, 823-828.
- Schweitzer, M., Gilpin, L., & Frampton, S. (2004). Healing spaces: Elements of environmental design that make an impact on health. *The Journal of Alternative and Complementary Medicine, 10*, S71-S83.
- Schulze, L. J. H. (2000). Workstation ergonomics. *Professional Safety, 12*, 51.
- Scott, H. (2004). Working environments have a direct impact on care. *British Journal of Nursing, 13*(15), 893.
- Seeyle, A. (1982). Hospital ward layout and nurse staffing. *Journal of Advanced Nursing, 7*, 195-201.
- Sehulster, L. & Chinn, R. Y. W. (2003). *Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the healthcare infection control practices advisory committee (HICPAC), 52*(RR-10), 1-44.
- Shaver, K. H., & Lacey, L. M. (2003). Job and career satisfaction among staff nurses: Effects of job setting and environment. *Journal of Nursing Administration, 33*(3), 166-172.
- Shepley, M. M., & Davies, K. (2003). *Nursing Unit Configuration and Its Relationship to Noise and Nurse Walking Behavior: An AIDS/HIV Unit Case Study*. Retrieved 11/26/2004, from http://www.aia.org/aah_a_jrnl_0401_article4
- Shepley, M. M. (2002). Predesign and postoccupancy analysis of staff behavior in a neonatal intensive care unit. *Children's Health Care, 31*(3), 237-253.
- Shirley, K. L. (1999). Effect on an automated dispensing system on medication administration time. *American Journal of Health-System Pharmacy, 56*, 1542-1545.
- Shumaker, S. A. & Pequegnat, W. (1989). Hospital design, health providers, and the delivery of effective health care. In E. H. Zube & G. T. Moore (Eds.), *Advances in environment, behavior, and design, Vol. 2* (pp. 161-199). New York: Plenum.
- Shumaker, S. A. & Reizemstein, J. E. (1982). Environmental factors affecting inpatient stress in acute care hospitals. In G. Evans (ed.), *Environmental stress* (pp. 179-223). Cambridge, London: Cambridge University Press.
- Silen-Lipponen, M., Tossavainen, K., Turunen, H., & Smith, A. (2005). Potential errors and their prevention in operating room teamwork as experienced by Finnish, British, and American nurses. *International Journal of Nursing Practice, 11*, 21-32.
- Simmons, J. C. (Ed.). (2003, April). Designing for Quality: Hospitals look to the built environment to provide better patient care and outcomes. *The Quality Letter for Healthcare Leaders, 2*-13.
- Small, S. D., & Barach, P. (2002). Patient safety and health policy: A history and review. *Hematology/Oncology Clinics of North America, 16*(6), 1463-1482.
- Smith, J., & Crawford, L. (2003). Medication errors and difficulty in first patient assignments of newly licensed nurses. *JONA's Healthcare Law, Ethics, and Regulation, 5*(3), 65-67.
- Sochalski, J. (2004). Is more better? The relationship between nurse staffing and the quality of nursing care in hospitals. *Medical Care, 42*(2), 1167-1173.

- Sochalski, J. (2001). Quality of Care, nurse staffing, and patient outcomes. *Policy, Politics, & Nursing Practice*, 2(1), 9-18.
- Spreckelmeyer, K. (2004, June 1). Ten design recommendations to improve environmental quality of nursing units. *Environmental Quality of Nursing Units*, 1-6.
- Spreckelmeyer, K. F. (1987). Environmental norms in the work place. *Design Methods and Theories*, 21(4), 723-730.
- Stelfox, H. T., Bates, D. W., & Redelmeir, D. A. (2003). Safety of patients isolated for infection control. *Journal of the American Medical Association*, 290(14), 1899-1905.
- Stichler, J. F. (2001). Creating healing environments in critical care units. *Critical Care Nursing Quarterly*, 24(3), 1-20.
- Stone, N. J. (2003). Environmental view and color for a simulated telemarketing task. *Journal of Environmental Psychology*, 23, 63-78.
- Stone, N. J., & English, A. J. (1998). Task type, posters, and workspace color on mood, satisfaction, and performance. *Journal of Environmental Psychology*, 18, 175-185.
- Streufert, S., Satish, U., & Barach, P. (2001). Improving medical care: The use of simulation technology. *Simulation and Gaming*, 32(2), 164-174.
- Sturdavant, M. (1960). Intensive nursing service in circular and rectangular units. *Hospitals, JAHA*, 34(14), 46-48, 71-78.
- Sundstrom, E. (1987). Work environments: Offices and factories. In D. Stokols & I. Altman (Eds.), *Handbook of Environmental Psychology* (pp. 733-782). New York: Wiley.
- Sundstrom, E. & Sundstrom, M. G. (1986). *Work places: The psychology of the physical environment in offices and factories*. Cambridge: Cambridge University Press.
- Sundstrom, E., Town, J. P., Rice, R. W., Osborn, D. P., & Brill, M. (1994). Office noise, satisfaction, and performance. *Environment and Behavior*, 26(2), 195-222.
- Sutherland, V., & Cooper, C. L. (2000). Stress and the changing nature of work. In D. Clemence-Croom (Ed.), *Creating the productive workplace* (pp. 77-90). London: Spon Press.
- Suzuki, K., Ohida, T., Kaneita, Y., Yokoyama, E., & Uchiyama, M. (2005). Daytime sleepiness, sleep habits and occupational accidents among hospital nurses. *Journal of Advanced Nursing*, 52(4), 445-453.
- Taylor, B., & Barling, J. (2004). Identifying sources and effects of carer fatigue and burnout for mental health nurses: A qualitative approach. *International Journal of Mental Health Nursing*, 13, 117-125.
- Thomas, E. J., & Brennan, T. A. (2000). Incidence and types of preventable adverse events in elderly patients: Population based review of medical errors. *BMJ*, 320, 741-744.
- Thorgaard, P., Ertmann, E., Hansen, V., Noerregaard, A., Hansen, V., Spanggaard, L. (2005). Designed sound and music environment in postanaesthesia care units—a multicentre study of patients and staff. *Intensive and Critical Care Nursing*, 21, 220-225.
- Tissot, E., Cornette, C., Demoly, P., Jacquet, M., Barale, F., & Capellier, G. (1999). Medication errors at the administration stage in an intensive care unit. *Intensive Care Medicine*, 25, 353-359.
- Tofle, R. B., Schwarz, B., & Max-Royale, A. (2004). *Color in healthcare environments: A monograph reference guide*.
- Topf, M. (1985). Noise-induced stress in hospital patients: Coping and nonauditory health outcomes. *Journal of Human Stress*, 11(3), 125-134.
- Topf, M. & Dillon, E. (1988). Noise-induced stress as a predictor of burnout in critical care nurses. *Heart Lung*, 17(5), 567-574.
- Tradewell, G. B. (1993). Contemporary nursing unit configuration. In D. K. Hamilton (Ed.) *Unit 2000: Patient beds for the future. A nursing unit design symposium* (pp. 191-215). Houston: Watkins Carter Hamilton Architects, Inc.
- Trites, D. K., Galbraith, F. D. Jr., Sturdavant, M., & Leckwart, J. F. (1970). Influence of nursing-unit design on the activities and subjective feelings of nursing personnel. *Environment and Behavior*, 2(3), 303-334.
- Trites, D. K., Galbraith, F. D. Jr., Leckwart, J. F., & Sturdavant, M. (1968). Radial nursing units prove best in controlled study. *Modern Hospital*, 112(4), 94-99.
- Trites, D. K., & Schwartz, N. W. (1967). Nursing or clerking. *Nursing Outlook*, 55-56.
- Tuttas, C. A. (2003). Decreasing nurse staffing costs in a hospital setting: Development and support of core staff stability. *Journal of Nursing Care Quality*, 18(3), 226-240.
- Tyson, G. A., Lambert, G., & Beattie, L. (2002). The impact of ward design on the behaviour, occupational satisfaction and well-being of psychiatric nurses. *International Journal of Mental Health Nursing*, 11, 94-102.

- Tyson, G.A, Lambert, W. G., & Beattie, L. (1995). The quality of psychiatric nurses' interaction with patients: An observational study. *International Journal of Nursing Studies*, 32, 49-58.
- Tzeng, H., Ketefian, S., Redman, R. W. (2002). Relationship of nurses' assessment of organizational culture, job satisfaction, and patient satisfaction with nursing care. *International Journal of Nursing Studies*, 39, 79-84.
- Ulrich, R. (1984, April). View through a window may influence recovery from surgery. *Science*, 224(4647), 420-421.
- Ulrich, R. (2003, October). *Creating a healing environment with evidence-based design*. Paper presented at the American Institute of Architects Academy of Architecture for Health Virtual Seminar Healing Environments.
- Ulrich, R., & Barach, P. (2006, February). *Designing safe healthcare facilities-What are the data and where do we go from here?* Paper presented at the Healthcare Environments Research Summit 2006, Atlanta, GA.
- Ulrich, R., Zimring, C., Quan, X., Joseph, A., & Choudhary, R. (2004). *The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity*. Report to the Center for Health Design for the Designing the 21st Century Hospital Project.
- Unruh, L. (2003). Licensed nurse staffing and adverse events in hospitals. *Medical Care*, 41(1), 142-152.
- Upenieks, V.V. (1998). Work sampling: Assessing nursing efficiency. *Nursing Management*, 29(4), 27-29.
- Vahey, D. C., Aiken, L. H., Sloane, D. M., Clarke, S. P., Vargas, D. (2004). Nurse burnout and patient satisfaction. *Medical Care*, 42(2), 1157-1166.
- Varni, J. M., Burwinkle, T. M., Dickinson, P., Sherman, S. A., Dixon, P., Ervice, J. A. et al. (2004). Evaluation of the built environment at a children's convalescent hospital: Development of the Pediatric Quality of Life Inventory parent and staff satisfaction measures for pediatric health care facilities. *Developmental and Behavioral Pediatrics*, 25(1), 10-20.
- Veitch, J. A. (1997). Revisiting the performance and mood effects of information about lighting and fluorescent lamp type. *Journal of Environmental Psychology*, 17, 253-262.
- Veitch, J. A., & Newsham, G. R. (2000). Exercised control, lighting choices, and energy use: An office stimulation experiment. *Journal of Environmental Psychology*, 20, 219-237.
- Verderber, S. & Fine, D. J. (2000). Reinventing the patient room. In S. Verderber & D. Fine, *Healthcare architecture in an era of radical transformation* (pp. 195-222). New Haven, CT: Yale University Press.
- Vietri, N. J., Dooley, D. P., Davis, C. E. Jr., Longfield, J. N., Meier, P.A., & Whelen, A. C. (2004). The effect of moving to a new hospital facility on the prevalence of methicillin-resistant *Staphylococcus aureus*. *American Journal of Infection Control*, 32, 262-267.
- Voelker, R. (1994). New trends aimed at healing by design. *Journal of the American Medical Association*, 272(24), 1885-1886.
- Walch, J. M., Rabin, B. S., Day, R., Williams, J. N., Choi, K., & Kang, J. D. (2005). The effect of sunlight on post-operative analgesic medication usage: A prospective study of spinal surgery patients. *Psychosomatic Medicine*, 67(1), 156-163.
- Weber, D. O. (1995, March-April). Environments that heal. *The Healthcare Forum Journal*, 38(2), 42.
- Whitby, M., & McLaws, M. L. (2004). Handwashing in healthcare workers: Accessibility of sink location does not improve compliance. *Journal of Hospital Infection*, 58, 247-253.
- Whitehead, C., Polsky, R., Crookshank, C. & Fik, E. (1984). Objective and subjective evaluation of psychiatric ward redesign. *American Journal of Psychiatry*, 141(5), 639-644.
- Whitman, G. R., Kim, Y., Davidson, L. J., Wolf, G. A., & Wang, S. (2002). The impact of staffing on patient outcomes across specialty units. *Journal of Nursing Administration*, 32(12), 633-639.
- Whole Building Design Guide Productive Committee. (2005, February 1). *Productive*. <http://www.wbdg.org/design/productive.php>
- Williams, M.A. (1988). The physical environment and patient care. *Annual Review of Nursing Research*, 6, 61-84.
- Wineman, J. D. (1979). Color in environmental design: Its impact on human behavior. *Environmental Design Research Association*, 10, 436-439.
- Woods, A., & Doan-Johnson, S. (2002). Executive summary: Toward a taxonomy of nursing practice errors. *Nursing Management*, 33(10), 45-48.
- Wright, A. A., & Katz, I.T. (2005). Bar coding for patient safety. *New England Journal of Medicine*, 353(4), 329-331.

Wright, L. M., & Leahey, M. (2005). The three most common error in family nursing: How to avoid or sidestep. *Journal of Family Nursing*, 11(2), 90-101.

Yang, K. (2003). Relationships between nurse staffing and patient outcomes. *Journal of Nursing Research*, 11(3), 149-157.

Yassi, A., Cohen, M., Cvitkovich, Y., Park, I. H., Ratner, P. A., Ostry, A. S., Village, J., & Pollack, N. (2004). Factors associated with staff injuries in intermediate care facilities in British Columbia, Canada. *Nursing Research*, 53(2), 87-98.

Annotated References

Empirical Articles: Nursing and Medical Errors

Aiken, L. H., Clarke, S. P., Cheung, R. B., Douglas, D. M., Silber, J. H. (2003). Educational levels of hospital nurses and surgical patient mortality. *Journal of the American Medical Association*, *290*(12), 1617-1623.

Focus of Study

- To examine the effect of nurses' education levels on patient mortality

Research Design

- A survey distributed to nurses included measures pertaining to the nurses' highest credential in nursing, nursing workload, and experience as a nurse; hospital characteristics included size, teaching status, and technology
- Discharge abstracts for patients undergoing general surgical, orthopedic, or vascular procedures were obtained
- Patient outcomes measured include death within 30 days of hospital admission and death within 30 days of admission for patients who experienced complications

Sample Information & Site

- The sample included 168 of 210 adult acute-care general hospitals in Pennsylvania
- 10,184 nurses participated in this study.

Findings

- Statistically significant relationship between proportion of nurses in hospital with bachelor's and master's degree and risks of mortality and failure to rescue
- Each 10 percent increase in proportion of nurses with higher degrees decreased risk of mortality and failure to rescue by 5 percent
- Years of experience of nurses was not a significant predictor of mortality or failure to rescue

Implications of Findings

- Increasing the percentage of nurses earning a Bachelor of Science would produce substantial decreases in mortality rates for surgical patients and for patients who develop complications

Baker, G. R., Norton, P. G., Flintoft, V., Blais, R., Brown, A., Cox, J. et al. (2004). The Canadian adverse events study: The incidence of adverse events among hospital patients in Canada. *Canadian Medical Association Journal*, *170*(11), 1678-1686.

Focus of Study

- To provide a national estimate of the occurrence of adverse events in Canadian hospitals

Research Design

- Random sample of hospital charts was selected by Canadian Institute for Health Information (CIHI)
- 2-stage review of hospital charts occurred
- In first stage, nurses or health records professionals assessed hospital charts for presence of 1 of 18 screening criteria known to be sensitive to occurrence of adverse event
- In second stage, physicians reviewed charts that were positive for at least one screening criterion; physicians determined extent to which healthcare management was responsible for adverse event
- Demographic data was provided by CIHI

Sample Information & Site

- The study took place in 4 hospitals in each of five provinces (British Columbia, Alberta, Ontario, Quebec, and Nova Scotia); 1 large community hospital, 2 small community hospitals, and 1 teaching hospital were selected in each province
- 3745 hospital admissions were reviewed

Findings

- Approximately 40 percent of charts were assessed positive for 1 or more screening criteria
- Overall rate of adverse events was 7.5 percent (after weighting for sample frame); 36.9 percent of patients judged to have highly preventable adverse events
- Adverse events mainly resulted in longer hospital stays or temporary disability; small but significant proportion of patients died or experienced permanent disability as a result of adverse event
- Trend for adverse events to occur more often in teaching hospitals
- Most common types of adverse events were associated with surgical procedures followed by drug- or fluid-related events

Implications of Findings

- The occurrence of adverse events resulted in longer stays and temporary disability for the majority of patients. A small proportion of patients died or experienced permanent disability as a result of the adverse events
- Efforts to make the environment safer for patients need to be implemented and monitored

Barach, P., & Small, S. (2000a). Reporting and preventing medical mishaps: Lessons from non-medical near miss reporting systems. *British Medical Journal*, 320, 759-763.

Focus of Study

- To report findings of a study of incident reporting systems in non-medical settings

Research Design

- Three main sources were used for the analysis: literature search, compilation and classification of key features of reporting systems, and interviews with directors of reporting systems and experts

Sample Information & Site

- This study reviewed literature on non-medical safety systems and interviewed directors and designers of safety systems.

Findings

- 12 systems were reviewed, of which 7 were mandated by the federal government, with voluntary participation
- 10 systems were confidential, 2 were anonymous
- Comparison of adverse events to near misses advantageous because near misses occur more often, fewer barriers to data collection exists, recovery strategies can be studied, and hindsight bias is reduced
- Disincentives to reporting depend on organizational culture
- Incentives to reporting include confidentiality, immunity, and therapeutic
- Quality of incident reporting systems depends on immunity, confidentiality, independent outsourcing of report collection, rapid meaningful feedback, ease of reporting, and sustained leadership support

Implications of Findings

- Systems which are non-punitive, protected, and voluntary have been essential in obtaining information in non-medical industries

Bates, D.W., Boyle, D. L., Vander Vliet, M. B., Schneider, J., & Leape, L. (1995). Relationship between medication errors and adverse drug events. *Journal of General Internal Medicine*, 10, 199-205.

Focus of Study

- To evaluate the frequency of medication errors and to determine how often medication errors are associated with actual and potential adverse drug events

Research Design

- New medication orders were evaluated to determine whether they represented potential medication errors
- Potential medication errors detected by: pharmacists reporting prescribing errors identified during dispensing process, study nurse reviewing all charts for evidence of medication errors, and trained reviewer evaluated medication sheets received by pharmacy
- Reports of incidents of adverse drug events followed same procedure; in addition information was solicited from nurses through daily visits to units and by daily electronic mail notes to nurses on units
- Clinical data gathered from the patient's medical record includes date and time of incident, name and dose of drug involved, complications, and source of identification of incident
- Potential medication errors and incidents were evaluated by physician reviewers; actual and potential adverse events classified according to severity and preventability

Sample Information & Site

- This study took place at Brigham and Women's Hospital in Boston, Massachusetts.
- The sample includes all adults admitted to three medical units (2 general medical units, 1 medical intensive care unit) over a 51-day period between October and November 1992

Findings

- The rate of medication errors was 1.4 errors per admission
- 53% of medication errors associated with missing doses and 47% were associated with non-missing dose errors (including dose errors, frequency errors, and route errors)
- Antibiotics were drug class most often associated with missing dose errors and remainder of medication errors
- 82% of medication errors identified through review of medication sheets
- 5 of 530 medication errors resulted in adverse drug events
- Most of potential adverse events were intercepted before medication administered
- Physicians responsible for 93% of intercepted potential adverse drug events and 81% of errors in which medication ordered for patient with known drug allergy

Implications of Findings

- Most serious medication errors result from prescribing errors by physicians
- Relatively few medication errors result in adverse drug events
- Error rates could be reduced through use of physician computer order entry

Bates, D. W., Leape, L. L., Cullen, D. J., Laird, N., Petersen, L. A., Small, S. D., et al. (1995). Incidence of adverse drug events and potential adverse drug events. *Journal of the American Medical Association*, 274(1), 29-34.

Focus of Study

- To evaluate the incidence and preventability of adverse drug events and potential adverse drug events

Research Design

- Incidents were identified by: nurses and pharmacists asked to report incidents to investigators, nurse investigator visited each unit at least twice daily on weekdays and solicited information from nurses, pharmacists, and clerical personnel, and nurse investigator reviewed all charts at least daily on weekdays
- All incidents were evaluated independently by two physician reviewers

Sample Information & Site

- This study took place at Brigham and Women's Hospital in Boston, Massachusetts.
- All adults at these two hospitals admitted to any of 11 units from February through July 1993 were included in the sample

Findings

- Rate of adverse drug event was 6.5 per 100 admissions
- 247 adverse drug events were found of which 70 (28%) were preventable
- 194 potential adverse drug events were found of which 83 (43%) were intercepted before drug was given
- Rate of adverse drug event highest in medical ICUs; rates relatively similar in surgical ICUs and medical and surgical general care units
- More severe adverse drug events were more often preventable
- The 247 adverse drug events associated with 101 different drugs; analgesics was drug class most often associated with adverse drug event followed by antibiotics
- Analgesics leading drug associated with preventable adverse drug events

- Primary error for preventable adverse events occurred in ordering stage; error more likely to be intercepted if occurred early in process; ordering wrong dose most common ordering error followed by wrong choice, known allergy, wrong frequency, and drug-drug interaction
- Most common transcription errors were wrong frequency and missed dose
- Administration errors include wrong dose, wrong technique, wrong drug, missed dose, and wrong time of administration

Implications of Findings

- Errors resulting in adverse drug events occur most often in the ordering stage followed by the administration stage
- Improvement in systems in which drugs are ordered and administered could prevent many adverse drug events

Bates, D. W., Leape, L. L., Cullen, D. J., Laird, N., Petersen, L. A., Teich, J. M. et al. (1998). Effect of computerized physician order entry and a team intervention on prevention of serious medical errors. *Journal of the American Medical Association*, 280(15), 1311-1316.

Focus of Study

- To evaluate the effectiveness of two interventions designed to prevent nonintercepted serious medical errors

Research Design

- Baseline data was collected over a six month period. Six study units (2 intensive care and 4 general care units) were randomly selected; in intervention phase same units plus and additional two units (1 medical and 1 surgical) were used
- Two interventions were introduced: physician computer order-entry system (POE) in which physicians wrote all their orders online and a team intervention which included several small interventions developed by teams of nurses, physicians, and pharmacists and targeted administration and dispensing of drugs
- Primary measure was number of nonintercepted serious medication errors
- Secondary outcomes evaluated include numbers of errors in each stage and within specific categories targeted by intervention
- Incidents identified through: nurses and pharmacists asked to report incidents to investigators, information was solicited at least twice daily by researchers from nurses, pharmacists, and clerical personnel, and study charts were reviewed at least daily by investigators
- All incidents evaluated by 2 physician reviewers blinded to intervention groups

Sample Information & Site

- This study took place at Brigham and Women's Hospital in Boston, Massachusetts.
- All adults admitted to the study units were included in this study; 2491 admissions occurred during phase one and 4220 admissions occurred during phase two

Findings

- Nonintercepted medication errors decreased across all levels of severity
- Rate of ordering errors decreased by 19 percent overall
- Transcription errors fell by 84 percent
- No significant differences were found between the POE units only and the POE plus team interventions
- Rates of dispensing errors decreased by 68 percent
- Rates of administration errors decreased by 59 percent
- Nonintercepted serious medication errors fell for all drug types except sedatives, which increased 99 percent
- Dose errors decreased by 23 percent; known allergy errors declined by 56 percent
- 134 serious medication errors were not prevented in the intervention phase

Implications of Findings

- Using the physician computer order-entry system prevented more than half of the serious medication errors

Benjamin, D. M., & Pendrak, R. F. (2003). Medication errors: An analysis comparing PHICO's closed claims data and PHICO's event reporting trending system (PERTS). *Journal of Clinical Pharmacology*, 43, 754-759.

Focus of Study

- To examine the claims and events reported to PHICO insurance company between 1996 and 1998.

Research Design

- Data was obtained using PHICO's closed claims data and PHICO's event reporting trending system

Sample Information & Site

- This study includes data collected by PHICO.

Findings

- Approximately 25% of claims filed between 1996 and 1998 involved allergic or adverse reaction to medication
- Highest percentage of claims were for an allergic or adverse reaction to medication (27%) followed by incorrect dosage (20%) and wrong drug given (11%)

- Antibiotics were most common type of medication involved in errors

Implications of Findings

- Reducing medical errors is necessary to improve patient care; data needs to be collected on types and severities of the reported adverse reactions as well as the drugs involved

Benner, P., Sheets, V., Uris, P., Malloch, K., Schwed, K., & Jamison, D. (2002). Individual, practice, and system causes of errors in nursing: A taxonomy. *Journal of Nursing Administration*, 32(10), 509-523.

Focus of Study

- To develop a taxonomy of errors that could lead to a proactive reporting system to promote improvement in reducing medical errors

Research Design

- 21 cases involving competency and clinical judgment where actual or potential harm occurred were selected to develop a taxonomy of nursing errors, describe types of corrective actions taken by State Boards of Nursing, and determine the feasibility of using the taxonomy to design an instrument to provide feedback on nursing errors

Sample Information & Site

- Data was extracted from 21 completed disciplinary case files from 9 State Boards of Nursing

Findings

- 8 categories of nursing errors were identified: lack of attentiveness, lack of agency/fiduciary concern, inappropriate judgment, medication errors, lack of intervention on patient's behalf, lack of prevention, missed or mistaken MD/Healthcare provider's orders, and documentation errors
- Lack of attentiveness could be caused by system level problems such as understaffing or high staff turnover; sometimes associated with lack of sufficient supervisory monitoring of patient care needs; surveillance systems identifying patients in crises by unit and nurse assignment needed to ensure additional nursing support available during times of high demand
- Lack of agency/fiduciary concern occurs when nurses do not have the patient's/family's best interest; can occur when nurses fails to question inappropriate physician order; fails to heed patient or family requests for assistance, or fails to call physician when patient's vital signs are critical; also occurs when nurses breaches patient confidentiality
- Inappropriate judgment includes inadequate assessment, inadequate clinical judgment, nurse does not know or does not recognize implications of signs and symptoms identified,

lack of appropriate priorities, tunnel vision, faulty logic due to use of habitual action or convention, using unwarranted or faulty intervention, and unreasonable expectations for lesser-trained staff

- Medication errors identified include missed doses of medication, wrong time of administration, IV rate too fast, wrong concentration or dosage of medication delivered in IV, wrong route of administration, wrong medication administered, and wrong medications delivered due to misidentifying patient
- Identifying potential and actual medication errors expectation of nurses' role
- Missed or mistaken physician/healthcare provider's orders include instances of carrying out inappropriate medical errors or mistaking orders
- Lack of attentiveness led to lack of intervention on patient's behalf in 4 cases, all of which led to death
- Documentation errors include charting procedures or medications before they were completed and lack of charting of observations of patient
- Lack of prevention includes breach of infection precautions, lack of prevention of hazards of immobility and decreased mobility, and lack of provision of safe environment

Implications of Findings

- Using a taxonomy of errors approach, 8 categories of errors were discovered which led to a patient experiencing an adverse event, including death.

Binnekade, J. M., Vroom, M. B., de Mol, B. A., & de Haan, R. J. (2003). The quality of intensive care nursing before, during, and after the introduction of nurses without ICU training. *Heart & Lung, 32*(3), 190-196.

Focus of Study

- To determine whether the introduction of nurses without ICU experience into the Intensive Care Unit causes a significant shift in the quality of care

Research Design

- Prospective observational design was used
- Critical Nursing Situation Index (CNSI) was used to assess the incidence rates of predefined observable nursing errors
- The CSNI was applied before the nurses without ICU training were introduced, after a 3-month introductory period, and after their employment ended
- Data from patients were collected regarding their gender, age, referral specialty, length of stay at time of CNSI observation, and daily therapy intensity using Therapeutic Intervention Score System at time of CNSI observation

- Amount of time available for direct patient care per patient per hour was recorded daily

Sample Information & Site

- This study was conducted in a 30-bed Intensive Care Unit at the Academic Medical Center in Amsterdam
- 90 full time equivalent ICU nurses, 36 ICU trainees, and 16 full time equivalent nurses worked on the ICU unit during this study
- 256 patients were observed

Findings

- Significant decrease in incidence of critical nursing situations when non-ICU trained nurses introduced on ward
- Introduction of nurses during intervention phase significantly improved average available nursing time per patient per hour
- Net available nursing time for ICU nurses and trainees per patient hour did not differ during the three study periods

Implications of Findings

- The employment of additional nurses without ICU training into an ICU ward resulted in an improvement in certain aspects of quality of care, mainly because of the increased availability of nursing time

Blendon, R. J., DesRoches, C. M., Brodie, M., Benson, J. M., Rosen, A. B., Schneider, E., Altman, D. E., Zapert, K., Herrmann, M. J., & Steffenson, A. E. (2002). Patient safety: Views of practicing physicians and the public on medical errors. *New England Journal of Medicine, 347*(24), 1933-1940.

Focus of Study

- To learn the views of physicians and the general public regarding medical errors.

Research Design

- Parallel surveys of the public and physicians were conducted
- Physicians were randomly selected by Medical Marketing Service and questionnaires were mailed out to those selected; the questionnaire included questions pertaining to inpatient medical errors
- Random digit dialing was used to contact members of the general public; a telephone survey was used to obtain responses from the public regarding inpatient medical errors

Sample Information & Site

- 1207 members of the public and 831 physicians participated in the survey.

Findings

- 35% of physicians and 42% of the public reported experiencing an error in their care or in the care of a family member
- 18% of physicians and 24% of the public reported an error that led to serious health consequences
- 1/3 of both respondents reported that the healthcare worker reported the error to them and apologized
- Neither the public nor physicians thought medical errors were the largest problem in healthcare; physicians thought costs of malpractice insurance were most problematic; public reported costs of healthcare and prescription drugs as most important
- Physicians think causes of errors are understaffing in hospitals and healthcare workers being overworked
- Public think causes of errors are due to physicians' not having enough time with patients, healthcare workers being overworked, failure of healthcare professionals to work together, and understaffing
- Physicians think errors could be prevented if hospitals were required to develop systems for preventing errors and by increasing the number of nurses
- Public think errors could be prevented if physicians had more time to spend with patients, if hospitals were required to develop systems for preventing errors, if health professionals were provided with better training, and if only physicians trained in intensive care worked on ICUs

Implications of Findings

- Both physicians and the general public do not feel medical errors are the largest problem in healthcare and each group has solutions to reducing the number of medical errors that occur. Physicians feel increasing nurses will help prevent errors while the public feels better training and more time spent with patients will help reduce errors.
- No mention was made in regards to specific nursing unit design.

Booker, J. M. & Roseman, C. (1995). A seasonal pattern of hospital medication errors in Alaska. *Psychiatry Research*, 57, 251-257.

Focus of Study

- To examine the relationship between medication errors and seasonal patterns of daylight and darkness.

Research Design

- Medication error data was gathered for a five year period from October 1, 1984 through September 30, 1989. The daily inpatient count ranged from 90-110 patients.
- Daylight and darkness hours were prepared by the U.S. Weather Bureau in Anchorage, Alaska.

Sample Information & Site

- This study took place at an acute care medical center in Anchorage, Alaska.
- 127 nursing staff and 20 supervisory clinical nurses were part of the staff during the study period.

Findings

- Errors increased in each year during the fall and winter months
- Largest percentage of errors occurred in late winter, March, and February; 58% of medication errors were reported during the first quarter of the year
- Medication errors averaged 4.45 each month over the 5 years
- Errors are positively associated with number of shifts worked by temporary staff, and negatively associated with overtime shifts and patient days

Implications of Findings

- Medication errors are significantly associated with the seasonal pattern of darkness

Boreham, N. C., Shea, C. E., & Mackway-Jones, K. (2000). Clinical risk and collective competence in the hospital emergency department in the UK. *Social Science and Medicine*, 51, 83-91.

Focus of Study

- To clarify the nature of risk and how it is managed in the Emergency department

Research Design

- The researcher observed whole shifts and assisted medical staff; she worked in the department on a regular basis over a period of 30 days
- Critical incident technique used – critical incident defined as event that significantly raised risk of adverse outcome to patient
- Three ways to identify critical incidents: staff were asked to report them voluntarily; researcher observed incidents herself, and consultants routinely reviewed patient cards to monitor senior house officers performance
- Information collected regarding background of incident, circumstances that led to it, what occurred, whether risk was detected at the time, and action taken to recover situation

Sample Information & Site

- Two university teaching hospitals in Britain were used for this study
- 25 critical incidents were observed

Findings

- Some incidents occurred due to large number of patients in the Emergency department at the same time
- Some incidents caused by cognitive errors including slips and mistakes by staff
- Some incidents due to breakdown in communication among staff in different professions
- Majority of incidents regarding communication breakdown occurred because collaboration from members of different professions or from senior member of same profession needed but process hindered by established pattern of deferring to formal authority

Implications of Findings

- Workplace culture in which authority of practitioner is derived from official status and ground knowledge (acquired through experience and access to information) may improve risk management

Borel, J. M., & Rascati, K. L. (1995). Effect of an automated, nursing unit-based drug-dispensing device on medication errors. *American Journal of Health-System Pharmacy*, 52, 1875-1879.

Focus of Study

- To determine the effect of an automated drug-dispensing system on medication error rates

Research Design

- Data collected before (unit dose exchange carts used) and approximately two months after implementation of Medstation Rx
- Medstation Rx is an automated, computer controlled dispensing device; drugs are stored directly on nursing unit and are immediately available to nurse
- Observations were made at least two days per week
- Information obtained included patient identification number or room number; time of drug administration, day of the week, time medication was ordered to be given, description of events during administration of dose, and type of medication error, if any

Sample Information & Site

- This study took place on 3 units at a 600-bed teaching hospital in Dallas, Texas.

Findings

- The error rate during phase one was 16.9%; during the second phase the error rate was 10.4%
- Most of the errors in both phases were wrong-time errors, though there were fewer in the second phase

- Common complaint for Medstation Rx was need to line up at machine during busy times
- Reduction in errors of omission with use of Medstation Rx

Implications of Findings

- The use of Medstation Rx was associated with a reduction in medication error rates

Brennan, T. A., Hebert, L. E., Laird, N. M., Lawthers, A., Thorpe, K. E., Leape, L. L., et al. (1991). Hospital characteristics associated with adverse events and substandard care. *Journal of the American Medical Association*, 265(24), 3265-3269.

Focus of Study

- To explore interhospital variation in patient outcomes in 51 New York state hospitals

Research Design

- Two-stage sampling process was used to create weighted sample of 31,429 records of hospitalized patients discharged from nonfederal acute care hospitals in New York in 1984
- Records were reviewed by physicians in regards to adverse events that occurred and were discovered during the index hospitalization and those caused by medical management before index hospitalization
- Judgments regarding negligence were made if evidence of an adverse event was found
- Hospital characteristics were defined with information from the Department of Health of the state of New York and the *American Hospital Association Guide*
- Hospital ownership was classified as nonprofit, governmental, or proprietary
- Hospital location was identified as New York City, New York City suburban, upstate metropolitan areas, and upstate rural

Sample Information & Site

- The sample included 31,429 records from discharged patients in New York state hospitals

Findings

- Average rate of adverse events was 3.2%
- 24.9% of adverse events for all hospitals was due to negligence
- University teaching hospitals had higher rates of adverse events than affiliate teaching centers and nonteaching hospitals; only 10.7% of adverse events at university teaching hospitals were due to negligence
- Ownership of hospitals not correlated with rates of adverse events

- Percentage of adverse events due to negligence was lower in proprietary hospitals than nonprofit or governmental hospitals
- Over 35% of adverse events were due to negligence in governmental hospitals
- Number of adverse events associated with negligence was higher in hospitals with largely minority patients than in other hospitals
- Rural hospitals had lower rates of adverse events

Implications of Findings

- The rate of adverse events varies in hospitals. University teaching hospitals were found to have the highest rates of adverse events, but they had the lowest number of adverse events due to negligence.

Brennan, T. A., Leape, L. L., Laird, N. M., Hebert, L., Localio, R., Lawthers, A. G. et al. (1991). Incidence of adverse events and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. *The New England Journal of Medicine*, 324(6), 370-376.

Focus of Study

- To investigate the incidence of adverse events and negligence in hospitalized patients

Research Design

- Two-stage sampling process was used to create weighted sample of 31,429 records of hospitalized patients discharged from nonfederal acute care hospitals in New York in 1984
- Records were reviewed by physicians in regards to adverse events that occurred and were discovered during the index hospitalization and those caused by medical management before index hospitalization
- Level of disability and negligence was also determined
- Months after the initial review of records, hospitals were contacted to attempt to identify current status of records that had not been located earlier

Sample Information & Site

- The sample included 31,429 records from discharged patients in New York state hospitals

Findings

- Estimated statewide incidence of adverse events is 3.7%
- Rate of adverse events due to negligence was 1.0%
- Most adverse events (56.8%) resulted in minor impairment with complete recovery occurring in one month
- 2.6% of adverse events lead to permanent disability; 13.6% of adverse events lead to death

- Negligence more frequent in patients having more severe adverse events
- Rates of adverse events increased with age; people over the age of 65 had more than double the risk than people between 16 and 44 years of age
- Rate of negligence among those older than 64 higher than that of any other age group
- Percentage of adverse events due to negligence did not vary according to specialty

Implications of Findings

- Adverse events were most likely to result in minor impairments; Higher rates of adverse events were likely in the elderly

Classen, D. C., Pestotnik, S. L., Evans, R. S., Lloyd, J. F., & Burke, J. P. (1997). Adverse drug events in hospitalized patients. *Journal of the American Medical Association*, 277(4), 301-305.

Focus of Study

- To investigate the excess length of stay, extra costs, and mortality associated with adverse drug events (ADEs) in hospitalized patients.

Research Design

- A hospital information system was used which has a computerized medical record containing an integrated patient database drawn from numerous sources, including pharmacy, laboratory, surgery, and admitting
- Matched controls were selected among those admitted during the study time frame

Sample Information & Site

- This study took place at LDS hospital, a 520-bed teaching hospital affiliated with the University of Utah School of Medicine, in Salt Lake City.
- All patients admitted between January 1, 1990 to December 31, 1993 who had a confirmed ADE participated (2227 patients).

Findings

2.4% of patients experienced an adverse event

- Average time from admission to development of an ADE was 3.67 days
- Average number of different drugs given to a patient before experiencing an ADE was 12.52
- 28% of patients experiencing an ADE spent time in an intensive care unit
- Excess drug dosage for patient's weight and calculated renal function accounted for 42% of ADEs

- Leading types of ADEs were itching, nausea/vomiting, rash, dizziness, fever, renal failure, confusion, and arrhythmia
- Variables associated with increased mortality include increased age and higher acuity levels
- Average cost of ADE was \$2013

Implications of Findings

- Occurrence of adverse drug events prolongs a patient's hospital stay and increases hospital costs as well as mortality

Cook, A. F., Hoas, H., Guttmanova, K., & Joyner, J. C. (2004). An error by any other name. *American Journal of Nursing, 104(6), 32-43.*

Focus of Study

- To examine the patient safety and medical errors and their relationship to overall working conditions
- To suggest strategies that may improve patient safety and aid in sustaining well-trained nurse workforce

Research Design

Data gathered from seven substudies conducted over a three-year period

- Instruments used to obtain data include hospital data sheets from each hospital, Close Call Pilot Culture Assessment, error-reporting tool, e-mail questionnaires, quarterly telephone interviews, staff-patient survey, and case studies with embedded medical errors
- Hospitals asked to create interdisciplinary teams of providers; included physician, nurse, and either pharmacist or administrator or both
- Primary contact at each hospital completed data sheet, Close Call Pilot Culture Assessment, and error-reporting tool; quarterly follow-up interviews conducted
- Team members received two or three case studies involving errors and adverse events each month via email; asked to identify errors and describe protocols that might increase patient safety
- Staff-patient survey distributed to team members and health care professionals

Sample Information & Site

- The sample includes teams of nurses, physicians, pharmacists, and administrators
- The study took place at 29 rural hospitals in nine Western states in the U.S.; Majority of hospitals had fewer than 50 acute care beds; hospitals included acute care facilities or combination of acute care and long-term care facilities

Findings

- Respondents' ratings of their attitudes towards errors and those of their institutions were more favorable than unfavorable
- Majority of health care providers believed hospital supports idea that anyone can make mistakes and that error reporting system open to all employees, confidential, and impartial
- Three types of errors consistently identified include medication errors (wrong patient, time, dose, drug, or mode of delivery), patient falls, and errors caused by illegible handwriting on orders
- Medication errors most common
- Physicians and nurses hesitant to designate treatment and diagnostic problems as errors
- If relationship with physician lacking or if lacking support of administration, nurses hesitant to question clinical practices
- Lack of consistent guidelines and narrow definitions contribute to lack of consensus on what constitutes error; lack of agreement influences willingness to report and chart errors and develop strategies that may reduce risk
- Only 22 percent of respondents believed physicians, nurses, pharmacists, and administrators share responsibility for patient safety equally; 96 percent of nurses and over 90 percent physicians, administrators, and pharmacists assign primary responsibility to nurses
- Four most needed resources include standards of practice, timely notification of changes in procedures, summary of events, and clinical guidelines

Implications of Findings

- Conceptual approach which incorporates a vision of safety as a priority, a commitment to replace systems that do not work, interdisciplinary training, and accessible resources may increase patient safety and reduce errors

Davydov, L., Caliendo, G., Mehl, B., & Smith, L. G. (2004). Investigation of correlation between house-staff work hours and prescribing errors. *American Journal of Health-System Pharmacy, 61, 1130-1134.*

Focus of Study

- To assess the possible correlation between the frequency and significance of prescribing errors and the length of shift worked by a medical intern or resident

Research Design

- Drug orders written by house officers on the two units were collected daily for two months
- Orders were evaluated by a pharmacist for obvious errors and clinical errors; errors were classified as being due to

possible knowledge deficit, possible effect of fatigue, faulty entry into the system, or an unknown factor

- Once errors were identified, information was collected pertaining to identity of prescribing house officer; time and date of order; work schedule of house officer; type of prescribing error; drug involved, and significance of error
- Number of errors for each hour worked was calculated

Sample Information & Site

- This study took place on two inpatient units with computerized physician order entry at a 1200-bed teaching hospital
- 43 residents participated in this study

Findings

- Of the 45,366 orders entered, 498 (1.1%) were found to be erroneous; 66 erroneous orders reached the patient
- Most frequent errors involved wrong dose, wrong dosage frequency, and duplicate orders
- Prescribing-error rate was not significantly correlated with number of hours worked when the error was made

Implications of Findings

- In this study, neither the frequency of prescribing errors nor their significance increases when medical house officers worked up to 24-hour shifts

Dean, B. S., Allan, E. L., Barber, N. D., & Barker, K. N. (1995). Comparison of medication errors in an American and British hospital. *American Journal of Health-System Pharmacy*, 52, 2543-2549.

Focus of Study

- To compare medication errors in a hospital in the United Kingdom with the ward pharmacy system (pharmacists visit ward on regular basis; combined drug prescription sheet and MAR created to reduce frequency of medication errors) to a hospital in the United States with the unit dose system (tablets or other dosage units are individually wrapped & nurse determines how many to administer).

Research Design

- Disguised-observation method used; observer records all doses administered and later compares them with original medication errors to identify any discrepancies
- In the U.S. hospital, a 24-hour pharmacy service was available; daily drug cart exchanges and deliveries of newly ordered medications occurred every half hour; drug orders were faxed to the pharmacy for entry into patient drug profile and initiation of supply process
- In the U.K. hospital, pharmacy department was open during office hours Monday through Friday; twice-daily deliveries to the wards were made daily and Saturday and Sunday morn-

ings; pharmacist visited each ward twice daily Monday through Friday and once on Saturday morning and reviewed each patient's medication chart

- In the U.K., the observer attended consecutive weekday drug rounds on each ward until targeted number of observations reached
- In the U.S., the observer waited at medication cart until nurse began preparing doses and accompanied the nurse until all unit doses were administered
- In the U.S., medication errors were identified retrospectively; in the U.K., medication errors were identified concurrently

Sample Information & Site

- In the U.S., two large general medical-surgical units were selected from a university hospital. In the U.K., two general medicine, two general surgery, and two geriatric wards were selected. Both hospitals have a high oral-medication related workload.
- 500 opportunities for error were chosen for each ward

Findings

- In the U.S., medication error rates were 6.9%; in the U.K., medication error rates were 3.0%
- Controlled substances and stocked drugs obtained from automated dispensing machine were associated with much higher rate of errors than when drugs obtained from patient's medication drawer or non-automated floor stock
- Medication chart used in the U.K. helps eliminate transcription errors
- Half of the errors of omission in the U.K. hospitals due to unavailability of drug on ward
- Poor handwriting by prescribers contributing factor to errors in both hospitals
- Both systems associated with errors caused by indirect drug selection or preparation by nurse; this error three times more likely in U.S. hospital
- Strength of U.S. system is superior ability to provide drug as soon as it's needed; weakness is that process of prescribing and transcription can result in error
- Strength of U.K. system is physicians write orders on medication chart and 80% of drugs are provided from ward stock; weakness is that about 1 in 80 doses has not been supplied to ward by time needed

Implications of Findings

- The U.S. hospital using a unit dose dispensing system had a higher medication error rate than a U.K. hospital using a ward-based dispensing system

Dowdell, E. B. (2004). Pediatric medical errors part I: The case – A pediatric drug overdose case. *Pediatric Nursing*, 30(4), 328-330.

Focus of Study

- To describe failures within a medication administration process regarding a pediatric patient
- To make recommendations base on this case

Research Design

- Patient was treated with intravenous antibiotics for upper respiratory infection; congestive heart failure slowly improved but patient had persistent vomiting
- Radiographic study of upper gastrointestinal tract performed
- Patient returned from radiographic study and was in discomfort; nurse called physician and documented three verbal orders; one order was to administer 0.7 mg of digoxin intravenously – correct dosage based on weight should have been 0.07mg
- Within two hours of administration of digoxin, patient began vomiting, went into respiratory distress, and subsequently went into cardiac arrest
- Patient was resuscitated and received drug to reverse possible narcotic-induced respiratory depression
- Patient improved slightly, but eventually went into cardiac arrest again and died

Sample Information & Site

- This case study took place in the pediatric intensive care unit or a suburban hospital in the United States.
- The patient in this study is a 14-month old white male admitted to the hospital with congestive heart failure and upper respiratory infection.

Findings

- Incidence report filed by charge nurse after patient went into cardiac arrest first time
- Nurse who administered drug had no specialized training in intensive care for children and had never administered the drug before; all three medications given without calculating correct dosage
- Attending physician stated order appropriate oral, not intravenous dosage of digoxin; stated did not recall ordering other two drugs
- Review panel did not recommend suspensions of either nurse or physician
- Recommendations include: ensuring child's weight is current, confirming drug dosage, reviewing medication ordered, double-checking cardiac medications ordered with another registered nurse or order sheet, and verifying all new drug orders

Implications of Findings

- Measures, including the medication administration policies of pediatric hospitals, should be in place to reduce errors

Facchinetti, N., Campbell, G., & Jones, D. P. (1999). Evaluating dispensing error detection rates in a hospital pharmacy. *Medical Care*, 37(1), 39-43.

Focus of Study

- To determine whether licensed practical nurses (LPNs) are as competent as pharmacists in checking for errors in unit dose cassettes prepared for patients

Research Design

- Two quality control systems were compared: the existing system where pharmacists make the final check for errors vs. an experimental system where LPNs had the final check
- Two changes were made to drug distribution system: additional LPN checked for errors in medication cassettes and harmless artificial errors were introduced into the cassettes and removed after medication carts were checked by pharmacists and LPNs
- Seven types of errors were introduced: wrong drug, wrong strength, wrong dosage form, omitting doses, adding doses, omitting patient drawers to carts, and adding patient drawers to carts
- Checking errors occurred when artificial filling error exists and checker fails to discover it
- Error detection form included name of patient, room, drug name and type of error detected; participants filled forms out in private areas

Sample Information & Site

- This study was conducted on four patient floor at the University of Connecticut Health Center's John Dempsey Hospital
- Seven staff pharmacists and nine licensed practical nurses participated in this study

Findings

- Pharmacists and LPNs were not significantly different from each other when accuracy rates measured on basis of correct doses divided by total doses
- Pharmacists significantly better when accuracy rates calculated as detected errors divided by total errors
- Pharmacists significantly better than LPNs in detecting incorrect strengths of drugs

Implications of Findings

- Pharmacists are superior to LPNs in detecting errors, especially those pertaining to drug strengths

Gandhi, T. K., Weingart, S. N., Seger, A. C., Borus, J., Burdick, E., Poon, E. G., Leape, L. L., & Bates, D. W. (2005). Outpatient prescribing errors and the impact of computerized prescribing. *Journal of General Internal Medicine, 20(9), 837-841.*

Focus of Study

- To determine rates, types, and severity of prescribing errors and assess the impact of computerized prescribing errors.

Research Design

- Copies of prescriptions written by participating physicians were collected daily for a 4-week period.
- For handwritten copies, carbon copies were obtained. For computerized copies, duplicates were printed.
- A pharmacist screened up to 3 prescriptions at random per patient to identify possible errors; errors with potential serious harm were reported to the prescribing physician
- Letters were sent out to patients one day after the initial visit to explain the study. 10 to 14 days later after the initial visit, patients willing to participate were surveyed about medication-related symptoms, timing, and actions taken; 3 months later, the patients were surveyed about symptoms and general health; medical records were examined by nurses to identify adverse drug events documented during 3-month interval
- If an error was discovered by a pharmacist during the review of the prescription, 2 physicians independently reviewed the prescription and judged whether an error had occurred. Errors were classified as an error without potential for harm, a potential adverse drug event, or a rule violation; adverse drug events were classified as fatal, serious, or significant

Sample Information & Site

- This study took place at 2 community-based and 2 hospital based adult primary care practices affiliated with an academic medical center in Boston, MA.
- All physicians at 3 sites and 7 of 27 physicians at the fourth site participated in this study. 661 patients of participating doctors who received a prescription during an office visit and who were older than 18 years of age participated in the two-week survey; 600 completed the 3-month survey

Findings

- 29% of 1879 prescriptions reviewed were found to have possible prescribing errors or rule violations
- 143 prescriptions contained an error and 62 represented potential adverse drug events
- Most frequent errors were incorrect or missing dose or frequency
- Medications most commonly involved in prescribing errors were antibiotics, nonsteroidal anti-inflammatories, narcotic analgesics, corticosteroids, and antidepressants

- Prescriptions from computerized sites did not contain significantly fewer prescribing errors; potential adverse drug events were not significantly different
- Majority of errors could have been prevented by system requiring complete prescriptions and providing mandatory default dose and frequency lists

Implications of Findings

- Computerized prescription systems were not associated with fewer errors. If systems included decision support mechanisms such as dose and frequency checking, errors could have been reduced.

Groves, J. E., Lavori, P. W., & Rosenbaum, J. F. (1993, Winter). Accidental injuries of hospitalized patients. A prospective cohort study. *International Journal of Technology Assessment in Health Care, 9(1), 139-144.*

Focus of Study

- To study the frequency and types of incident reports filed for patients by nursing staff.

Research Design

- Incident reports were retrieved for patients from the files of the legal department in the hospital.
- To record the incidents, the 'Report of Incident or Unusual Occurrence' form was used. Details on this form include items such as the patients' names, the incident location and time, the person who discovered the incident, condition at discovery, and nature of injury

Sample Information & Site

- The study was conducted over a three-month period at a 1,082-bed tertiary-care hospital.
- The sample included 806 patients who were admitted through the emergency ward.

Findings

- Of the subjects included in the study, 107 patients experienced a total of 161 incidents.
- Of these, 93 incidents were considered hazardous, or non-medication errors.
- 18 patients suffered minor injuries.
- Hazardous incidents were more common among males between the ages of 20 and 40 and medically ill females over the age of 60.

Implications of Findings

- The majority of incidents that occurred were not due to medication errors. Rather, they were due to falls and other incidents.

Halford, S., & Leonard, P. (2003). Space and place in the construction and performance of gendered nursing identities. *Journal of Advanced Nursing*, 42(2), 201-208.

Focus of Study

- To explore ways in which hospital spaces influence the working lives of nurses.

Research Design

- Two phases of 24-hour nonparticipant observation occurred; one phase was at the beginning of the study while the other occurred towards the end of the study
- Details of the physical environment, individuals present, activities, movement, and conversations were recorded
- 53 in-depth interviews were conducted with nurses and doctors

Sample Information & Site

- This study took place at two National Health Service (NHS) hospitals in the United Kingdom. 'Lakeside' hospital is a 700-bed District General hospital. The Accident and Emergency ward was studied in this hospital. 'Seaside' hospital is a 60-bed community hospital which provides mainly rehabilitation and medium-term care of the elderly. All wards, the Day hospital, and Minor Injuries Unit from this hospital were studied.
- Interviews were conducted with 53 nurses and doctors

Findings

- Nurses had the least access to space in both hospitals; nurses rarely visited other parts of the hospital and if they did, it was with a patient
- Spatial confinement was associated with little sense of allegiance to the hospital and negative images of other hospital spaces
- For nurses, workplace identities were strongly rooted in the wards
- Nurses at Seaside identified themselves strongly with their ward
- Lack of space generates stress and limits opportunities to relax

Implications of Findings

- Spatial confinement on wards was associated with workplace identities being rooted in the wards

Hayward, R. A., & Hofer, T. P. (2001). Estimating hospital deaths due to medical error: Preventability is in the eye of the reviewer. *Journal of the American Medical Association*, 286(4), 415-420.

Focus of Study

- To examine the reliability of reviewer ratings of medical error in terms of the probability of survival if care had been optimal

Research Design

- 14 board-certified internists with experience in inpatient medicine were trained to assess medical records and identify medical errors documented in the care of patients who died at 7 Department of Veterans Affairs medical centers; they were asked to estimate the probability that these deaths could have been prevented if medical care had been optimal

Sample Information & Site

- 111 cases of patient deaths at 7 Department of Veterans Affairs medical centers were reviewed

Findings

- Overall care was rated as substandard in 7.0% of reviews and 6.0% of deaths
- Deaths rated as definitely or probably preventable in 8.6% of reviews and 6.0% of deaths
- Optimal care at hospitals studied would result in approximately 1 additional patient of every 10,000 admissions living 3 or more months in good cognitive health
- Many deaths reported as result of medical error occurred at end of life or in critically ill patients whom death was most likely outcome
- If many reviewers evaluate charts for preventable deaths, some reviewers will strongly believe death could have been avoided by different care

Implications of Findings

- In general, reviewers analyzing charts have difficult agreeing on whether an error caused an adverse event or whether it was an error at all; reviewer assessment had poor reliability and was usually skewed

Hilton, B. A. (1985). Noise in acute patient care areas. *Research in Nursing and Health*, 8, 283-291.

Focus of Study

- To determine sources of sound, levels of sound, patient perceptions of sound, and which types of sounds can be modified in acute patient care areas.

Research Design

- This study used an exploratory and descriptive design.
- Sound levels measured in the proximity of each patient over a 24-hour period.
- An observer sat near the patient for two 3-hour observation periods during each 24-hour period to determine the sources of sound.
- For each patient, an observer sat near the patient for two 3-hour observation periods, during the 24-hour interval, to determine the sources of sound. The sounds were then categorized according to source, number of occurrences, duration, and loudness.
- Participants were also asked to complete a short questionnaire through interviews. Questions asked pertained to how the noise affected patients, whether they thought the noise levels were acceptable, and whether the noise levels were bothersome and affected the patients' sleep.

Sample Information & Site

- The study was conducted at three hospitals in a large metropolitan area in Northwest Canada. Of these three hospitals, one was a large hospital, one was a small teaching hospital, and one was a small community hospital. Intensive care units were studied at each hospital. In addition, pre- and postoperative wards for open-heart surgery were studied at the large hospital, and two medical wards were studied at the small teaching hospital.
- A convenience sample of 25 subjects was used and consisted of four to five subjects from each of the units.

Findings

- The critical and noncritical areas in the small hospitals were quieter than those at the large hospital.
- Sound levels dropped at night on all units except the recovery room and intensive care unit of the large hospital
- Staff, patients, and visitors created levels of talking that were higher than necessary.
- Equipment noises that were steady were those created by oxygen, chest-tube bubbling, and ventilator functioning.
- Patients were satisfied with sound levels at the large hospital's pre- and postoperative ward, the medical wards and intensive care units at the small teaching hospital, and the intensive care unit at the small community hospital.
- Patients were dissatisfied with the sound levels of the recovery room at the large hospital. Noise levels that were generated outside the room were reduced when the door to the patient's room was closed.
- On the intensive care units of the small hospital, rooms were single occupancy, and noise levels were lower.
- In the large hospital, patient rooms consisted of two to eight patients and this produced unacceptable sound levels.

Implications of Findings

- Sound levels appear to be related to room size, in that they were lower in rooms with single occupancy rather than multiple occupancy rooms.

Hodgkinson, B., Koch, S., Nay, R., & Nichols, K. (2006). Strategies to reduce medication errors with reference to older adults. *International Journal of Evidence Based Healthcare*, 4, 2-41.

Focus of Study

- To present evidence for strategies to prevent or reduce medication errors in older persons in acute, subacute, and residential care settings in Australia.

Research Design

- Panel of 13 clinicians, nurses, pharmacists, and other health professionals was established to guide reviews of research studies
- Included in the review were any systematic reviews or randomized control studies that evaluate strategies aimed at reducing or preventing medication errors
- People involved in prescribing, dispensing, or administering medication to older adults were included in the review, including nurses, pharmacists, physicians/practitioners, and personal care attendants
- Main outcome measure was number of medication errors after an intervention
- Various databases were searched to find systematic reviews

Sample Information & Site

- This study reviewed research pertaining to medication errors and interventions.

Findings

- Most common medication errors in Australia are prescription/medication ordering errors, dispensing errors, errors in administration, and errors in medication record
- Causes of medication errors in community settings include poor communication between patient and health professional, error of judgement, poor communication between health professionals, and failure to recognize signs and symptoms
- Most common types of dispensing errors reported by pharmacists include incorrect strength, incorrect product, or misinterpretation of prescription
- Factors contributing to dispensing errors include high prescription volume, overwork, fatigue, interruptions, and 'look alike, sound alike' drug names
- Targeting prevention strategies at procedures and not individuals is more effective

- Computerized physician order entry may be effective in reducing errors
- No evidence suggests that automated dosing systems, the use of bedside terminal systems, or bar coding reduces medication errors
- No evidence suggests that education addressing medication calculation is effective in reducing medication errors
- Clinical pharmacists may play a role in preventing adverse drug events in inpatient settings
- Use of protocols in which nurses are not disturbed could reduce distractions during administration
- Medication Administration Review and Safety can reduce incidence of medication administration documentation errors

Implications of Findings

- Recommendations to reduce adverse drug events include the use of computerized physician order entry, individual patient medication supply, having pharmacists available to double check medication orders, and the use of nursing care models.

Janssen, P.A., Harris, S. J., Soolsma, J., Klein, M. C., & Seymour, L. C. (2001, September). Single room maternity care: The nursing response. *Birth, 28(3), 173-179.*

Focus of Study

- To evaluate the responses of nurses in regards to working on a single-room maternity unit after having worked in traditional delivery suites.

Research Design

- Nurses scheduled to work on a new single room maternity ward as part of a pilot project were asked to complete surveys six months prior to the new ward opening and three months after the new ward opened.
- Surveys were also distributed to nurses working in the traditional delivery suites as well as the postpartum ward.
- Questions addressed the nurses' perception of the physical setting, the quality of care given to patients, their perceived competence, and their practicing environment.

Sample Information & Site

- The study was conducted at BC Women's Hospital in Vancouver, Canada.
- The sample included twenty nurses who worked both on the new and traditional wards, 26 delivery suite nurses, and 26 postpartum nurses.

Findings

- The physical space of the single rooms was greater and enabled easier accessibility of equipment and supplies.
- Privacy was also greater in this environment and noise levels were reduced.
- Quality of care was perceived as greater in the single room unit as nurses were better able to respond to the physical, emotional, and spiritual needs of the patients.
- Nurses also felt greater accountability for their decisions in the single rooms and felt highly competent in all aspects of their work.
- Job satisfaction increased for nurses once they moved to the single room unit.
- The one disadvantage of the new unit was that the medical staff was less readily available.

Implications of Findings

- Nurses appeared to prefer working on the single room wards as they felt the quality of care was greater, the rooms offered more privacy, and they were better able to respond to the needs of the patients.

Koppel, R., Metlay, J., Cohen, A., Abaluck, B., Localio, A. R., Kimmel, S. E., & Strom, B. L. (2005). Role of computerized physician order entry systems in facilitating medication errors. *Journal of the American Medical Association, 293(10), 1197-1203.*

Focus of Study

- To identify the role of computerized physician order entry (CPOE) in facilitating the risks of prescription error.

Research Design

- A quantitative and qualitative study design was used
- Interviews were conducted with house staff, pharmacists, nurses, nurse-managers, attending physicians, and information technology managers
- Observations were made of house staff writing orders, nurses charting medications, and hospital pharmacists reviewing orders
- Focus groups were held with house staff regarding sources of stress and prescribing errors
- Questionnaires focusing on working conditions and sources of error and stress were administered to house staff

Sample Information & Site

- This study took place at a major urban tertiary-care teaching hospital in the United States with 750 beds
- Interviews were conducted with the surgery chair, pharmacy and technology directors, clinical nursing director, 4 nurse-

managers, 5 nurses, an infectious disease fellow, and 5 attending physicians

- 4 house staff, 3 attending physicians, and 9 nurses, and 3 pharmacists were observed
- 261 house staff completed the questionnaire

Findings

- 22 previously unexplored medication-error sources facilitated by CPOE were identified and grouped into 2 categories: information errors and human-machine interface flaws
- Information errors include dosage information (dosages listed in CPOE are based on warehousing and purchasing decisions, not clinical guidelines; house staff regularly use CPOE to determine dosages), medication discontinuation failures (canceling medications requires multiple screens), procedure-linked medication discontinuation faults (medications are not canceled even if procedures are canceled or postponed), discontinuation faults (failure to chart or cancel order can result in unintended medication on subsequent days or duplications on same day), antibiotic renewal failure, diluent options and errors, allergy information delay, and conflicting or duplicative medications
- Human-machine interface flaws include patient selection (easy to select wrong patient since names grouped alphabetically), wrong medication selection, unclear log on/log off, failure to provide medications after surgery (CPOE cancels previous medications for patients who undergo surgery), loss of data when CPOE is nonfunctional during maintenance, sending medications to wrong room, late-in-day orders lost for 24 hours, inaccurate and delayed medication administration due to charting difficulties, and inflexible ordering screens

Implications of Findings

- The computerized physician order entry system can both facilitate and reduce errors risks

Leape, L., Bates, D., Cullen, D., Cooper, J., Demenaco, H, Gallivan, T., Hallisey, R., Ives, J, Laird, N., Laffel, G., Nemeskal, R., Peterson, L., Porter, K, Servi, S., Shea, B., Small, S., Sweitzer, B. Thompson, b., & Vander Vleit, M. (1995). Systems analysis of adverse drug events. *Journal of the American Medical Association*, 274(1), 35-43.

Focus of Study

- To identify systems failures that underlie errors which cause adverse drug events.

Research Design

- Investigators went to each unit participating in the study daily and asked for voluntary reports from personnel regarding possible and potential adverse drug events.
- Patient records were reviewed each day for errors or complications related to drug use.

- Potential and possible adverse drug events were investigated to determine the causes
- Investigations of the adverse drug events were analyzed at biweekly meetings.

Sample Information & Site

- This study took place at Brigham and Women's Hospital and Massachusetts General Hospital. Five adult intensive care units and six nonobstetric general care units were used.
- The sample included all adult patients in these hospitals who were nonobstetric.

Findings

- 264 of the 441 adverse drug events were preventable
- Most errors occurred in physician ordering and nurse administration
- Most common errors were regarding dosage
- Lack of knowledge regarding the drug accounted for 72% of the errors while lack of information about the patient accounted for 14% of the errors

Implications of Findings

- Correcting faults in underlying systems, such as physician ordering and nurse administration, and increasing knowledge regarding medication may result in significant error reduction
- No mention was made in regards to specific nursing unit design

Leape, L. L., Brennan, T. A., Laird, N., Lawthers, A. G., Localio, R., Barnes, B. A. et al. (1991). The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. *The New England Journal of Medicine*, 324(6), 377-384.

Focus of Study

- To analyze injuries in hospitalized patients, including types of adverse events, types most likely to result in serious disability, types most likely to be caused by negligence, effects of various risk factors, and management errors responsible

Research Design

- Records were screened by trained nurses or medical-records administrators using 18 screening criteria
- Records meeting criteria were reviewed independently by two physicians who identified adverse events and instances of negligence
- Reviewers were asked to describe adverse event and its relation to medical care; asked to estimate degree of disability that resulted
- Adverse events classified regarding type of injury

Sample Information & Site

- 30,195 randomly selected records from 51 hospitals in the state of New York were reviewed

Findings

- 1133 adverse events were identified; 48% resulted from operations
- Wound infections were most common surgical adverse event
- Drug complications were most common single type of adverse event
- 28% of adverse events resulted from negligent care
- Majority of adverse events did not result in serious disability
- Patients over age of 64 had adverse events and negligence-related adverse events at rates more than double younger patients
- Surgical failures constituted higher fraction of total number of adverse events in young adults than older age groups
- Adverse events common among elderly include nontechnical postoperative complications, noninvasive treatment mishaps, fractures, and falls
- Largest number of adverse events resulted from treatment in operating room followed by patient's hospital room
- Most common physician error involved performance of procedure or operation
- Technical errors most common class of error observed but few judged to result from negligence; errors of omission often classified as being negligent
- Adverse events resulting from negligence more likely than other adverse events to lead to serious disability
- Major determinants of adverse event is complexity of disease or treatment, presence of coexisting conditions, location where care is provided, and medical nature of intervention

Implications of Findings

- The majority of adverse events occurred during an operation, and most events did not result in serious disability
- Elderly patients were more likely than younger patients to experience an adverse event

Meurier, C. E., Vincent, C. A., & Parmar, D. G. (1997). Learning from errors in nursing practice. *Journal of Advanced Nursing*, 26, 111-119.

Focus of Study

- To discover the causes of nursing errors, how nurses respond to their errors, and what factors predict whether nurses learn from their errors.

Research Design

- Questionnaires regarding medical errors were distributed to nursing staff
- Measures included causes of errors, ward climate, emotional reactions to error, coping methods, responses to discussion of error, and learning from the error

Sample Information & Site

- Nurses participating in this study worked for NHS trust hospitals
- 129 nurses participated in this study

Findings

- Errors were classified into four categories based on stages of nursing process: communication, assessment and planning, intervention, and evaluation
- Most errors occur in intervention phases,
- 64% of nurses report error had some consequence to patient
- Causes of error attributed to inexperience, lack of supervision, job overload, and faulty judgment
- Majority of nurses experienced emotional distress in response to error
- 68% of nurses willing to accept responsibility for error
- 80% of nurses reported changes in practice resulting from error
- Nurses with more experience develop better ways of managing the error and take appropriate measures to ensure error not made again
- Discipline led to loss of confidence and increased anxiety
- Inexperience and work overload associated with constructive changes
- Errors caused by faulty judgment, work overload and stressful atmosphere led to loss of confidence and increased anxiety

Implications of Findings

- Nurses were most likely to make errors in the intervention phase of the nursing process. Errors were attributed to inexperience, lack of supervision, job overload, and faulty judgment

Meurier, C. E., Vincent, C. A., & Parmar, D. G. (1998). Nurses' responses to severity dependent errors: A study of the causal attributions made by nurses following an error. *Journal of Advanced Nursing*, 27, 349-354.

Focus of Study

- To examine the causal attributions made by nurses following an error in an effort to understand how nurses respond to error

Research Design

- Participants were asked to complete a questionnaire
- Participants were asked to read a scenario; half of nurses had scenario where non-serious outcome resulted from error; other half of nurses had scenario where serious outcome resulted from error
- Participants had to describe what they thought was most important cause of error (internal vs. external); evaluations of cause using causal dimensions scale were completed
- Participants had to rate responses to questions regarding globality, importance, and responsibility
- Nurses had to write down present grade and number of years in nursing

Sample Information & Site

- This study took place in a hospital in the United Kingdom.
- 60 nurses participated in this study.

Findings

- 80 percent responding to serious outcome and 63 percent of those responding to non-serious outcome would have blamed themselves if they had made error; more internal attributions made by those involved in serious outcome
- Both groups of nurses judged cause of error to be internal, unstable, and controllable
- Both groups considered error could affect work generally
- Nurses in serious group more inclined to take responsibility
- More importance attached to error if outcome severe

Implications of Findings

- Nurses tend to blame themselves for errors, especially when the adverse event is serious.

Peterson, G. M., Wu, M. S. H., & Bergin, J. K. (1999). Pharmacists' attitudes towards dispensing errors: Their causes and prevention. *Journal of Clinical Pharmacy and Therapeutics*, 24, 57-71.

Focus of Study

- To obtain pharmacists' opinions on the issue of dispensing errors.

Research Design

- Pharmacists registered in Tasmania, Australia were sent a personalized letter and a survey
- Surveys included measures regarding demographics and their opinions on dispensing errors

Sample Information & Site

- 209 pharmacists registered in Tasmania, Australia participated in this study.

Findings

- 82 percent of pharmacists felt the risk of dispensing errors is increasing
- 47 percent of respondents felt actual errors in dispensing are becoming more common
- Risk factors for dispensing errors include high dispensing volume, pharmacist overwork and fatigue, interruptions to dispensing, and confusing or similar drug names
- Increased period of registration was associated with a decline in concern about contributions to errors of packaging and labeling products, doctor's handwriting, access to adequate technical resources, and sufficient time to counsel patients
- 70% of respondents to question of whether they were aware of any dispensing errors that had left the pharmacy undetected in past six month said yes
- Safe dispensing load for pharmacists around 150 prescriptions per day for one pharmacist
- Majority of respondents approved having regulatory guideline for maximum safe dispensing load in Australia
- Methods suggested to improve drug dispensing include having mechanisms for checking dispensing procedures, checking the original prescription when dispensing repeats, improved packaging and labeling, avoiding interruptions, and reducing workload

Implications of Findings

- Pharmacists feel the risk of dispensing errors is increasing and suggested measures, such as reduced interruption and workload to improve drug dispensing

Rogers, A. E., Hwang, W., Scott, L. D., Aiken, L. H., & Dinges, D. F. (2004). The working hours of hospital staff nurses and patient safety. *Health Affairs*, 23(4), 202-212.

Focus of Study

- To determine if a relationship exists between the number of hours worked by hospital staff nurses and frequency of errors.

Research Design

- Nurses were mailed two logbooks, each covering a two-week period.
- The logbooks collected information regarding hours worked, time of day worked, overtime, days off, and sleep/wake patterns; questions also included errors and near errors

Sample Information & Site

- Nurses were solicited from the American Nurses Association. A total of 393 registered nurses participated.

Findings

- Nurses worked longer than scheduled on a daily basis, and tended to work more than forty hours per week.
- In 39 percent of the cases, nurses worked at least 12.5 consecutive hours; 14 percent of nurses worked 16 or more consecutive hours at least once during the four-week study period
- Participants worked an average of 55 minutes longer than scheduled each day
- More than 25 percent of nurses reported working mandatory overtime at least once during the four-week study period
- 199 errors and 213 near errors were reported; more than half involved medication administration
- 30 percent of nurses reported making at least one error; 32 percent of nurses reported at least one near error
- Likelihood of making an error increased with longer work hours
- Error rates were three times higher when nurses worked 12.5 hours or more
- Working more than 40 and 50 hours per week increased risk of making error

Implications of Findings

- Working long hours can have a negative impact on patient care, since nurses working more than 12 hours were more likely to make an error

Rothschild, J. M., Keohane, C. A., Cook, E. F., Orav, E. J., Burdick, E., Thompson, S., et al. (2005). A controlled trial of smart infusion pumps to improve medication safety in critically ill patients. *Critical Care Medicine*, 33(3), 533-540.

Focus of Study

- To determine the impact if using a smart infusion pump system on medication error rates.

Research Design

- New intravenous infusion pumps replaced the preexisting pumps two weeks before data collection
- The study took place over 8 weeks and was divided into 4 periods; first and third periods were control periods and the second and fourth periods were the intervention phases
- Medication errors included drug ordering, transcribing, dispensing, administering, or monitoring
- Patient related data included demographics, admitting diagnoses, operative procedures, comorbidities, and total number of intravenous medications
- Pump-related transaction information was obtained from pump log downloads

- Cases were found through chart reviews, solicited staff reports, hospital incident reports, and computerized adverse drug event surveillance monitor
- Serious medication errors were analyzed for injury severity as well as system related factors

Sample Information & Site

- This study was conducted at Brigham and Women's Hospital in Boston, Massachusetts.
- 744 admissions to the hospital were analyzed.

Findings

- In intervention phase, 22 adverse drug events were found, of which 11 were preventable; 82 nonintercepted preventable adverse drug events were also discovered
- During the control period, 28 adverse drug events were found, of which 14 were preventable; there were 73 nonintercepted preventable adverse drug events
- Overall, there were a total of 219 intravenous medication errors
- Most common types of errors were incorrect dosing and incorrect intravenous drug rates
- Most common injuries resulting from adverse drug events were cardiovascular
- Most preventable adverse drug events were serious or life-threatening
- Two problematic practices were bypassing the drug library and overriding alerts

Implications of Findings

- Smart pumps did not reduce the rate of serious medication errors, possibly due to the pump set up in which nurses were able to bypass the drug library and override alerts

Santell, J. P., Hicks, R. W., McMeekin, J., & Cousins, D. D. (2003). Medication errors: Experience of the United States Pharmacopeia (USP) Medmarx reporting system. *Journal of Clinical Pharmacology*, 43, 760-767.

Focus of Study

- To present a 3-year summary of records from facilities using the MEDMARX program (anonymous and confidential Internet-accessible medication error reporting program)

Research Design

- Queries were conducted from 3-year period (1999, 2000, 2001)
- Fields analyzed include error category, type of error, cause of error, contributing factors, and product

Sample Information & Site

- 154,816 medication error records from 403 facilities were reviewed

Findings

- 91.3% of records included errors that actually occurred
- Majority of actual errors (97%) did not result in harm
- Errors most frequently initiated at administering stage
- Omission errors, improper dose/quantity, prescribing error, unauthorized drug, and administering drug at wrong time accounted for 80% of errors
- Causes of error include performance deficit, procedure/protocol not followed, documentation, communication and inaccurate transcription
- Organizational factors causing errors include communication, computer entry, drug distribution system, and knowledge deficit
- Most common contributing factor to error is distractions followed by increase in workload, inexperienced staff and insufficient staff

Implications of Findings

- Information on the MEDMARX system can aid in understanding the causes of health system errors which may lead to designing effective interventions

Schwarz, H. O., & Brodowy, B.A. (1995). Implementation and evaluation of an automated dispensing system. *American Journal of Health-System Pharmacy*, 52, 823-828.

Focus of Study

- To describe the effect of replacing a traditional unit dose cassette-exchange system with Medstation Rx

Research Design

- Before Medstation Rx activated, regular Medstation installed on pilot nursing units to enable staff to get acquainted with system
- Medstation Rx stores most drugs routinely needed on a nursing unit; interface between Medstation Rx and pharmacy computer system enables medication orders entered into pharmacy computer to be transferred electronically to the Medstation Rx
- Information on missing doses request forms filled out by nurses was recorded two months before and two months after implementation of Medstation Rx
- Type and frequency of medication errors indicated in incident reports were recorded for six months prior to and three months after implementation of Medstation Rx
- Time spent processing unit dose cassettes was compared to time spent for similar routine functions under Medstation Rx

- Questionnaires were given to nurses on the study units three months after the implementation to determine their attitudes regarding Medstation Rx
- 5-year financial analysis performed

Sample Information & Site

- This study took place on a surgical unit and cardiovascular intensive care unit at the University of California at San Francisco teaching hospital
- 20 nurses completed questionnaires

Findings

- Fewer missing doses reported after Medstation Rx implemented
- Fewer errors reported by the surgical unit, but more errors were reported on the cardiovascular intensive care unit
- Number of new orders and time required to process them dropped with use of Medstation Rx
- Respondents to the questionnaire liked Medstation Rx for the acquisition of controlled substances and most liked obtaining all medications through the system
- Potential savings from using system would be from reduction in personnel

Implications of Findings

- Results suggest that the Medstation Rx system is an improvement over the unit dose cassette system

Shirley, K. L. (1999). Effect on an automated dispensing system on medication administration time. *American Journal of Health-System Pharmacy*, 56, 1542-1545.

Focus of Study

- To determine the potential for automated dispensing systems to enhance medication distribution.

Research Design

- Data was collected prior to and approximately one month after the implementation of Medstation Rx 1000, a computer-controlled dispensing unit that stores drugs directly on nursing units and records medication administration when it occurs
- Information recorded included patient number, patient room number, admission data and time, time the order was written, medication administration schedule, and time of administration

Sample Information & Site

- This study was conducted at Mercy Hospital in Scranton, Pennsylvania
- Data collected was obtained by tracking all newly admitted patients

Findings

- Prior to the implementation of the automated system, 59% of 76 medication doses were administered as scheduled
- After implementation of system, 77% of 87 doses were administered as scheduled
- Medications were 2.3 times more likely to be administered as scheduled after implementation of system

Implications of Findings

- The implementation of an automated medication dispensing system resulted in improvements in the administration of medication as scheduled

Silen-Lipponen, M., Tossavainen, K., Turunen, H., & Smith, A. (2005). Potential errors and their prevention in operating room teamwork as experienced by Finnish, British, and American nurses. *International Journal of Nursing Practice, 11*, 21-32.

Focus of Study

- To determine how the threat of errors are experienced by Finnish, British, and American nurses working in operating rooms

Research Design

- Personal audio-taped interviews were conducted and guided by open request to describe critical incidents about teamwork in operating rooms

Sample Information & Site

- This study used hospitals from Britain, Finland, and the United States
- 10 nurses from each of the three countries (Britain, Finland, and the United States) who work in operating rooms participated in this study

Findings

- Need to manage multiple, simultaneous demands while providing high-quality care imposed pressure on nurses and was potential source of error; nurses were afraid of making an error because they were judged harshly; constant changes in the team caused distrust and impaired one's ability to work in teams; working overtime led to feelings of oppression and loss of concentration; continuous emotional distress led to stress
- Novice and less educated British and American nurses relied more on rituals and had lower commitment levels to the organization which could lead to errors

- To prevent errors a shared responsibility in the team was needed; familiarity with team members increased confidence as team members could anticipate each others' needs and created calm working environment; to control safety continuous monitoring is needed; formal documentation of errors required
- Organized teamwork also needed to prevent errors; includes scheduling and diffusion of knowledge resulting from continuous interaction and collaborative decision-making, competency, good management, and the size of the physical environment (smaller unit teams are more flexible, comfortable with each other, and better at implementing decisions) and correct use of equipment

Implications of Findings

- Focus of error prevention needs to be widened from individual to team responsibility and underlying organizational factors should be included
- Shared responsibility to minimize errors, error-making, and learning from mistakes should be connected
- Need to clarify how work patterns capitalize on experience of team members; team compositions and staffing levels should be reviewed

Smith, J., & Crawford, L. (2003). Medication errors and difficulty in first patient assignments of newly licensed nurses. *JONA's Healthcare Law, Ethics, and Regulation, 5*(3), 65-67.

Focus of Study

- To determine the degree to which new nurses are involved in errors

Research Design

- Data was obtained from the Practice and Professional Issues Survey conducted by the National Council of State Boards of Nursing in 2002
- Information obtained include nurses' employment, age, previous work experience, medical errors experienced, and client assignments

Sample Information & Site

- 655 registered nurses and 623 licensed practical/vocational nurses participated in this study
- Respondents worked in hospitals, long-term care facilities, and community or ambulatory care settings in the United States

Findings

- 49% of RNs and 41% of LPN/VNs have made errors or been involved in errors made by others
- Delays in care or treatment reported by about one-third of RNs and LPN/VNs involved in errors

- 74% of LPN/VNs and 70% of RNs stated that inadequate staffing contributed to errors; those involved in errors were more likely to have significantly more patients assigned to them than those not involved in errors
- One-fourth of RNs and LPN/VNs identified long work hours as factor influencing errors
- 44% of both RNs and LPN/VNs identified lack of adequate communication as factor contributing to errors
- Approximately 20% of RNs think current patient assignment too difficult

Implications of Findings

- Inadequate staffing, lack of adequate communication, long work hours, and amount of overtime worked contribute to medication errors

Suzuki, K., Ohida, T., Kaneita, Y., Yokoyama, E., & Uchiyama, M. (2005). Daytime sleepiness, sleep habits and occupational accidents among hospital nurses. *Journal of Advanced Nursing*, 52(4), 445-453.

Focus of Study

- To determine the prevalence of excessive daytime sleepiness among nurses
- To determine associations between sleepiness and medical errors

Research Design

- Cross-sectional survey was carried out for one month
- Questionnaires include information regarding sleep patterns, occupational errors and accidents, demographic information, and shift-work system
- Errors measured include drug administration errors, incorrect operation of medical equipment, and needlestick injuries

Sample Information & Site

- A convenience sample of 4279 female nurses working in 8 general hospitals in Metropolitan Tokyo and other cities in Japan (Tochigi, Mie, Fukui, and Aomori prefectures) was used

Findings

- Prevalence of excessive daytime sleepiness was 26.0%
- Sleep sufficiency (very insufficient & sufficient) was inversely related to age
- Excessive daytime sleepiness is associated with impaired attentiveness, tiredness, and low morale
- Excessive daytime sleepiness was associated with administration errors, incorrect operation of medical equipment, and needlestick injuries

- Night or irregular shift work most strongly associated with drug administration errors
- Excessive daytime sleepiness most strongly associated with incorrect operation of medical equipment
- Age most strongly associated with needlestick injuries

Implications of Findings

- Excessive daytime sleepiness is a factor in error rates of nurses.

Thomas, E. J., & Brennan, T.A. (2000). Incidence and types of preventable adverse events in elderly patients: Population based review of medical errors. *BMJ*, 320, 741-744.

Focus of Study

- To illustrate the incidence and types of preventable adverse events in elderly patients as well as compare the morbidity and mortality caused by these events in elderly versus non-elderly patients

Research Design

- 31 trained nurses reviewed medical records for any one of 18 criteria associated with an adverse event; positive records were referred to one of 22 physicians trained to use the adverse event analysis form
- Data regarding age, sex, and payment method were obtained from state discharge databases and confirmed by chart reviewers
- Disability ratings were made by physicians, followed by two investigators and panel of adjusters for medical malpractice claims

Sample Information & Site

- Based on a random sample of hospitals, 4943 discharges in Utah and 9757 discharges in Colorado were reviewed
- 13 hospitals in Utah and 15 hospitals in Colorado participated in this study.

Findings

- 241 adverse events were detected among non-elderly patients and 207 adverse events were detected among elderly patients
- Incidence of preventable adverse events nearly twice as high in elderly patients
- Greater proportion of elderly patients than non-elderly patients experiencing preventable adverse event had permanent disability or death as a result
- Incidence of adverse events related to medical procedure, preventable adverse drug event, and preventable fall higher in elderly patients

- Age not independently associated with preventable adverse event

Implications of Findings

- Elderly patients experienced more preventable adverse events than younger patients; this may be due in part to increased complexity in care for the elderly

Tissot, E., Cornette, C., Demoly, P., Jacquet, M., Barale, F., & Capellier, G. (1999). Medication errors at the administration stage in an intensive care unit. *Intensive Care Medicine, 25*, 353-359.

Focus of Study

- To examine the frequency, type, and potential clinical significance of preparation and administration errors

Research Design

- A prospective study took place over a 2-month period; a disguised-observation technique was used
- Two observers, who were pharmacy residents, observed two randomly selected nurses daily
- Nurses were accompanied while administering medication; observers wrote down what nurses did when preparing and administering medicine
- The observers' notes were compared with the original prescription, recommendations of the manufacturer, and data available in the literature
- Error categories included wrong drug preparation, dose error, wrong administration technique, physiochemical compatibility errors, wrong rate, and wrong time
- The potential significance of the error was evaluated by an ICU physician; categories included fatal, life-threatening, significant, and minor

Sample Information & Site

- This study took place in the medical intensive care unit in Besançon University Hospital, France.
- Nurses working on this unit were observed during the study.

Findings

- 132 errors (6.6% of interventions) were detected
- 24 preparation errors, including incorrect dilution and incorrect reconstitution, were observed
- No potential fatal errors were observed
- 21% of errors were assessed as life-threatening
- The error rate for wrong drug preparation was 4.2%
- 41 dose errors occurred; 3 were omission errors and 38 were the wrong dose

- Wrong admission technique accounted for 1.6% of errors
- 19 physiochemical errors were recorded; potential clinical effects were significant or life-threatening
- Wrong rate of medication occurred only in intravenous techniques
- Factors contributing to errors include lack of knowledge in use of drugs, incomplete, illegible, or verbal prescriptions, wrong preparation, lack of standardization of protocols for preparation and administration, inappropriate use of medical devices, partial prescription retranscription, work overload, and lack of the presence of a pharmacist

Implications of Findings

- The medication administration error rate in this facility was 6.6%. Measures, including improving nurses' knowledge of the use of medications, and the presence of a pharmacist can help reduce the occurrence of errors.

Unruh, L. (2003). Licensed nurse staffing and adverse events in hospitals. *Medical Care, 41*(1), 142-152.

Focus of Study

- To investigate changes in licensed nurses in Pennsylvania hospitals from 1991 to 1997
- To examine the relationship between licensed nurses staffing with patient adverse events

Research Design

- The Pennsylvania Department of Health and the American Hospital Association provided data on nursing personnel and hospital characteristics
- Yearly percentage change in numbers of licensed nurses, their numbers related to patient load, and skill mix were assessed
- Adverse events included atelectasis, decubitus ulcers, falls, pneumonia, postsurgical and treatment infections, and urinary tract infections
- Patient characteristics examined include age, gender, race, ethnicity, and level of severity upon admission
- Hospital characteristics addressed include ownership status, hospital mergers, number of board-certified physicians, and capacity utilization

Sample Information & Site

- The study included 211 hospitals in Pennsylvania yearly, with a total of 1477 hospitals over 7 years
- Medical and surgical patients in the hospital for the year were included as part of the sample

Findings

- The intensity of nursing care increased over the course of 7 years

- More patients in the hospitals was related to a greater occurrence of adverse events
- Hospitals with higher acuity levels had a greater number of adverse events
- Proportion of skilled nurses available to deal with higher patient acuity declined
- Hospitals with more licensed nurses had lower incidences of atelectasis, decubiti, falls, and urinary tract infections; pneumonia levels increased as number of licensed nurses increased
- Number of licensed nurses is stronger predictor of adverse events than proportion of licensed nurses to total nursing staff

Implications of Findings

- Hospitals should have flexible staffing systems that account for daily patient severity
- Hospitals need to increase supply of nurses, since number of licensed nurses is strong predictor of adverse events

Varni, J. M., Burwinkle, T. M., Dickinson, P., Sherman, S. A., Dixon, P., Ervice, J. A. et al. (2004). Evaluation of the built environment at a children's convalescent hospital: Development of the Pediatric Quality of Life Inventory parent and staff satisfaction measures for pediatric health care facilities. *Developmental and Behavioral Pediatrics, 25*(1), 10-20.

Focus of Study

- To develop pediatric measurement instruments for patient and staff satisfaction with the built environment, parent satisfaction with the health care services provided to their child, and staff satisfaction with their coworker relationships

Research Design

- Focus groups were conducted to discuss parent and staff satisfaction with the built environment of the existing facility, parent satisfaction with health care services, and staff satisfaction with coworker relationships
- Focus groups were conducted prior to the construction of a new facility
- Parents and staff were asked to complete questionnaires regarding the built environment and satisfaction

Sample Information & Site

- This study took place at the Children's Convalescent Hospital at the Children's Hospital and Health Center in San Diego
- 40 parents and 99 staff members responded to the questionnaire

Findings

- For the most part, parents were moderately satisfied with the built environment of the existing facility; based on parent feedback, design changes included larger bathrooms, extra closet space, increased parking spaces, a more spacious family room, a well-landscaped outdoor recreation area, two nursing stations located in close proximity to patient rooms, natural lighting, and increased number of windows
- Staff members were generally dissatisfied with the built environment; changes in design based on the feedback include larger closets in the residents' rooms, larger activity space, large dining room, wheelchair storage built into each bedroom, and counter space at nursing stations for charting
- Higher parent satisfaction with the built environment was associated with higher health care satisfaction
- Higher staff satisfaction with the built environment was associated with higher coworker relationship satisfaction

Implications of Findings

- Higher satisfaction with the built environment was associated with higher health care satisfaction for parents and higher coworker relationship satisfaction for staff members

Woods, A., & Doan-Johnson, S. (2002). Executive summary: Toward a taxonomy of nursing practice errors. *Nursing Management, 33*(10), 45-48.

Focus of Study

- To analyze case studies of nursing errors to develop a taxonomy of nursing errors

Research Design

- The Practice Breakdown Research Advisory Panel (PBRAP) examined 21 disciplinary case files from nine state boards of nursing

Sample Information & Site

- 21 case studies from nine state boards of nursing were analyzed

Findings

- Eight categories of nursing errors were identified: lack of attentiveness, lack of agency/fiduciary concern, inappropriate judgment, medication errors, lack of intervention on patient's behalf, lack of prevention, missed or mistaken physician or health care provider orders, and documentation errors
- Lack of attentiveness could be caused by system level problems such as understaffing and high staff turnover
- Lack of agency/fiduciary concern included not advocating on patient's or family's behalf and breaching patient confidentiality
- Inappropriate judgment include inadequate assessment, faulty logic, an unwarranted or faulty intervention, and unreasonable expectations for lesser-trained staff

- Medication errors identified include missed doses, wrong administration time, I.V. rate too fast, wrong concentration of dosage delivered I.V., wrong route of administration, and wrong medications delivered; 9 of 21 cases involved medication errors and 8 of the patients died as a result of the error
- Lack of prevention include breach on infection precautions, lack of prevention hazards of immobility/decreased mobility, and lack of provision of a safe environment
- Missed or mistaken physician orders include instances of carrying out inappropriate medical orders or mistaking orders
- Documentation errors include charting procedures or medications before completed and lack of charting of observations of the patient

Implications of Findings

- Goal of creating a taxonomy of errors is to provide concrete suggestions for reducing and preventing errors

Banbury, S., & Berry, D. C. (1998). Disruption of office-related tasks by speech and office noise. *British Journal of Psychology, 89*, 499-517.

Focus of Study

- Three experiments were conducted to examine the effects of noise on the performance of office-related tasks.
- Experiment one examined effects of office noise on memory for prose and mental arithmetic
- Experiment two examined memory for prose task by varying duration and meaningfulness of the noise source
- Experiment three investigated whether the meaning of speech influences the disruption of a mental arithmetic task

Research Design

- Experiment one: participants had to learn and recall in the correct order a short passage of text; participants also had to add and subtract a series of single digit numbers; noise was presented through a stereo sound system; 4 conditions were tested: speech, office noise with speech, office noise without speech, and quiet
- Experiment two: prose task was same as in experiment one; noise was created by a male Greek speaker who was recorded speaking a translated version of a radio broadcast into Greek; seven test conditions were used: office noise with speech, office noise without speech, and meaningless speech presented in either a learning phase alone or in both learning and recall phase and a quiet control condition
- Experiment three: arithmetic task from experiment one was used; noise sources included random numbers, random speech, and Greek speech; four conditions were used: Greek speech, random speech, number speech, and quiet

Sample Information & Site

- Experiment one included 48 undergraduates from the University of Reading, U.K.
- Experiment two included 84 undergraduates from the University of Reading, U.K.
- Experiment three included 48 undergraduates from the University of Reading, U.K.

Findings

- Experiment one: for prose task, performance in speech and office noise with speech conditions was significantly worse than in office noise without speech and quiet conditions; office noise without speech was not significantly different from quiet control; for arithmetic task, all three conditions with noise or speech produced performances that were significantly worse than the quiet control
- Experiment two: Increasing the duration of the irrelevant noise was associated with greater disruptive effects; for office noise without speech and meaningless speech condition, performance was significantly worse when background noise presented in both learning and recall phases; performance in all noise conditions was worse than in quiet control condition; disruption of office noise without speech was less than office noise with speech
- Experiment three: No significant differences were found between the three test conditions though performance was worse in these conditions than quiet control

Implications of Findings

- Performance on memory for prose and arithmetic tasks can be reduced by background irrelevant speech
- Office noise, in general, can disrupt performance on arithmetic tasks and memory for prose

Banbury, S. P., & Berry, D. C. (2005). Office noise and employee concentration: Identifying causes of disruption and potential improvements. *Ergonomics, 48*(1), 25-37.

Focus of Study

- To assess the impact of office noise on environmental satisfaction and job performance.

Research Design

- Participants completed questionnaires regarding noise levels in their office environment as well as their reactions to the noise; questions were also included regarding potential improvements to the office
- Noise sources included telephones ringing, telephones left ringing at vacant posts, other people's telephone conversations, printers, typewriters and keyboards, computers, external sources, and other people talking

- Sound levels measurements were taken in the offices on the same day questionnaires were administered

Sample Information & Site

- This study took place in two offices (one a large banking organization and the other the divisional headquarter of a large computing organization) in the United Kingdom.
- 45 employees from one office and 43 employees from a second office participated in the study.

Findings

- 99% of respondents reported that at least one of the noise sources disrupted their concentration
- A 'slight deterioration' in concentration was caused by the noise sources
- Telephones left ringing at vacant posts were reported to have significantly more disruption to concentration than other noise sources
- Improvements favored include sound absorption and partitioning, followed by quiet areas, interview rooms, and coffee areas

Implications of Findings

- Concentration in the work place was disrupted by noise levels.

Birdi, K. S., & Zapf, D. (1997). Age differences in reactions to errors in computer based work. *Behaviour and Information Technology, 16(6), 309-319.*

Focus of Study

- To examine age differences among older and younger workers in reaction to problems encountered when using a computer.

Research Design

- Participants filled out questionnaires regarding their emotional response to the occurrence of an error of medium-level seriousness, their attitudes toward new technology, their computer experience, demographic information, attempts at self-correction, and sources of support
- Participants were observed over a two-hour period; observations focused on the number of errors that occurred, emotional reactions, and attempts at self-correction

Sample Information & Site

- 134 office workers using computers in 12 companies situated in the southern part of the Federal Republic of Germany participated in this study.

Findings

- On average, participants reported not being greatly disturbed when encountering a single error of medium-level seriousness
- Approximately half of the participants demonstrated some form of overt negative emotional reaction to errors
- Average respondent tried one attempt at self-correction without help per error
- Older workers show a more negative reaction than younger workers when making an error
- Negative attitudes to new technology associated with self-reported negative emotional reactions
- Older workers less likely to solve error without using other sources of help; most likely to use manual for help rather than ask supervisors or colleagues

Implications of Findings

- Older workers show a more negative emotional reaction to errors in computer-based work than younger workers and they are less likely to correct the error without support

Brasche, S., Bullinger, M., Schwab, R., Gebhart, H., Herzog, V., & Bischof, W. (2004). Comparison of risk factor profiles concerning self-reported skin complaints and objectively determined skin symptoms in German office workers. *Indoor Air, 14, 137-143.*

Focus of Study

- To examine the relationship between impact factor profiles of self-reported skin sensation and objectively determined skin symptoms

Research Design

- This study comprised of two phases: phase one included an initial questionnaire while phase two included an in-depth assessment of health and environment of selected individuals
- Phase two consisted of a self administered questionnaire, investigation of job characteristics and ergonomic design of the workplace, measurements of biological variables in rooms and air-conditioning systems, measurements of physical and chemical variables in rooms, evaluation of building related factors and air-conditioning systems, and medical examinations of skin and eyes

Sample Information & Site

- This study took place in 14 German office buildings.
- 4596 employees took part in phase one; 1497 employees participated in phase two, of which 925 took part in the medical exams of phase two

Findings

- Prevalence of self-reported skin symptoms is higher in work places characterized by low job characteristics and the need to work with poor software longer than 4 hours per day
- Self-reported skin symptoms are influenced by females, use of skin cream, self-reported allergy, unfavorable job characteristics, and computer work based on poor software
- Relative humidity exceeding 90th percentile has significant protective effect on measured low skin hydration

Implications of Findings

- Skin related sensory perception influenced by job-related and personal factors

Feuerstein, M., Nicholas, R. A., Huang, G. D., Dimberg, L., Ali, D., & Rogers, H. (2004). Job stress management and ergonomic intervention for work-related upper extremity symptoms. *Applied Ergonomics*, 35, 565-574.

Focus of Study

- To design a workplace study that focuses on specific outcome measures including upper extremity pain, symptoms, job stress, functional limitations, and ergonomic risk exposures in office workers

Research Design

- Participants had a worksite visit and consultation from an occupational health nurses and a former rehabilitation engineer
- Levels of ergonomic risk present in the workstation were recorded by the occupational health professionals
- Adjustments were made to workstation when possible; individuals were instructed as to how the environment and task behaviors could be modified to prevent ergonomic risk; stretching exercises were shown to participants
- Assessment of the workstation was completed again at 3- and 12-month follow-up periods
- Individuals were divided into 2 groups: "Ergo-only" in which only ergonomic modifications were made and "Ergo-stress" in which ergonomic modifications were made in addition to job stress management education and training during 2 meetings held the first and third weeks of the intervention
- Participants in the "Ergo-stress" condition were also given a CD providing exercises in muscle relaxation, diaphragmatic breathing, and relaxation imagery; participants were given two workbooks as personal reference
- Sociodemographic information was obtained
- Participants were also asked to rate their level of pain; the upper extremity function scale was used to assess perceptions of the degree to which workers' symptoms affected

overall function; a measure was included for the participants' perceived overall physical and mental health; participants were also asked to rate their work stress

Sample Information & Site

- Participants for this study included 70 employees of World Bank in Washington, D.C.

Findings

- Participants in both conditions (ergonomic intervention only and ergonomic intervention in addition to stress management) experienced similar long-term improvements
- Improvements in reported physical health did not persist beyond three months for both groups
- The addition of the stress management component did not result in significant improvements compared to the ergonomic intervention alone

Implications of Findings

- Ergonomic interventions improved the reported physical health of participants for the first three months of the study.

Furnham, A., & Strbac, L. (2002). Music is as distracting as noise: The differential distraction of background music and noise on the cognitive test performance of introverts and extroverts. *Ergonomics*, 45(3), 203-217.

Focus of Study

- To examine whether background noise is as distracting as music on cognitive test performances of introverts and extroverts on three types of tasks

Research Design

- Participants were asked to perform three different tasks: reading comprehension (extracted from SHL Practice Tasks), memory for prose task (150 word paragraph), and mental arithmetic task (12 sets of 15-single-digit sums)
- Subjects first completed the Eysenck Personality Questionnaire; they then completed the reading comprehension task, prose recall task, and mental arithmetic task
- Subjects completed on task in a noise condition, one task in the music condition, and one task in silence; Noise was produced from BBC's SFX CD of 'Essential Sounds of the City'; Music included UK Garage-style music
- After completing the tasks, a post-test questionnaire was given asking participants to rate how distracting they found the noise and music and how motivated they were

Sample Information & Site

- 76 students in the United Kingdom took part in this study.

Findings

- For all three tasks, performance declined in the presence of music and noise compared to silence
- Extraverts performed better than introverts in the noise and music conditions for reading comprehension task
- The more extraverted the participant was, the more likely the participant was to report studying with music
- Negative correlation between extraversion scores and the likelihood of reporting finding the music and noise distracting throughout the study

Implications of Findings

- The presence of noise and music is distracting and results in a performance decline
- Introverts are more negatively affected by noise and music than extroverts

Gander, P. H., Gregory, K. B., Graeber, R. C., Connell, L. J., Miller, D. L., & Rosekind, M. R. (1998a). Flight crew fatigue II: Shore-haul fixed-wing air transport operations. *Aviation, Space, and Environmental Medicine, 69(9)*, B8-B15.

Focus of Study

- To determine fatigue levels of aircraft operators working short-haul flights.

Research Design

- Two commercial airlines participated in this study; flights selected include the most challenging 3-4 day trips flown
- Participants were monitored prior to, during, and after the flights
- Data for duty times and layovers was obtained from daily logbooks kept by the crewmembers
- Logbooks completed by crewmembers were used to measure fatigue
- Changes in heart rate during different phases of the flight were examined

Sample Information & Site

- 37 captains and 37 first officers participated in this study, though complete data was obtained from 44 crewmembers.

Findings

- Crewmembers slept less, awoke earlier, and reported greater difficulty falling asleep on trips
- Sleep was lighter, less restful, and of overall poorer quality on trips than pre-trip or post-trip
- Crewmembers accumulated a sleep debt across trips; hours of sleep lost during trips was not regained after 2 nights of post-trip sleep

- Crewmembers working 3-day trips had more sleep loss than those working 4-day trips
- Caffeine and snack consumption increased during drips
- Significant increases in heart rate occurred during descent and landing for crewmember flying
- Three most common physical symptoms reported were headaches, congested nose, and back pain

Implications of Findings

- While working short-haul flights, crewmembers suffered from poorer sleep which was not regained after 2 nights of returning from the flights

Gander, P. H., Gregory, K. B., Graeber, R. C., Connell, L. J., Miller, D. L., & Rosekind, M. R. (1998b). Flight crew fatigue V: Long-haul air transport operations. *Aviation, Space, and Environmental Medicine, 69(9)*, B37-B48.

Focus of Study

- To assess fatigue levels of aircraft operators working long-haul flights.

Research Design

- Four trip patterns, which lasted between 4 and 9 days were selected
- Participants were monitored prior to, during, and after the flights
- Data for duty times and layover duration was obtained from daily logbooks kept by the crewmembers
- Logbooks completed by crewmembers were used to measure fatigue
- Core temperature rhythm was used to measure the position of the circadian clock
- Crewmembers completed a Background Questionnaire in which they described their sleep strategy after crossing multiple time zones

Sample Information & Site

- 32 male flight crewmembers participated in this study.

Findings

- Sleep episodes were shorter during layovers than either pre-trip or post-trip
- Crewmembers reported significantly less sleep per 24 hours during trips than pre-trip or post-trip; sleep debt was accumulated across days of trip
- Greater sleep loss was related to night flights; sleep disruption was greater for eastward overnight flights
- Flight direction influenced organization of layover sleep but not amount of sleep obtained

- Majority of crewmembers tried to adapt to local time, though they felt they were moderately successful
- Preference is to sleep during local night; secondary preference is to sleep local afternoon time
- Positive and negative affect did not change significantly on trips compared to pre-trip
- Caffeine and snack consumption increased during drips
- Three most common physical symptoms reported were headaches, congested nose, and back pain
- Fatigue levels were rated higher and activation levels were rated lower on duty days rather than pre-trip days

Implications of Findings

- Crewmembers working long-haul flights were likely to sleep less during their layovers and report increased fatigue levels on duty rather than pre-trip days

Hightower, D. P., Thomas, S. H., Stone, K., Brinkley, S., & Brown, D. F. M. (1995). Red cabin lights impair air medical crew performance of color-dependent tasks. *Air Medical Journal, 14*(2), 75-78.

Focus of Study

- To assess if red lighting impairs color-dependent tasks for air medical crews.

Research Design

- An emergency medical services instructor pilot adjusted the lighting in a BO-105 helicopter to its maximum acceptable intensity
- Light conditions were measured for maximum acceptable red lighting intensity
- In both the normal and red light settings, residents were shown positive and negative CO₂ detectors and skin-colored and cyan-tinted rubber masks, and 10 medication labels; comparisons were made between responses in both light settings

Sample Information & Site

- This study took place on a helicopter parked on the hospital helipad.
- 13 emergency room residents participated in this study.

Findings

- With normal lighting, accuracy of all tasks, including medication label reading, tinted mask identification, and CO₂ detector status was 100%

- Only 28.5% of medication labeling information could be read under the red lighting; other tasks significantly declined under red lighting

Implications of Findings

- Red lighting appears to impair the performance of certain tasks for air medical crews.

Huang, Y., Roberston, M. M., & Chang, K. (2004). The role of environmental control on environmental satisfaction, communication, and psychological stress: Effects of office ergonomics training. *Environment and Behavior, 36*(5), 617-637.

Focus of Study

- To examine whether an office ergonomics training program reduces psychological stress experienced by employees as well as improves their environmental control and satisfaction and their communication levels.

Research Design

- A quasi-experimental field study was used with a pretest-post-test design.
- Office ergonomics training program was 1.5 hour interactive workshop on company time; instructional design model was based on systems approach
- Questionnaires were used to measure the workplace environment, environmental satisfaction, psychological stress, communication, and environmental control

Sample Information & Site

- This study took place in office buildings of two U.S. companies in the telecommunications and publishing industries.
- 89 office workers participated.

Findings

- Following training, employees reported a higher level of environmental control, greater satisfaction with their working environment, and an increase in satisfaction with ease of communication and with the degree to which the environment supported communication with coworkers
- Employees were able to transfer the knowledge learned in the session to their office and rearranged their work spaces to support their tasks and job demands

Implications of Findings

- Having adjustable workstations as well as ergonomic training allowed employees to modify their workstation according to their needs

Hygge, S., & Knez, S. (2001). Effects of noise, heat and indoor lighting on cognitive performance and self-reported affect. *Journal of Environmental Psychology, 21*, 291-299.

Focus of Study

- To determine the interaction effects between noise, heat, and illuminance levels on attention, memory, and problem solving.

Research Design

- Air temperatures were controlled by a computerized climate system
- Ceiling-mounted luminaries provided illuminance levels of 300 and 1500 lx.
- A factorial between-subject design was used with three independent variables: noise (38 and 58 dBA), heat (21 and 27 degrees Celsius) and illuminance (300 and 1500 lx)
- Dependent measures included attentional performance, problem solving tasks, long-term recall and recognition tasks, short-term recall, and affect

Sample Information & Site

- 128 participants aged 18-19 years were recruited from local high schools in Sweden.
- The experiment was in an off-white chamber furnished as an office

Findings

- Working memory and attention work faster with noise but with reduced accuracy
- Long term recall is better in higher illumination levels and in lower noises when the temperature is 27 degrees Celsius
- Free recall is better in the lower temperature condition and in the low noise condition when illumination levels are higher
- Women performed better than men in the problem solving task and women had better short term recall than men

Implications of Findings

- Noise, heat, and lighting levels interact at different levels and impact cognitive performance

Kjellberg, A., Landstrom, U., Tesarz, M., Soderberg, L., & Akerlund, E. (1996). The effects of nonphysical noise characteristics, ongoing task and noise sensitivity on annoyance and distraction due to noise at work. *Journal of Environmental Psychology, 16*, 123-136.

Focus of Study

- To evaluate how nonphysical noise, ongoing activity, and noise sensitivity contribute to noise annoyance.

Research Design

- 5 minute noise recordings were made in each workplace
- Participants answered questionnaires before noise levels were taken regarding noise, work, environmental and individual characteristics
- Participants were asked to judge annoyance due to noise; other responses to noise, including frequency of attention to the noise during work, effects on task performance, and complaints were also measured
- Other measures included self-rated noise characteristics, exposure time, task characteristics, and type of worksite

Sample Information & Site

- This study took place in offices, laboratories, and industries in Sweden.
- 439 individuals participated in this study.

Findings

- Distraction depends on sound events rather than mean sound levels
- Individuals believing noise levels could be lowered were more annoyed with the noise and more distracted by the noise than individuals who thought the possibility to lower noise did not exist
- Lowest annoyance levels were found in laboratories; highest annoyance levels were found in laboratory personnel
- Most distracting noise sources were conversations together with telephone signals
- Workload did not impact annoyance or distraction levels
- Women were slightly more annoyed than men

Implications of Findings

- Distractions and annoyance with noise levels were associated with the perceptions that noise levels could be lower in the particular workspace

Kwallek, N., & Lewis, C. M. (1990). Effects of environmental colour on males and females: A red or white or green office. *Applied Ergonomics*, 21(4), 275-278.

Focus of Study

- To compare the effects that red, white, or green office colors have on worker productivity and mood.

Research Design

- Subjects completed the Profile of Mood States questionnaire which measures mood; subjects were administered a clerical test to measure speed and accuracy
- Three subjects were tested at a time
- Subjects completed the mood questionnaire prior to completing the task; they were then randomly placed in one of the three colored offices (red, white, or green) where information sheet was completed followed by clerical test
- Once clerical test completed, subjects completed mood test for a second time and filled out questionnaire regarding opinions on the color of the office in a work environment

Sample Information & Site

- This study took place at the University of Texas at Austin.
- 222 Introductory Psychology students participated in this study.

Findings

- Significantly more errors were made by subjects in white office than those in the red office
- Significantly lower confusion-bewilderment scores were obtained with those working in the red office compared to those in the green office
- Females reported more tension than males and males reported more vigor than females on the mood post-test
- Subjects in the white environment reported they would like working in their experimental environment more than those in the red and green environment
- Subjects in white office rated it less distracting than those in the red office

Implications of Findings

- Although white appears to be the preferred color to work in, subjects made the most errors in the white environment.

Leather, P., Beale, D., & Sullivan, L. (2003). Noise, psychosocial stress and their interaction in the workplace. *Journal of Environmental Psychology*, 23, 213-222.

Focus of Study

- To determine the interaction between noise and psychosocial job stress

Research Design

- Semi-structured interviews were conducted with a representative sample of employees working in two buildings; interviews focused on concerns with the physical environment of the workplace
- Questionnaires were developed and piloted with a small number of office employees; measures included features of the physical work environment, job design characteristics, attitudes to work and the workplace, and self-reported health and well-being
- Physical noise measurements were taken at each employee's workstation

Sample Information & Site

- 128 workers employed by a government agency in a city in the Midlands region of the United Kingdom participated in this study.

Findings

- Increased job strain was associated with decreased job satisfaction, decreased organizational commitment, and increased symptoms of ill health
- Lower noise levels assisted in buffering the negative impact of job strain on job satisfaction, organizational commitment, and self-reported symptoms of ill-health

Implications of Findings

- When noise levels are reduced, the impact of job strain on job satisfaction, organizational commitment, and self-reported symptoms of ill-health is buffered

Lee, S.Y., & Brand, J. L. (2005). Effects of control over office workspace on perceptions of the work environment and work outcomes. *Journal of Environmental Psychology*, 25, 323-333.

Focus of Study

- To determine the effects of distractions, flexible use of workspace, and personal control over the work environment on perceived job performance, job satisfaction, group cohesiveness, and preferences to work alone

Research Design

- Questionnaires, which were either physically distributed or online, were utilized
- Questionnaires measured individual perceptions of individual and group aspects and outcomes from work environments, design issues, and demographic items
- Data was collected prior to facility renovations

Sample Information & Site

- 228 individuals from five different organizations participated in this study.

Findings

- Perceived distraction levels were not related to self-assessed performance, but were positively related to employees' inclination to work alone or in an enclosed space and negatively related to satisfaction with the physical work environment
- Perceived control was positively related to job satisfaction, perceived group cohesiveness, and satisfaction with the physical work environment
- There were no significant effects for environmental satisfaction on job satisfaction
- Group cohesiveness was positively related to job satisfaction
- Job satisfaction was positively related to perceived performance

Implications of Findings

- Distractions, perceived control, and group cohesiveness were all related to job satisfaction, and job satisfaction was positively associated with perceived performance

Liao, M. H., & Drury, C. G. (2000). Posture, discomfort and performance in a VDT task. *Ergonomics*, 43(3), 345-359.

Focus of Study

- To determine the effects of workplace design and work duration on posture, discomfort, and performance in a computer-based task

Research Design

- Two-factor design with repeated measures was used
- Three levels of keyboard height were utilized
- A total work period of 120 minutes was used; 12 intervals of 10 minutes each were used
- Joint angles were measured using a video technique
- Postural shifts were measured to determine the intensity of discomfort

- Questionnaires were administered on-screen to assess discomfort or pain in each of 16 body parts and to determine fatigue levels
- Performance was measured through speed and accuracy of the task
- Workstations were adjusted to minimize discomfort; at each level of keyboard height, three 40-minute typing sessions were completed with two 3-minute rest breaks

Sample Information & Site

- Six college students participated in this U.S. based study.

Findings

- Frequency of upper body and overall postural shifts increased with time;
- Frequencies of postural shifts increased with development of discomfort and fatigue
- Lowest body position discomfort was reported on thighs and legs
- Error rates were lower in the first hour of keying than in the second

Implications of Findings

- The amount of time spent on a task had significant effects on postural discomfort

Luna, T. D., French, J., & Mitcha, J. (1997). A study of USAF air traffic controller shift work: Sleep, Fatigue, Activity, and Mood Analyses. *Aviation, Space, and Environmental Medicine*, 68(1), 18-23.

Focus of Study

- To evaluate shift-specific sleep, general activity levels, cognitive performance, and mood of air traffic controllers working shift schedules.

Research Design

- Observational study was conducted in August and September 1992
- Air traffic controllers maintained subjective sleep log during the study; noted all sleep, including naps, occurring off-duty
- Air traffic controllers were given oral thermometers to record their temperature every 4 hours while awake for study duration
- Computerized, wrist-worn activity monitors were worn at all times (9 participants completed this portion)
- Profile of Mood States (POMS) questionnaire was used to measure subjective mood at midpoint of each shift
- Novasacn "B" computerized performance test used to measure performance at midpoint of each shift

Sample Information & Site

- The study took place at Loring AFB, ME.
- 13 Air traffic controllers participated in this study. Participants worked 2-2-2 forward rapid rotation shift schedules (2 day shifts, 2 swing shifts, 2 night shifts)

Findings

- More sleep was reported during the night shift than on the day or swing shifts
- More sleep was reported in off-duty period after swing shift than after day shift
- Sleep was less restful following day shift than following night or swing shifts
- Activity levels were lower on night-shift than other shifts
- Increased fatigue, confusion, and decreased vigor reported on night shift than on day or swing shifts

Implications of Findings

- Air traffic controllers slept more and felt greater confusion, fatigue, and decreased vigor when working the night shift rather than swing or day shifts.

Marans, R. W., & Spreckelmeyer, K. F. (1982a). Evaluating open and conventional office design. *Environment and Behavior, 14(3), 333-351.*

Focus of Study

- To present and utilize a framework which is effective for evaluating work environments

Research Design

- The conceptual model suggests that environmental satisfaction is dependent upon four factors: the characteristics of the employee, the organizational context in which the employees work in, the individual's perceptions and assessments of specific attributes, and objective attributes
- The model suggests that the individual's assessment and perceptions of a particular attribute depend upon the standard used to judge the attribute and the objective attribute itself
- A case study of the federal office building in Ann Arbor, Michigan was used to test the model
- Questionnaires were administered to all federal employees and to samples of community residents
- Data were collected on specific environmental characteristics and attributes of the building

Sample Information & Site

- This study took place at the federal office building in Ann Arbor, Michigan
- Employees working in the federal office building and community residents participated in this study.

Findings

- People's evaluations of the building and environmental settings were influenced by their feelings regarding their immediate workplace
- More than one-third of employees expressed some dissatisfaction with the office environment
- People with greater control over their environment were more satisfied than those with less control
- Employees in private office spaces were more satisfied than those in open or pool arrangements
- Most negative ratings were related to conversational and visual privacy
- Important predictors of satisfaction include amount of workspace, the type of workstation, and the agency in which the station was located

Implications of Findings

- Satisfaction with one's environment is based on a number of factors, most important of which is their satisfaction with their workstation

Marans, R. W., & Spreckelmeyer, K. F. (1982b). Measuring overall architectural quality: A component of building evaluation. *Environment and Behavior, 14(6), 652-670.*

Focus of Study

- To evaluate the architectural design of the federal building in Ann Arbor, Michigan.

Research Design

- Residents of Ann Arbor were randomly selected and interviewed
- On-site visitors were contacted upon leaving the building
- Federal employees were asked to complete a questionnaire
- Working drawings, furniture plans, and field measures of light, temperature, and noise conditions were recorded
- Observations were made of employees and the public regarding how they used the building and its spaces

Sample Information & Site

- This study took place at the federal building in Ann Arbor, Michigan
- 113 residents, 60 visitors, and 239 federal employees participated

Findings

- Building attributes by community residents which were viewed favorably include the plaza, the overall design, and the windows and skylights

- On-site visitors mentioned overall design and spaciousness of the interior as the best attributes
- One-third of community residents disliked the overall building design
- People's feelings regarding their immediate work environments influenced their overall ratings of the building as a workplace
- Ratings of architectural quality depended upon the agency employees worked in, the type of job they had, and the amount of time spent in the building
- Two-thirds of employees rated the appearance of the agency negatively
- Four conditions were related to people's feelings about the overall ambience of their agencies: noise from other agencies, noise from their own agency, movement from other people and equipment, and quality of building's air; air quality was most important ambient condition
- 49% of participants reported being bothered by uncomfortable room temperatures; those bothered by uncomfortable room temperatures accepted excessive warmth better than excessive cold
- 41% of respondents voted for more air movement
- 48% of respondents were dissatisfied with air quality
- Participants who did not accept their thermal environment were more likely to experience headaches, dry eyes, nose irritation, irritated throat, and tiredness than participants who accepted their environment
- Large individual differences were obtained with regards to sensitivity to air movement

Implications of Findings

- The employee's feelings regarding the ambience of the agency they work in is related to their assessments of the overall architectural quality of the building they work in

Melikov, A., Pitchurov, G., Naydenov, K., & Langkilde, G. (2005). Field study on occupant comfort and the office thermal environment in rooms with displacement ventilation. *Indoor Air, 15, 205-214.*

Focus of Study

- To identify the response of occupants regarding their indoor environment with displacement ventilation.

Research Design

- Measures of the mean velocity, turbulence intensity, and air temperature were made at various heights.
- Questionnaires were utilized to assess general thermal sensation; background information, including workplace design, job satisfaction, health, clothing garment checklist, sensitivity to the environment, noise, lighting, air quality, ergonomics, social relations, and level of privacy, was obtained

Sample Information & Site

- This study took place in 10 office buildings with displacement ventilation in Denmark.
- 133 females and 94 males working in the offices participated.

Findings

- More than one-third of the respondents felt thermally neutral
- 82% of respondents felt their thermal environment was acceptable at the time of measurement

Implications of Findings

- A large number of respondents was not satisfied with the thermal air quality of the working environment.

Menozi, M. Napflin, U., & Krueger, H. (1999). CRT versus LCD: A pilot study on visual performance and suitability of two display technologies for use in office work. *Displays, 20, 3-10.*

Focus of Study

- To compare cathode ray tube (CRT) display and liquid crystal display (LCD) for their suitability in visual tasks.

Research Design

- A search task was used to record reaction times for detecting targets and errors that occurred during the task
- Task consisted of scanning the computer display and pressing 'yes' or 'no' button of answer box, depending upon whether the target was seen or not
- Subjects were asked to accomplish task within minimum time while avoiding errors
- Experiment was carried out in two levels of ambient light; each subject completed the task using both displays in both sets of lighting
- Four blocks of forty trials each were conducted
- Subjects were asked to rate how much they would appreciate completing office work in the four environmental conditions once all tasks were completed

Sample Information & Site

- 10 subjects participated in this study.

Findings

- Most incorrect answers (given at 246 trials) resulted from missed detection of a target
- Correct detection of the targets occurred in 559 trials
- Error frequency at LCD-tasks was significantly lower than error frequency at CRT-tasks regardless of ambient lighting

- No subjective preferences were statistically demonstrated

Implications of Findings

- LCD technology improves accuracy in detecting targets; may cause lower visual strain and cause less visual complaints than CRT technology

Raffaello, M. & Maass, A. (2002). Chronic exposure to noise in industry: The effects of satisfaction, stress symptoms, and company attachment. *Environment and Behavior*, 34(5), 651-671.

Focus of Study

- To determine the effect of noise on job satisfaction, stress, and attachment to one's company.

Research Design

- A field study with a pretest and posttest design was used.
- In the pretest, the experimental group was located in two offices; the company was relocated and both sites moved to one large site
- The control group had similar conditions to the experimental group prior to the move
- Noise levels were measure in the pretest and posttest through the use of a phonometer during thirty minute time periods
- Questionnaires were distributed 6 weeks prior to the move, and redistributed 2 months after the move; questionnaires measured job satisfaction, environmental satisfaction, stress symptoms, perceived noise, desire to communicate, difficulty of communication, company image, company attachment, safety, evaluation of new site, and sociodemographic variables
- Productivity data was obtained from management of both companies

Sample Information & Site

- This study took place in production departments of two companies in Vicenza, Italy.
- In the experimental group, 38 production department workers who participated in the pretest and posttest participated
- In the control group, 24 workers took part in both the pretest and posttest and were included in this sample

Findings

- Pretest data demonstrated that, for the most part, the companies did not differ; two exceptions were that the control company had a more negative image and company attachment was lower
- In comparing pretest and posttests, there were no changes for any of the variables for the control company

- Significant improvements occurred for the experimental company for all variables after the move
- The experimental group reported significantly less noise disturbance, greater environmental satisfaction, greater job satisfaction, fewer stress symptoms, and less difficulty in communication; the image of the company became more favorable and employees reported greater company attachment
- Desire for communication did not change after the move
- Higher noise levels and difficult communication were negatively associated with work and environmental satisfaction, company image, and company attachment and positively associated with stress symptoms

Implications of Findings

- Improved working conditions in which the environment was perceived as less noisy led to greater environmental and job satisfaction, fewer stress symptoms, a more favorable company image and greater company attachment

Spreckelmeyer, K. F. (1987). Environmental norms in the work place. *Design Methods and Theories*, 21(4), 723-730.

Focus of Study

- To examine aspects of design which impact the satisfaction of employees

Research Design

- Four evaluation studies regarding work environments were conducted
- Study one: reports data from national survey of office workers; forms basis for establishing overall measure of environmental satisfaction
- Study two: compilation of user responses from a post-occupancy evaluation of a federal building
- Study 3: examines data obtained in a post-occupancy evaluation of a private office building
- Study 4: analyzes responses from a building evaluation of a radio and television facility
- Each study measured the relationships between perceptions of office workers and their physical surroundings
- Primary method of data collection in each study was face-to-face interviews

Sample Information & Site

- Four different locations were used in these studies. One study included national data obtained from office workers. The second study used data from a study of federal employees working in Ann Arbor, Michigan. The third study used data from employees of a private office building, while the fourth study took place in a radio and television facility.

Findings

- Conversational and visual privacy and space for storing work were rated negatively compared to other attributes in the four studies
- Furniture selection, lighting, and to a certain degree, workstation size have been positive aspects of designs

Implications of Findings

- By examining different designs, an assessment profile can be obtained regarding environmental attributes critical to design; the profile gives a sense as to how well the attributes support the needs of the users

Sundstrom, E., Town, J. P., Rice, R. W., Osborn, D. P., & Brill, M. (1994). Office noise, satisfaction, and performance. *Environment and Behavior*, 26(2), 195-222.

Focus of Study

- To explore the impact of office noise on environmental satisfaction, job satisfaction, and job performance.

Research Design

- Office employees completed a questionnaire pertaining to the office environment, satisfaction, and job performance before and/or after the renovation of their offices
- Supervisors rated job performance independently
- The pretest-only group contained individuals who completed the survey before changing offices; the posttest-only group comprised of individuals who completed the survey after changing offices; the pretest-posttest group completed the survey both before and after the relocation or renovation
- The pretest-posttest design group was subdivided into three groups: increased noise disturbance after the renovation, decreased disturbance, or no change

Sample Information & Site

- 10 private corporations, 15 federal agencies, and 1 state government in the United States and Canada participated in this study.
- 2,391 employees from 58 sites completed a questionnaire; 365 supervisors provided performance ratings

Findings

- 54% of participants in the pretest and posttest combined reported being bothered "often" by one or more noise sources
- Environmental satisfaction decreased when noise levels increased; the opposite was true when noise levels decreased
- Job satisfaction was inversely correlated with noises from phones ringing, people talking on the phone, people talking

face-to-face, piped-in sound, office equipment, and combined sources

- Noise disturbances did not correlate with performance ratings
- Noise from telephones ringing consistently correlated with environmental and job dissatisfaction

Implications of Findings

- Noise disturbances were inversely correlated with both job satisfaction and environmental satisfaction

Stone, N. J. (2003). Environmental view and color for a simulated telemarketing task. *Journal of Environmental Psychology*, 23, 63-78.

Focus of Study

- To determine the effects of task type, environmental color, and environmental view on mood, satisfaction, motivation, and performance

Research Design

- Experiment 1: Two partitioned workspaces were placed within a room; partitions were painted either dark red or light blue; each workstation had a chair, computer, and headphones; in some conditions, a poster of a sunset behind mountains across a lake was placed above the computer
- Audio tapes were created with individuals playing the role of airline reservationist or customers; tasks were either high demand or low demand; four sessions were conducted
- Questionnaires were used to measure mood, task demand, perceptions of the task, performance satisfaction, motivation to perform the task, perceptions of room temperature, perceptions of lighting, perceptions of picture pleasantness, and the desire to see or be seen by other task performers
- Experiment 2: Same as experiment one except one condition was added: break or no break; audio tapes for the break condition had 90 seconds of quiet time inserted between sessions 3 and 4
- 2 items were added to the questionnaire to measure whether one looked around the environment when not entering data

Sample Information & Site

- This study took place at a mid-size, private Midwestern university in the United States.
- 32 male students and 96 female students completed experiment 1. 36 male and 92 female students completed experiment 2.

Findings

- Experiment 1: Individuals in the blue environment had a greater desire to be viewed by or to view others and higher

ratings of task demand and perceptions of privacy when a picture was present; individuals in the red environment had a greater desire to be viewed by or to view others and higher ratings of task demand and perceptions of privacy when a picture was not present

- No effects of environmental color or view on positive mood, task perception, or perceptions of privacy available; mood and performance satisfaction are more affected by what the task is rather than the environment in which the task is performed
- During the last session, individuals in the blue environment made significantly more errors than those in the red environment
- Fewer errors occurred for the low demand task than the high demand task; significant increase in errors from sessions 1 to 4 for both tasks
- Students in the low demand task reported lower levels of negative mood, higher levels of satisfaction with performance, lower levels of task demand, greater feelings of isolation, and a greater desire to see and be seen by others than those in the high demand task
- Experiment 2: Mood and performance satisfaction were not affected by environmental color, view, or the break
- Individuals had lower desire to view or be viewed when there was no scenic picture
- Individuals in the red environment with no scenic picture had more errors when a break did not occur than when there was a break; they also had more errors individuals in the red environment with a scenic picture and no break
- Errors were greater in session 4 than session 1; errors lower in session one in the blue environment without a picture than in the red environment without a picture
- Errors were greater in the blue environment with the scenic picture
- Errors were greater in the red environment without the scenic picture

Implications of Findings

- Negative mood and performance satisfaction are affected by the demands of the task not the environment in which the tasks are performed
- Errors are affected by environmental stimuli and color

Stone, N. J., & English, A. J. (1998). Task type, posters, and workspace color on mood, satisfaction, and performance. *Journal of Environmental Psychology, 18*, 175-185.

Focus of Study

- To determine the effects of task type, poster presence, and work space color on mood, satisfaction, and performance

Research Design

- A partitioned workspace was created; partitions were painted red or light blue
- Within each partition was a desk, chair, computer, and headphones
- Audio tapes of a short, repeated conversation between 2 individuals playing the roles of telemarketer and customer were created as data input; two types of tapes were created: low attentional demand and high attentional demand
- In some conditions, a poster of a sunset behind mountains across a lake was placed above the computer
- A questionnaire was used to measure mood, and satisfaction with performance, the task, and the cubicle as well as perceptions of the task demands, feelings of privacy, feelings of isolation, and ambient conditions such as temperature and lighting levels

Sample Information & Site

- This study took place at a small, private mid-western university in the United States.
- 50 male and 62 female students participated in this study.

Findings

- Individuals who performed the low demand task were more hostile than those performing the high demand task
- Satisfaction with the task or performance might be influenced by actual performance and not characteristics of the environment
- Contrary to expectations, participants performing the low demand task had the most errors
- Individuals performing the high demand task rated the cubicle least pleasant when a poster was not present
- When working in a blue environment, the high demand task may appear to have greater task demand in comparison to the calming aspect of the color; the low demand task was perceived as having less actual task demand in comparison to the blue environment
- When working in the red environment, the stimulation from the color may make the high demand task seem less taxing and the low demand task more taxing

Implications of Findings

- Environmental color and the presence of a scenic poster interact with perceptions of task demand, affecting perceptions and mood in diverse ways

Veitch, J.A. (1997). Revisiting the performance and mood effects of information about lighting and fluorescent lamp type. *Journal of Environmental Psychology*, 17, 253-262.

Focus of Study

- To explore the impact of fluorescent lighting on performance and mood

Research Design

- 4 windowless office mock-ups were used within a laboratory setting
- Two offices had cool-white fluorescent lamps and two had full-spectrum fluorescent lamps
- Illuminance levels were equated in each of the four settings to achieve 680 lux mean horizontal illuminance
- Scales were used to measure pre-existing lighting beliefs and their beliefs about the behavioral and mood effects of the physical environment in general

Task performance was measured through the use of brain-teaser puzzles; reading comprehension was also measured; mood was measured through the use of the Russell and Mehrabian Three Factor Mood Scale

Participants completed a questionnaire at the end of each session to probe their expectations about the purpose and anticipated results of the study; questions were also included regarding the difficulty of the tasks and the credibility of the video presentation

Sample Information & Site

- This study took place in a government laboratory in Canada.
- 104 women and 104 men participated.

Findings

- Information provided about lighting, nor the specific type of fluorescent lamp affected mood or performance

Implications of Findings

- Fluorescent lamp type is not a solution to problems with fluorescent lighting

Empirical Articles: Patient Safety

Agency for Healthcare Research and Quality. (2003, March). *The effect of health care working conditions on patient safety. Summary, Evidence Report/Technology Assessment: Number 74. AHRQ Publication No. 03-E024. Rockville, MD. <http://www.ahrq.gov/clinic/epcsums/worksum.htm>*

Focus of Study

- To review scientific evidence regarding the effects of health care working conditions on patient safety

Research Design

- Five databases were searched: MEDLINE, CINAHL, PsycINFO, EBSCO, and the Campbell Collaboration; searches were limited to the years 1980 to 2002
- Searches were performed regarding working conditions, including workforce staffing, workflow design, personal/social factors, physical environment, and organizational factors
- Studies were reviewed and rated for quality by researchers

Sample Information & Site

- 115 studies were included for review

Findings

- Increased staffing levels (licensed and unlicensed nurses) will likely lead to improved patient outcomes
- Preventable complications lower when complex technical procedures are performed by physicians who conduct these procedures frequently
- Experience levels of health care professional is associated with better patient outcomes in some areas
- Reductions in interruptions and distractions will likely reduce number of medical errors
- Levels of ambient noise do not adversely affect patient safety
- Medication errors are reduced when systems are in place to improve information exchange, transfer of responsibility, and continuity of care between hospital and non-hospital settings

Implications of Findings

- Increased staffing, greater experience levels and reduced interruptions, among other factors, will improve patient outcomes

Ali, N.A., Mekhjian, H. S., Kuehn, P. L., Bentley, T. D., Kumar, R., Ferketich, A. K., & Hoffmann, S. P. (2005). Specificity of computerized physician order entry has a significant effect on the efficiency of workflow for critically ill patients. *Critical Care Medicine, 33*(1), 110-114.

Focus of Study

- To assess the effect of computer physician order entry on intensive care patients

Research Design

- Patients admitted during the initial implementation of the computer physician order entry (CPOE) who had their orders entered through CPOE were included in the first group; data was obtained retrospectively
- CPOE was modified and re-implemented seven months after initial installation
- Patients admitted after the modifications were included in the second group; data was obtained retrospectively
- Changes made included screen changes for ordering of intravenous drips and mechanical ventilation, as well as ventilator weaning, potassium replacement and intravenous drip protocols

Sample Information & Site

- This study took place in the intensive care unit at Ohio State University hospital.
- A total of 91 patients participated in this study.

Findings

- With the modified CPOE, patient care delivered through the more efficient systems significantly increased
- There was a significant difference in order volume per patient for the modified CPOE, making it more efficient
- Ventilation management orders decreased significantly with the modified system
- Clinician workload was potentially significantly reduced
- Decreased time spent on medication orders may have resulted in more time spent in patient care

Implications of Findings

- Modifications to the computer physician order entry made ICU care less burdensome and helped physicians adjust to and accept the new technology which could reduce the potential for error

Christenfeld, R, Wagner, J. Pastva, G. & Acrish, W. P. (1989). How physical settings affect chronic mental patients. *Psychiatric Quarterly, 60*, 253-264.

Focus of Study

- To determine the effects of physical changes in a ward with psychotic inpatients and staff who treat them.

Research Design

- Physical changes were made to 2 psychiatric wards. These include lowering the dayroom ceiling, installing shaded lights, redoing the floors in light-colored tiles, and covering the walls with vinyl in calm colors. The nursing station was relocated to permit maximum viewing of the dayroom, porch, and adjoining room. Bedroom ceilings were lowered and the hallway had recessed lighting, vinyl walls, archways, and carpeting installed.
- Baseline data was gathered from the two Model wards and four control wards during the month before the model wards were opened.
- Structured interviews and questionnaires were used for baseline data. The same measures were used on all six wards for 4-8 months after the Model wards were opened. Both staff members and patients were surveyed.

Sample Information & Site

- The study took place on six wards at Harlem Valley Psychiatric Center in New York State.
- 37 patients from the Model wards were interviewed and 44 patients from the control groups were interviewed.
- 23 staff members from the Model wards completed both surveys and 31 staff members from the control wards completed both surveys.

Findings

- After moving to the Model wards, staff showed marked improvement in their mood levels, while the control ward's staff morale remained constant.
- Staff on the Model wards had fewer unscheduled absences following the move.
- Patients had a positive reaction the new wards; they had a decrease in negative self-image and episodes of violence.

Implications of Findings

- When the environment improved, patients thought better of themselves and staff had higher morale and fewer absences.

Cooper, B., Mohide, A., & Gilbert, S. (1989, September). Testing the use of color in a long-term care setting. *Dimensions*, 22-26.

Focus of Study

- To determine whether the selective use of color would affect undesired behavior; desired behavior; and ward atmosphere.

Research Design

- Changes made to the environment include painting all doors leading into the restricted nursing areas and out of the ward the same color as the main corridor; interiors of restricted areas were painted in pale colors; closet doors in bedroom were painted the same color as the walls; bedroom doors were painted in bright colors; bedrooms were painted in paler shades of colors used on the doors; washroom doors were accentuated with bright colors
- Staff were given questionnaires prior to the decorating regarding the environment and patient outcomes
- Six months after the decorating, interviews were held with staff members regarding their opinions of the changes
- Interviews were held with family members before and after the intervention to rate their satisfaction with the environment as well as factors affecting the patient's quality of life

Sample Information & Site

- This study took place at St. Peter's hospital in Hamilton, Ontario.
- Staff and family members participated in this study.

Findings

- Each type of undesired behavior decreased after the intervention, with the exception of patients wandering into others' bedrooms
- Staff and family members felt the environment was more cheerful and less institutional
- Minimizing attention by eliminating color cues is an effective way of reducing undesired behavior

Implications of Findings

- Color schemes within a long-term care setting can be used to promote desired behaviors and deter undesired behaviors

Dettenkofer, M., Seegers, S., Antes, G., Motschall, E., Schumacher, M., & Daschner, F. D. (2004). Does the architecture of hospital facilities influence nosocomial infection rates? A systematic review. *Infection Control and Hospital Epidemiology*, 25(1), 21-25.

Focus of Study

- To review evidence regarding interventions in hospital design and construction and their impact on the occurrence of nosocomial infections

Research Design

- Databases, including Medline, Science Citation Index/Web of Science, Current Contents, Heclinet, Healthstar, Somed, and Embase, were searched (1975 to 2001)
- Studies published in English, French, German, Italian, and Spanish using experimental or observational approaches to examine effect of hospital architecture modifications on nosocomial infection were used
- Two or more independent reviewers screened the abstracts

Sample Information & Site

- 178 articles meeting inclusion criteria were utilized; 17 described completed concurrent or historical cohort studies matching criteria for final inclusion
- 9 ICU's, 4 surgical departments, 2 isolation units, and 2 hospitals in general comprised of the sample

Findings

- Patients on ICU's with more than 11 beds were at a higher risk of acquiring a nosocomial infection than patients on ICU's with fewer than 6 beds
- Lower risk of infection occurred on smaller isolation wards without a central corridor and with a higher staff-to-patient ratio
- Rate of nosocomial infection increased when a fifth bed was added to a 4-bed open ward
- Compliance of hand washing is affected by behavior of senior healthcare workers but not by more hand washing sinks

Implications of Findings

- Improvements in infection control may occur if needs such as availability of sufficient space, isolation capacity, and facilities for hand washing are provided

Gotlieb, J. (2002). Understanding the effects of nurses on the process by which patients develop hospital satisfaction. *Holistic Nursing Practice*, 17(1), 49-60.

Focus of Study

- To identify the effects of patient hospital rooms and locus of causality on patients' evaluation of nurses.
- To clarify the importance of nurses on patients' hospital satisfaction

Research Design

- Questionnaires were mailed out to hospital patients who had been discharged from the hospital.
- Scales included in the measure pertained to hospital satisfaction, patients' perceptions of nurses, and patients' evaluations of their rooms.

Sample Information & Site

- 232 patients took part in this study.
- The study took place at a large hospital in a major metropolitan area in the United States.

Findings

- As evaluations of rooms became more positive, patients' evaluations of their nurses became more positive as did their ratings of satisfaction with their hospital.
- As evaluations of nurses became more positive, their hospital satisfaction increased.

Implications of Findings

- Patient evaluations of their rooms and nurses affects their evaluations of hospital quality.
- No mention was made in regards to specific nursing unit design.

Gotlieb, J. (2000). Understanding effects of nurses, patients' hospital rooms, and patients' perception of control in the perceived quality of a hospital. *Health Marketing Quarterly*, 18(1/2), 1-14.

Focus of Study

- To propose a model and provide empirical evidence suggesting patients' hospital rooms affect their perceptions of nurses and hospital quality.
- To identify the effects of patients' perception of control on their perception of nurses and hospital quality.
- To identify the effect of patients' perception of nurses on their perception of hospital quality.

Research Design

- Questionnaires, which included measures pertaining to the hospital environment, were distributed to patients.

Sample Information & Site

- 232 patients participated in this study.
- The study took place at a large hospital in a major metropolitan area in the United States.

Findings

- Patients' perceptions of their rooms affected their perceptions of their nurses and quality of the hospital.
- Patients' perceptions of control affected their perceptions of their nurses.
- Patients' perceptions of their nurses affected their perceptions of the perceived quality of the hospital.

Implications of Findings

- Improving patients' rooms is likely to result in a more positive perception of their nurses and of hospital quality.
- No mention was made in regards to specific nursing unit design

Griffiths, P., Edwards, M., Forbes, A., & Harris, R. (2004). Post-acute intermediate care in nursing-led units: A systematic review of effectiveness. *International Journal of Nursing Studies*, 42, 107-116.

Focus of Study

- To review evidence regarding how effectively prepared patients are for discharge in nursing-led inpatient units (NLU)

Research Design

- NLU is an institutional setting where nurses, rather than doctors, are responsible for the care management function and team leadership
- Databases (ex. Medline, Cinahl, Cochrane Library) were searched
- Post-acute adult patients eligible for nurse-managed care were considered as participants
- Main outcomes considered include mortality, functional status, early readmission, institutionalization after discharge, and length of stay
- Nine studies were included in the review

Sample Information & Site

- The articles reviewed pertain to the United Kingdom and United States
- The sample included post-acute adult patients eligible for nurse-managed care

Findings

- Length of stay is increased for patients cared for in NLUs
- No differences in mortality rates between patients on NLUs and those in regular inpatient units
- Patients in NLUs had better health status at time of discharge
- Patients discharged from NLUs were more independent regarding functional status

Implications of Findings

- Nursing led units, in general, are viewed favorably, though more evidence is needed for a concrete review
- No mention was made in regards to specific nursing unit design

Hall, L. M., Doran, D. & Pink, G. H. (2004). Nurse staffing models, nursing hours, and patient safety outcomes. *Journal of Nursing Administration*, 34(1), 41-45.

Focus of Study

- To evaluate how different nurse staffing models affect costs and patient outcomes including patient falls, medication errors, wound infections, and urinary tract infections

Research Design

- Descriptive correlational design used
- Questionnaires were distributed to unit managers regarding nurse staffing variables
- Patient outcome data and information regarding costs were acquired from administrative records
- Patient outcome data included patient falls, medication errors, wound infections, and urinary tract infections
- The Nurse Staffing Model included the mix of nursing staff on the patient unit
- To measure nursing resources, case nursing hours were used
- Patient complexity scores were obtained for each patient

Sample Information & Site

- This study took place in 77 adult medical, surgical, and obstetric units in 19 urban teaching hospitals in Ontario, Canada

Findings

- The lower the proportion of professional nursing staff in the staff mix, the more nursing hours were used
- The more complex the patient, the higher the number of nursing hours used
- Medical-surgical patients required more nursing care hours

- Nursing hours were greater for older patients
- The lower the number of professional nursing staff, the higher the number of medication errors and wound infections
- Nursing staff with less experience was associated with a higher number of wound infections

Implications of Findings

- Higher levels of professional nursing staff are associated with improvements in patient safety particularly with medication errors and wound infections

Hendrich, A, Fay, J., & Sorrells, A. K. (2004). Effects of acuity-adaptable rooms on flow of patients and delivery of care. *American Journal of Critical Care*, 13(1), 35-45.

Focus of Study

- To examine whether acuity-adaptable rooms aid in reducing patient transfers and medical errors and increasing satisfaction levels.

Research Design

- Clinical and financial measures were obtained prior to moving patients into acuity-adaptable rooms and after the move occurred.
- 2 years of baseline data was collected prior to the move as well as 3 years of data in months after the implementation

Sample Information & Site

- The study took place at the Methodist campus of Clarian Health, Indianapolis, Ind.

Findings

- Patient transfers were reduced by more than 90% in the new unit
- Medication errors were reduced by 70% after the move
- The unit incorporated decentralized nursing stations outside each patient's room; this increased the time available for patient care and reduced the time and distance traveled by nurses
- Patients level of dissatisfaction decreased in the new unit
- Some nurses felt isolated with the decentralized nursing stations and not having another critical care nurse visible

Implications of Findings

- Overall, acuity-adaptable rooms appear to increase the amount of time nurses are able to spend with patients. Patient care improved and satisfaction among patients increased.

Kibbler, C. C., Quick, A., & O'Neill, A. M. (1998). The effect of increased bed numbers on MRSA transmission in acute medical wards. *Journal of Hospital Infection*, *39*, 213-219.

Focus of Study

- To examine the effect of adding a fifth bed in four-bedded bays has on the transmission of methicillin-resistant *Staphylococcus aureus* (MRSA)

Research Design

- Two acute medical wards were converted from a 28 bed format (six four-bedded bays and four private rooms) to 32 bed wards (a fifth bed was added to each medium and low dependency bay)
- A third ward (Dermatology & Rheumatology) added the fifth beds midway through the study
- Each ward had an increase in the number of nurses: One ward increased by 3 nurses, another by 5 nurses and the third ward by 3 nurses
- Patients were identified from specific samples taken (ex. skin lesions and blood cultures)
- Observational studies were carried out on the dermatology ward and a 28-bed ward (liver medicine)
- The study took place over an 18 month period

Sample Information & Site

- This study took place on four acute medical wards in a London hospital
- Patients on these wards participated in the study

Findings

- More than twice as many cases were identified in the five-bed medium dependency bays than on the four-bed bays
- When four-bedded bays were increased to five-bedded bays, infection rates increased
- Adding an extra patient multiplies the existing risk by a similar factor in both low-dependency and medium-dependency bays

Implications of Findings

- While adding an extra bed may be more cost effective in meeting patient demands, the risk of infection of MRSA increases
- Having more patients on a ward increases infection rates and thus can prolong a patient's stay

Kumari, D. N., Haji, T. C., Keer, V., Hawkey, P. M., Duncanson, V., & Flower, E. (1998). Ventilation grilles as a potential source of methicillin-resistant *Staphylococcus aureus* causing an outbreak in an orthopaedic ward at a district general hospital. *The Journal of Hospital Infection*, *39*(2), 127-133.

Focus of Study

- To describe the outbreak of MRSA related to ventilation in an orthopedic ward.

Research Design

- The events following the outbreak of MRSA were followed.
- Screening swabs from patients and ward staff were taken.
- Samples from the corridor floor, treatment room, nursing station, air outlets, and ventilation systems were collected.

Sample Information & Site

- This study took place on an orthopedic ward at Grimsby District General Hospital on the east coast of England.
- Patients and staff on the ward were included.

Findings

- Spread of MRSA between patients was thought to be through direct contact from the hands of healthcare workers.
- Staff caring for patients with MRSA infected wounds are more likely to acquire the infection.
- Contaminated dust in the ventilation system was the source of MRSA in patients acquiring the infection during their stay.
- Thorough cleaning of the ventilation system and the entire ward terminated the outbreak.

Implications of Findings

- Regular cleaning of the ventilation systems can help prevent the spread of infection.
- No mention was made in regards to specific nursing unit design

Morrison, A. L., Beckmann, U., Durie, M., Carless, R., Gillies, D. M. (2001). The effects of nursing staff inexperience (NSI) on the occurrence of adverse patient experiences in ICUs. *Australian Critical Care*, *14*(3), 116-121.

Focus of Study

- To identify incidents of nursing staff inexperience and determine their effect on patient care

Research Design

- Data was obtained by searching the AIMS-ICU database, which consists of anonymous voluntary incident report-

ing in intensive care units; narrative keywords and contributing factors relating to staff inexperience were used in the search

Sample Information & Site

- This study took place in an intensive care unit in an intensive care unit.
- A total of 735 reports which covered 1,472 incidents were identified as relating to nursing staff inexperience

Findings

- Major categories for the 1,472 incidents included airway and ventilation, drugs and therapeutics, procedures, lines and equipment, patient environment, and unit management
- 94% of the incidents involved individual patients
- Four major concerns regarding staffing included the use of relief staff, novice ICU nurses, staff shortage, and a lack of experienced staff
- Availability of experienced staff to assist the inexperienced staff members limited the effects of errors
- Incidents associated with nursing staff inexperience were associated with 10% of all incidents reported in the database and 18% of reports in which a nurse precipitated the incident
- In 80% of incidents, the event did not cause a significant adverse outcome for the patient
- Staff shortage, high unit acuity, and inadequate supervision and training of inexperienced staff contribute to incidents

Implications of Findings

- Inexperience in intensive care units can lead to negative outcomes in patients, and thus adequate support, supervision, and education is needed for inexperienced nurses

Needham, D. M., Anderson, G., Pink, G. H., McKillop, I., Tomlinson, G. A., & Detsky, A. S. (2003). A province-wide study of the association between hospital resource allocation and length of stay. *Health Services Management Research, 16*, 155-166.

Focus of Study

- To examine the relationship between allocation of resources and clinical efficiency in Ontario, Canada

Research Design

- Hospital efficiency was measured using length of stay; information was obtained from the Canadian Institute for Health Information national abstract database
- Control variables included hospital size, number of beds, teaching activity, geographic region, occupancy rates, hospital-specific management styles, and physician practice patterns

- Hospital spending was the sum of four expense categories including inpatient nursing, ambulatory care, administration and support, and diagnostics and therapeutic services

Sample Information & Site

- This study took place at 162 acute care hospitals in Ontario

Findings

- Relatively too little or too much spending in any one budget area is associated with longer lengths of stay
- Key to hospital management is allocation of resources between nursing, ambulatory care, administration and support, and diagnostic and therapeutic services
- Hospitals with higher levels of teaching activity had lower length of stay

Implications of Findings

- Spending needs to be allocated among the various departments; too much spending in one department can affect the quality of care provided by another department, thus increasing the patient's length of stay

Nicklin, W., & McVeety, J. E. (2002). Canadian nurses' perceptions of patient safety in hospitals. *Canadian Journal of Nursing Leadership, 15*(3), 11-21.

Focus of Study

- To determine nurses' perception regarding patient safety in a hospital environment

Research Design

- Focus groups were organized by nursing executives in 22 teaching hospitals
- Nurses were invited to participate in the focus groups; a total of 33 focus groups were held
- A structured question format was used to determine patient safety

Sample Information & Site

- The study took place at 22 teaching hospitals in Canada; 3 hospitals were in the eastern region, 13 were in the central region, and 6 were located in the western region
- 503 nurses participated

Findings

- Nurses felt the environment poses risks for the patients
- Workload contributes to increased risk for patients: ex. staff to patient ratios are inappropriate, increased pace of work, patient turnover is too fast
- Human resources, nursing shortage, restructuring, and patient acuity contributes to increased risk: ex. inability to fill

vacancies, losing experienced nurses, nurses overworked, bed closures result in decreased length of stay, increased patient acuity

- Systems issues are problematic: ex. too many drug suppliers, lack of response to ongoing risks
- Problems with the physical environment can lead to increased risk of patient safety; ex. facilities are deteriorating, inadequate storage, overcrowding resulting in excess noise and lack of privacy
- Uncertainty and insecurity among nurses reduces morale
- Suggested improvements include increasing the staff to patient ratio, retaining experienced staff, stopping double shifts and overtime, educate staff regarding new technology

Implications of Findings

- Factors such as workload, patient acuity, reduction in experienced staff, and overcrowding all result in increased risks to the safety of patients
- Nurses suggest changes should be made to improve the environment including retaining experienced nurses and increasing the number of staff per patient

Preston, G. A., Larson, E. L., & Stamm, W. E. (1981). The effect of private isolation rooms on patient care practices, colonization and infection in an intensive care unit. *The American Journal of Medicine*, 70, 641-645.

Focus of Study

- To determine if private patient rooms rather than open bay wards help prevent the spread of infection in the Intensive Care Unit

Research Design

- The old intensive care unit consisted of a six-bed open unit with only two sinks and without individual patient cubicles
- The new unit has 14 private isolation rooms with an individual hand washing sink in each room
- Surveillance cultures were obtained from patients in intensive care
- Demographic information was obtained for each patient as well as diagnosis on admission and selected risk factors for infection
- Patients were monitored during their stay and air sampling took place

Sample Information & Site

- This study took place in a medical-surgical intensive care unit in a 336-bed University Hospital in Seattle, Washington
- 410 patients were monitored on the open ward and 1,022 patients were monitored in the isolation rooms

Findings

- Respiratory tract infections decreased in the isolation rooms, but other infections showed little change
- Reduction of people circulating near the patient occurred in isolation rooms
- Frequency of hand washing did not improve in the isolation units
- At least half of intensive care unit-related infections would not be preventable by design features – 55% of infections were caused by organisms that the patient possessed at time of admission

Implications of Findings

- The redesign of an intensive care unit did not have a drastic effect on a reduction of infection rates
- The greater availability of hand washing sinks did not increase the compliance of medical staff; education regarding the importance of hand washing would benefit the staff and patients

Shepley, M. M. (2002). Predesign and postoccupancy analysis of staff behavior in a neonatal intensive care unit. *Children's Health Care*, 31(3), 237-253.

Focus of Study

- To provide data on the behavioral issues associated with the design of a neonatal intensive care unit.

Research Design

- Multimethod approach, which included behavioral mapping, interviews, questionnaires, and calibrated measures of walking, noise, and temperature was used
- Observations were made of staff members over a 3-hour period and information was recorded in terms of patient census, staff designation, activity location, and time data
- The interviews and questionnaires focused on the efficiency of the floor plan, the impact of natural light, and perceptions of space allocation

Sample Information & Site

- The study was conducted prior to and after renovations were made to a neonatal intensive care unit. The original unit consisted of six small rooms that accommodated one to five babies in each room. The new unit was open and divided into bays of six baby stations each
- The sample included nursing staff that worked on the pre-design and postoccupancy units. Twenty-one staff members were observed, ten staff members filled out questionnaires, and eight staff members were interviewed

Findings

- New design focused on the development of a more efficient floor plan, the provision of space for supportive family-centered care, and the use of natural light
- On the new unit, nurses were found to spend most of their time in active baby care followed by walking, conversations, passive baby care, and charting
- More time was spent taking care of the babies on the new unit than on the old unit.
- Those responding to the questionnaires perceived the new unit as comforting and clean but less secure than the old unit
- Family-centered care was perceived as supportive of babies and their families, though its ratings were lower for the supportiveness of nurses and physicians
- The unit was rated as generally being efficient and the new lighting was thought to have a positive impact on the patients
- Those who were interviewed felt that families were utilizing the majority of space designated to them; felt the design was efficient, lighting was improved, and noise levels were lower

Implications of Findings

- For the most part, the new unit was rated positively. Nurses were able to move at a greater velocity in the new unit as well as spend more time with the infants

Stelfox, H. T., Bates, D. W., & Redelmeir, D. A. (2003). Safety of patients isolated for infection control. *Journal of the American Medical Association*, 290(14), 1899-1905.

Focus of Study

- To examine the safety and quality of care provided to patients isolated for infection control

Research Design

- Patients isolated for at least 2 days because of methicillin-resistant *Staphylococcus aureus* in one facility and patients with congestive heart failure, a previously recorded isolate of MRSA, and admission order for isolation at another facility were used; control patients at both facilities were also included
- Patient charts were reviewed for demographic, clinical, and hospital data
- Process of care measures included documentation of vital signs
- Adverse events were reviewed
- Patient satisfaction levels were measured using medical records and files from public relations offices at both hospitals

Sample Information & Site

- The study took place at Sunnybrook and Women's College Health Sciences Center in Toronto, Ontario and Brigham and Women's Hospital in Boston, Massachusetts
- 78 isolated patients and 156 control patients were included as part of the general cohort
- 72 isolated patients and 144 control patients were included in the congestive heart failure cohort

Findings

- Isolated patients were more likely to have vital signs incompletely recorded or not recorded at all; isolated patients were almost twice as likely to have vital signs not recorded as ordered
- Isolated patients with congestive heart failure were less likely to have angiograms, stress tests, or their weight recorded; once discharged, these patients were less likely to have documentation regarding congestive heart failure education and timely follow-up appointments
- Isolated patients had longer stays and higher rates of adverse events than control patients
- Isolated patients were 8 times more likely to experience falls, pressure ulcers, and fluid or electrolyte disorders
- Isolated patients were less satisfied with their treatment and stay than control patients

Implications of Findings

- Patients in isolated care experienced more adverse events and were less satisfied with their treatment than patients who were not in isolation
- Greater care needs to be taken to ensure interventions are in place to ensure the safety of all patients in hospital

Thorgaard, P., Ertmann, E., Hansen, V., Noerregaard, A., Hansen, V., Spanggaard, L. (2005). Designed sound and music environment in postanaesthesia care units-a multicentre study of patients and staff. *Intensive and Critical Care Nursing*, 21, 220-225.

Focus of Study

- To determine the effect of music on patients recovering after anesthesia
- To examine staff and patient opinions regarding the music environment

Research Design

- Patients and staff completed questionnaires regarding their opinions of the music
- Patients who participated were all recovering from operations which included general anesthesia or regional analgesia

- The music, which was specially designed, was played through ceiling-suspended loud speakers

Sample Information & Site

- This study took place in five wards at three university hospitals in Denmark.
- 325 patients and 91 patients participated in this study.

Findings

- 83% of patients found the sound environment pleasant, while 6% found it unpleasant
- 70% of staff members found the sound environment pleasant, while 15% found it unpleasant
- 69% of staff members felt the music environment diminished stress, while 16% felt it increased stress
- 65% of staff felt the patient had a positive experience with the sound environment
- Staff satisfaction varied based on geographical location

Implications of Findings

- Both patients and staff were satisfied with the implementation of a sound environment

Trites, D. K., & Schwartau, N. W. (1967). Nursing or clerking. *Nursing Outlook*, 55-56.

Focus of Study

- To obtain information regarding medication handling systems in hospitals

Research Design

- The 1965 Guide Issue of *Hospitals*, J.A.H.A. was used to select a random sample of hospitals. The sample hospitals represented 5% of the hospitals in each of the 50 states and District of Columbia.
- Questionnaires were administered to staff. Questions pertained to factual information about the hospital and the frequency with which things were done in the hospital

Sample Information & Site

- 5% of the hospitals in each of the 50 states and District of Columbia were used
- 274 staff members participated in the study.

Findings

- Nurses transcribed physician's order approximately 90% of the time for the pharmacist
- Nurses most frequently carried medication orders to the pharmacy
- Nurses reordered refills of prescribed medication

- Nurses had to detect whether physicians had written orders
- Would be easier and more efficient if all medication orders were written in one place

Implications of Findings

- Nurses spend a great deal of time on clerical activities. A better organization and communication system could be in place to relieve a nurse of her clerical duties.
- No mention was made in regards to specific nursing unit design

Tyson, G. A., Lambert, W. G., & Beattie, L. (1995). The quality of psychiatric nurses' interactions with patients: An observational study. *International Journal of Nursing Studies*, 32(1), 49-58.

Focus of Study

- To determine the quality of patient-nurse interactions in a psychiatric ward.

Research Design

- Observations were conducted for 7 hours/day, during which interactions were most likely to occur
- Observers were trained and made observations in 5 minute intervals. Observations started with the first nurse encountered and continued until each member of the nursing staff was observed.

Sample Information & Site

- The study took place in a rural psychiatric hospital in New South Wales, Australia. The hospital consists of 253 beds.
- 129 nurses (46 male, 83 female) were observed.

Findings

- On average, nurses' time was divided evenly between interacting with patients and staff, engaging in solitary tasks as well as other activities.
- Trend for more junior staff members to spend more time with patients while Nursing Unit Managers spent the least amount of time interacting with patients.
- Almost all interactions with patients were rated positively

Implications of Findings

- Though most interactions with patients were rated positively, very little time was spent interacting with patients. Staff-patient interaction may be increased through a reduction in clerical work.
- No mention was made in regards to specific nursing unit design

Ulrich, R. (1984, April). View through a window may influence recovery from surgery. *Science*, 224(4647), 420-421.

Focus of Study

- To investigate whether having a room with a window view of a natural setting impacts the recovery of patients.

Research Design

- Records were obtained for patients assigned to the second and third floors of a three-story hospital.
- Data included the length of stay of patients, the complications suffered, the amount of analgesics and tranquilizers, barbiturates, and anti-anxiety drugs taken as well as the notes made by nurses
- The rooms patients stayed in either had a view of a brown brick wall or a small stand of trees; rooms were all double occupancy and were nearly identical in all facets besides their view

Sample Information & Site

- Records for patients staying in a suburban Pennsylvania hospital during 1972 and 1981 were obtained.
- The sample included forty-six patients who had undergone cholecystectomy

Findings

- Patients with a view of trees had a shorter length of stay in the hospital and took a smaller amount of analgesics between their second and fifth days of treatment; those with a view of trees also received more positive comments from the nurses

Implications of Findings

- The nature of the view patients have from their windows appears to have some effects on their recovery. Vietri, N. J.,

Dooley, D. P., Davis, C. E. Jr., Longfield, J. N., Meier, P. A., & Whelen, A. C. (2004). The effect of moving to a new hospital facility on the prevalence of methicillin-resistant *Staphylococcus aureus*. *American Journal of Infection Control*, 32, 262-267.

Focus of Study

- To compare Methicillin-resistant *Staphylococcus aureus* (MRSA) rates in two hospital units

Research Design

- The old Brooke Army Medical Center housed patients in 2 buildings; the Main Hospital was a 418-bed facility housing surgical wards and surgical intensive care units designed in 1937; the Beach Pavilion was an old barracks that housed

most of the medical wards and medical intensive care units; wards were open and contained 12 to 35 beds; few sinks for hand washing

- The new facility opened in 1996 and consists of a 450-bed state-of-the art medical facility; ward beds are segregated into 1- to 4-bed rooms with a sink in each room entrance; intensive care unit beds are individually partitioned and have at least 2 dedicated sinks
- Nasal cultures of all patients were obtained 2 times before the move and 2 times after the move to the new facility
- Patients were screened for MRSA colonization 30 days and 1 year after the move
- Room design was noted at time of culture
- Records of MRSA isolates were reviewed retrospectively for a period of 4 years
- Hand washing compliance was observed in the old and new units

Sample Information & Site

- The study took place at the old and new Brooke Army Medical Center; a military tertiary hospital in Fort Sam Houston, in San Antonio, Texas; both surgical and medical wards were used
- The sample included all patients on 8 selected wards; 119 patients before the move and 130 patients after the move underwent nasal swabs

Findings

- No differences in overall rates of MRSA isolation for 2 years before the move compared to 2 years after the move
- Hand hygiene compliance did not differ in the old and new facilities, despite the presence of more sinks in the new facility
- Radical changes in facility design did not, in and of itself, reduce the rate of MRSA transmission

Implications of Findings

- Improved ward design and increased facilities for hand washing did not reduce rates of MRSA transmission

Whitman, G. R., Kim, Y., Davidson, L. J., Wolf, G. A., & Wang, S. (2002). The impact of staffing on patient outcomes across specialty units. *Journal of Nursing Administration*, 32(12), 633-639.

Focus of Study

- To determine the relationship between nurse staffing and nurse-sensitive outcomes

Research Design

- A secondary analysis was conducted of prospective observational data

- Staffing hours included total worked hours for all personnel; Work hours per patient days were calculated by dividing total worked hours by the monthly patient days for each unit
- Nursing sensitive outcomes included rate for central line blood-associated infection, pressure ulcer, medication error, fall, and restraint application duration

Sample Information & Site

- The study took place in 95 patient care units across 10 adult acute care hospitals (rural, community, and tertiary) in the eastern United States

Findings

- Impact of staffing on outcomes varies across units; lower staffing results in higher rates out all outcomes
- Staffing plays a role in preventing falls, especially in moderately acute patients
- Environments with higher acuity patients are sensitive to changes in staffing
- Negative outcomes were not associated with staffing levels

Implications of Findings

- Staffing is inversely related to falls, medication errors, and restraint application duration
- No mention was made in regards to nursing unit design

Yang, K. (2003). Relationships between nurse staffing and patient outcomes. *Journal of Nursing Research*, 11(3), 149-157.

Focus of Study

- To assess the relationship between hospital nurse staffing and patient outcomes

Research Design

- Descriptive correlational design was used
- Data was obtained from hospital statistics and head nurses or supervisors
- Nurse staffing variables included daily average hours of care, ratio of registered nurses to average patient census, workload index, and skill mix; data drawn from monthly statistical reports on staffing needs
- Patient outcome variables included patient falls, pressure ulcers, respiratory tract infections, and patient/family complaints; data was provided by the nursing quality improvement committee and hospital infection control department
- Patient acuity levels were obtained from hospital information system

Sample Information & Site

- This study took place in a tertiary care medical center in Taiwan; the facility holds 1394 beds; cluster sample of all 21 medical-surgical units was used
- 347 full-time registered nurses and 29,424 patients participated in this study

Findings

- Average hours of care were positively associated with urinary tract infections and falls
- Ratio of registered nurses to patients was negatively correlated to patient falls, urinary tract infection, and complaints
- Greater workload levels were positively correlated with higher numbers of respiratory tract infections, complaints, and patient acuity
- Most powerful predictors of adverse patient events were workload, hours of care, and skill mix
- Best predictors of nosocomial infection were average hours of care, workload, and ratio of registered nurses

Implications of Findings

- Workload, skill mix, and average hours of care predict adverse patient events
- The greater the number of registered nurses, the less likely adverse events were to occur
- Nurse staffing and workload are related to the quality of care provided. Efforts should be made to reduce the workload and increase staffing to increase the quality of care provided to patients and reduce the occurrence of adverse events

Non Empirical Articles: Patient Safety

Barach, P., & Dickerman, K. N. (2006, February). *Hospital design promoting patient safety. Paper presented at the American Society for Healthcare Engineering International Conference, San Diego, CA.*

Focus of Article

- To describe the process of facility design as well as review the current state of patient safety.
- Type of Healthcare Facility The material presented in this paper applies to acute care facilities.

Recommendations for Healthcare Setting

- There is a direct link between hospital design, quality of care received and patient health.
- Negative effects of stress are psychological, physiological, and behavioral

- Causes of nosocomial infections include poor air quality and ventilation and placing two or more patients in the same room
- Inadequate lighting is associated with staff medication errors
- Work conditions leading to errors include fatigue from 24-hour duty rotations, double shifts, high workloads, noisy environments, confusing labels, poor handwriting, and poorly designed equipment
- Human factors, technology and facilities, and the impact of equipment are typically not explored early in the design process
- Important to use the concept of a system, components which are related to one another, when discussing facility design and safety
- Components of the healthcare system include medical and clinical processes, technology, organization, providers, and the built environment
- Healthcare is highly complex and tightly interrelated
- Challenge is to incorporate safety-driven design principles in traditional design process
- Design process for patient safety should include reduced risk of injury to patients and staff, removal of minimization of hazards, and education for the design team regarding the complexity of designing health care setting

Implications of Findings

- Healthcare is complex and thus, the design of a facility should address all the complexities to promote patient safety

Barach, P., & Small, S. (2000). How the NHS can improve safety and learning. *British Medical Journal*, 320, 1683-1684.

Focus of Article

- To describe the culture of safety in NHS hospitals.

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities in the United Kingdom.

Recommendations for Healthcare Setting

As many as 850,000 adverse events may occur in an NHS facility, of which half are preventable

- Necessary to look at events as part of a system along with individual accountability
- NHS described as passive learning organization
- Effort for change is slow and costly
- Recommendations of report, *An Organisation with a Memory*, suggest national mandatory reporting scheme for adverse events and near misses

- Barriers include confidentiality and accountability, protection for reporters, and feedback to reporters

Implications of Findings

- NHS hospitals are making positive changes, but at a slow and costly pace.

Bilchik, G. S. (2002, July-August). A better place to heal. *Health Forum Journal*, 45(4), 10-15.

Focus of Article

- To describe various facilities incorporating the pebble project, which uses empirical evidence to evaluate impacts of healthcare design.

Type of Healthcare Facility

- The facilities featured in this article are Children's Hospital in San Diego, Methodist Hospital/Clarian Health Partners in Indianapolis, Bronson Methodist Hospital in Michigan, and the Barbara Ann Karmanos Cancer Institute in Michigan.

Recommendations for Healthcare Setting

- Children's Hospital in San Diego is opening a convalescent care hospital, which is designed to promote long-term care for permanently disabled children. The design includes wheelchair storage in patients' rooms that is out-of-sight, as well as private spaces outside the patient rooms for parents to hold their children. The air ventilation system will be improved and it is expected that fewer respiratory infections will occur.
- The Methodist Hospital in Indianapolis opened a 56-bed cardiovascular critical care unit. Patients are admitted directly to their rooms from the emergency room, admitting, physicians' offices or the Lifeline helicopter. Patient rooms are private and patients are in control of the temperature and light. Each room also has an interior window that can become opaque to increase privacy. Nurses can observe patients better and the number of falls has decreased by half and transfers have decreased substantially from 200 per month to an average of 20 per month.
- Bronson Methodist Hospital in Michigan opened a new facility with private patient rooms. Patients have access to nature through indoor gardens, natural light, and landscape views. Stress is reduced through the use of positive distractions such as music, water sounds, artwork, and daylight.
- The Barbara Ann Karmanos Cancer Institute renovated several hospital areas to be patient-centered and to provide a more pleasant environment. Medical rooms were made larger and an emphasis was placed on lighting and acoustics. A decrease has occurred in the use of pain medication on these units as well as a decrease in medication errors.

Implications of Findings

- The majority of these facilities incorporated private rooms into their designs and patients have had successful outcomes in these new and renovated facilities.

Brady, M.T. (2005). Health care-associated infections in the neonatal intensive care unit. *American Journal of Infection Control*, 33(5), 268-275.

Focus of Article

- To describe measures to reduce infections in neonatal intensive care units

Type of Healthcare Facility

- The material presented in this article applies to neonatal intensive care units.

Recommendations for Healthcare Setting

- Best indicators for risk of nosocomial infection are birth weight, exposure to invasive devices, and acuity of underlying illness
- Blood stream infections are most important infections in neonatal intensive care units; have potential for life threatening consequences
- Main cause of nosocomial bacteremia in neonatal intensive care unit is indwelling vascular catheters
- Late onset pneumonia and tracheitis are commonly caused by endotracheal intubation; infection could be reduced by minimizing intubation days and proper maintenance of ventilator-endotracheal tube circuit
- Hand hygiene is most important factor in infection control activity in neonatal intensive care unit; should be 1 sink for every 2 patients
- Attention should be placed on minimizing use of invasive devices; proper care should be taken if devices in place
- Optimal for infant space to be 150 square feet
- Positive pressure ventilation should be in place; isolation rooms with negative pressure should be available
- Employees should be immune to rubella, measles, polio, hepatitis B, and influenza
- Gloves, gowns, masks, and goggles should be available and used when necessary
- Parents and immediate family members should be encouraged to visit; should perform hand hygiene
- Nursery and its equipment should be cleaned
- Narrowest spectrum antibiotics should be used to treat condition

Implications of Findings

- Patients in neonatal intensive care units are at risk of developing infection; measures such as isolation rooms, hand washing facilities, and minimal use of invasive devices should be used to aid in prevention

Burke, J. P. (2003). Infection control: A problem for patient safety. *New England Journal of Medicine*, 348(7), 651-656.

Focus of Article

- To describe the impact of infection control on patient safety.

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities in the United States.

Recommendations for Healthcare Setting

- Urinary tract infections, surgical-site infections, bloodstream infections, and pneumonia account for 80 percent of all nosocomial infections
- Nearly 70 percent of infections are due to microorganisms resistant to antibiotics
- Health care workers with contaminated hands are major source of cross-infection; compliance with hand washing protocol low due to understaffing and poor design, impractical guidelines, and insufficient enforcement by infection-control personnel
- Patients who receive incorrect timing of prophylaxis treatment are at greater risk of acquiring surgical-site infection
- Detection, investigation, and control of outbreaks are critical in patient safety
- Reductions in respiratory tract, urinary tract, and bloodstream sites infections in intensive care units of selected hospitals have occurred after adjusting the duration of use of invasive devices; reduction cannot be attributed to any specific intervention

Implications of Findings

- To prevent the outbreak of infections, detection, investigation, and control are necessary
- Compliance with hand washing is critical to reducing the number of infections

Cabrera, I. N., & Lee, M. H. M. (2000). Reducing noise pollution in the hospital setting by establishing a department of sound: A survey of recent research on the effects of noise and music in health care. *Preventive Medicine, 30*, 339-345.

Focus of Article

- To propose a solution to reduce patients' stress and anxiety in a hospital setting by using music therapy

Type of Healthcare Facility

- The suggestions in the article apply acute care facilities in the United States

Recommendations for Healthcare Setting

- Noise pollution causes increased amounts of anxiety, pain perception, loss of sleep, and prolonged convalescence in the population
- Problem in hospitals is that the noise levels are significantly higher than the recommended levels, and this has been correlated with increased length of stay for patients as well as burnout symptoms among critical care nurses
- Recommend excess noise be replaced with carefully monitored music
- "Sound Control Center" should be established throughout the hospital; it would be responsible for reducing noise levels as well as providing a center for music therapy
- Music has been proven to successfully reduce anxiety prior to and during surgery and is a practical source for alleviating pain

Implications of Findings

- Excess noises in a hospital can be reduced with the installation of a "Sound Control Center"
- Patients may experience reduced anxiety and improvement in their health with music therapy
- No mention was made in regards to specific nursing unit design

Carayon, P., Alvarado, C. J., & Hundt., A. S. (2003). Reducing workload and increasing patient safety through work and workspace design. Madison WI: Center for Quality and Productivity Improvement.

Focus of Article

- To describe how workspace design can increase patient safety and reduce staff workload.

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities.

Recommendations for Healthcare Setting

- Nursing shortages and inadequate staffing are possible factors which contribute to poor patient care, high job stress, and low job satisfaction
- Work redesign is intended to improve work processes including dealing with recruitment and turnover; targeting sources of patient safety problems, and improving work efficiency and effectiveness
- Ergonomics is important for creating the proper work environment to perform the job safely, effectively, and efficiently
- Ergonomic design principles include minimizing perception, decision, and manipulation time as well as optimizing opportunity for movement and minimizing the need for human strength
- Designing the workspace includes examining what nurses need in terms of space, specifications by the design team, identifying options, evaluating solutions, and implementing the selected design
- Noise is major source of stress and potentially of error
- Successful work design includes employee participation, information and communication, continuous improvement, training and learning, feedback, and project management
- St. Joseph's hospital in West Bend, WI incorporated standardization of facility and room design which decreases the cognitive load on nurses, reducing the potential for error; close proximity exists between patients and nurses enabling visibility of patients to staff; automation was used where possible, decision making information was brought close to the patient
- To minimize noise, the source of the noise must be managed, including overhead paging, plumbing, and equipment alarms; sound absorbing materials are also useful
- Minimizing fatigue is critical to reducing error
- In magnet hospitals, nurses' work systems include three features: autonomy over practice, nursing control over the practice environment, and effective communication between nurses, physicians, and administrators

Implications of Findings

- Work redesign can improve patient safety and increase efficiencies through the removal of performance obstacles

Connolly, C. (2005, June 3). Toyota assembly line inspires improvements at hospital. *Washington Post*, p. A01.

Focus of Article

- To describe changes made to a hospital that were inspired by the assembly line at Toyota Motor Corp.

Type of Healthcare Facility

- The material presented in this article applies to Virginia Mason Medical Center in Seattle, Washington.

Recommendations for Healthcare Setting

- The cancer center at this facility was spread out which made it difficult for a patient receiving treatment
- Changes were made in which the patient requires less travel; the distance between the exam room and lab is less than 12 feet
- Theme of cancer center is high quality, super efficiency, and putting the patient first – based on Toyota Motor Corp concepts
- Principles revolve around eliminating waste – from paperwork to waiting delays
- Hospital has saved \$6 million in capital investment, freed 13,000 square feet of space, cut inventory costs, reduced staff travel time, slashed infection rates and improved patient satisfaction
- Preparation time for chemotherapy has been reduced which enables treatment of 50 additional patients per week
- Errors are being reduced by standardizing procedures and engaging patients and families

Implications of Findings

- By adopting the principles of a high quality, super efficient environment which puts the needs of the patient first, Virginia
- Mason Medical Center has decreased costs and improved patient satisfaction

Dawson, D. (2005). The problem of noise and the solution of sound? *Intensive and Critical Care Nursing*, 21, 197-198.

Focus of Article

- To describe the problem with noise in acute care facilities.

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities.

Recommendations for Healthcare Setting

- A European directive expects the employer to reduce the risk of noise exposure to the lowest practical level; to keep records for noise measurements; and when purchasing new equipment to buy quieter equipment to minimize the noise exposure of employees
- Excessive noise is detrimental to staff health and patient recovery

- Music therapy may promote relaxation and comfort in critically ill patients

Implications of Findings

- Excess noise levels can be harmful to both staff and patients and the use of music therapy may improve patient recovery
- Measures need to be taken to reduce exposure to excess noise levels

Devlin, A. S., & Arneill, A. B. (2003). Health care environments and patient outcomes: A review of literature. *Environment and Behavior*, 35(5), 665-694.

Focus of Article

- To review literature on patient involvement in health care, the impact of the ambient environment, and designs of buildings for specific populations

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities.

Recommendations for Healthcare Setting

- Planetree model emphasizes homelike environment; goals are to train patients to be active in their care and increasing nurses' satisfaction
- Having sense of control may reduce stress for patients
- Patients become annoyed with noise during their stay; noise can negatively affect rest and sleep
- Noises which are annoying to staff members include telephones, alarms on equipment, and beeping of monitors
- Music may have beneficial effects
- Windows are a source of natural light; views have a positive impact on patients
- Bright, indirect lighting is recommended for hospital environments
- Color can enhance mood, improve way finding, and reduce patient disorientation

Implications of Findings

- Tools do exist to conduct research which will lead to evidence-based design
- Key elements of design are controlling noise, lighting, and color

Gross, R. , Sasson, Y. Zarhy, M. & Zohar, J. (1998). Healing environment in psychiatric hospital design. *General Hospital Psychiatry, 20, 108-114.*

Focus of Article

- To discuss the positive effects of the healing environment on patients and staff.

Type of Healthcare Facility

- The information in this article pertains to the Psychiatric ward at Chaim Sheba Medical Center in Tel-Hashomer, Israel.
- This hospital contains three acute inpatient wards, a day care, and a large outpatient clinic.

Recommendations for Healthcare Setting

- Altered physical design variables consistent with treatment philosophy are associated with positive perceptions from both staff and patients
- The environment offers patients a safe, comfortable, non-threatening surrounding
- Patients are not overcrowded and are given the opportunity to retreat
- Patients and staff react positively towards the classical daylight and fresh air
- Openness of design encourages staff to spend more time in the day room
- Patient living areas can easily be observed by staff
- Staff working areas are segregated and have separate entrances, but are easily accessible to patients and visitors

Implications of Findings

- Psychoenvironmental approach, including space, daylight, and fresh air, can provide effective design tool that benefits both patients and staff.

Hendrich, A. (2006, February). *Hospital work environments: Implications for nursing practice and patient care quality.* Paper presented at the Healthcare Environments Research Summit 2006, Atlanta, GA.

Focus of Article

- To describe how the hospital environment impacts nurses' ability to care for patients.

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities.

Recommendations for Healthcare Setting

- Poorly designed work spaces have been slow to improve
- Nursing shortage combined with a retiring workforce will threaten the sustainability of hospitals in America within the next 10 years
- Works sampling studies provide a basis for redesigning the workplace for registered nurses which will promote increased hours devoted to direct patient care
- Increasing aging population helps create the nursing shortage and compounds the challenges due to health care needs
- Hospitals with lower staffing levels tend to have higher rates of poor patient outcomes
- Lower patient-nurse ratios are associated with lower rates of adverse events
- Magnet hospitals have low turnover rates, flexible scheduling, strong nurse leadership, adequate staffing levels, and good relationships with physicians
- Stable, adequate staff maximizes the opportunity for direct patient care and increases work satisfaction
- Factors affecting nursing recruitment include issues related to foreign born nurses and a large number of new, older nurses entering the workforce
- Time spent in nursing activities is affected by unit design, location and availability of equipment, and the effectiveness of systems designed to support and integrate patient care

Implications of Findings

- The root cause of the hospital nursing turnover must be addressed to reduce the nursing shortage and improve patient care

Hendrich, A., Fay, J., & Sorrells, A. (2002, September). *Acuity-adaptable patient rooms and decentralized nursing stations-A winning combination.* *Healthcare Design, 11-13.*

Focus of Article

- To describe the design of the Critical Care Unit at Methodist Hospital

Type of Healthcare Facility

- The material presented applies to the Comprehensive Cardiac Critical Care Unit in Methodist Hospital of Clarian Health Partners in Indianapolis

Recommendations for Healthcare Setting

- Based on data from a time-and-motion study on a nursing unit, it was discovered that patients in the hospital were moved between three and six times due to changes in their acuity levels

- Multiple caregivers were used for one patient and, as a result, tasks were duplicated and error rates increased
- Nurses were also traveling long distances each shift to find supplies
- A highly flexible environment was created with private rooms that supported the changing levels of acuity in patients
- Rooms are 400 square feet and are divided into three areas: a family zone, a patient zone, and a caregiver zone
- Nursing stations are decentralized and computers are located outside each patient room
- Additional nurse workspace area located outside patient rooms
- Nursing staff have education center equipped with computers for access to information and training
- Equipment and supplies are easily accessible for staff members and patients can control lighting, temperature, and privacy as their condition improves
- Initial baseline data indicates that unit-to-unit transfers have decreased by 90 percent. Overall patient days per bed have increased since the patient is not required to move
- Patient falls and medication errors have also decreased and patient safety has improved with the decentralized nursing stations

Implications of Findings

- The acuity adaptable rooms have helped improve clinical outcomes, cost and operational efficiency, and staff and patient satisfaction

Hosking, S. & Haggard, L. (1999). The human factor. In S. Hosking and L. Haggard, *Healing the hospital environment: Design, management and maintenance of healthcare premises* (pp.159-171). London: Routledge.

Focus of Article

- To describe aspects of hospitals that can improve patient conditions.

Type of Healthcare Facility

- The material presented in this article applies to hospitals in general.

Recommendations for Healthcare Setting

- Noise in the environment can increase patient stress.
- Unpleasant noise, however, is tolerated when the noise is identified and deemed necessary.
- Control of noise is important for the recovery of patients, as tolerance of noise is lower during illness.
- Pleasant smells can contribute positively to the recovery of

patients. This can be achieved through the use of aromatherapy and scented oils, among other items.

- Efforts are made to preserve the patients' dignity. This can be achieved through increased privacy, especially when the patient is in the bathroom, undressing, or in a great deal of pain.
- The sense of touch can also facilitate recovery. Patients have experienced lower stress levels when petting tame animals.

Implications of Findings

- Factors such as a reduction in noise, increased privacy, and pleasant smells can contribute to a positive healing environment.

Institute of Medicine (IOM) (2004). *Keeping patients safe: Transforming the work environment of nurses: Executive summary*. Washington, DC: National Academy Press.

Focus of Article

- To describe how the work environment of nurses affects patients and to offer recommendations regarding improvements in the environment

Type of Healthcare Facility

- The material presented in this summary applies to acute care facilities in the United States.

Recommendations for Healthcare Setting

- As many as 98,000 patients in hospitals die as a result of errors in their care
- Larger nursing staff is associated with better patient outcomes
- Nurses have lost trust in hospital administration; feel emphasis is efficiency rather than patient safety
- Voice of nurses has weakened with reduction of nursing leadership
- Methods, such as stopping admissions on a unit with inadequate staffing levels, are not applied consistently in hospitals or nursing homes
- Newly licensed nurses do not have skills to provide safe, effective care; lack skills in recognizing abnormal physical and diagnostic findings and responding to emergencies; better training is needed
- Long nursing hours are threat to patient safety; fatigue results in slowed reaction time, errors of omission, lack of attention to detail, reduced motivation, an decreased energy; work hours per week should be limited
- Medication administration often handled in manner which increases likelihood of errors
- Leaders and managers should be capable of transforming

physical environment and beliefs and practices of nurses and health care providers

- Patient outcomes affected by nurse staffing levels, nurses' skill level, and extent to which workers collaborated in sharing knowledge and skills; minimum standards should be updated for nurse staffing; nurse staffing practices should identify needed staff levels for each patient care unit per shift; ongoing evaluations of effectiveness of nurse staffing practices needed
- Workspace design needs to be efficient and less conducive to commission of errors; detection and remedy of errors should be facilitated
- Hand washing and medication administration are critical in effective design
- Organization should be committed to vigilance in preventing potential errors; should detect, analyze, and redress errors when occur
- Fair and just manner in responding to errors reduces fear and disincentive to report errors and near misses

Implications of Findings

- Management needs to adopt evidence-based leadership practices, the capability of the workforce should be maximized, workspace design should be effective in reducing errors, and a culture of safety should be created and sustained

Jackson, L., & Gleason, J. (2004). Proactive management breaks the fall cycle. *Nursing Management*, 35(6), 37-38.

Focus of Article

- To describe the fall prevention approach of St. Clare Hospital

Type of Healthcare Facility

- The material presented in this article applies to St. Clare Hospital in Lakewood, Washington.
- St. Clare Hospital has 106 beds and 539 employees

Recommendations for Healthcare Setting

- Fall prevention approach includes: installation of electronic devices on beds measuring and signaling when a patient shift to a rising position, development of staff performance initiative program, continual education and training, ongoing assessment, and evaluation and focused training
- Restraint usage has decreased 99%
- Fewer observers are used

Implications of Findings

- St. Clare Hospital has implemented a successful fall prevention program which has reduced the need for restraints and observers

- No mention was made in regards to nursing unit design

Lowers, J. (1999, August). Improving quality through the built environment. *Quality Letter for Healthcare Leaders*, 11, 2-9.

Focus of Article

- To describe the design of patient-centered hospitals.

Type of Healthcare Facility

- The material presented in this article pertains to hospitals that incorporate the patient-centered approach.

Recommendations for Healthcare Setting

- Based on focus groups conducted by The Picker Institute, it has been suggested that important factors for patients in terms of a hospital stay are a sense of control, safety, and confidentiality.
- The built environment should enable patients to connect with staff members, be conducive to the patients' sense of well-being, be convenient and accessible, include private rooms which give the patient privacy and space for family members, be safe and secure, and should foster connections to the outside world.
- Indirect lighting diffuses light and creates a more natural effect.
- Carpeted hallways help keep noise to a minimum.
- Through temperature controls, patients are able to adjust the temperature as needed.
- Music should be available for patients to help reduce stress.
- The design should engage the patients' senses. This can be accomplished through the use of plants and outdoor gardens, as well as atrium lobbies and artwork.
- Nursing stations should be accessible to patients, and thus, should have low counters and no glass.
- Mini-nursing stations can eliminate the central gathering point.
- Staff should also be provided with lounges to relax and recover from stressful work.

Implications of Findings

- In this design, single-occupancy rooms are preferred as they increase the patients' privacy and confidentiality. Family members also have space to take part in the patients' care.

McCarthy, M. (2004). Healthy design. *The Lancet*, 364, 405-406.

Focus of Article

- To describe the impact of hospital design on staff and patients

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities in the United States.

Recommendations for Healthcare Setting

- Most hospitals are cold, noisy, and frightening for patients
- Crowded, poorly designed nursing stations add to staff stress and increase the risk of medical errors
- Noise, chaotic work environment, and lack of patient contact contribute to high nurse turnovers
- Single rooms should replace multi-patients rooms to increase patient privacy and reduce rate of nosocomial infections
- Decentralized nursing stations improve patient care and staff satisfaction

Implications of Findings

- Through decentralized nursing stations, which provide a less chaotic environment, staff may be able to provide better patient care.

O'Connell, N. H., & Humphreys, H. (2000). Intensive care unit design and environmental factors in the acquisition of infection. *Journal of Hospital Infection*, 45, 255-262.

Focus of Article

- To describe the environmental factors and design of intensive care units in terms of infection control

Type of Healthcare Facility

- The material presented in this article applies to all acute care facilities.

Recommendations for Healthcare Setting

- A patient in the intensive care unit is at greater risk than patients in non-critical care of acquiring an infection
- Most commonly encountered infections in ICU include ventilator-associated pneumonia, bacteraemia, urinary tract infection, and wound infection
- Horizontal transmission of strains occurs due to poor compliance with hand washing, and shortages or nursing staff combined with high density crowding of patients
- Use of isolation rooms and rigorous cleaning and disinfecting of contaminated equipment are recommended to prevent the spread of *Methicillin-resistant Staphylococcus aureus* (MRSA); inanimate surfaces near patients are frequently contaminated with MRSA
- *Serratia marcescens* is associated with blood-stream infection and pneumonia; bacteria can be recovered from mechanical respirators, intravenous catheters, nurses' skin scrub cream, and dust-particles

- Vancomycin-resistant enterococci (VRE) is highly transmissible and difficult to clear; environmental contamination is major factor in spread of VRE; surfaces need to be disinfected
- *Acinetobacter baumannii* is major cause of severe lower respiratory tract infections and bacteraemia in debilitated patients; strains survive for month on surfaces
- *Stenotrophomonas maltophilia* may spread from contaminated equipment or from environmental source
- Fungal infections can be caused by yeast carriage on hands of personnel working in intensive care
- Isolation rooms are recommended to reduce the spread of infection
- Traffic in ICU should be kept to a minimum; adequate space (225 square feet) should be kept between beds in ward-style ICU's
- Two hand basins should be available for every other bed
- Hand washing is most important factor in preventing infection

Provision of negative and positive isolation critical

- Separate rooms for clean and dirty utility is ideal as is adequate storage space
- Floors should be easy to clean, walls and paint should be washable, ceilings should be appropriate, and countertops should be a nonporous solid material
- Cleaning and disinfection is necessary, especially when patients leave the room or are discharged

Implications of Findings

- Hand washing is critical to reducing the spread of infection
- The design of an ICU should include adequate provisions for hand washing as well as materials on the floors, walls, and countertops that can be disinfected easily

Page, A. (Ed.). (2004). Work and workspace design to prevent and mitigate errors. In *Keeping patients safe: Transforming the work environment of nurses* (pp. 226-285). Washington, D.C.: The National Academies Press.

Focus of Article

- To describe how the design of the workspace can prevent and mitigate errors

Type of Healthcare Facility

- The material presented in this review applies to acute care facilities in the United States

Recommendations for Healthcare Setting

- Fatigue results in slowed reaction time, reduced attention to detail, errors of omission, and compromised problem solving

- Nurses working the night shift made more errors due to sleepiness than nurses working other shifts
- Working prolonged hours impairs speed and accuracy, decision making, memory, and hand-eye coordination – error rates increase
- No evidence supports notion that any amount of training, motivation, or professionalism can overcome performance deficits associated with fatigue
- Limiting number of hours nurses spend in providing direct patient care is recommended
- Increasing number of new drugs available factor in medication errors; lack of knowledge about medication a cause of adverse drug events; other causes include interruptions, fatigue, overwork, miscommunication, lack of information regarding patient, and problems with infusion pumps
- Ongoing in-service education, use of reference material, and medication administration assistance devices may help reduce rates of adverse drug events
- Most hospital acquired infections transmitted from patient to patient via hands of healthcare worker; hand washing is most effective method for reducing incidences of nosocomial infections; lack of time one reason for failure to wash hands
- Nurses spend significant amount of time completing inefficient activities and amount of time spent in direct patient care is reduced; too much time is spent documenting patient care activities; exception-based charting helps reduce documentation and focuses on abnormal or significant findings
- Poor design of workspace reduces amount of time nurses have for patient care
- Nursing unit designs include nightingale form, corridor form, duplex, racetrack, courtyard, cluster, radial, and triangle
- Open designs maximize patient visibility but reduce patient privacy; race track designs can maximize number of beds on a unit but increase travel times; triangle design decreases travel time but reduces square footage in patient's room which affects family space
- Majority of nurses' time is spent traveling or in the nursing station
- Transfer of patient between nurses and units is a source of errors and adverse events
- Sensory distractions, such as noise, poor lighting, glare-producing surfaces, and clutter can impede nurses' work
- Design process should aim to eliminate errors; workers should be involved in design process; common work procedures should be simplified; reliance on the memory of workers should be avoided; interruptions and distractions should be decreased; access to information should be improved; alerts should be generated when standards of care are not being followed; attention to work design is ongoing

- Decentralized nursing stations reduce chaos found in central nursing station

Implications of Findings

- Working long hours results in fatigue, which can hamper care provided to patients and increase errors; hospital design should emphasize the reduction of errors
- Poor design results in less time being spent in direct patient care

Reiling, J., Breckbill, C., Murphy, M., McCullough, S., & Chernos, S. (2003, May-June). Facility designing around patient safety and its effect on nursing. *Nursing Economics*, 21(3), 143-147.

Focus of Article

- To examine the changes made at St. Joseph's hospital in West Bend, WI.

Type of Healthcare Facility

- The information in this article pertains to St Joseph's hospital in West Bend, WI.
- The hospital is an independent, nonprofit, 80-bed acute care facility.

Recommendations for Healthcare Setting

- Primary focus of the design was to increase patient safety and enhance an organizational culture of safety.
- Safety-driven principles were developed to minimize the occurrence of serious adverse events such as patient falls and operative/postoperative complications.
- Nursing errors are likely to occur because of distractions, interruptions, multi-tasking, or deviation from routine activity. Stress, fatigue, noise, time pressure, and temperature could also have a negative effect on behavior.
- Design of patient rooms and of the hospital in general will increase efficiency and safety in providing patient care.
- A charting alcove with a window was created to increase patient visibility for nurses, physicians, and staff
- Other improvements include noise reduction, readily accessible patient information, bar coding of drugs resulting in less medication errors, central meeting area, and fewer falls due to improved technology.
- Nurses should be able to spend more time on direct patient care due to changes.

Implications of Findings

- Safety design changes, such as reduction in noise, bar coding of drugs, and readily accessible patient information, were implemented to help create a safe and efficient patient-centered environment.

Rollins, J.A. (2004). Evidence-based hospital design improves health care outcomes for patients, families, and staff. *Pediatric Nursing*, 30(4), 338-339.

Focus of Article

- To describe the effect the healthcare environment has on patient health and safety, care efficiency, and staff effectiveness and morale

Type of Healthcare Facility

- The material presented in this hospital applies to acute care facilities.

Recommendations for Healthcare Setting

- The design of the hospital environment contributes to anxiety, depression, anger, increased blood pressure, elevated stress, and sleeplessness, among other factors, in patients
- Staff members often do their charting and fill medication orders in crowded areas, which can lead to errors and burnout
- Only single patient rooms that can be adjusted towards a patient's needs should be used
- Well-designed ventilation systems and air filters to prevent nosocomial infections should be utilized
- Noise can be reduced through the use of carpeting and sound-absorbing ceiling tiles
- Access to natural light and better lighting in general can reduce stress and improve patient safety
- Hospitals should be easy to navigate through
- The hospital environment should be pleasant and comfortable
- Hospitals should be designed to help staff do their jobs; well-lit spaces that are organized around critical activities can reduce medication errors and stress amongst staff

Implications of Findings

- Design of hospitals should meet the needs of patients and staff. This includes well-designed ventilation system, access to natural light, and wayfinding.
- No mention was made in regards to specific nursing unit design.
- Schweitzer, M., Gilpin, L., & Frampton, S. (2004). Healing spaces: Elements of environmental design that make an impact on health. *The Journal of Alternative and Complementary Medicine*, 10, S71-S83.

Focus of Article

- To examine how design influences interactions, behaviors and actions
- To present models and approaches which have made an impact on design in health care settings

- To review design elements which are healing

Type of Healthcare Facility

- The material presented in this article applies to health care facilities.

Recommendations for Healthcare Setting

- Design that provides opportunities for staff/patient interactions (e.g. decentralized nursing stations) is useful
- Private rooms are preferred for better communication, less transfers, fewer medication errors, decreased infection rates, and inclusion of family
- Noise increases patients' perceptions of pain, increases use of pain medications, may cause patient confusion, contributes to sleep deprivation, increases blood pressure, elevates heart rate, and reduces patient satisfaction; high noise levels also source of stress for staff members – cognition is impeded, people are less interpersonally engaged, and tendency to seek simple solutions
- Natural ventilation can increase energy efficiency and improve indoor conditions
- Daylight positively impacts patients and staff
- Having a view is associated with shorter patient stays, higher satisfaction with nursing care, and decreased use of medication
- Images of nature decrease anxiety; too much stimulation has negative impact
- Important for patients and family members to feel connected with staff

Implications of Findings

- Environmental aspects of design impact both patient and staff satisfaction

Sehulster, L. & Chinn, R.Y.W. (2003, June 6). Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the healthcare infection control practices advisory committee (HICPAC), 52(RR-10), 1-44.

Focus of Article

- To review previous guidelines and make recommendations for preventing environment-associated infections in health-care facilities.

Type of Healthcare Facility

- The material presented applies to hospitals in the United States.

Recommendations for Healthcare Setting

- Heating, ventilation, and air conditioning filters should be properly installed and maintained

- Immunocompromised patients require rooms where positive pressure is maintained.
- Time spent outside their rooms should be minimized and they should have minimal exposure to activities that may cause "aerosolization of fungal spores" (p. 10).
- Respiratory protection should be provided for these patients and ventilation specifications and dust-controlling processes should be used in the protective environment units (units with a positive air flow in relation to the corridor).
- Patients diagnosed with or suspected of having an airborne infectious disease should be placed in isolation rooms that receive numerous air changes per hour and are under negative pressure.
- Patients with smallpox should also be placed in a negative pressure room, preferably one that includes an anteroom.
- Standard cleaning and disinfecting procedures should be used to control environmental contamination with antibiotic-resistant strains of bacterial culture.
- Hand hygiene should be practiced to prevent hand transfer of waterborne pathogens
- Sound-attenuating surfaces need to be used to reduce the amount of noise produced.
- When temperatures are incongruent with the needs of the patients, stress may result.
- Patients should be provided with individual controls in their rooms.
- Poor lighting can cause discomfort and unpleasant odors can be disturbing. Surfaces that reduce glare should be used and appropriate lighting should be used for various tasks.
- To curb odors, surfaces that do not retain odors should be used.
- Privacy serves many functions for patients, including control over personal information, an opportunity for resting, and an opportunity to discuss feelings and needs with family and friends.
- The number of patients in a room as well as the presence of an interior window to the corridor, the relation of the head of the bed to the doorway, the presence of visual screening devices, and the location of the bathroom in relation the hallway all impact the privacy of patients.
- Using curtains around the beds, as well as lowering voices when discussing the patients' illnesses, can meet the needs of patients.
- Giving patients the ability to personalize their rooms enables them to establish their own territory and increases their sense of security and self-identity.
- The design of the patient rooms can convey symbolic meaning to patients. The layout and visual and acoustical screening represent the hospital's view of importance of a patient's privacy and territoriality.
- The patient's territory in a multiple occupancy room is also symbolic in terms of the patient's proximity to the bathroom, the door, or closet, especially if distances are uneven among patients.

Implications of Findings

- To prevent the spreading of infection, patients with airborne infectious diseases should be placed in isolation rooms with proper ventilation
- Room should be cleaned properly to avoid contamination

Shumaker, S.A. & Reizemstein, J. E. (1982). Environmental factors affecting inpatient stress in acute care hospitals. In G. Evans (ed.), *Environmental stress* (pp.179-223). Cambridge, London: Cambridge University Press.

Focus of Article

- To describe factors that affect inpatient stress in acute care settings.

Type of Healthcare Facility

- The material presented in this article applies to hospitals in general.

Recommendations for Healthcare Setting

- Factors of hospitals that affect a patient's level of stress are wayfinding, physical comfort, control over privacy and personal territory, and the symbolic meaning of the hospital environment.
- Aspects of the environment that can influence patient comfort are noise, temperature and humidity, lighting, body positioning, odors, and manipulation of switches.
- Patients are highly sensitive to hospital sounds due to pain, the nature of their illness, or their lack of control over the sounds.

Implications of Findings

- An environment that meets the patient needs and gives them a sense of control helps reduce patient stress.

Simmons, J. C. (Ed.). (2003, April). Designing for Quality: Hospitals look to the built environment to provide better patient care and outcomes. *The Quality Letter for Healthcare Leaders*, 2-13.

Focus of Article

- To describe hospital designs which focus on patient-centered care.

Type of Healthcare Facility

- The facilities discussed in this article include Bronson Methodist Hospital in Kalamazoo, MI, the Barbara Ann Karmanos Cancer Institute in Detroit, MI, Methodist Hospital

in Indianapolis, St. Joseph's Hospital in West Bend, WI, and Indiana Heart Hospital in Indiana.

Recommendations for Healthcare Setting

- Planetree model incorporates architecture into healing process
- Technological advancements are changing the manner in which health care workers do their jobs
- Pebble projects provide examples of facilities which have improved their care through design
- Bronson Methodist – puts patient as central focus; new facilities reflect movement to ambulatory care; nursing staff gave input into design of nursing units; all rooms are private – patient satisfaction scores increased in facility; nosocomial infection rates declining, in part due to convenient location of hand sinks and to use of private rooms
- Karmanos Cancer Institute – Use of warm colors; original artwork placed over beds; wall sconces and reading lights replaced overhead lighting; couches and sleeper beds were available for family members; computers were available in patient rooms; variable costs per case were 23.5% less on renovated unit than old unit; medication rooms are spacious and more counter space was added – medication error rates declined
- Methodist Hospital – Acuity adaptable rooms were used in which patients stayed in the same room regardless of their level of acuity; private rooms reduced problems such as getting the right bed for the patient based on gender or condition; medication errors and falls decreased by approximately 70% and satisfaction levels increased
- St. Joseph's Hospital – conducted learning labs to discuss designing a facility tailored to patient safety; guiding principles for design included patient-centered atmosphere, healing environment, operational efficiency, safety, quality care, technological advancements, and staff-friendly workplace; design included standardized patient rooms, hand washing areas, noise reduction & adjacent departments,
- Indiana Heart Hospital – first all digital hospital for cardiovascular patients; hospital has 650 computers (6.5/bed); making better use of space and staff resources through availability of information technology; each patient rooms has a computer; outside every two rooms is computer station for nurses; eliminated use of patient intercoms since nurse is always close to patient; hospital has reduced staffing by 20% from what would be needed in traditional facility

Implications of Findings

- Various facilities have focused on a patient-centered design which has improved patient care as well as patient satisfaction with their care
- Small, S. D., & Barach, P. (2002). Patient safety and health policy: A history and review.

Hematology/Oncology Clinics of North America, 16(6), 1463-1482.

Focus of Article

- To review a history of patient safety and health policy.

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities.

Recommendations for Healthcare Setting

- Estimates of national costs for adverse events are between \$38 billion and \$50 billion annually
- IOM recommendations include establishing a national focus to enhance knowledge regarding safety, to identify and learn from errors, to raise standards and expectations, and to create safety systems through implementation of safe practices when delivering care
- Federal agencies also prepared an action plan to improve patient safety
- A national summit on patient safety served as a basis for a \$250 million, 5 year patient safety research plan
- The National Quality Forum was established as a public-private venture and its mission is to support more effective, safer, and efficient care as well as high quality service
- States have chief responsibility for licensing and monitoring health care providers
- Leapfrog Group strives to improve patient safety by redirecting patients to health care facilities that comply with computerized order entry systems, evidence-based hospital referrals for complex treatments, and the presence of board-certified intensive care physicians in intensive care units during the day
- Inadequate educational preparation and organizational causes can play a role in creating situations with adverse events for patients
- Teamwork plays a critical role in patient safety

Implications of Findings

- Mechanisms to ensure patient safety have evolved over the years and various measures have been implemented and continue to be discussed regarding improving patient safety
- Education and leadership are key to creating a safety culture and defense system against adverse events

Stichler, J. F. (2001). Creating healing environments in critical care units. *Critical Care Nursing Quarterly, 24(3), 1-20.*

Focus of Article

- To describe how the critical care unit can be designed to enhance the healing process of patients

Type of Healthcare Facility

- The material presented in this article applies to the Critical Care Units of hospitals in the United States

Recommendations for Healthcare Setting

- Patients experience a positive outcome in environment that incorporates natural light, elements of nature, soothing colors and pleasant sounds
- Healing environments improve one's connection with nature, culture, and people, and promote a positive awareness of one's self
- Trend exists toward the use of universal rooms; these rooms are larger and can accommodate patients and family members as well as provide increased storage for equipment
- Bathrooms should be placed in each patient room or between every two patient rooms to increase flexibility and adaptability of the unit
- Visibility into and out of the patient room is also critical and patients should have a view from an outside window. A balance must be achieved between the need for staff to view patients and respect for the patients' privacy
- Natural light should be included in the rooms, and patients and their visitors should control the intensity of lighting
- Colors should be soothing, and artwork should focus on nature scenes that are serene
- Furnishings used in the rooms and on the ward should be comfortable and durable
- Noise reduction strategies should be in place and patients should have their need for privacy respected
- Optimal design of nursing unit would include a mini-station between every two patient rooms, which includes computers, telephones, and visibility into the patients' rooms.
- Central nursing unit should be placed within the unit to maximize visibility into all the patient rooms
- Staff lounges should be comfortable and should be located nearby so that staff can return to the unit quickly should an emergency arise
- Optimal design of the patient unit is in multiples of four beds to provide easy access to the patients and to promote visualization of patients
- Circular design of a unit allows for the centralization of care functions and provides immediate access to the patient. Disadvantages of this unit are that it is noisy, storage space is small, and it appears cluttered
- Triangular design reduces travel distance from the nursing station to the patients' rooms, it provides for a maximum number of rooms to be located on one floor; it allows for the design of multiple nursing stations, and centralizes space for supplies and equipment. Disadvantages of this design are that visibility of patients in remote corners is minimized and expansion of this unit is difficult

- Clustered designs facilitate the visualization of nurses of their patients, enable more patient rooms to be located on the peripheries of the building, and allow for the design of mini-nursing stations. Disadvantages of this design are the decentralization of care and the social needs of nurses not being met
- Rectilinear design is less costly to build, contains a centralized location for supplies and equipment, and improves way-finding for visitors. The disadvantages of this design are increased distance traveled by nurses, diminished visualization of patients in remote rooms, and increased space required for patient rooms

Implications of Findings

- Patient rooms incorporate the universal design, which facilitates patient comfort
- Environment should be designed to promote healing; this includes incorporation of natural light, elements of nature, soothing colors and pleasant sounds
- Various ward designs can be used, and each has its own advantages and disadvantages

Streufert, S., Satish, U., & Barach, P. (2001). Improving medical care: The use of simulation technology. *Simulation and Gaming*, 32(2), 164-174.

Focus of Article

- To describe how simulation techniques can enhance training and improve patient care.

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities.

Recommendations for Healthcare Setting

- Simulations have been used toward assessment and training in industry and the military
- Applications of simulation technology have been less frequent in medicine
- In a simulation, an attempt is made to duplicate essential element of reality, while maintaining the reality under control; want to see how a unit of interest behaves in response to the reality created
- Medical simulation must generate cognitive, behavioral, and autonomic responses that are observed in real-world medical tasks
- Thought is required for medical staff to handle problems when an easy 'right' answer is not available
- Types of simulations include free simulations, experimental simulations, quasi-experimental simulations, and computer simulations

Implications of Findings

- Simulation technology may be an effective technique in determining the competency of medical personnel as well as in training medical staff, and engaging in research which may result in improved patient care

Ulrich, R. (2003, October). *Creating a healing environment with evidence-based design*. Paper presented at the American Institute of Architects Academy of Architecture for Health Virtual Seminar Healing Environments.

Focus of Article

- To describe how evidence based design in regards to environmental features of hospitals can be used to improve patient outcomes.

Type of Healthcare Facility

- The information presented in this article applies to all hospitals.

Recommendations for Healthcare Setting

- Evidence-based design is used to create healthcare environments that help facilitate patient outcomes, including increasing the safety of patients
- Architectural features that affect patient outcomes are noise, single versus multiple occupancy rooms, positive distractions, the presence of windows and the views provided by windows, air quality, furniture arrangements, and carpeting
- Infection rates are lower in single-occupancy rooms than in open wards or double-occupancy rooms
- Excess noise can increase the amount of stress experienced by patients; single-occupancy rooms appear to be quieter than double-occupancy rooms
- Privacy can aid in increasing control and decreasing stress levels
- Roommates are a source of stress for patients and incompatible roommates can lead to costly transfers and higher medication errors as a result of the transfers
- When family members are able to stay with the patient, falls can be reduced, as patients are less likely to get up out of bed without assistance

Implications of Findings

- Single-occupancy rooms reduce the likelihood of the occurrence of nosocomial infections, patient falls, and patient transfers, and they can result in lower noise levels

Ulrich, R., & Barach, P. (2006, February). *Designing safe healthcare facilities-What are the data and where do we go from here?* Paper presented at the Healthcare Environments Research Summit 2006, Atlanta, GA.

Focus of Article

- To review evidence based research on the impact of design of patient outcomes and review factors which impact patient safety

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities

Recommendations for Healthcare Setting

- Research has not emphasized the impact of the built environment on patient outcomes
- Factors that can influence patient outcomes include light, color, views, noise, as well as path and frequency of movement, patient visibility to staff, patient room configuration, details of design, and standardization
- Hospital design does not promote teamwork, which is fundamental to providing safe and effective care
- Exceptional design requires a constant focus on safety by leadership and staff and continuously needs to be evaluated and improved
- Design plans typically do not take into account patient safety
- Approximately 100,000 patients are estimated to die preventable deaths annually in U.S. hospitals
- Institute of Medicine report made recommendations for hospital design including establishing a national focus group and identifying and learning from errors through mandatory reporting efforts
- The mission of the National Quality Forum is to support care that is effective, safer, more efficient, and of high quality
- Joint Commission on Accreditation of Health Care Organizations instituted policy whose purpose is to ensure health care organizations are knowledgeable and employ systems to understand the occurrence of and how to prevent adverse events
- Federal policy recommends improving education and training
- Teamwork plays a critical role in error management and carrying out complex work efficiently
- Simulation techniques have been used as part of education and training
- Noise, poor lighting, interruptions, distractions, poor air quality, room occupancy, hand washing, and patient transfers have been linked to negative patient outcomes

Implications of Findings

- Healthcare needs to move from a culture of blame to one in which openness exists and information is shared to improve patient outcomes and prevent adverse events

Ulrich, R., Zimring, C., Quan, X., Joseph, A., & Choudhary, R. (2004). *The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity. Report to the Center for Health Design for the Designing the 21st Century Hospital Project.*

Focus of Article

- To address research on what is considered "good" and "bad" hospital design
- To determine whether scientific evidence exists suggesting that design impacts staff and patient outcomes.
- To determine whether hospital design impacts stress experienced by staff, patients, and family members.

Type of Healthcare Facility

- The information presented in this article applies to all hospitals.

Recommendations for Healthcare Setting

- Shortage of nurses is impacting patient care and putting lives in danger
- Adequate ventilation and its maintenance are necessary to ensure the safety of staff and patients
- Noise-induced stress in nurses is related to burnout
- Reducing staff stress through ergonomic interventions and improving the air quality, noise levels, and lighting can impact the health of staff members
- Hospital design can impact a nurse's effectiveness in delivering care; unit layout influences the amount of time nurses spend walking and the amount of time they spend in patient care
- Radial units decrease the amount of time nurses spend walking; more time was spent on patient care; nurses are better able to supervise their patients with a radial design
- Physical environment impacts hospital-acquired infection rates by affecting airborne and contact transmission routes
- Good air quality and private rooms reduce infection rates; providing alcohol-rub dispensers and hand washing sinks can decrease contamination
- Hand washing compliance is lower in units that are understaffed and have a high bed-occupancy rate; hands of health care staff are the principal cause of contact transmission from patient to patient
- Providing private rooms with sinks located in each room reduces nosocomial infection rates in intensive care units

- Environmental factors, such as lighting, distractions, and interruptions have been linked to medication errors
- Hospitals are excessively noisy due to numerous, loud noise sources and environmental surfaces which create poor acoustic conditions; sound absorbing ceiling tiles and private rooms aid in noise reduction

Implications of Findings

- The quality of care provided to patients depends on hospital design. When noise levels are low, patients are in private rooms, and staff fatigue is reduced, patients benefit greatly.
- Nursing unit layout influences the amount of time nurses spend in patient care; radial designs reduce the amount of time spent traveling and improve supervision and patient care

Winkel, G. H. & Holahan, C. J. (1985). *The environmental psychology of the hospital. Is the cure worse than the illness. Prevention in Human Services, 4, 11-33.*

Focus of Article

- To discuss the impact the physical environment plays in preventing and reducing psychological and social problems among patients in acute care and psychiatric facilities

Type of Healthcare Facility

- The material presented in this article applies to acute care and psychiatric facilities.

Recommendations for Healthcare Setting

- Greatest sources of potential psychological strain involve information available to patients regarding their conditions, probability of success, and amount of risk associated with the treatment
- Professional staff may be unwilling or not equipped to deal with psychological difficulties experienced by patients
- Psychiatric environments are more flexible in physical design because high technology equipment is not needed as part of treatment
- Psychiatric patients are more prone to perceptual distortions of environment due to medications
- Psychiatric staff are more sensitive to stress related problems and ways in which they are handled
- Effectiveness of treatment rests partially on spatial layout of unit; circular wards enable greater supervision and staff are able to spend more time with patients but lack of privacy for patients
- Need to balance patients' needs for privacy with needs for social contact and staff demands for functional efficiency
- Information overload can impact person's capacity to process information; sights and sounds may frighten patients

- People tend to prefer environments that are visually interesting without becoming disorienting
- Environmental stimulation, which may improve patient outcomes, include being near a window, having a television set, having access to reading material, and unrestricted access to family members
- Patients in single-occupancy rooms are less withdrawn than those in multiple-occupancy rooms, who see their behavior as limited and constricted
- In waiting areas, as density increases, degree of upset regarding wait increases among patients

Implications of Findings

- Poorly designed environments can create difficulties for patients and staff and can interfere with the efficiency of treatment
- A patient's need for privacy and environmental stimulation should be met to improve outcomes

Empirical Articles: Health Care Design and Staff Health and Safety

Arikan, O. A., Ozgultekin, A., Tulunay, M., Turan, G., Oral, M., & Rosenthal, V. D. (2005). Effect of education and performance feedback on hand washing in two hospitals in Istanbul and Ankara. *American Journal of Infection Control, 33(5), E75.*

Focus of Study

- To determine the effect of education and performance feedback on hand washing compliance

Research Design

- Observations of hand washing compliance of physicians, nursing personnel, and ancillary staff took place both before and after educational programs and performance feedback were implemented

Sample Information & Site

- This study took place on intensive care units in two public hospitals in Turkey (Istanbul and Ankara).
- Staff working on these units participated in the study.

Findings

- Baseline rates of hand washing compliance were 11.95%
- After the education and performance feedback were implemented, hand washing compliance increased to 43.99%

Implications of Findings

- Education and performance feedback significantly improved hand washing compliance among healthcare workers.

Bayo, M. V., Garcia, A. M., & Garcia, A. (1995). Noise levels in an urban hospital and workers' subjective responses. *Archives of Environmental Health, 50(3), 247-250.*

Focus of Study

- To identify the noise sources and noisy areas within a hospital as well as the staff's reaction to the noise.

Research Design

- Noise levels were measured both inside and outside the hospital.
- Questionnaires were used to evaluate the health workers' subjective responses to noise.

Sample Information & Site

- The study took place at a public University Hospital in Valencia, Spain.
- 295 health care workers participated.

Findings

- Main noise sources outside the hospital included road traffic, human voices, aircraft noise, and sirens.
- Noise levels within the hospital were produced by hospital workers, visitors, patients, and hospital devices.
- 76% of those interviewed felt the majority of the noise was initiated inside the hospital.
- Noise levels inside the hospital were found to be well above those suitable for a health-care facility.
- Those interviewed felt noise levels affected the patients' comfort and recovery. Negative effects to the workers were perceived with less frequency.
- High proportion of workers felt it was possible to reduce noise levels within the hospital.

Implications of Findings

- Noise levels, which were found to be well above suitable levels, should be controlled to make the environment suitable for both patients and staff.
- No mention was made in regards to specific nursing unit design

Brady, R., Chester, F. R., Pierce, L. L., Salter, J. P., Schreck, S., and Radziewicz, R. (1993). Geriatric falls: Prevention strategies for the staff. *Journal of Gerontological Nursing, 19(9), 26-32.*

Focus of Study

- To describe efforts in reducing the amount of geriatric falls in a rehabilitation center

Research Design

- Retrospective chart review conducted in a quality improvement effort on a 28-bed geriatric rehabilitation unit
- Quality improvement monitor designed to provide proactive nursing interventions aimed at reducing patient falls
- 30 minutes prior to peak fall times, nursing staff asked each patient on unit if assistance was needed with toileting, nourishment, and getting in or out of bed
- Falls Prevention Program focused on nursing interventions and risk factors for falls; after protocol written, 2-week pilot study conducted

Sample Information & Site

- This study took place at MetroHealth Center for Rehabilitation in Cleveland, Ohio.
- 71 patient charts were reviewed; 25 patients participated in the quality improvement project

Findings

- Most falls occurred in patient's room or bathroom
- Largest percent of fallers were between ages of 70-79
- Activities which were attempted when falls occurred include attempting to get to bathroom, leaning forward in chairs, and transferring in and out of bed
- Falls were reduced by approximately 80 percent through use of proactive nursing interventions
- Fewer restraints were needed, patient autonomy increased, and decreased loss of self-esteem occurred in patients

Implications of Findings

- Awareness of activities which were most likely to lead to patient falls enabled the introduction of proactive interventions which reduced the number of patient falls

Burgio, L., Engel, B., Hawkins, A. McCorick, K., Scheve, A. (1990). A descriptive analysis of nursing staff behaviors in a teaching nursing home: Differences among NAs, LPNs and RNs. *The Gerontologist*, 30, 107-112.

Focus of Study

- To analyze staff behavior over a representative period of time.

Research Design

- Staff behaviors were observed and recorded as well as whether the staff member was a registered nurse (RN), licensed practical nurse (LPN), or nursing assistant (NA).
- Observations were conducted from Monday to Friday for 37 months.

Sample Information & Site

- The study took place in a 223-bed teaching nursing home in an urban area. It primarily serves elderly individuals.
- The sample included 77 NAs, 12 LPNs, and 7 RNs.

Findings

- Most frequently observed behavior was patient care followed by walking.
- LPNs displayed significantly more patient care behaviors while NAs displayed significantly more nonwork behaviors.
- Staff members interacted nearly twice as often with other staff than they did with patients.
- Very little time was spent engaged in nonproductive activities.

Implications of Findings

- In general, nurses spend the majority of their time doing work related activities, especially patient care.
- No mention was made in regards to specific nursing unit design

Cohen, B., Saiman, L., Cimiotti, J. & Larson, E. (2003). Factors associated with hand hygiene practices in two neonatal intensive care units. *Pediatric Infectious Disease Journal*, 22(6), 494-499

Focus of Study

- To determine whether hand hygiene practices differ between levels of contact with neonates
- To characterize the hand hygiene practices of staff who touch neonates
- To compare hand hygiene practices in two different neonatal intensive care units (NICUs) using different products.

Research Design

- In NICU A, an alcohol based rub was used for hand washing and a universal gloving policy was adopted for touching neonates.
- In NICU B, a traditional antimicrobial soap was used for hand washing. Glove use was limited to contact with body fluids.
- Observers recorded all staff and visitor touches that occurred to infants under observation.

Sample Information & Site

- The study took place in two university affiliated New York City Level III and IV NICU facilities.
- The sample included any person whose hands came into contact with a neonate under observation, their Isolette and/or equipment.

Findings

- Staff using an alcohol based product for hand washing were significantly more likely to touch neonates with clean hands than staff using an antiseptic detergent.
- More than one-half of touches made directly to neonates were with unwashed gloved hands.
- Adherence to appropriate hand hygiene increased as level of contact with the neonate increased.
- Nurses demonstrated greater adherence to hand hygiene than other health care professionals.

Implications of Findings

- Hand hygiene increased as the level of contact with the neonate increased.
- Alcohol-based products produced greater adherence to hand hygiene.
- No mention was made in regards to specific nursing unit design

Christensen, M. (2005). What knowledge do ICU nurses have with regard to the effects of noise exposure in the intensive care unit? *Intensive and Critical Care Nursing, 21*, 199-207.

Focus of Study

- To measure the knowledge intensive care unit nurses had regarding noise levels in a clinical area

Research Design

- Self-administered questionnaires were used to determine the knowledge of nurses regarding noise related issues; political, psychological, and physiological components were addressed
- A pilot study was used to refine the questionnaire

Sample Information & Site

- The study took place in a 15-bed general intensive care unit in a regional district/teaching hospital in the United Kingdom
- 96 nurses from the general intensive care unit participated.

Findings

- There were no significant differences between clinical areas and between nursing level regarding knowledge of noise issues
- Overall, only 5% of respondents were able to answer questions correctly
- The staff nurse did better overall than the other two nursing grades, especially with regards to socio-political questions; the poorest performers were sister/charge nurses
- Nursing staff may perceive noise levels in terms of personal annoyance rather than as a specific noise level

Implications of Findings

- Overall, nurses performed poorly with regards to knowledge of noise levels in terms of psychological, political, and physiological issues

Costa, G., Sartori, S., Bertoldo, B., Olivato, D., Antonacci, G., Ciuffa, V., Mauli, F. (2005). Work ability in health care workers. *International Congress Series, 1280*, 264-269.

Focus of Study

- To use the Work Ability Index to evaluate the functional working capacity of healthcare workers as well as plan more appropriate preventive and compensatory measures

Research Design

- Participants completed the Work Ability Index (WAI) and were submitted to a general medical examination

Sample Information & Site

- This study took place at a healthcare facility in Italy.
- 867 healthcare workers (physicians, registered nurses, biologists and technicians, assistant nurses, and clerks) participated in this study

Findings

- More women than men reported lower scores on the WAI, despite being younger and having less work experience
- Women nurses had more consistent and earlier decreasing WAI scores over the years than other healthcare workers
- Women shift-workers showed more pronounced decrease of WAI scores over the years
- As number of illnesses increase, WAI scores decrease across all age groups
- Most frequently reported illnesses include musculoskeletal ones, injuries, digestive, and respiratory disorders

Implications of Findings

- The Work Ability Index of healthcare workers is affected by gender, as women are likely to have lower indices, and by illnesses, since as the number of illnesses increase, the index decreases

Emery, S., Nennig, M., & Gold, D. (2005). Control of a methicillin-resistant *Staphylococcus aureus* (MRSA) cluster in critical care by reinforcing hand hygiene and standard precautions. *American Journal of Infection Control, 33*(5), E53-E54.

Focus of Study

- To examine the use of contact precautions regarding methicillin-resistant *Staphylococcus aureus* (MRSA)

Research Design

- 22 patients in an intensive care unit and/or coronary care units and cardiovascular intensive care unit became colonized or infected with MRSA
- Infection control investigation included observations of patient care practices, interactions with staff to determine factors that may contribute to MRSA transmission, DNA testing, literature review, audits of waterless alcohol degermer use, and consultation with hospital epidemiologist

Sample Information & Site

- This study took place on an intensive care unit, coronary care unit, and cardiovascular intensive care unit
- Staff on these units participated in this study.

Findings

- Majority of problems centered on missed opportunities for use of degermer and/or hand washing breaches
- Interventions focused on importance of hand hygiene, emphasized use of degermer, and reinforced standard precautions; use of artificial nails discouraged; staff members reminded to report any skin conditions
- With use of interventions, cluster of MRSA terminated

Implications of Findings

- Through the emphasis of standard precautions and importance of hand washing, the cluster of MRSA ended

Fitzgerald, M., Pearson, A., Walsh, K., Long, L., & Heinrich, N. (2003). Patterns of nursing: A review of nursing in a large metropolitan hospital. *Journal of Clinical Nursing, 12, 326-332.*

Focus of Study

- To identify current approaches to the management of nursing care
- To promote the development of new approaches to managing nursing care
- To assist charge nurses in conveying an approach taken to nursing care
- To develop a statement of care delivery in wards

Research Design

- Two phases were utilized in this study
- Phase I included structured interviews and observations of nursing staff in a clinical setting; six observations per shift were made by trained nursing staff
- Phase II included meetings with charge nurses on each ward; results from phase I were presented and value statements were redeveloped with each ward team

Sample Information & Site

- The study took place in a large metropolitan tertiary referral hospital in Australia
- 96 nurses were interviewed and 144 nurses were observed

Findings

- Continuity of care was provided by written and verbal reporting rather than allocation of a patient to the same nurse each shift
- Most common method of allocating work is matching nursing skill to severity of patients' illness
- View of nursing emphasized in interviews is meeting needs of patients and relatives through biopsychosocial and educative care
- Observations demonstrated that only small portion of time dedicated to educating or talking to patients
- Large amounts of time were spent on activities deemed not important in interviews

Implications of Findings

- Quality of care may improve if patterns of care were associated more with nursing vision statements
- Greater role clarity may lead to more effective utilization of resources
- No mention was made in regards to specific nursing unit design

Florin, J., Ehrenberg, A., & Ehnfors, M. (2005). Patients' and nurses' perceptions of nursing problems in acute care setting. *Journal of Advanced Nursing, 51(2), 140-149.*

Focus of Study

- To examine the degree of consistency between the perceptions of registered nurses and patients regarding the presence, severity, and importance of nursing problems in an acute care facility

Research Design

- Patients were invited to participate in the study; the nurses assigned to the patient on the day of data collection also had to agree to participate to produce matched dyads
- A questionnaire was used which included measures regarding physical, psychosocial, and spiritual patient problems in nursing
- Questionnaires for patients and nurses were identical except that for nurses, the statements reflected a professional perspective

Sample Information & Site

- This study took place on an acute ward for infectious diseases in an acute care facility in Sweden.

- 80 patients admitted to the ward participated in this study
- 30 registered nurses on the ward participated in this study

Findings

- Registered nurses identified 697 nursing problems; patients identified 614 problems
- 305 problems were identified by the dyads; only 27% were described with the same degree of severity by nurses and patients; Registered nurses more often underestimated the severity of the problem
- Psychosocial needs of patients are more unmet than physical needs

Implications of Findings

- Nurses lacked knowledge regarding a patient's needs as they tended to underestimate the problems patients encountered
- Nurses need to take a patient's perspective to a greater extent when performing assessments
- Gadbois, C., Bourgeois, P., Goeh-Akue-Gad, M. M., Guillaume, J., & Urbain, M. A. (1992).
- Hospital design and the temporal and spatial organization of nursing activity. *Work & Stress*, 6(3), 277-291.

Focus of Study

- To analyze the spatial and temporal organization of nurses' work in medical and surgical units of French hospitals

Research Design

- Nursing activity was observed and recorded on a U-shaped ward
- Observers recorded activity related to the sequence of areas visited, the tasks executed in these areas, the reasons for travel between these areas, and the times of entry and exit in these areas
- Data was collected during the day shift over a six-month period

Sample Information & Site

- The study took place in a medical and surgical ward in a private hospital in Paris
- The sample included nurses working on this ward

Findings

- Nursing work is divided into various acts, which are distributed through time and space
- Majority of the activities performed by nurses lasted less than two minutes on either unit
- Average of 23 activities per hour were performed in the surgical unit, while an average of 25.3 activities per hour were performed on the medical unit

- Work performed by nurses resided in various sites. On the surgical unit, nurses performed 3855 trips that lasted approximately 3 minutes and 25 seconds each. 4521 trips were performed by nurses on the medical units, each lasting approximately 3 minutes and 9 seconds
- Large number of activities performed in one area, such as the corridor or patients' rooms, were followed by an activity in another location
- Constant movement by nurses varied based on the spatial organization of the unit as well as the temporal structure of the tasks
- Nurses' work areas can be divided into four categories: the patients' rooms, the nurses' area, the corridor, and other specialized areas such as storage and medical offices
- Nurses generally followed three paths in their trips: different points of the nurses area, trips between the patients' rooms and nurses' area, and trips between patients' rooms
- On the surgical unit, nurses were interrupted, on average, once every 20 minutes, while on the medical unit, nurses were interrupted an average of once every 12 minutes
- Visibility of staff members was difficult due to the U-shaped design of the ward

Implications of Findings

- The work of nurses is dependent upon the spatial configuration of the ward as well as the temporal organization of the work

Garg, A., & Owen, B. (1992). Reducing back stress to nursing personnel: An ergonomic intervention in a nursing home. *Ergonomics*, 35(11), 1353-1375.

Focus of Study

- To determine if an ergonomics approach is effective in reducing back stress in nurses working in a nursing home

Research Design

- This was a longitudinal study that took place over the course of 4 years
- Patient-handling tasks perceived to be the most stressful by nursing assistants were identified
- Ergonomic evaluation of work performed by nursing assistants took place
- Pilot study identified and located assistive devices; preliminary trials of devices performed
- Laboratory study was conducted to select patient-handling devices that were less stressful than existing methods
- Selected devices were introduced into nursing home and nursing assistants were trained regarding their use; devices included walking belts, shower chairs, and hoists

- Measurement of back injuries, acceptability rates, biomechanical task demands, and perceived levels of physical stress were completed after introduction of intervention

Sample Information & Site

- This study took place in a nursing care facility in Southeastern Wisconsin. Two units were selected with four wings on each unit with about 18 patients on each wing.
- 35 nursing assistants participated in the pre-intervention phase and 57 nursing assistants participated in the intervention and post-intervention phase.

Findings

- Incidence rates for back injuries decreased
- Incidence rates for total injuries decreased
- Injuries that occurred after the intervention included: pushing tables together; manually transferring a patient from a wheelchair to examination table, grabbing a falling patient, manually lifting patient from floor; and turning a patient in bed
- Acceptability rates for patient transferring devices were high
- Longer transfer time required by using patient-handling devices a reason for non-compliance
- Perceived physical stresses after the intervention were very low
- Profound decrease in lost and restricted work days
- Number of patient transfers reduced through use of shower chair and mechanical hoist

Implications of Findings

- With the introduction of ergonomic patient-handling devices, the number of patient transfers decreased, the number of injuries decreased, and a decrease occurred in restricted work days

Gershon, R. R. M., Karkashian, C. D., Grosch, J. W., Murphy, L., Escamilla-Cejudo, A., Flanagan, P. A., Bernacki, E., Kasting, C., & Martin, L. (2000). Hospital safety climate and its relationship with safe work practices and workplace exposure incidents. *American Journal of Infection Control*, 28(3), 211-221.

Focus of Study

- To develop an effective tool to measure hospital safety climate that is specific for bloodborne pathogen management and determine its relationship to workplace behavior:

Research Design

- A cross-sectional survey of healthcare workers was conducted.

- Questionnaires were mailed out to employees of a large, urban research medical center:

Sample Information & Site

- The study used 789 employees from a larger, urban research medical center with over 200 separate clinical services.
- Hospital departments considered at risk for blood and body fluid were selected, including critical care, pathology, surgical services, emergency, and obstetrics and gynecology

Findings

- Compliance with safety practices was generally quite good
- Lowest rates of compliance were reported for recapping contaminated needles, wearing disposable face masks, wearing protective eye shields, and unscrewing needles from needle holders.
- Highest rates of compliance occurred for proper disposal of biomedical waste, proper disposal of sharps, wearing disposable gloves when necessary, and taking special care with sharp objects.

Implications of Findings

- Employees' perceptions regarding the safety of the hospital influences their adoption of safe work practices
- No mention was made in regards to specific nursing unit design
- Gould, D. (1994). Nurses' hand decontamination practice: Results of a local study. *Journal of Hospital Infection*, 28, 15-30.

Gould, D., & Ream, E. (1993). Assessing nurses' hand decontamination performance. *Nursing Times*, 89(25), 47-50.

Focus of Study

- To examine the hand decontamination practices of nurses working in intensive care and surgical and medical units

Research Design

- Data from two hospitals was compared: one hospital had an infection control nurse and recently updated infection control policies (hospital A) while the second hospital lacked these facilities (hospital B)
- Observations of nurses took place; data collected pertained to the frequency, appropriateness, and technique of hand decontamination; information was also obtained regarding workload and availability of hand decontaminating agents
- Questionnaires were used to obtain data regarding knowledge of contact precautions to prevent the spread of infection and educational opportunities regarding infection control

Sample Information & Site

- The study took place on an intensive care, a medical, and a surgical unit in two facilities in England.

- 173 nurses participated in this study

Findings

- Hand decontamination occurred most often in the intensive care unit in hospital B; essential decontaminations were superior on this unit
- Hand decontamination technique was superior in intensive care units, regardless of which hospital
- Knowledge regarding infection control was poor
- Nurses in hospital B had taken additional training regarding infection control
- Fewest decontaminations occurred on intensive care unit of hospital A, which also had the highest workload
- Handrub was readily available on the ICU in hospital B; when nurses became busy, they were more likely to use the handrub

Implications of Findings

- Nurses' knowledge regarding infection control was poor; but those who had taken additional training regarding infection control had better compliance
- When workloads were high, nurses were more likely to use handrub if it was available to them

Grotta, P., Przykucki, J., & Patterson, J. (2005). Prevent transmission: Isolating vancomycin-resistant Enterococci (VRE) and breaking the chain of contagion. *American Journal of Infection Control*, 33(5), E31-E32.

Focus of Study

- To identify factors that can prevent the transmission of vancomycin-resistant Enterococci (VRE)

Research Design

- Root causes analysis team composed of housekeeping, nursing, medicine, supply, and infection control analyzed causes of VRE transmission
- Role of environmental contamination, compliance to contact precautions, and other risk factors were assessed
- Action taken included: use of disposable wipes to clean and disinfect hard nonporous environmental surfaces, tracking VRE in electronic medical record, improving use of and accessibility to alcohol hand rub, installing glove dispensers next to hand rubs at entrance of patient rooms, implementation of disposable perineal wash clothes, improvement in availability of personal protective equipment, educating staff, simplifying precaution signage, and evaluating alternatives to computer keyboards
- Repeat prevalence survey conducted after implementation of actions

Sample Information & Site

- This study took place on a 25-bed medical unit and 10-bed medical intensive care unit in an acute care facility in the United States.

Findings

- No positive cultures were found after implementation of actions
- VRE prevalence decreased from 27% to 22% on the medical unit and from 57% to 20% on the medical intensive care unit

Implications of Findings

- VRE prevalence decreased after the implementation of actions targeted at improving compliance with infection control procedures

Hignett, S., & Richardson, B. (1995). Manual handling human loads in a hospital: An exploratory study to identify nurses' perceptions. *Applied Ergonomics*, 26(3), 221-226.

Focus of Study

- To explore nurses' perceptions of manual handling operations
- To investigate the 'ergonomic approach' and identify factors which may minimize the risks inherent in patient-handling tasks.

Research Design

- An exploratory approach was used
- Framework concepts, including factors of the 'ergonomic approach' were identified and acted as a structure for a first round of interviews which focused on risk assessment
- Data collected from the first set of interviews underwent preliminary analysis and then, and a second round of interviews was conducted
- A secondary analysis was conducted based on the interviews, and a model was developed; a final round of interviews was then conducted to validate the model and challenge the 'task' concept

Sample Information & Site

- This study took place in England.
- 26 nurses from two wards caring for the elderly participated in this study.

Findings

- Nurses perceived handling of patients is altered to maintain quality of care
- Interactions of staff with managers affected the way manual handling operations were carried out

- Style of nursing system (e.g. functional vs. team nursing) can affect manual handling operations
- Nurses had own standards and professional identity which influenced their treatment of patients
- Training and experience, fatigue, and stress affected manual handling operations
- Building design, furniture, and lifting equipment influenced the manual handling of patients

Implications of Findings

- It is suggested that checklists for risk assessment of manual handling operations do not adequately address the hazards of handling patients
- A structured approach needs to be used to address the problems of manual handling and to arrive at effective solutions

Hodges, V., Sandford, D. & Elzinga, R. (1986). The role of ward structure on nursing staff behaviors: An observational study of three psychiatric wards. *Acta Psychiatrica Scandinavica*, 73, 6-11.

Focus of Study

- To investigate the relationship between ward structure and patient chronicity and staff interactions.

Research Design

- Staff members were observed for 10 days per ward and behavior patterns were recorded.

Sample Information & Site

- The study took place in three psychiatric wards of a large metropolitan hospital.
- The nursing staff was observed on each ward regarding interactions with their patients.

Findings

- Chronic patients experienced significantly higher rates of staff contact than acute patients
- Staff in each ward spent at least one-third of their time in solitary tasks such as ward maintenance
- On acute wards, the more staff, the more interaction occurred with patients; for chronic patients on the closed ward, the opposite was true - they were more likely to be engaged in interaction as staff numbers decreased
- Inverse relationship exists between the staff interaction rate and the length of time the patient has been on the ward
- Token economy program facilitates interaction because of the nature of its structure and allows for greater involvement in patient management

Implications of Findings

- Since patient interaction decreased as their length of stay increased, patients should be discharged within the first 2 weeks following admission, if possible. When this is not possible, programs should be implemented to ensure staff-patient interaction occurs.
- No mention was made in regards to specific nursing unit design

Howell, K., Fontes, D., Hamvas, A., Mathur, A., & Holzmann-Pazgal, G. (2005). Compliance with contact precautions in a neonatal intensive care unit. *American Journal of Infection Control*, 33(5), E132.

Focus of Study

- To determine compliance with contact precautions regarding methicillin-resistant *Staphylococcus aureus* (MRSA) during an outbreak in a neonatal intensive care unit

Research Design

- After discovering 3 patient specimens were positive for MRSA, nares cultures of patients were initiated weekly and upon admission
- Cohorting of infected patients and education regarding compliance with precautions and hand hygiene took place
- Compliance was audited regarding hand hygiene and contact precautions during patient contact or contact with immediate environment

Sample Information & Site

- This study took place on a neonatal intensive care unit in a 235-bed tertiary-care center in St. Louis, Missouri
- Healthcare workers on this unit participated in this study.

Findings

- 35% of healthcare workers were compliant with hand hygiene before and after contact
- 68% of healthcare workers were compliant with hand hygiene after contact
- 29% of healthcare workers did not engage in hand hygiene
- 71% of healthcare workers gowned and 90% wore gloves

Implications of Findings

- Overall, compliance with hand hygiene varied among healthcare workers. Effective interventions need to be implemented to increase compliance and reduce the spread of MRSA

Hui, L., Ng, G.Y. F., Yeung, S. S. M., & Hui-Chan, C. W.Y. (2001). Evaluation of physiological work demands and low back neuromuscular fatigue on nurses working in geriatric wards. *Applied Ergonomics*, 32, 479-483.

Focus of Study

- To compare subjective ratings and objective measures of the intensity of nursing activities in a geriatric setting
- To compare back fatigue in nurses before and after their daily shift

Research Design

- Nurses were asked to subjectively rate their anticipated exertion while performing activities in a typical day
- Continuous heart rate monitoring was used as an objective measure of physical demands
- Surface electromyography was used to measure back muscle fatigue

Sample Information & Site

- 21 female nurses working in geriatric wards in a Hong Kong hospital participated in this study.

Findings

- Activities rated as most physically demanding and exerting are turning, transferring, and showering patients
- Intensity of activities varies widely over an 8-hour shift
- Increased fatigue of the back muscles after the work shift was observed

Implications of Findings

- Several activities, including turning, transferring, and showering patients are physically demanding for nurses and instruction of biomechanics, lifting, and assisting techniques are needed
- Proper staffing of geriatric wards and other heavy care wards are needed

Jiang, S., Huang, L., Xilong, C., Jinfeng, W., Wei, W. et al. (2003). Ventilation of wards and nosocomial outbreak of severe acute respiratory syndrome among healthcare workers. *Chinese Medical Journal*, 116(9), 1293-1297.

Focus of Study

- To identify measure for preventing outbreaks of Severe Acute Respiratory Syndrome (SARS) among health care workers

Research Design

- Admitted SARS cases and infection of health care workers as well as architectural factors were analyzed

Sample Information & Site

- This study took place on 4 different wards in the Second Affiliated Hospital at Sun Yat-Sen University in China.
- 4 infected hospital patients' records were analyzed as well as staff members who became infected.

Findings

- Infection rates were significantly higher on the wards with the worst ventilation
- Infection rates were significantly lower on the ward with good ventilation

Implications of Findings

- When the ratio of area of ventilation windows to volume of the room was higher (i.e. ventilation was good), number of infected health care workers was smaller and infection rates became lower
- No mention was made in regards to specific nursing unit design

Kaplan, L. M., & McGuckin, M. (1986). Increasing hand washing compliance with more accessible sinks. *Infection Control*, 7(8), 408-410.

Focus of Study

- To observe the frequency of hand washing among nurses in a medical ICU.

Research Design

- Personnel in a medical and surgical ICU were observed.
- A record was made of all hand washing after direct contact with patients or their support equipment.

Sample Information & Site

- The study took place in a medical ICU at a university-affiliated teaching hospital. This unit contains seven beds and seven sinks in an open unit. A 16-bed surgical ICU was also observed. There are four isolation rooms with separate sinks and 12 beds in an open unit with three sinks.
- 80 physicians, 30 nurses, and 4 technicians were observed.

Findings

- Significantly greater number of hand washes per contact in the medical ICU where more sinks were available.
- Compliance by physicians with hand washing recommendations was poor

Implications of Findings

- Compliance with hand washing increased when more sinks were available.
- In-service education of hospital personnel should be conducted to increase awareness of hand washing and its effect in reducing the spread of infection.

- No mention was made in regards to specific nursing unit design

Lankford, M. G., Zembower, T. R., Trick, W. E., Hacek, D. M., Noskin, G. A., & Peterson, L. R. (2003). Influence of role models and hospital design on hand hygiene of health care workers. *Emerging Infectious Diseases*, 9(2), 217-223.

Focus of Study

- To assess the effect of medical staff role models and the number of healthcare worker sinks on hand hygiene compliance
- To determine whether compliance with hand washing is affected by the behavior of senior medical staff members

Research Design

- Hand hygiene compliance was assessed prior to and after the construction of a new facility
- In the old facility with 683 private and semi-private rooms, sinks were limited and located in various sites
- The new hospital consisted of 492 private rooms with a sink located inside every patient rooms; no sinks were located in the hallways
- Staff were observed by during 1-hour observation periods; data included time of day, type and number of healthcare workers entering the room, patient or equipment contact, compliance with hand hygiene practices, glove use, invasive procedures, nursing unit and hospital, and whether isolation precautions were posted

Sample Information & Site

- This study took place on four nursing units including solid organ transplant unit, surgical intensive care unit, hematology/oncology unit, and medical intensive care unit
- Staff on these units at the time of observation participated in this study; 560 healthcare worker-patient interactions were observed (237 registered nurses, 190 physicians, and 133 other healthcare workers)

Findings

- Hand hygiene compliance was better in the old hospital compared to the new hospital
- Compliance was better after a hand hygiene opportunity compared to before a hand hygiene opportunity
- When a higher ranking person in the room did not perform hand hygiene, other staff were less likely to wash their hands
- Predictors of compliance include using gloves, performing an invasive procedure, having patient contact, working in the old hospital, and performing hand hygiene on room entry
- If a higher ranking person was in the room and performed hand hygiene, frequency of hand hygiene for others in the

group was no better than in rooms where only one person entered

Implications of Findings

- Having greater access to sinks did not increase compliance with hand washing
- The behaviors of senior staff are critical in affecting compliance with hand washing

Larson, E. (1988). A causal link between hand washing and risk of infection? Examination of evidence. *Infection Control*, 8, 28-36.

Focus of Study

- To examine a causal link between hand washing and risk of infection

Research Design

- Published studies of hand washing and skin antisepsis were sought from the *Index Medicus*, *The Cumulative Index to Nursing and Allied Health Literature*, the *Index of National Library of Medicine Serial Trials*, the *American Journal of Infection Control* and *Infection Control* journal.
- Years searched included 1879 through 1986

Sample Information & Site

- This study reviewed 423 articles published in various databases pertaining to hand washing.

Findings

- Very few clinical trials have been conducted assessing a causal link between hand washing and risk of infection
- Personnel hands were a major source of infection transmission
- Once an infection begins, it is spread by the contaminated hands of staff
- Hand washing has been associated with significant reductions in nosocomial infections.

Implications of Findings

- Hand washing can help reduce the rates of nosocomial infections
- No mention was made in regards to specific nursing unit design

Lockhart, J. (2005). The healthcare-associated training calendar: An innovative approach to infection control education. *American Journal of Infection Control*, 33(5) E69.

Focus of Study

- To implement an educational tool to teach the principles of infection control

Research Design

- A calendar featuring monthly infection control topic used
- Calendar was displayed in employee meeting room and was clearly visible to staff
- Team of nurses provided 24 hour/day individualized education; targeted staff, physicians, patients, and visitors
- Education provided focused on hand hygiene, review of isolation and VRE policies and procedures, and donning and removal of PPE

Sample Information & Site

- This study took place in an acute care facility in the United States.

Findings

- Healthcare associated VRE colonization cases were reduced

Implications of Findings

- The presence of 24 hour/day infection control staff helped to educate staff and led to a reduction in VRE infections

McManis & Monsalve Associates (2003). Healthy work environments: Striving for excellence Volume II.

Focus of Study

- To investigate how hospitals are managing nurse retention and recruitment issues through improvements in the work environment.

Research Design

- Telephone interviews were used in which respondents were asked to describe their hospital's approach to nurse retention and work environment issues. They were also asked about improvements that have been carried out in their hospitals.

Sample Information & Site

- 21 hospitals in 17 states were surveyed.
- A total of 61 individuals were surveyed. They include chief nursing officers, senior executives, clinical directors, and nurse managers.

Findings

- Nurse recruitment and retention are among the issues at the forefront of hospital leaders.
- Six factors are essential to achieving improvements in the work environment: leadership development and effectiveness, empowered collaborative decision-making, work design and service delivery innovation, value-driven organizational culture, recognition and rewards systems, and professional growth and accountability.

Implications of Findings

- A work environment that values ongoing organizational learning and innovation is important to deal with future environmental trends in health care.
- No mention was made in regards to specific nursing unit design

Mastromarino, P., Conti, C., Donato, K., Strappini, P. M., Cattaruzza, M. S., & Orsi, G. B. (2005). Does hospital work constitute a risk factor for *Helicobacter pylori* infection? *Journal of Hospital Infection*, 60, 261-268.

Focus of Study

- To assess whether healthcare workers with and without patient contact are at equal risk of acquiring *Helicobacter pylori* (*H. pylori*)

Research Design

- Subjects underwent a non-invasive stool antigen test (HpSA) to assess *H. pylori* infection status
- Questionnaires were completed and included information pertaining to age, sex, profession, department of employment, length of employment, exposure to gastrointestinal or oral secretions, history of gastrointestinal pain, dyspepsia, or ulcer disease, and use of medication for gastrointestinal complaints

Sample Information & Site

- This study took place at Umberto I Hospital in Rome, Italy
- 249 healthcare workers (physicians and nurses working in an endoscopy unit; physicians and nurses in contact with patients but not working on an endoscopy unit; healthcare workers in laboratories and other units without patient contact) participated in this study

Findings

- 81 subjects (32.5%) tested positive for *H. pylori*
- Prevalence of *H. pylori* was higher among healthcare workers in direct contact with patients
- Prevalence of *H. pylori* increased with age
- Risk was greater among healthcare workers in direct patient contact with less than 8 years of education
- Most commonly reported gastrointestinal symptoms were abdominal pain, dyspepsia, and nausea
- For those with a previous history of *H. pylori*, re-infection was greater among staff with direct patient contact
- Infection prevalence was highest in nurses
- Among endoscopy staff, older personnel had a higher rate of infection

Implications of Findings

- Working in direct patient contact is associated with infection rates of *H. pylori*
- Since nurses are in greater contact with patients and have the highest infection rates, stricter guidelines are needed to reduce the transmission of *H. pylori*

Menzies, D., Fanning, A., Yaun, L. & FitzGerald, J. M. (2000). Hospital ventilation and risk for tuberculosis infection in Canadian health care workers. *Annals of Internal Medicine*, 133(10), 779-789.

Focus of Study

- To estimate the association between ventilation of patient care areas and tuberculin conversion among health care workers

Research Design

- Staff members completed questionnaires and underwent tuberculin testing
- Staff in the infection control department completed questionnaires regarding screening of personnel, isolation policies, respirator use, availability of negative pressure rooms, and changes to ventilation systems on the study units
- Ventilation systems were assessed
- Records of patients diagnosed with pulmonary tuberculosis were reviewed

Sample Information & Site

- The study took place in seventeen acute-care community or university hospitals across four Canadian cities (Montreal, Toronto, Edmonton, and Vancouver)
- 4525 workers participated in this study

Findings

- Even though most hospitals had a current policy of testing workers for tuberculosis at hiring, fewer than half of all workers surveyed had been tested
- Inadequate ventilation was discovered in nonisolation patient rooms that were an average 57 years old
- Adequate ventilation was discovered in rooms that were an average of 33 years old
- Inadequate ventilation of patient rooms was significantly associated with tuberculin conversion among staff
- Inadequate ventilation of bronchoscopy rooms was significantly associated with tuberculin conversions among respiratory therapists
- Risk for tuberculin conversion was greater in nonisolation rooms with less than an average of 2 air exchanges per hour

Implications of Findings

- A relationship exists between deficiencies in ventilation and tuberculin conversion among staff in hospitals working in nonisolation rooms
- No mention was made in regards to specific nursing unit design

Muto, C A, Siström, M G, & Farr, B M (2000). Hand hygiene rates unaffected by installation of dispensers of a rapidly acting hand antiseptic. *American Journal of Infection Control*, 28(3), 273-276.

Focus of Study

- To improve health care workers' compliance with hand hygiene by introducing an alcohol-based hand antiseptic

Research Design

- Baseline hand washing was assessed on 2 hospital units
- Brief educational and motivational campaign took place on both wards regarding hand washing and the new alcohol dispensers
- Alcohol dispensers were mounted next to each door on both units
- Observations took place two months after installation to determine compliance

Sample Information & Site

- This study took place on the Medical Intensive Care Unit and its stepdown unit 3 West at the University of Virginia Health System hospital
- Staff on both units were observed

Findings

- Baseline hand washing rate of compliance was 60%
- After installing the alcohol based dispensers, compliance was reduced to 52%
- Decrease in compliance was due to a lower compliance by physicians after a change in rotations

Implications of Findings

- Educational and motivational campaigns and the installation of alcohol based dispensers were ineffective in increasing compliance with hand washing
- No mention was made in regards to specific nursing unit design

O'Malley, A., Varadharajan, V., & Lok, S. (2005). Hand decontamination by medical staff in general medical wards. *Journal of Hospital Infection*, 59, 369-376.

Focus of Study

- To determine hand decontamination practices among physicians during ward rounds

Research Design

- Four house officers monitored other physicians on the team, over a two-week period, to determine whether the other doctors on the team decontaminated their hands after examining patients
- An audit was performed to determine if facilities were available for hand decontamination

Sample Information & Site

- 17 ward rounds by four medical teams were observed

Findings

- Hand decontamination after patient contact occurred 31% of the time
- More senior members decontaminated their hands more frequently
- Staff may be more likely to decontaminate their hands if facilities are available and convenient

Implications of Findings

- Medical staff have poor compliance with hand decontamination. The importance of hand decontamination needs to be reiterated.
- No mention was made in regards to specific nursing unit design

Pittet, D., Mourouga, P., Perneger, T.V. (1999). Compliance with hand washing in a teaching hospital. *Annals of Internal Medicine*, 130(2), 126-130.

Focus of Study

- To investigate factors related to poor compliance with hand washing in a teaching facility

Research Design

- Observational study took place
- Five trained infection-control nurses recorded potential opportunities and actual performance of hand washing during 20-minute observation periods
- Predictor variables included hospital ward, patient-to-staff ratios, time of day, day of week, professional category, type of patient care, and level of risk for cross-contamination

Sample Information & Site

- This study took place at the University of Geneva Hospital, in Geneva, Switzerland; 48 wards were used
- 1,043 healthcare workers were observed (520 nurses, 158 physicians, 166 nursing assistants, 199 other healthcare workers)

Findings

- Average compliance with hand washing was 48 percent
- In 34 percent of instances, hand washing was done with soap and in 14 percent of instances it was done with anti-septic solutions
- Compliance lower in surgical and intensive care units
- Compliance lower during morning shifts and on weekdays
- Compliance lower for high-risk transmission procedures; compliance higher for low-risk activities
- Compliance lower when activity index high
- Nurses had better compliance than other healthcare workers

Implications of Findings

- Understaffing and high workloads contributed to decreased compliance with hand washing procedures
- Education programs and bedside antiseptics may help increase compliance

Salerno, S., Canulla, M., Talamanca, I. F. (2005). Ageing in nursing: A ten year follow up study. *International Congress Series*, 1280, 124-129.

Focus of Study

- To evaluate the role of job stress on ageing among nurses who had shown menstrual irregularities related to work stress

Research Design

- The nurses examined in an earlier study (1992) were contacted
- An interview took place to obtain information pertaining to work status, health status, and reproductive history
- Perceived stress was measured by the NIOSH work stress questionnaire

Sample Information & Site

- This study took place in a University hospital in Rome, Italy.
- 28 female nurses who took part in a previous study participated in this study.

Findings

- 61% of the nurses had changed nursing job
- 33% of the nurses had moved to less stressful unit

- High stress perceptions increased both at work and out of work, but strenuous work activity decreased
- Nurses reported increase in chronic disease
- Frequency of irregular menstrual patterns increased with age
- Pregnancy outcomes were poor especially among nurses on high stress units; higher risk for nonvoluntary abortion occurred among nurses in high stress units, older nurses, and in smokers
- Percent of delayed pregnancies greatest among nurses on high stress unit

Implications of Findings

- Majority of nurses, over time, moved to less stressful units
- Nurses on high stress units had greater complications with pregnancies

Shepley, M. M., & Davies, K. (2003). *Nursing Unit Configuration and Its Relationship to Noise and Nurse Walking Behavior: An AIDS/HIV Unit Case Study*. Retrieved 11/26/2004, from http://www.aia.org/aah_a_jrnl_0401_article4

Focus of Study

- To compare two nursing unit designs in AIDS facilities.

Research Design

- Two nursing units within a few miles of each other were selected
- The plan configuration of the two units was diverse. One unit had a double-corridor rectangular floor plan with the nurses' station in the core and patient rooms on the perimeter. The other unit had a circular design with the nurses' station in the center and patient rooms around the circumference
- Sound levels were measured with a noise-logging dosimeter; walking was measured using electronic pedometers
- Noise data and walking measure were obtained

Sample Information & Site

- Two nursing units in hospitals within a few miles of each other were selected; the nursing units had a focus on care for HIV/AIDS patients
- Nursing staff on both units participated

Findings

- Nurses on the radial unit walked an average of 1.97 miles per segment while nurses on the rectangular unit walked an average of 6.87 miles
- Noise levels did not vary significantly among the units

Implications of Findings

- Nurses working on the radial design walk less than those working on the rectangular design. By walking less, they may be able to spend more time in patient care.

Sturdavant, M. (1960). *Intensive nursing service in circular and rectangular units. Hospitals, JAHA, 34(14),46-48, 71-78.*

Focus of Study

- To test the effectiveness of the circular unit for intensive nursing care

Research Design

- The design includes a nurses' station encircled by a corridor around which there are 12 private rooms
- The circular unit was compared to a rectangular unit
- Observations of nurses' behaviors were made

Sample Information & Site

- This study took place at Rochester (Minn.) Methodist Hospital
- All nurses (18) on both units were observed and interviewed
- 119 patients on the rectangular unit and 128 patients on the circular unit were interviewed
- 86 relatives of patients on the rectangular and 108 relatives of patients on the circular unit filled out questionnaires
- 10 surgeons filled out questionnaires

Findings

- Visibility into the patients' room was greater on the circular unit
- Staff could not see their patients for 10% of their working time in the circular unit compared to 50% of their working time in the rectangular unit
- Patients were more satisfied overall with the circular unit; visual contact accounted most strongly for the higher satisfaction
- Relatives of patients on the circular unit reported greater satisfaction than relatives of patients on the rectangular ward
- All nurses and the majority of surgeons preferred the circular unit
- Nurses spent less time traveling on the circular unit
- The amount of time spent with patients was similar in both units, though it was used more effectively in the circular unit

Implications of Findings

- Nursing time was more effectively used in the circular unit, and patients, relatives, surgeons, and nurses were more satisfied on this unit

Topf, M. & Dillon, E. (1988). Noise-induced stress as a predictor of burnout in critical care nurses. *Heart Lung, 17(5), 567-574.*

Focus of Study

- To assess the degree and sources of noise-induced stress among critical care workers
- To determine whether noise-induced stress is associated with burnout

Research Design

- Nurses completed questionnaires which included The Life Experiences Survey, used to measure life events stress in nurses, The Nursing Stress Scale, used to measure occupational stress, Weinstein's Noise Sensitivity Scale, used to measure nurses' sensitivity to noise, Disturbance Due to Hospital Noise Scale, used to measure stress caused by hospital sounds, and the Maslach Burnout Inventory and Jones's SBS-HP, used to measure burnout

Sample Information & Site

- This study took place at two large university-affiliated hospitals on the West Coast; Units sampled include cardiac, medical-surgical, urology, neonatal, and pediatric critical care units
- 76 nurses from one hospital and 24 nurses from the second hospital participated in this study

Findings

- Nurses who worked eight-hour evening shifts were more distressed by noise

Nurses who rotated shifts had higher levels of emotional exhaustion

- Most disturbing noises were produced by telephones, alarms on equipment, and beeping of patient monitoring devices
- Greater degree of noise-induced stress associated with higher levels of burnout

Implications of Findings

- Noise-induced stress was related to higher levels of burnout among critical care nurses
- Efforts should be made to reduce noise levels

Trites, D. K., Galbraith, F. D. Jr., Sturdavant, M., & Leckwart, J. F. (1970, December). Influence of nursing-unit design on the activities and subjective feelings of nursing personnel. *Environment and Behavior, 303-334.*

Focus of Study

- To investigate the impact of radial, single-corridor, and double-corridor nursing unit designs on the activities and subjective feelings of nurses working on these units

Research Design

- Twelve observers collected work sampling data over a period of eighty-two days
- Nurses were also asked to complete questionnaires pre-shift and post-shift, which examined patient care and the subjective feelings of staff members
- Units examined were four units of each design type including: radial, single-corridor, and double-corridor

Sample Information & Site

- The study took place at Rochester Methodist Hospital
- The sample included 590 staff members who worked on the units

Findings

- Radial design was found to be the best design regarding nursing activities and their locations
- Single-corridor design was the worst of the three designs
- Nurses had the most accidents on the single-corridor design and the lowest absenteeism on the radial design
- Majority of nurses stated that they would prefer to work on the radial design unit and the radial design had the most positive effect on the subjective feelings of the nurses studied
- Time spent traveling by nurses was lowest on the radial design unit

Implications of Findings

- The radial design was preferred as nurses spent less time in travel than those on the other units and, as a result, they were able to spend more time with patients

Trites, D. K., Galbraith, F. D. Jr., Leckwart, J. F., & Sturdavant, M. (1968). Radial nursing units prove best in controlled study. *Modern Hospital, 112(4), 94-99*

Focus of Study

- To investigate the impact of radial, single-corridor, and double-corridor nursing unit designs on the activities and subjective feelings of nurses working on these units

Research Design

- Nursing students collected work-sampling data between June and September of 1967
- Nurses asked to complete questionnaires pre-shift and post-shift, which examined patient care and the subjective feelings of staff members
- Units examined were four units of each design type including radial, single-corridor, and double-corridor

Sample Information & Site

- The study took place at Rochester Methodist Hospital
- The sample included 590 staff members who worked on the units

Findings

- The radial design was superior to the other designs on all three shifts
- Nurses spent significantly less time traveling on the radial ward, and in turn, they were able to spend more time with patients
- Average distance from the center of the radial nursing unit to the patient's bedside is 34 feet; in the double-corridor design the distance is 48 feet; on the single-corridor design the distance is 71 feet
- Nurses preferred working on the radial unit and fewer staff absences and fewer accidents occurred on the radial unit
- Fewer complaints were received on the radial unit by patients, relatives, and physicians

Implications of Findings

- The radial design was preferred as nurses spent less time in travel than those on the other units and, as a result, they were able to spend more time with patients

Whitby, M., & McLaws, M. L. (2004). Hand washing in healthcare workers: Accessibility of sink location does not improve compliance. *Journal of Hospital Infection*, 58, 247-253.

Focus of Study

- To evaluate compliance with hand washing after the rebuilding and relocation of a tertiary referral hospital

Research Design

- Old facility contained Nightingale-style wards with three hand washing positions on each ward
- New facility had sinks positioned at the bedside and at entrance to patient room
- Before relocation, staff was observed for frequency of hand washing
- Observations were repeated one month and ten months after relocation

Sample Information & Site

- This study took place at Princess Alexandra Hospital, in Brisbane, Australia; it is an 800-bed tertiary referral hospital; observations took place on intensive care unit, infectious diseases unit, internal medicine ward, and urology ward
- Staff working on these four units participated in this study

Findings

- Prior to the move, compliance with hand washing post-patient contact was highest on the infectious diseases unit and intensive care unit
- One month after move, hand washing higher in internal medicine ward, intensive care unit, and infectious disease unit; increased compliance not sustained
- Compliance with hand washing prior to a procedure consistently low on all units

Implications of Findings

- The increased availability of sinks did not significantly increase compliance with hand washing among healthcare workers

Yassi, A., Cohen, M., Cvitkovich, Y., Park, I. H., Ratner, P. A., Ostry, A. S., Village, J., & Pollack, N. (2004). Factors associated with staff injuries in intermediate care facilities in British Columbia, Canada. *Nursing Research*, 53(2), 87-98.

Focus of Study

- To identify organizational, psychosocial, and biomechanical factors associated with staff injuries
- To identify management practices that may reduce staff injuries

Research Design

- Data over a five year period (1995-1995) was provided by the Workers' Compensation Board of British Columbia
- Four facilities with highest quartile of time-loss injury rates were selected and matched with four facilities with injury trend in the lowest quartile
- Ergonomic data was collected, interviews and focus groups were conducted with managers and frontline staff, and telephone surveys of care aides and LPNs employed at the facilities were conducted
- 39 interviews and 8 focus groups were held

Sample Information & Site

- Four representative intermediate care facilities with high staff injury rates and four facilities with comparable low injury rates in British Columbia, Canada were used
- Managers, frontline staff, care aides and LPNs participated in this study

Findings

- Physical workload and staffing levels were associated with time loss injury rates and self-reported pain, burnout, health, and job satisfaction
- Organizational culture more positive at facilities with lowest quartile time-loss injury rates; these facilities were more suc-

cessful at running meetings including workers, staff were informed of relevant information regarding new patients, care aides and LPNs attended care conferences for patients, staff showed greater understanding of philosophy of care, and relationship with director of care was more open, sympathetic, and responsive

- Workers at facilities with highest quartile of time-loss injury rates felt they were poorly informed about new patients, had a cynical attitude towards management's views about quality of care, and did not trust their director of care
- Employees at facilities with lowest quartile time-loss injury rates felt their facilities invested time and money to improve staff safety
- Employees at facilities with lowest quartile time-loss injury rates had better staffing levels, fewer injuries, less pain, and better self-reported health; reported feeling better able to provide quality care

Implications of Findings

- Better staffing levels reflects organizational focus supporting well-being of workers and patients
- Managers at facilities with lowest quartile time-loss injury are likely to have an engaged workplace, a substantive philosophy of care, and concrete policies and practices

Non Empirical Articles: Health Care Design and Staff Health and Safety

Allen, C., & Jones, J. (2002). Acute wards: Problems and solutions. *Psychiatric Bulletin*, 26, 458-459.

Focus of Article

- To identify problems and solutions in acute care mental health wards

Type of Healthcare Facility

- The material presented in this article applies to acute care mental health wards in the United Kingdom.

Recommendations for Healthcare Setting

- Most in-patient units are not viewed positively by patients, families, and nursing staff
- In-patients do not have many opportunities for therapeutic and recreational interventions; they are at risk of self-harm, suicide, and physical attack; find ward atmosphere bleak and unsafe
- Nursing staff lack opportunities for development and training in management of aggression, and experience high levels of stress
- Nurses should spend more time interacting with patients; may enable patients to feel safer, reassured, and more cared for

Implications of Findings

- Nurses need to spend more time engaging with patients to increase comfort levels of patients
- No mention was made in regards to specific nursing unit design

Elliott, P. R. A. (1992). Hand washing: A process of judgement and effective decision-making. *Professional Nurse*, 2, 292-296.

Focus of Article

- To examine the relationship between clinical judgment and decision-making and hand washing.

Type of Healthcare Facility

- The information presented in this article applies to acute care facilities.

Recommendations for Healthcare Setting

- Factors influencing hand washing include: degree of stress practitioners are subjected to, time available, degree of education and training received, observed practices of clinical managers and peers, whether gloves are used, and attitudes
- Practitioners are failing to rationalize their hand washing decisions
- Educational establishments should emphasize the need for increased understanding and awareness
- Management should actively encourage practitioners to consider the effect of their actions
- Posters and leaflets should be displayed for hospital staff
- Distribute infection control policies and hand washing procedures to all employees

Implications of Findings

- Efforts, such as distributing posters and infection control policies, should be made to increase practitioners' knowledge of hand washing implications
- No mention was made in regards to specific nursing unit design

Fisher, S. (1982). Design reduces nurses' walking, encourages patients to visit with each other. *American Health Care Association Journal*, 8(2), 40-43.

Focus of Article

- To discuss the design of a nursing home and its impact on nurses.

Type of Healthcare Facility

- The information presented in this article applies to the Christian City Convalescent Center; near Union City, Georgia. It is a 200-bed nursing home.

Recommendations for Healthcare Setting

- Two frequent complaints made by nurses in nursing homes are that they have tired feet and that patients have a tendency to gather around their workstations.
- The design of this facility incorporates a square structure. Rooms are located around the perimeter; and patient rooms are located within 45 feet of the nurses' station.
- Patient bathrooms are located on the exterior walls, and this feature enables nurses to observe patients without entering the patient room.
- Design maximizes the use of space, increases the intensity of patient care, and makes the facility feel less institutional.
- Less walking is required to get anywhere within the facility. Nurses have to walk less and visitors have an easier time locating the patients.
- Morale is high and turnover is low among registered nurses, partly because of the reduced amount of walking that is required.
- Lounges are designed to be conducive to socializing, as an open space is located at each corner of the square.

Implications of Findings

- Compact square design of this facility makes maximal use of space and reduces the amount of traveling done by nurses

Girard, N. E. (1978). Room clusters facilitate nursing care. *Modern Healthcare*, 8, 46-47.

Focus of Article

- To describe renovations made to Somerville Hospital.

Type of Healthcare Facility

- The material presented in this article applies to Somerville Hospital in Boston, Massachusetts.

Recommendations for Healthcare Setting

- Rooms were grouped into clusters and arranged to minimize amount of walking for nurses and bring them closer to more patients
- 121 beds were replaced with two 60-bed cluster floors; 20 patients in 12 rooms are grouped into two six-room clusters across from each other
- Each 20-bed grouping has a nursing team
- Cluster design minimizes distances between nurse to patient and eliminates link between nurses' station to patient
- Patient/staff visibility most noted by both parties
- Patients feel get more attention and complaints of privacy are resolved by drawing bedside curtain or closing door
- Staffing is 14% less than required in old building

Implications of Findings

- Through a cluster design, nurses are required to walk less, they have better patient visibility, and they are closer to their patients.

Harrison, S. (2004). Bad hospital design leads to poor staff performance. *Nursing Standard* 1, 8(46), 7.

Focus of Article

- To describe how hospital design impacts staff performance

Type of Healthcare Facility

- The material presented in this article applies to National Health Service hospitals in England.

Recommendations for Healthcare Setting

- Well-designed hospitals improve staff performance
- Bad design impacts recruitment and retention
- Nurses feel they should be consulted on hospital design
- Nurses base their decisions of employment on the work-space of wards, visible security, and secure parking
- Insufficient storage and electrical outlets as well as small doors were complaints made by nurses

Implications of Findings

- Hospital design impacts nurses' performance as well as their desire to remain working in the hospital
- No mention was made in regards to specific nursing unit design

Lundstrom, T., Pugliese, G., Bartley, J., Cox, J., & Guither, C. (2002). Organizational and environmental factors that affect worker health and safety and patient outcomes. *American Journal of Infection Control*, 30(2), 93-106.

Focus of Article

- To review organizational factors which influence satisfaction, health, safety, and well-being of healthcare workers and ultimately impact patient care
- To discuss the impact of the work environment on working conditions and its effects on healthcare workers and patients

Type of Healthcare Facility

- The material presented in this article applies to healthcare facilities in general.

Recommendations for Healthcare Setting

- Work stressors include role ambiguity, role conflict, pressure, heavy workloads, and physical discomforts; stress results in

job dissatisfaction, burnout, injuries and illness, staff turnover, and reduced mental health

- Stressors can be reduced through supportive social environment
- Strong safety climate associated with positive attitudes among staff; need to know administration concerned about their safety
- Lack of resources, such as support from coworkers and supervisors, contributes to stress and burnout
- Work pressure, high work demands, lack of coworker support, and fear of job loss contribute to occurrence of musculoskeletal disorders among staff
- Compliance with safety-related behaviors related to senior management commitment and support for safety programs, absence of barriers to safe work practices, and cleanliness and orderliness of worksite
- Healthcare workers can acquire infections from patients, visitors, other healthcare workers, and the environment; healthcare workers can also infect patients
- High-reliability units, which are technologically complex and interactive, reduce patient injury
- Degree of stress experienced by staff and understaffing are related to occurrence of patient incidences
- Higher mixes of registered nurses on a unit is associated with fewer medication errors and lower rates of patient falls
- Shift rotation is related to decreased worker satisfaction and poorer performance
- Factors important for healing and well-being of patients in physical environment include connection to staff, conducive to well-being, convenient and accessible, allows confidentiality and privacy, provides connection to outside world, is safe and secure, cares for family, and is considerate of impairments
- Negative outcomes associated with poor ventilation; room location and design and location of air intakes and exhaust vents critical determinants in transmission of airborne contaminants
- Contaminated water can be source of waterborne pathogens
- Magnet hospitals provide excellent patient care and professional patient environments; empower nurses to use professional knowledge
- Nurses in magnet hospitals have lower levels of emotional exhaustion and higher job satisfaction than nurses in non-magnet hospitals; patients have higher satisfaction; lower mortality rates found in magnet hospitals

Implications of Findings

- Factors that lead to stress among nurses include role ambiguity, role conflict, heavy workloads, and lack of resources
- Higher stress levels among staff lead to poorer patient outcomes

- Key factors of the physical environment include conduciveness to well-being of staff and patients, confidentiality and privacy, connection to outside world, and safety and security

McCaughey, B. (2005, June 6). Coming Clean, *The New York Times*, p.A19.

Focus of Article

- To describe infection control measures.

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities in the United States.

Recommendations for Healthcare Setting

- One out of every 20 patients acquires an infection during stay at hospital as a result of poor hygiene
- One of deadliest germs in methicillin-resistant *Staphylococcus aureus* (MRSA); lives harmlessly on skin but damaging if enters body
- Hospitals in Denmark, Finland, and the Netherlands have reduced infection rates of MRSA through enforcement of hand washing rules, meticulous cleaning of equipment and hospital rooms, used of gowns and disposable aprons, and testing incoming patients to identify those carrying MRSA
- In the United States, doctors and healthcare workers fail to wash their hands more than half the time when treating patients
- Nearly three-quarters of rooms are infected with MRSA
- Costs of infection high since patients have increased lengths of stay

Implications of Findings

- Infection control measures such as enforcement of hand washing rules, meticulous cleaning of equipment and hospital rooms, and use of gowns and disposable aprons may help reduce the transmission of MRSA in facilities

Pittet, D. (2004). The Lowbury lecture: Behaviour in infection control. *Journal of Hospital Infection*, 58, 1-13.

Focus of Article

- To describe methods to improve infection control

Type of Healthcare Facility

- The material presented in this article applies to healthcare facilities in general.

Recommendations for Healthcare Setting

- Education integral to improving hand hygiene
- Educational programs should emphasize availability and awareness of guidelines for hand hygiene, potential risks of

transmission of microorganisms to patients, knowledge regarding hand hygiene, awareness of low compliance, and recognition of opportunities for hand hygiene

- Teaching should address morbidity, mortality, and costs associated with nosocomial infections
- System changes may be needed in hospitals which promote skin care for health care workers' hands and introduce monitoring and performance feedback
- Compliance is associated with knowledge of being observed, belief of being role model, positive attitudes towards hand hygiene after patient contact, and easy access to alcohol-based rub solutions
- Noncompliance is affected by high workload, high risk of cross-transmission activities, technical medical specialties, surgery, anesthetics, emergency medicine, and intensive care medicine

Implications of Findings

- Education, which focuses on the negative implications of poor hand hygiene and ways to improve hand hygiene, is critical to improving compliance

Scott, H. (2004). Working environments have a direct impact on care. *British Journal of Nursing*, 13(15), 893.

Focus of Article

- To describe research on how the working environment of nurses impacts quality of care

Type of Healthcare Facility

- The material presented in this article applies to National Health Service hospitals in England.

Recommendations for Healthcare Setting

- Design and layout of hospital is a major contributing factor for recruiting and retaining nurses
- Exposure to artificial lights is very draining for nurses
- Factors impacting nurses' morale include design and organization of the environment and quality of staff facilities
- Nurses do not feel their views are being considered regarding the working environment

Implications of Findings

- The design of the working environment greatly impacts nurses' morale and their decision to continue working in the hospital
- No mention was made in regards to specific nursing unit design

Seeyle, A. (1982). Hospital ward layout and nurse staffing. *Journal of Advanced Nursing*, 7, 195-201.

Focus of Article

- To discuss the relationship between ward design and nurse staffing levels.

Type of Healthcare Facility

- The information presented in this article applies to acute care facilities.

Recommendations for Healthcare Setting

- Number of factors affect nurses' workload: characteristics of the patients, organizational policies, physical layout of the ward, support systems, equipment, and changes in medical treatment.
- Design of ward influences the work patterns of nurses
- Circular units required less walking time for nurses and nurses were able to spend more time with patients.
- Patients on radial and double-corridor units had more favorable opinions than patients on the single-corridor units
- Radial wards had greater visibility of patients allowing for increased contact between patients and nurses.
- Medical patients require less travel than surgical patients
- Main cause of complaints for patients is related to staff-patient communication

Implications of Findings

- Ward design should facilitate contact between nurses and their patients as well as reduce the amount of time nurses spend walking to obtain items necessary for patient care.

Williams, M.A. (1988). The physical environment and patient care. *Annual Review of Nursing Research*, 6, 61-84.

Focus of Article

- To review literature linking physical environment factors to patient care and nursing behaviors

Type of Healthcare Facility

- The material presented in this article applies to studies conducted in the United States and the United Kingdom.

Recommendations for Healthcare Setting

- Nursing behaviors affected by unit design are ease and frequency of interaction with patients and families, travel time, staffing requirements, infection control, satisfaction, surveillance, and communication
- Effective and efficient nursing care related to short travel distances traveled by nurses and features that maximize communication between nurses and patients

- Social organization of the hospital was discovered to define the relationship between space use and staff roles
- Physical design of work environment can influence nature of interpersonal interaction between supervisor and nurse
- Regarding noise levels, infants were found to be particularly vulnerable to continual loud noises
- Average levels of sound in patient rooms were found to exceed recommended levels on a surgical nursing unit

Implications of Findings

- The physical environment can impact the behaviors of nurses including traveling distances and interpersonal interactions with supervisors

Empirical Articles: Healthcare Design and Staff Outcomes

Adamson, B., Kenny, D., & Wilson-Barnett, J. (1995). The impact of perceived medical dominance on the workplace satisfaction of Australian and British nurses. *Journal of Advanced Nursing*, 21, 172-183.

Focus of Study

- To determine the degree to which Australian and British nurses experience structural dominance as well as how their perceptions influence workplace satisfaction.

Research Design

- Questionnaires were distributed to Australian and British nurses.
- Questionnaires included information pertaining to nurses' self-perceptions, self-descriptions, perceptions of the medical profession, and description of the medical profession.

Sample Information & Site

- Nurses working in large metropolitan hospitals and clinics in Sydney, Australia were recruited. Nurses working in two major metropolitan hospitals in England were also approached.
- 133 Australian nurses and 108 British nurses participated.

Findings

- British nurses perceived themselves to be more dissatisfied than Australian nurses regarding their working conditions, status and influence.
- British nurses perceived the medical profession to be more authoritarian than their Australian counterparts regarding patient and professional relationships

- In general, nurses were more dissatisfied than the medical profession regarding their pay, status, and relationships with professional associations

Implications of Findings

- Both Australian and British nurses experienced high levels of dissatisfaction with their professional status. They perceived the medical profession to be highly satisfied with their professional status.
- No mention was made in regards to specific nursing unit design

Aiken, L. H., Clarke, S. P., Sloane, D. M., Sochalski, J., & Silber, J. H. (2002). Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *Journal of the American Medical Association*, 288(16), 1987-1993.

Focus of Study

- To determine the relationship between the patient-to-nurse ratio and patient mortality as well as nurse retention.

Research Design

- Information regarding hospital staffing and organization obtained from nurse surveys was combined with patient outcomes derived from hospital discharge abstracts and hospital characteristics retrieved from administrative databases.
- Data from all 210 adult general hospitals in Pennsylvania was obtained. Information regarding hospital characteristics was obtained from the 1999 American Hospital Association Annual Survey and the 1999 Pennsylvania Department of Health Hospital Survey.
- Nurses completed questionnaires regarding their workload, job satisfaction and burnout.
- The Pennsylvania Health Care Cost Containment Council provided discharge abstracts from 1998 to 1999.

Sample Information & Site

- This study included 168 general hospitals in Pennsylvania.
- A random sample of nurses working at the hospitals was used. A total of 10,184 nurses participated.
- Data was obtained for 232,342 general, orthopedic, and vascular surgery patients.

Findings

- Of the patients studied, 23% experienced a major complication during their stay and 2.0% died within 30 days of admission.
- As the amount of patients per nurse increased, job dissatisfaction and burnout increased.
- Mortality rates could decrease from increasing the amount of nurses

- Nurses in hospitals with high nurse-to-patient ratios are more than twice as likely to be dissatisfied with their jobs than nurses in hospitals with the lowest ratios.

Implications of Findings

- Increased nurse staffing could reduce the mortality rates of patients as well as the levels of burnout and dissatisfaction experienced by nurses.
- No mention was made in regards to specific nursing unit design

Aiken, L., Clarke, S., Sloane, D. Sochalski, J., Busse, R., Clarke, H., Giovannetti, P., Hunt, J., Rafferty, A., & Shamian, J. (2001). Nurses' reports on hospital care in five countries. *Health Affairs, 20(3), 43-53.*

Aiken, L. H., Clarke, S. P., Sloane, D. M., & Sochalski, J. A., (2001). An international perspective on hospital nurses' work environments: The case for reform. *Policy, Politics, & Nursing Practice, 2(4), 255-263.*

Focus of Study

- To investigate work environments and quality of care provided at hospitals in five different countries: United States, Canada, England, Scotland, and Germany.

Research Design

- Nurses from 711 hospitals in 5 countries were surveyed to determine organizational climate, nurse staffing, and nurse and patient outcomes.
- Sampling of nurses was designed to assess a large number of hospitals in each country studied.

Sample Information & Site

- The sample consists of 43,329 nurses from the United States (Pennsylvania), 17,450 nurses from Canada, 5,006 nurses from England, 4,721 nurses from Scotland, and 2,681 nurses in Germany.
- Nurses were working in adult acute care hospitals in 1998 and 1999.

Findings

- Large amounts of nurses in every country except Germany were dissatisfied with their jobs.
- Job dissatisfaction among nurses in the United States is higher than other groups of workers (40% vs. 10-15%).
- Percentage of nurses under the age of 30 who plan to leave their jobs within the next year is higher than among nurses in general.

- Fewer than half the nurses in each country reported that management was responsive to their concerns and allowed them to participate in decision making
- Deterioration of care was more commonly reported in North American countries than in European countries
- North American nurses were more likely to report patient falls and medication errors, as well as complaints from the patient and family, occurred with regularity during the preceding year.

Implications of Findings

- Nurses in the five countries surveyed are dissatisfied with their jobs. To retain a qualified nursing staff and to create an environment in which nurses want to work in, management needs to respond to their concerns and include them in aspects of decision making. Hospitals need to develop policies comparable to those of other businesses.
- No mention was made in regards to specific nursing unit design

Alimoglu, M. K., & Donmez, L. (2005). Daylight exposure and the other predictors of burnout among nurses in a university hospital. *International Journal of Nursing Studies, 42, 549-555.*

Focus of Study

- To determine if daylight exposure is a predictor of burnout among nurses

Research Design

- Questionnaires were distributed to nurses
- Measures included the Maslach Burnout Inventory (MBI), the Work related Strain Inventory (WRSI) and the Work Satisfaction Questionnaire (WSQ); demographic, socio-economic, personal, and work related information were also obtained

Sample Information & Site

- The study took place at Akdeniz University Hospital in Antalya, Turkey.
- 141 nurses participated in the study.

Findings

- Levels of emotional exhaustion were moderate, feelings of detachment were low, and feelings of incompetence and lack of productivity were high
- A link exists between work stress, job satisfaction, and burnout
- 66 nurses reported they were exposed to less than 3 hours of daylight during a typical workday

- Exposure to at least 3 hours of daylight reduced work stress and dissatisfaction

Implications of Findings

- Work related stress and job satisfaction mediated the relationship between exposure to daylight hours and burnout
- As their exposure to daylight increased, nurses were less likely to experience stress and dissatisfaction with their jobs, and thus, levels of burnout were lower

Amos, M. A., Hu, J., & Herrick, C. A. (2005). The impact of team building on communication and job satisfaction of nursing staff. *Journal for Nurses in Staff Development, 21(1)*, 10-16.

Focus of Study

- To assess the impact of team-building strategies on communication and job satisfaction

Research Design

- Group pretest and posttest design was used
- Pretest data was obtained using a demographic questionnaire, a staff communication evaluation tool and the IWS to measure job satisfaction
- Staff attended a team-building intervention program after baseline data was collected
- 3 months after the intervention, a posttest was conducted using the same questionnaires as the pretest. Participants also completed the hospital employee perceptions survey

Sample Information & Site

- 44 of the 52 nurses, nursing assistants, and nursing secretaries/monitor technicians on a medical-surgical unit took part in this study
- The study took place in a general hospital in the United States

Findings

- After the intervention, the use of positive and constructive feedback by staff improved 5 percent
- Listening skills were improved and communication occurred more freely after the intervention
- Improvements occurred in following through on commitments, explaining obstacles, keeping others updated on progress, accepting constructive feedback in positive manner, demonstrating personal accountability, and acquiring and sharing job related knowledge
- The turnover rate decreased by approximately 7 percent the year after the intervention in comparison to the year before the intervention
- Staff was not satisfied with pay rates and indicated pay rates were most important factor in work satisfaction

Implications of Findings

- Turnover rates decreased after the team-building intervention program
- Staff members who are satisfied with their work environment will want to remain in their place of work, thus saving the hospital money on recruitment
- A stable work force will enable hospitals to provide quality care which will result in positive patient outcomes

Bloom, J. R., Alexander, J. A., & Nuchols, B. A. (1997). Nurse staffing patterns and hospital efficiency in the United States. *Social Sciences Medicine, 44(2)*, 147-155.

Focus of Study

- To assess the effects of nurse staffing patterns on the efficiency of patient care delivery
- Four nursing patterns were observed: use of temporary nursing agencies, use of part time nurses, increased skill mix of nursing staff, and increased experience of nursing staff

Research Design

- Data was obtained from the Nurse Personnel Survey which was developed to obtain information pertaining to vacancies and turnover among nurses
- The general organizational structure of the hospitals was obtained from the 1981 AHA annual survey of hospitals
- Area Resource file provided county-level data on external environment of hospital

Sample Information & Site

- 583 hospitals in the United States were the focus of this study

Findings

- Hospitals with a higher proportion of registered nurses with more than five years tenure have lower pay and benefits costs per admission
- Greater use of temporary agency registered nurses was associated with higher operating costs
- Use of part-time and more experienced staff was associated with increased operating efficiency and lower operating costs
- Organizational variables having a positive effect on operating costs include: presence of residency program, longer length of stay, greater acuity of patient mix, and higher wages for new employees
- Hospitals in urban areas and areas with more competition have higher costs
- Skill mix of staff is unrelated to either personnel or non-personnel operating costs

- Private ownership of hospitals is related to lower personnel costs, but was unrelated to operating costs

Implications of Findings

- When hospitals use temporary agency registered nurses frequently, operational costs increase
- Hospitals with a more experienced nursing staff are likely to have lower operating costs

Bowers, B. J., Luring, C., & Jackson, N. (2001). How nurses manage time and work in long-term care. *Journal of Advanced Nursing*, 33(4), 484-491.

Focus of Study

- To understand how working conditions affect the quality of care provided by nurses in long-term care.

Research Design

- Formal interviews were conducted with 18 nurses from 2 not-for-profit nursing homes in the Midwestern United States.
- Observations of nurses were conducted over a 3-month period. Throughout the observations, informal interviews were conducted which focused on nursing activities.

Sample Information & Site

- Nurses were recruited based on variations in their work patterns and years of experience.
- The study took place in two not-for-profit nursing homes. One was located in an urban and the other in a rural area of Midwestern United States. Each facility has between 100-150 beds.

Findings

- Tasks completed by nurses during a shift included passing medications, monitoring resident status, charting and creating documentation, and interacting with physicians.
- Job satisfaction was mainly found in nurses' interactions with the residents.
- Main source of job dissatisfaction was time. Nurses felt they did not have enough time to complete their required tasks and spend time with residents.
- Strategies to manage time include minimizing time spent doing required tasks as well as redefining work responsibilities.
- By reducing time spent doing required tasks, quality of patient care declined.

Implications of Findings

- Nurses felt they did not have enough time to complete their required tasks, and as a result, patient care suffered. Increasing the staff ratios could result in improved outcomes for the patients since nurses would be able to provide better care.

- No mention was made in regards to specific nursing unit design

Cavanagh, S. J. (1992). Job satisfaction of nursing staff working in hospitals. *Journal of Advanced Nursing*, 17, 704-711.

Focus of Study

- To develop a model of nursing job satisfaction
- To use structural modeling techniques to test the model

Research Design

- After reviewing the literature, the researchers identified 10 variables related to job satisfaction: salary, benefits, communication, social integration, justice, promotion, participation, education, opportunity, and routine
- Based on these variables a model of job satisfaction was created
- Subjects were asked to complete a questionnaire assessing these variables

Sample Information & Site

- 221 female nurses working in the greater Los Angeles area participated in this study

Findings

- Nurses were predominantly satisfied with their job
- Variables with a positive effect on satisfaction were benefits, participation, promotion, routine, communication, and salary
- Variables associated with dissatisfaction include education, opportunity, integration, and justice
- Benefits had largest effect on job satisfaction
- Education had the largest effect on job dissatisfaction

Implications of Findings

- The most important factor in predicting job satisfaction is staff benefits, while the most important factor in predicting job dissatisfaction is education.
- Nurses with higher qualifications may have higher expectations for the job, and organizations may be unwilling to meet these expectations.
- No mention was made regarding nursing unit design

Ernst, M., Messmer, P. R., Franco, M., & Gonzalez, J. L. (2004). Nurses' job satisfaction, stress, and recognition in a pediatric setting. *Pediatric Nursing*, 30, 219-227.

Focus of Study

- To identify factors describing nursing satisfaction in the pediatric setting

Research Design

- An exploratory descriptive design was used
- Questionnaires were sent out to nurses; measures included nursing job satisfaction, organizational work satisfaction, job stress, and nurse recognition scale

Sample Information & Site

- This study took place in a 268-bed, pediatric urban hospital in the Southeastern United States
- 249 pediatric nurses were included in the sample.

Findings

- Nurses, in general, were satisfied with their jobs
- Older nurses were more satisfied with the recognition received than younger nurses
- Nurses with more experience had more confidence and were less concerned with time demands and task requirements than younger nurses
- Job stress was inversely related to age, years as a nurse, and years at the hospital
- Nurses want recognition to be more consistent

Implications of Findings

- Older nurses and those with more experience had less stress and greater satisfaction with their jobs. Older nurses had more confidence in their abilities and were not stressed with time demands.
- No mention was made in regards to specific nursing unit design

Gillespie, M., Melby, V. (2003). Burnout among nursing staff in accident and emergency and acute medicine: A comparative study. *Journal of Clinical Nursing*, 12, 842-851.

Focus of Study

- To compare burnout levels among nurses working in accident and emergency and those working on an acute medical ward

Research Design

- Quantitative and qualitative methods were used
- Nurses participated in interviews and completed the Maslach Burnout Inventory

Sample Information & Site

- The study took place in a National Health Service trust
- 16 nurses working in acute care and 20 nurses working in accident and emergency completed the questionnaires
- 6 nurses participated in focus group interviews

Findings

- Nurses working in acute medicine had higher levels of exhaustion than those working in accident and emergency
- Staff shortages contributed to high levels of emotional exhaustion
- Perceived lack of support from those in managerial positions
- Lack of time for group reflection contributed to emotional exhaustion
- Length of shift reported as a problem

Implications of Findings

- Nurses working in acute medicine had higher levels of emotional exhaustion than those working in accident and emergency
- Burnout levels were affected by staff shortages, lack of support from managers, lack of time, and length of shift.
- No mention was made in regards to nursing unit design

Halford, S., & Leonard, P. (2003). Space and place in the construction and performance of gendered nursing identities. *Journal of Advanced Nursing*, 42(2), 201-208.

Focus of Study

- To explore ways in which hospital spaces influence the working lives of nurses.

Research Design

- Two phases of 24-hour nonparticipant observation occurred; one phase was at the beginning of the study while the other occurred towards the end of the study
- Details of the physical environment, individuals present, activities, movement, and conversations were recorded
- 53 in-depth interviews were conducted with nurses and doctors

Sample Information & Site

- This study took place at two National Health Service (NHS) hospitals in the United Kingdom. 'Lakeside' hospital is a 700-bed District General hospital. The Accident and Emergency ward was studied in this hospital. 'Seaside' hospital is a 60-bed community hospital which provides mainly rehabilitation and medium-term care of the elderly. All wards, the Day hospital, and Minor Injuries Unit from this hospital were studied.
- Interviews were conducted with 53 nurses and doctors

Findings

- Nurses had the least access to space in both hospitals; nurses rarely visited other parts of the hospital and if they did, it was with a patient

- Spatial confinement was associated with little sense of allegiance to the hospital and negative images of other hospital spaces
- For nurses, workplace identities were strongly rooted in the wards
- Nurses at Seaside identified themselves strongly with their ward
- Lack of space generates stress and limits opportunities to relax

Implications of Findings

- Spatial confinement on wards was associated with workplace identities being rooted in the wards

Happell, B., Martin, T., & Pinikahana, J. (2003). Burnout and job satisfaction: A comparative study of psychiatric nurses from forensic and a mainstream mental health service. *International Journal of Mental Health Nursing, 12, 39-47.*

Focus of Study

- To compare the levels of stress, burnout, and job satisfaction in psychiatric/mental health nurses working in forensic in comparison to mainstream health service.

Research Design

- Participants completed surveys including measures pertaining to burnout, job satisfaction, and satisfaction with nursing care and work

Sample Information & Site

- The study took place in the metropolitan area of Melbourne.
- 95 forensic psychiatric nurses and 96 psychiatric nurses employed in mainstream mental health service were surveyed

Findings

- Forensic psychiatric nurses are more satisfied with their jobs than nurses from mainstream services
- Forensic nurses are more satisfied with their independence, responsibility, the care organization, quality of care, and the opportunity to discuss work
- Nurses employed in mainstream mental health services experience greater burnout than forensic nurses

Implications of Findings

- Forensic psychiatric nurses, who are content with their organization, experience less burnout and greater satisfaction with their jobs than nurses in mainstream mental health services
- No mention was made in regards to nursing unit design

Hodge, B., & Thompson, J. F. (1990). Noise pollution in the operating theatre. *The Lancet, 335, 891-894.*

Focus of Study

- To identify the main sources of noise in the operating room.

Research Design

- An operation was recorded to analyze overall noise levels during a typical major surgical procedure.
- Noise levels were measured with two sound level meters.

Sample Information & Site

- The study took place in the operating room of an Australian hospital.

Findings

- Loudest noises were recorded during the preparation period of the surgery.
- Background noises were low enough to make no substantial contribution to noise levels measured
- Peak sound levels recorded during the surgery could interfere with the concentration of staff members
- Excessive noise levels can impair and prevent reliable communication

Implications of Findings

- Strategies to reduce noise levels, especially during the preparation period of surgery, should be used to improve communication among staff members and to decrease patient anxiety.
- No mention was made in regards to specific nursing unit design

Hoffman, A. J., & Scott, L. D. (2003). Role stress and career satisfaction among registered nurses by work shift patterns. *Journal of Nursing Administration, 33(6), 337-342.*

Focus of Study

- To examine role stress and career satisfaction among registered nurses by shift length

Research Design

- A cross-sectional design was used
- A probability sample of Registered Nurses was recruited from the Michigan Nurses Association membership list
- Questionnaires were mailed out to nurses; measures of nursing stress, work satisfaction, and career satisfaction were used

Sample Information & Site

- 208 nurses from the Michigan Nurses Association participated

Findings

- Nurses working 12-hours shifts reported higher levels of stress than nurses working 8-hour shifts when caring for dying patients and managing workload situations
- Pay, autonomy, and professional autonomy are most expected sources of career satisfaction
- Least important factors contributing to career satisfaction include interaction with co-workers, task requirements, and involvement in organizational policies
- As amount of role stress increased, degree of career satisfaction was perceived to decrease
- Nurses with less work experience were more stressed than colleagues

Implications of Findings

- Registered nurses may experience greater satisfaction in their positions when strategies are implemented which promote autonomy, provide financial incentives, and recognize their professional status.
- Nurses with less work experience are more stressed, and when stress levels increase, satisfaction with career decreases
- No mention was made in regards to specific nursing unit design

Jenkins, R., & Elliott, P. (2004). Stressors, burnout and social support: Nurses in acute mental health settings. *Journal of Advanced Nursing*, 48(6), 622-631.

Focus of Study

- To compare stressors and burnout levels among qualified and unqualified nurses in acute mental health settings
- To examine the relationship between stressors and burnout
- To evaluate the impact of social support on burnout and stressor-burnout relationships

Research Design

- A convenience sample of nurses was identified from staff lists of 11 acute mental health wards at four hospitals in London and south-east England
- Self-report questionnaire was used including measures pertaining to background information, levels of stressors, burnout, and social support

Sample Information & Site

- The study took place on acute mental health wards at four hospitals in London and south-east England
- 57 qualified nurses and 36 nursing assistants participated in the study

Findings

- Main stressors for qualified nurses were lack of adequate staffing; for nursing assistants main stressors were client-related difficulties
- Higher stressor scores were related to higher levels of emotional exhaustion and depersonalization
- Higher levels of co-worker support were associated with lower levels of emotional exhaustion
- Qualified nurses and nursing assistants did not differ significantly in terms of burnout
- Workload had the strongest relationship with emotional exhaustion

Implications of Findings

- Lack of adequate staffing is a major source of stress for qualified nurses. Staffing levels should be maintained at a level where nurses can manage their workload so patient care does not suffer and so staff members do not experience burnout
- No mention was made in regards to nursing unit design

Jones, R. G. (1988). Experimental study to evaluate nursing staff morale in a high stimulation geriatric psychiatry setting. *Journal of Advanced Nursing*, 13, 352-357.

Focus of Study

- To examine staff morale in two geriatric psychiatric wards, each with distinct management approaches regarding care of the elderly with dementia

Research Design

- Staff were asked to complete questionnaires pertaining to their attitudes in an informal interview
- Data was collected from 2 wards: the control ward included a traditional nursing approach and provision of humane environment without unnecessary activities; the experimental ward included physical changes to promote social interaction and resource materials were readily available

Sample Information & Site

- All nursing staff on both geriatric psychiatric wards participated in this study (13 on the control ward; 16 on the experimental ward)
- The study took place in a Scottish hospital

Findings

- Nurses on the experimental ward are more satisfied with their jobs than those on the control ward
- Experimental ward nurses had more positive and decisive attitudes toward working in their area; control group was more indecisive in their responses

Implications of Findings

- The experimental group, working in a structured, highly stimulating environment, had a more positive attitude towards working in the geriatric psychiatric ward

Kalliath, T., & Morris, R. (2002). Job satisfaction among nurses. *Journal of Nursing Administration*, 32(12), 648-654.

Focus of Study

- To assess the impact of different levels of job satisfaction on burnout in nurses

Research Design

- Nurses completed questionnaires during working hours
- Questionnaires included two measures: the Maslach Burnout Inventory to measure burnout and a job satisfaction scale

Sample Information & Site

- The study took place at a general community hospital in the Midwestern United States
- 203 nurses participated in this study.

Findings

- Job satisfaction had a significant direct negative effect on emotional exhaustion
- Emotional exhaustion had a direct positive effect on depersonalization
- Job satisfaction is a significant predictor of burnout

Implications of Findings

- Higher levels of job satisfaction predict lower levels of burnout among nurses
- No mention was made in regards to specific nursing unit design

Kuhar, P. A., Miller, D. M., Spear, B. T., Ulreich, S. M., & Mion, L. C. (2004). The meaningful retention strategy inventory: A targeted approach to implementing retention strategies. *Journal of Nursing Administration*, 34(1), 10-18.

Focus of Study

- To examine retention strategies perceived as meaningful to nurses
- To design and implement interventions for issues perceived strongly by nurses

Research Design

- The Meaningful Retention Strategy Inventory was developed by the authors; consists of 59 items reflecting 8 attributes

which contribute to job satisfaction: autonomy, communication, administrative, recognition, working conditions, professional practice, scheduling/staffing issues, and pay/benefits

- Questionnaires were distributed to nurses via their mailboxes

Sample Information & Site

- This study took place in 8 of 9 hospitals at the Cleveland Clinic Health System of northeast Ohio; hospitals range from a 100-bed community hospital to a 1,000-bed academic tertiary care center
- 1,174 staff nurses and nurse leaders were surveyed

Findings

- Nurse leaders were more satisfied than staff nurses
- Older staff nurses were more satisfied than younger staff nurses
- Communication strategies were implemented to ensure clear communication between nurses and administration
- Nurse-physician partnership was created to improve teamwork and coworker support
- An equipment technician position was created to ensure equipment is available, safe, and functional
- Patient service associate role introduced; provides service recovery; successfully increased nursing and patient satisfaction
- Admission nurse role implemented on units with high admissions; completes the admission database, starts IVs, and initiates patient education
- Paratech position – unlicensed support healthcare providers with higher education level than patient care nurse assistants
- Implementation of salary compensation structure occurred
- Transportation department provides transportation for 100% of discharged patients; allows nursing staff to remain at bedside rather than escorting patients out of building
- Bed utilization department improves bed flow and dietary department provides support to nursing personnel
- Implementation of new equipment and supplies which provide more efficient care; allow staff to remain at bedside

Implications of Findings

- Multicomponent approach necessary to create an environment that retains staff
- By creating additional roles and distributing the workload, nurses feel they can manage their roles better and provide quality care to their patients

Lane, I. M., Prestholdt, P. H., & Mathews, R. C. (1991). Organizational factors associated with beliefs of nurses that influence turnover. *Journal of Organizational Behavior*, 12(7), 641-649.

Focus of Study

- To determine the organizational factors associated with turnover among nurses

Research Design

- Participants completed a questionnaire with measures pertaining to nurses' beliefs regarding their jobs, organizational factors, and hospital-oriented items

Sample Information & Site

- 470 registered nurses working in 23 Louisiana hospitals participated in this study

Findings

- Four organizational factors are relevant to nursing turnover: hospital's emphasis on nursing, influence of nurses, evaluation of director of nursing, and evaluation of immediate supervisor
- Nurses working in a hospital with emphasis on nursing may feel that hospital cares about them
- Nurses working in a hospital where they feel they have influence and respect to accomplish goals are more likely to feel positively about their job
- Nurses look to their director to reduce stress and improve salaries and job security

Implications of Findings

- Nurses who work in a hospital that emphasizes nursing, and that takes into account their opinions feel more positively regarding their work
- When nurses feel they have an influence in what occurs in the hospital, they have a more positive outlook regarding the environment they work in and are thus more satisfied with their jobs

Leiter, M. P., Harvie, P. & Frizzell, c. (1998). The correspondence of patient satisfaction and nurse burnout. *Social Science and Medicine*, 47, 1611-1617.

Focus of Study

- To investigate the relationship between nursing staff burnout and patient satisfaction with care

Research Design

- Both patients and staff members completed surveys
- Staff member surveys included questionnaires pertaining to burnout, meaningfulness of work, and intention to quit

- Patients completed a version of the Patient Judgments of Hospital Quality questionnaire which included measures pertaining to rating nurses, rating doctors, effectiveness of information provided by staff, and general outcomes of their stay

Sample Information & Site

- This study took place on two units at an 800 bed tertiary care hospital in central Canada.
- 711 nurses in 16 different units were included as participants.
- 605 patients participated in this study.

Findings

Patients on units where nurses found their work meaningful were more satisfied with their hospital stay

- Patients were less satisfied with their care on units where nurses felt more exhausted or expressed the intention to quit

Implications of Findings

- Patient satisfaction may be increased in an environment which promotes meaningfulness of work for nurses as well as reduces or prevents burnout.
- No mention was made in regards to specific nursing unit design

Lum, L., Kervin, J., Clark, K., Reid, F., & Sirola, W. (1998). Explaining nursing turnover intent: Job satisfaction, pay satisfaction, or organizational commitment? *Journal of Organizational Behavior*, 19(3), 305-320.

Focus of Study

- To evaluate the direct and indirect impact of pay policies on turnover amongst pediatric nurses

Research Design

- Participants were asked to complete a questionnaire with measures pertaining to job satisfaction, pay satisfaction, organizational commitment, and intentions toward turnover
- Two types of tenure-based payments were made: bonuses offered to intensive care staff only and a 5 percent salary differential above union scale for all nurses

Sample Information & Site

- The study took place in neonatal and pediatric intensive care units in a metropolitan teaching hospital
- All nurses on both units were surveyed; for remaining 32 clinical units, one in four staff nurses was randomly selected
- 222 nurses from the general care participated and 244 nurses from the critical care units participated

Findings

- Job satisfaction affects commitment to one's job which in turn affects turnover intent
- Pay satisfaction was significantly and directly related to reducing turnover intent
- Pay satisfaction was also indirectly related to reduction in turnover intent; this relationship was mediated by satisfaction and organizational commitment and the indirect effect was weaker than the direct effect
- Nurses were not satisfied with the pay supplement in which intensive care nurses were rewarded more highly than general staff nurses
- Nurses with more experience were more satisfied with their pay and were less likely to leave

Implications of Findings

- If nurses are satisfied with their jobs and their pay and feel committed to their organization, they are less likely to voluntarily leave their jobs
- Higher satisfaction levels are associated with lower turnover rates, and thus a more stable environment is created

McNeese-Smith, D. K. (2001). Staff nurse views of their productivity and nonproductivity. *Health Care Management Review, 26*(2), 7-19.

Focus of Study

- To identify and describe nurses' views of their productivity and nonproductivity as well as factors that increase or decrease productivity

Research Design

- Semi-structured interviews were conducted
- 7 questions were asked regarding productivity and lack of productivity
- Demographic information obtained included: gender, age, education, ethnicity, experience, number of dependents, and financial dependence on their salary

Sample Information & Site

- This study was done in a large Los Angeles County hospital (over 500 beds) associated with a major university
- 30 staff nurses participated from the following units: Obstetrics/Gynecology, Pediatrics, Operating Room/Recovery, Medical, Surgical, and Intensive Care

Findings

- Productivity was related to two major categories: quality of work and quantity of work
- Quantity of work includes: working hard, finishing everything and doing extra work, teamwork, and organizational systems

- Quality of work includes: Processes of care, work and patient outcomes, and organizational systems, teaching others, and making suggestions
- Personal factors influencing productivity include: experience, knowledge, attitude, organizational skills, physically/mentally ready, and cultural/ethnic background
- Nonproductivity is related to organizational factors and personal factors
- Organizational factors include being overloaded, difficult patients, not enough work to do, and lack of teamwork
- Personal factors influencing lack of productivity include personal problems, not physically/mentally ready, forgetting to do something, and cultural/ethnic background

Implications of Findings

- Productivity is related to a nurse's quantity (ex. working hard, teamwork, completing work) and quality of work (ex. work and patient outcomes and organizational systems)
- Nurses are not productive when organizational and personal factors interfere with their quality of care

McNeese-Smith, D. K. (1999). The relationship between managerial motivation, leadership, nurse outcomes, and patient satisfaction. *Journal of Organizational Behavior, 20*(2), 243-259.

Focus of Study

- To examine the relationship between nurse manager motivation for power, achievement and affiliation, managerial leadership behaviors, staff nurse outcomes of job satisfaction, productivity, and organizational commitment

Research Design

- Nurse managers, full-time registered nurses, and patients completed a questionnaire.
- Measures included Job Choice Exercise and Power Motivation question to measure motivation of nurse managers, Leadership Practices Inventory for self and other to measure leadership practices, Job-In-General scale to measure overall job satisfaction, Productivity scale, Organizational Commitment scale, and Patient Satisfaction scale

Sample Information & Site

- This study was done in a large Los Angeles County hospital (over 500 beds) associated with a major university
- 19 nurse managers, 221 full-time registered nurses, and 299 patients participated in this study.

Findings

- Older nurses showed a higher level of organizational commitment

- Strong positive correlation between patient satisfaction and the perception that one nurse was in charge of the patient's care
- Negative relationship exists between managerial motivation for power and manager use of leadership behaviors and nurse outcomes
- Manager's motivation for power positively correlated with patient satisfaction
- Managerial motivation for achievement positively related to manager leadership, nurse outcomes, and patient satisfaction; managers motivated by achievement inspired staff by having a vision and giving staff opportunity to be involved in vision

Implications of Findings

- Nurse managers play a critical role in both patient satisfaction and nurse outcomes. Managers who are motivated for achievement create an environment in which both nurses and patients are satisfied. These managers articulate what their vision is for the hospital and allow nurses to actively participate in meeting the vision
- Patient satisfaction is higher among nurse managers motivated by power; while staff outcomes are positive among nurse managers motivated by achievement

McVicar, A. (2003). Workplace stress in nursing: A literature review. *Journal of Advanced Nursing*, 44(6), 633-642.

Focus of Study

- To discover nurses' perceptions of stress in the workplace
- To consider the effectiveness of initiatives to reduce stress
- To identify directions for future research

Research Design

- CINAHL, MEDLINE, and COCHRANE databases were searched using the following key words: nursing, stress, distress, stress management, job satisfaction, staff turnover, and coping; the time frame included January 1985 to April 2003
- The literature search was limited to adult and child care nursing
- 100 papers and texts were used; 21 were primary research studies detailing the main sources of stress for nurses
- Documents from the United Kingdom Department of Health (1998-2003), the UK Royal College of Nursing, and the UK Health and Safety Executive were accessed regarding information on policy directions in the workplace for nurses

Sample Information & Site

- This study included a review of studies conducted in the United Kingdom regarding the stress of nurses in the workplace.

Findings

- Six main sources of stress are: workload, relationships with other staff members, leadership/management issues, coping with emotional needs of patients and their families, shift working, and lack of reward
- Low levels of confidence among inexperienced nurses is also a source of stress for them
- Interpersonal professional conflict, especially between nurses and physicians, is a problem
- To reduce workload, staffing levels need to be adequate; problem is that the National Health Service is understaffed
- An inclusive leadership style engenders group cohesion and empowerment; it's inversely related with burnout in nurses; could reduce interprofessional and intraprofessional conflict
- Improving pay for nurses is a long-term solution
- Equity in shift schedule allocation is needed to reduce social and personal impacts of shift working
- Problem-focused coping (ex. problem solving) is more effective in preventing burnout than emotion-focused coping
- Impact of stress in workplace varies among nurses in different workplaces and within the same facilities

Implications of Findings

- Even though improvements in leadership/management styles and interprofessional conflict are likely to occur in hospitals, workload, emotional labour, pay, and shift work will continue to be problems in the near future as staffing shortages are not diminishing

Ma, C., Samuels, M. E., & Alexander, J. W. (2003). Factors that influence nurses' job satisfaction. *Journal of Nursing Administration*, 33(5), 293-299.

Focus of Study

- To investigate which factors affect the job satisfaction of registered nurses in South Carolina

Research Design

- Every registered nurse who was licensed in South Carolina and currently working or who formerly worked in a hospital was targeted
- Surveys were mailed directly to the nurses; they included measures pertaining to demographic information, work-related information, and job satisfaction
- Data was also obtained from the South Carolina Health Alliance internal data file

Sample Information & Site

- This study included nurses working in all public and private hospitals in South Carolina. Federal hospitals of the Veterans Administration and military were excluded

- 3,472 nurses working in South Carolina participated in this study

Findings

- Approximately 60% of nurses reported their job satisfaction remained the same or declined over the past two years
- Nurses were most dissatisfied with lack of recognition
- Nurses who had over 2 years experience had lower levels of job satisfaction than nurses with less than 2 years experience
- Nurses who work in small urban areas had the highest level of satisfaction with their jobs
- Nurses whose hospitals participated in the South Carolina Retirement system had higher levels of satisfaction than those whose hospitals did not participate

Implications of Findings

- Satisfaction among nurses who work in South Carolina hospitals has decreased over the past 2 years; job dissatisfaction results in turnover as nurses leave their workplace or leave the profession entirely
- Nurses with more experience tend to expect greater autonomy, recognition, and opportunities; when this does not exist, dissatisfaction results
- Administrators need to communicate more effectively with nurses and should change the work context, including offering promotions, to increase job satisfaction and prevent turnover

Meehan, T., Bergen, H., & Fjeldsoe, K. (2003). Staff and patient perceptions of seclusion: Has anything changed? *Journal of Advanced Nursing*, 47, 33-38.

Focus of Study

- To explore the perceptions of nursing staff and patients in relation to seclusion.

Research Design

- A cross-sectional survey design was used.
- The Attitudes to Seclusion Survey was used to collect data from staff and patients.

Sample Information & Site

- The study took place on two acute inpatient units and a medium secure unit. One acute unit was at a general hospital while the other two units were at a tertiary mental health facility.
- 29 patients who had experienced seclusion (confined in a locked room when the patient would ordinarily be allowed to associate freely with other patients) in 12 months prior to the study participated.
- 60 nurses participated

Findings

- Both nursing staff and patients believed seclusion to be beneficial to the patient some of the time.
- Most common reasons for secluding a patient include aggression towards other people, objects, or oneself, and uncontrolled, excitable behaviour.
- Staff members were not in favor of changes to the seclusion process; most felt that increasing staff and resources would not enable their ward to function better without a seclusion room
- More nurses than patients attributed positive effects to seclusion

Implications of Findings

- Though seclusion is required for certain disturbing behaviors, staff should explore other alternatives to seclusion and understand the negative consequences of using seclusion as a threat to patients.

Milne, D & Day, S. R. (1986). Planning and evaluating innovations in nursing practice by measuring the ward atmosphere. *Journal of Advanced Nursing*, 11, 203-210.

Focus of Study

- To evaluate nurses' and patients' perceptions of the ward atmosphere to identify problems and evaluate corrective changes

Research Design

- Staff completed the Ward Atmosphere Scale both for acute patient days and chronic group days; patients also completed the same scale
- Both a control group and a group of acute patients were utilized
- After the baseline period, staff took two courses: one was an introduction to behaviour therapy and the other developed specialized skills in anxiety management
- A therapeutic program was implemented for the acute patients based on the staff training
- Post-test data was obtained after implementing the therapeutic program

Sample Information & Site

- This study took place in a National Health Service psychiatric day hospital
- 7 nurses participated in this study
- 49 patients participated in the baseline assessment and 41 patients participated in the post-test phase

Findings

- Significant improvements in ward atmosphere occurred after implementing the therapeutic program
- Control patients viewed the wards as less favorably than those in the therapeutic program

Implications of Findings

- Training staff in regards to behavioral therapy and anxiety management had beneficial effects for both staff and patients
- No mention was made in regards to specific nursing unit design

Moeser, S. D. (1988). Cognitive mapping in a complex building. *Environment and Behavior*, 20(1), 21-49.

Focus of Study

- To investigate the development of cognitive mapping abilities in a 5-story hospital with a complex design
- Study 1: To explore differences in cognitive maps between people who had only worked in the hospital for a few months versus those who had worked in the hospital for more than 2 years
- Study 2: To examine the nursing students' general knowledge of the building by using a labeling procedure
- Study 3: To investigate the relational knowledge of students

Research Design

- Study 1: Students were tested individually; they were asked to draw a map of four floors in the building to the best of their abilities; students were provided with blank sheets of paper and a pencil to draw with
- Study 2: Students were provided with maps of four floors and were provided with an alphabetical list of the rooms in the hospital; using the alphabetical list, they were asked to label the maps
- Study 3: Experimental subjects were asked to memorize maps of four floors of the building; were tested until they could perfectly label all the rooms on the floors; given a tour of the hospital with a map; after tour completed asked to lead a guide to various places in the building
- Study 3: Both control and experimental groups (2 days after location test) were asked to complete a direction pointing task and distance estimation task; in direction pointing, participants were asked to indicate on a compass the direction of six locations (on 1st and 2nd floors); in distance estimation, subjects were asked to verbally trace route from current position to the six locations on both floors
- Study 3: Control group, after the task, asked to complete labeling task of second study

Sample Information & Site

- The study took place at the Health Sciences Centre, a 5-story hospital in Newfoundland, Canada; first 3 floors have a distinct external outline; top 2 floors are identical, but different from first 3 floors
- Study 1 sample: 10 first-year female student nurses and 10 third-year female nurses
- Study 2 sample: 22 second-year female student nurses and 22 third-year student nurses
- Study 3 sample: 20 third-year student nurses (control group) and 20 second-year psychology students who had never worked or had extensive contact at the Health Sciences Centre (experimental group)

Findings

- Study 1: None of the maps resembled the actual floor plans; all students drew maps that were dissimilar from those of other students; third-year student nurses were significantly better than first-year student nurses in correctly locating rooms in hospital; third-year nurses made more minor errors than first-year nurses; all the nurses appeared to have poor cognitive mapping of the building
- Study 2: Third-year students were no better than the second-year students at labeling the hospital rooms; overall performance for both groups was poor; third-year students in this task did not perform any better than those in the first study
- Study 3: In direction pointing, experimental subjects were better than nursing students on 11 of 12 locations
- Study 3: In distance estimation, experimental subjects were better than nursing students on 10 of 12 locations
- Study 3: Nurses in experiment 3 performed better than nurses in experiment 2 on the labeling task; may have occurred because nurses in the third experiment volunteered and may have had better knowledge of building

Implications of Findings

- Overall, despite imperfect mapping systems, nursing students were able to locate places they needed to find; they use route methods to get around the hospital, which is not always the most efficient method
- Wayfinding is critical as difficulties with wayfinding could lead to high levels of anxiety and could interfere with performance

Mroczek, J., Mikitarian, G., Vieira, E. K., & Rotarius, T. (2005). Hospital design and staff perceptions: An exploratory analysis. *The Health Care Manager*, 24(3), 233-244.

Focus of Study

- To determine how the design of a hospital impacts staff perceptions of their workplace

Research Design

- An exploratory analysis was used on a subset of data from an employee satisfaction survey
- The analysis focused on the impact that physical aspects of the hospital have on quality of work life for staff

Sample Information & Site

- This study used data from Parrish Medical Center in Titusville, Florida
- A total of 734 staff members participated

Findings

- Increased natural light had a very positive impact on the work life of staff members
- Each patient room has access to natural light
- Increased light may increase arousal levels and the amount of time spent in the workplace
- Positive responses were also obtained for live instrumental music in atrium, airflow, separation of public areas from patient transport areas, water features, and home-like patient rooms
- Factors that had less of an impact are the circular building design, the hotel-like atmosphere, and artwork

Implications of Findings

- Design features affect staff perceptions of their physical working environment as well as the quality of their work life
- Natural light appears to have the most significant effect on work life

Norbeck, J. S. (1985). Perceived job stress, job satisfaction, and psychological symptoms in critical care nursing. *Research in Nursing & Health*, 8(3), 253-259.

Focus of Study

- To determine the effects of stressors on job satisfaction and psychological symptoms in critical care nurses
- To obtain data from multiple research sites and a variety of critical care units to improve the generalizability of the findings

Research Design

- Nurses completed questionnaires pertaining to job stress, job satisfaction, and psychological symptoms

Sample Information & Site

- 8 hospitals with adult critical care units in an urban-suburban area in the west were used
- 180 critical care nurses participated in this study.

Findings

- Night shift nurses have lower job satisfaction than those working other shifts
- Workload, physical setup of the unit, and communication problems were related to low job satisfaction
- Higher perceived job stress is related to decreased job satisfaction and increased psychological symptoms
- Nurses with less experience are more likely to experience job dissatisfaction

Implications of Findings

- Nurses who have greater perceived job stress are more likely to have decreased job satisfaction
- No mention was made in regards to specific nursing unit design

Olofsson, B., Bengtsson, C., & Brink, E. (2003). Absence of response: A study of nurses' experience of stress in the workplace. *Journal of Nursing Management*, 11, 351-358.

Focus of Study

- To understand nurses' perceptions regarding stress in the work place

Research Design

- A grounded theory approach was utilized
- Nurses in a Swedish rehabilitation clinic were invited to participate
- Semi-structured interviews were conducted pertaining to stress in the work place

Sample Information & Site

- The study took place at a Swedish rehabilitation clinic
- 4 nurses participated

Findings

- Nurses felt they were not being acknowledged and not receiving responses for their work
- Nurses were insecure over the scarcity of nurses on the ward and felt stressed over the fact that there may not be enough people to help if something unexpected happened
- High workloads and staff shortages were linked to the nurses thinking about their work at home
- Nurses were frustrated at not having enough time to care for patients because of increased time spent on administrative work
- Nurses felt powerless when they did not have enough time to take care of the patients in a way they saw fit

Implications of Findings

- Nurses experienced stress in the workplace due to lack of acknowledgement from supervisors, staff shortages, and high workloads. Nurses also felt they did not have time to properly take care of patients, creating an environment where patient care is not optimal
- No mention was made in regards to specific nursing unit design

Payne, N. (2001). Occupational stressors and coping as determinants of burnout in female hospice nurses. *Journal of Advanced Nursing*, 33(3), 396-405.

Focus of Study

- To investigate burnout levels among hospice nurses.
- To determine which aspects of nursing were related to burnout.
- To suggest interventions to reduce burnout.

Research Design

- Hospice nurses and nursing assistants completed questionnaires.
- Instruments used included the Maslach Burnout Inventory, the Nursing Stress Scale, and Folkman & Lazarus's (1986) Ways of Coping.

Sample Information & Site

- Nurses were recruited from nine hospices in the United Kingdom.
- 72 female hospice nurses and 17 female nursing assistants participated; the mean age was 39 years

Findings

- Burnout levels were not found to be high; they were lower than levels reported in other nursing disciplines
- Work related stressors were the most important determinants of burnout; these include conflict with other staff members, death and dying, and inadequate preparation.
- Problem-focused coping strategies were used most often and were found to be related to reduced burnout levels

Implications of Findings

- Overall, burnout levels among the hospice nurses surveyed were low.
- Burnout was most likely to be caused by patients dying, conflict with staff members, and not being adequately prepared to deal with patients
- No mention was made regarding nursing unit design.

Pierce, R. A., 2nd, Rogers, E. M., Sharp, M. H., & Musulin, M. (1990). Outpatient pharmacy redesign to improve work flow, waiting time, and patient satisfaction. *American Journal of Hospital Pharmacy*, 47(2), 351-356.

Focus of Study

- To describe the effect an open pharmacy has on workflow, waiting times for prescription pickup, and patient satisfaction

Research Design

- The outpatient pharmacy was redesigned. Modular work station fixtures incorporating two conveyor belts were installed
- Pharmacists were more involved in patient counseling and were more accessible to ambulatory-care patients
- Information was gathered from pharmacy records on workload, the number of personnel, and associated patient waiting times during a 12-month period before implementing the open pharmacy
- Data was compared to that collected for a six-month period after the open pharmacy program through direct observations and interviews
- Patients and pharmacy personnel were interviewed to determine satisfaction levels with the new program

Sample Information & Site

- The study took place at the VA outpatient clinic in Columbus, Ohio.
- All staff members in the outpatient area as well as one-hundred randomly selected patients were interviewed

Findings

- Handling times were reduced for prescriptions
- Most patients were satisfied with the new program
- Direct and individualized patient medication counseling occurred
- Instruction for prescriptions improved, encouraging patient compliance

Implications of Findings

- The open pharmacy program improved workflow and personnel use
- Patient waiting times were reduced which increases their satisfaction
- No mention was made in regards to specific nursing unit design.

Renzi, C., Tabolli, S., Ianni, A., Di Pietro, C., & Puddu, P. (2005). Burnout and job satisfaction comparing healthcare staff of a dermatological hospital and general hospital. *Journal of the European Academy of Dermatology and Venereology*, 19, 153-157.

Focus of Study

- To compare burnout and job satisfaction of dermatologists and nurses working with dermatological patients with physicians and nurses in other specialties

Research Design

- Questionnaires were distributed to personnel in a dermatological and a general hospital in Rome, Italy
- Questionnaires included measures pertaining to job satisfaction and burnout (Maslach Burnout Inventory)

Sample Information & Site

- A dermatological hospital (Istituto Dermopatico dell'Immacolata, IDI) and a general hospital (S. Carlo) in Rome, Italy were the site of this study
- 67 physicians and 59 nurses at the dermatological hospital and 70 physicians and 148 nurses at the general hospital completed questionnaires

Findings

- Emotional exhaustion is lower among nurses working in dermatology compared to those in other specialties
- More nurses working in dermatology are satisfied with opportunities for personal growth and available resources than nurses in other specialties
- Overall job satisfaction is higher for physicians in dermatology than in other specialties
- Burnout decreases with higher levels of overall job satisfaction and working in dermatology among nurses
- Probability of burnout increases with longer duration of employment at same hospital
- Higher levels of job satisfaction and older age are associated with less burnout among physicians
- Suggestions for improvement include more shared decision-making, more positive feedback, better planning of working hours, taking personal and family needs into account, and recognition of extra efforts

Implications of Findings

- Nurses in the general hospital were less satisfied with management of their units, opportunities for personal growth, and with resources
- To improve the working environment changes need to be made to include shared decision-making, more positive feed-

back, better planning of working hours, taking personal and family needs into account, and recognition of extra efforts

- No mention was made in regards to specific nursing unit design

Reynolds, D. M., Johnson, M. H., Longe, R. L. (1978). Medication delivery time requirements in centralized and decentralized unit dose drug distribution systems. *American Journal of Hospital Pharmacy*, 35(8), 941-943.

Focus of Study

- To compare the amount of time it takes to deliver medication in centralized and decentralized units.

Research Design

- The pharmacy-controlled portion of medication delivery was observed.
- Activity at the nursing station was observed by pharmacists

Sample Information & Site

- The study took place at the Medical College of Georgia.
- Staff on both a centralized and decentralized unit were observed for a week.

Findings

- Medication orders required less time on the decentralized unit than on the centralized unit
- Transport by the nurse was minimal in the decentralized system
- Other staff members were available to transport the medication on the decentralized unit

Implications of Findings

- Medication orders were handled more efficiently on a decentralized nursing unit rather than a centralized nursing unit

Shaver, K. H., & Lacey, L. M. (2003). Job and career satisfaction among staff nurses: Effects of job setting and environment. *Journal of Nursing Administration*, 33(3), 166-172.

Focus of Study

- To examine variables associated with job and career satisfaction among nurses.

Research Design

- A stratified sample, based on geographic location, was identified
- Questionnaires were mailed out to staff nurses

- Questionnaires included measures of satisfaction, employee setting, commitment, job tenure, years until retirement, short staffing, and patient load

Sample Information & Site

- This study took place in various around-the-clock facilities (hospital inpatient settings, nursing home/residential rehabilitation facilities) and community-based settings (e.g. hospital outpatient facilities, medical practices, public clinics) in North Carolina
- 599 nurses (325 RNs and 275 LPNs) participated

Findings

- As perceptions of short staffing increase, work satisfaction decreases for RNs

As patient load of RNs increases, satisfaction with work decreases

- RNs working in hospital inpatient units were less satisfied with their work than nurses working in other settings
- RNs who are less committed to their jobs were less satisfied than those who were more committed
- For LPNs, as perceptions of short staffing increase, work satisfaction decreases
- For RNs and LPNs, the more often short staffing occurs, the lower their career satisfaction; nurses who are further away from retirement are more satisfied with their career than nurses close to retirement

Implications of Findings

- Nurses' perceptions of the frequency with which short staffing interferes with patient care are significantly related to their levels of satisfaction with their jobs and career
- If nurses are not satisfied with their jobs, patient care may be impacted

Shepley, M. M. (2002). Predesign and postoccupancy analysis of staff behavior in a neonatal intensive care unit. *Children's Health Care, 31(3), 237-253.*

Focus of Study

- To provide data on the behavioral issues associated with the design of a neonatal intensive care unit

Research Design

- Multi-method approach was used, which included behavioral mapping, interviews, questionnaires, and calibrated measures of walking, noise, and temperature
- Observations were made of staff members over a 3-hour period and information was recorded in terms of patient census, staff designation, activity location, and time data

- Interviews and questionnaires focused on the efficiency of the floor plan, the impact of natural light, and perceptions of space allocation

Sample Information & Site

- Study was conducted prior to and after renovations were made to a neonatal intensive care unit; original unit consisted of six small rooms that accommodated one to five babies in each room. The new unit was open and divided into bays of six baby stations each
- The sample included nursing staff that worked on the pre-design and post-occupancy units. Twenty-one staff members were observed, ten staff members filled out questionnaires, and eight staff members were interviewed

Findings

- New design focused on the development of a more efficient floor plan, the provision of space for supportive family-centered care, and the use of natural light
- On the new unit, nurses were found to spend most of their time in active baby care followed by walking, conversations, passive baby care, and charting. More time was spent taking care of the babies on the new unit than on the old unit
- Those responding to the questionnaires perceived the new unit as comforting and clean but less secure than the old unit
- Family-centered care was perceived as supportive of babies and their families, though its ratings were lower for the supportiveness of nurses and physicians
- Unit was rated as generally being efficient and the new lighting was thought to have a positive impact on the patients
- Those who were interviewed felt that families were utilizing the majority of space designated to them. They felt the design was efficient, lighting was improved, and noise levels were lower

Implications of Findings

- For the most part, the new unit was rated positively. Nurses were able to move at a greater velocity in the new unit as well as spend more time with the infants. Thus, greater space and more light improved patient care.

Sochalski, J. (2004). Is more better? The relationship between nurse staffing and the quality of nursing care in hospitals. *Medical Care, 42(2), 1167-1173.*

Focus of Study

- To assess whether nursing workload is associated with the quality of care reported by nurses
- To evaluate whether workload is related to indicators of nursing care processes

Research Design

- A survey was used which collected information on patient workload, quality of care, work environment, and nursing care features in acute care general hospitals

Sample Information & Site

- This study took place in acute care hospitals in Pennsylvania.
- 8670 registered nurses working in acute care hospitals in Pennsylvania participated

Findings

- Workload had a significant effect on quality of care ratings
- Higher workload could influence quality of care through its effects on nurses' capacity to deliver care
- As number of patients per nurse declined, quality ratings rose

Implications of Findings

- Higher workloads were associated with lower quality of care ratings. Nurses with less patients felt they were able to deliver better care to their patients.
- No mention was made in regards to specific nursing unit design

Sochalski, J. (2001). Quality of Care, nurse staffing, and patient outcomes. *Policy, Politics, & Nursing Practice*, 2(1), 9-18.

Focus of Study

- To examine factors associated with quality of nursing care, including nurse staffing, occurrence of adverse events, and unit assignment
- To examine the impact of working conditions on job stress and satisfaction

Research Design

- A random sample of registered nurses, based on the State Board of Nursing in Pennsylvania, was used
- Nurses completed surveys measuring quality of nursing care, tasks undone, patient adverse events, patient workload, emotional exhaustion, and job satisfaction

Sample Information & Site

- This study took place in acute care hospitals in Pennsylvania.
- 13,200 registered nurses working in acute care hospitals in Pennsylvania participated

Findings

- Nurses who rated quality of care on their units as fair or poor reported higher medication errors, nosocomial infections, and patient falls with injuries than did nurses rating the

quality of care on their unit as excellent or good

- Medical-surgical units had lowest scores on quality of care compared to other hospital units
- Medical-surgical nurses had higher number of tasks left undone at end of shift than nurses on other units
- Patient falls occurred more frequently on medical-surgical units than other units, except rehabilitation units
- 41% of nurses report being moderately or very dissatisfied with their jobs; rates highest among medical-surgical nurses
- Medical-surgical nurses have highest rates of emotional exhaustion

Implications of Findings

- Medical-surgical nurses report the highest levels of burnout and the lowest levels of patient care. They felt they were unable to manage their patient workload and thus, the quality of care they provided was not optimal
- No mention was made in regards to specific nursing unit design

Taylor, B., & Barling, J. (2004). Identifying sources and effects of carer fatigue and burnout for mental health nurses: A qualitative approach. *International Journal of Mental Health Nursing*, 13, 117-125.

Focus of Study

- To identify and address sources of stress for mental health nurses which contribute to carer fatigue and burnout

Research Design

- A qualitative approach was used
- Semi-structured interviews were conducted; questions pertained to effect of burnout in mental health nursing

Sample Information & Site

- The study took place in Australia
- 20 registered nurses working in community and hospital settings participated in the study

Findings

- Sources of stress contributing to carer fatigue and burnout include: employment insecurity, casualization of the work force, issues with management and the system, difficulties with the nature of the work, problems with doctors, inadequate resources, undervaluing consumers and nurses, aggressive consumers, physical and emotional constraints of work setting, and nurse-nurse relationships
- Participants experienced emotional exhaustion, depersonalization, and reduced personal accomplishments

Implications of Findings

- Mental health nurses perceive a variety of stressors, including issues with management, conflict with coworkers, inadequate resources, and work setting, as contributing to burnout. These stressors led to higher levels of burnout.
- No mention was made in regards to specific nursing unit design

Tyson, G.A., Lambert, G., & Beattie, L. (2002). The impact of ward design on the occupational satisfaction and well-being of psychiatric nurses. *International Journal of Mental Health Nursing, 11*, 94-102.

Focus of Study

- To determine the impact of changes to the physical environment of psychiatric wards on hospital staff.

Research Design

- Both a long-stay ward and acute ward were redesigned.
- The new long-stay ward consisted on 16 beds - four sleeping areas with four single bedrooms in each
- The new acute area has 28 beds, eight of which are in a secure area
- For both wards, observations were conducted for 6 hours a day over a period of 10 days prior to the move, and 6 months after the move.
- Observers were trained and made observations in 5 minute intervals. Observations started with the first nurse encountered and continued until each member of the nursing staff was observed.
- Participants also completed the Maslach Burnout Inventory and took part in structured interviews.

Sample Information & Site

- The study took place at a rural psychiatric hospital in Australia.
- From the first phase of the study on the old ward, 37 questionnaires from nurses (18 females, 19 males) were returned.
- From the second phase of the study, 34 questionnaires were returned (15 females, 17 males).
- 16 staff members were interviewed.

Findings

- Burnout increased on the new wards.
- Depersonalization scores were higher on the new long-stay ward.
- New wards were more aesthetic and pleasant environments.

- New wards were thought to be better for patients in terms of increased privacy and personal space.
- New wards provided a better therapeutic environment.
- The amount of interaction increased in the acute ward and the quality of interaction was rated positively
- Interactions improved on the long-stay ward, but interaction time decreased.

Implications of Findings

- Although the new wards were evaluated positively, the benefits of the new environments were offset by increased levels of burnout. Without appropriate organizational change, the potential benefits of a new physical environment may be weakened.

Tzeng, H., Ketefian, S., Redman, R. W. (2002). Relationship of nurses' assessment of organizational culture, job satisfaction, and patient satisfaction with nursing care. *International Journal of Nursing Studies, 39*, 79-84.

Focus of Study

- To investigate the relationship between nurses' assessment of organizational culture, job satisfaction, and inpatient satisfaction with nursing care

Research Design

- This study used secondary data from an large on-going study
- Questionnaires were distributed to full-time and regular part-time employees as well as patients, who had been hospitalized for at least one night. Questionnaires for patients were mailed to their homes 4-6 weeks after discharge
- The nurses' questionnaires include the Nurses Assessment Survey, used to measure their perception of strength of culture and job satisfaction
- The patients' questionnaires included demographic information and the Nursing Services Inpatient Satisfaction Survey. This was used to measure inpatient satisfaction with information regarding home care and follow-up as well as general inpatient satisfaction with the nursing care they received.

Sample Information & Site

- This study was conducted in a tertiary health centre in the Mid-west, United States. 17 patient care units were used: 13 medical/surgical units, 2 adult psychiatric units, and 2 gynecology/obstetric units
- 520 nurses and 345 patients participated

Findings

- Nurses' perceptions of strength of organizational culture predicted job satisfaction

- Job satisfaction predicted level of patient satisfaction with home care
- Level of inpatient satisfaction with home care predicted the patient's general satisfaction with nursing care

Implications of Findings

- Nurses' job satisfaction predicts a patient's satisfaction with home care as well as their satisfaction with the care provided to them while in the hospital
- By promoting efforts for improvement with the quality of care provided, hospitals may improve patient retention and compliance

Upenieks, V.V. (1998). Work sampling: Assessing nursing efficiency. *Nursing Management*, 29(4), 27-29.

Focus of Study

- To assess nursing time allocation and task distribution
- To note areas of inefficiency and seek more useful means of effective staffing

Research Design

- A work sampling study was conducted
- A work flow observation tool was devised and utilized
- Staff members were observed performing work duties in 20-minute intervals
- Improvements were recommended and followed up 1 year after implementation

Sample Information & Site

- The study took place in a 36-bed inpatient surgical unit in the United States
- The unit included 16 Registered Nurses, 10 to 12 CNAs, and 3 to 4 secretaries
- 2,835 observations were made

Findings

- Registered nurses spent 30% of their time in direct patient care
- Documentation accounted for 13% of time spent by registered nurses
- CNAs spent the majority of their time in nonlicensed tasks
- Unit secretaries spent 57% of their time doing clerical tasks
- After tasks were redistributed to balance the workload, the majority of time for all staff members was spent on direct patient care

Implications of Findings

- Through evaluations of nursing efficiency, strategies to balance workload were implemented resulting in greater time spent in direct patient care
- No mention was made in regards to specific nursing unit design

Vahey, D. C., Aiken, L. H., Sloane, D. M., Clarke, S. P., Vargas, D. (2004). Nurse burnout and patient satisfaction. *Medical Care*, 42(2), 1157-1166.

Focus of Study

- To examine the relationship between nurse burnout and patient satisfaction.
- To explore whether factors accounting for nurse burnout also account for patient dissatisfaction.

Research Design

- Nurses completed a self-administered questionnaire which measured personal characteristics, including burnout, and hospital characteristics, including the nurse work environment
- Patients were interviewed in regards to their satisfaction with nursing care, process of care, and personal information

Sample Information & Site

- Data used for this study was collected in 20 hospitals in the United States.
- 820 nurses and 722 patients with AIDS participated in this study.

Findings

- More than one-third of nurses intend to leave their positions within the year
- Burnout levels are lower in units with good environments
- Satisfaction levels of patients are higher on units where nurses have lower than average levels of emotional exhaustion
- Satisfaction levels of patients are higher on units where nurses have higher than average levels of personal accomplishment
- Staffing levels, administrative support, and relations between nurses and physicians affect nurse burnout levels
- Feelings of depersonalization among nurses is not associated with patient dissatisfaction with care

Implications of Findings

- Patients have higher levels of satisfaction with care on units where nurses have lower levels of burnout
- No mention was made in regards to nursing unit layout

Varni, J. M., Burwinkle, T. M., Dickinson, P., Sherman, S. A., Dixon, P., Ervice, J. A. et al. (2004). Evaluation of the built environment at a children's convalescent hospital: Development of the Pediatric Quality of Life Inventory parent and staff satisfaction measures for pediatric health care facilities. *Developmental and Behavioral Pediatrics, 25(1)*, 10-20.

Focus of Study

- To develop pediatric measurement instruments for patient and staff satisfaction with the built environment, parent satisfaction with the health care services provided to their child, and staff satisfaction with their coworker relationships

Research Design

- Focus groups were conducted to discuss parent and staff satisfaction with the built environment of the existing facility, parent satisfaction with health care services, and staff satisfaction with coworker relationships
- Focus groups were conducted prior to the construction of a new facility
- Parents and staff were asked to complete questionnaires regarding the built environment and satisfaction

Sample Information & Site

- This study took place at the Children's Convalescent Hospital at the Children's Hospital and Health Center in San Diego
- 40 parents and 99 staff members responded to the questionnaire

Findings

- For the most part, parents were moderately satisfied with the built environment of the existing facility; based on parent feedback, design changes included larger bathrooms, extra closet space, increased parking spaces, a more spacious family room, a well-landscaped outdoor recreation area, two nursing stations located in close proximity to patient rooms, natural lighting, and increased number of windows
- Staff members were generally dissatisfied with the built environment; changes in design based on the feedback include larger closets in the residents' rooms, larger activity space, large dining room, wheelchair storage built into each bedroom, and counter space at nursing stations for charting
- Higher parent satisfaction with the built environment was associated with higher health care satisfaction
- Higher staff satisfaction with the built environment was associated with higher coworker relationship satisfaction

Implications of Findings

- Higher satisfaction with the built environment was associated with higher health care satisfaction for parents and higher coworker relationship satisfaction for staff members

Whitehead, C., Polsky, R., Crookshank, C. & Fik, E. (1984). Objective and subjective evaluation of psychiatric ward redesign. *American Journal of Psychiatry, 141(5)*, 639-644.

Focus of Study

- To describe and evaluate the redesign of a 30-bed psychiatric unit

Research Design

- The new design broke up long institutional corridors, added flexibility of use to dayroom areas, promotes humanistic values, and subdivides the dormitories
- Patient behaviors and attitudes were observed prior to and after the redesign

Sample Information & Site

- The study took place at a 30-bed psychiatric unit
- Male and female veterans were observed.

Findings

- Social behaviors occurred more often in hallways and hall intersection prior to the redesign; after the redesign, social behaviors occurred more often in the visiting room, cafeteria, and day room
- Staff and patients responded positively to the redesign
- Staff were more likely to spend time in the day room on the redesigned unit

Implications of Findings

- The psychoenvironmental design was associated with positive reactions from both staff and patients. Patients interacted more and staff were able to spend more time interacting with them
- No mention was made in regards to specific nursing unit design

Worley, L. L. M., Kunkel, E. J. S., Gitlin, D. F., & Menefee, L. A. (2000). Constant observation practices in the general hospital setting. *Psychosomatics, 41(4)*, 301-310.

Focus of Study

- To determine the patterns of constant observation at a national level
- To learn effective funding strategies to maintain patient safety and contain costs of constant observation

Research Design

- Surveys were mailed out to hospital administrators
- Telephone communication was used to contact 12 of 13 hospitals which reported not using constant observations

Sample Information & Site

- 353 medical/surgical acute care hospitals representing the various areas of the United States were utilized
- 102 administrators participated in the study, representing 37 of 50 states and the District of Columbia

Findings

- All general hospitals reported using constant observations to manage at risk patients
- Providers of constant observation include registered nurses, licensed practical nurses, nursing assistants, medical students, family members, and non-clinical hospital employees
- Registered nurses were most likely to provide constant observation
- Lack of uniformity regarding constant observations among hospitals
- Two most common reasons for using constant observation include risks of self-harm and confusion

Implications of Findings

- Constant observation is a costly practice to help manage at risk patients
- No mention was made in regards to specific nursing unit design

Non Empirical Articles: Healthcare Design and Staff Outcomes

American Institute of Architects. (2001). *Guidelines for design and construction of hospital and healthcare facilities*. Dallas, TX: Facilities Guideline Institute.

Focus of Article

- To describe design features of nursing units.

Type of Healthcare Facility

- The material presented applies to acute care facilities in the United States.

Recommendations for Healthcare Setting

- Maximum patient occupancy should be two patients per room
- Hand washing stations should be provided for each patient room
- Nursing stations should have space for counters and storage, convenient access to hand washing stations, and should allow for visual observation of all traffic on the unit
- Dictation area should be adjacent to but separate from nursing station

- Charting facilities should have enough surface space to enable staff and physicians to chart and have simultaneous access to information
- Bathroom should be conveniently located for staff
- Staff should have a lounge and storage facilities
- There should be separate rooms for clean and soiled materials
- Provisions should be made for distributing medication
- Nursing units should have clean linen storage, nourishment area, ice machines, a room for equipment storage, a space for emergency equipment storage, and a housekeeping room
- Units should have at least one airborne infection isolation room
- A nurse/supervisor office should be located on the unit

Implications of Findings

- To provide optimal patient care, nursing units need hand washing stations, charting facilities, and dictation areas, among others. Staff should have adequate storage facilities and a lounge in which to relax.
- Nursing units should have isolation rooms to prevent infections from spreading.
- The maximum number of patients per room should be two.

Andrews, D. R., & Dziegielewski, S. F. (2005). *The nurse manager: Job satisfaction, the nursing shortage and retention*. *Journal of Nursing Management*, 13, 286-295.

Focus of Article

- To outline issues contributing to the nursing shortage
- To provide nurse managers with information regarding influences on job satisfaction

Type of Healthcare Facility

- The material in this article applies to hospitals in the United States.

Recommendations for Healthcare Setting

- Current nursing shortage is broad-based; vacancies exist in hospitals, nursing homes, and home health care agencies
- Factors contributing to nursing shortage include concerns with educational system, nurse satisfaction, societal influences, and changes within health care due to economic influences
- Educational levels may affect professional autonomy in making responsible discretionary decisions
- Low job satisfaction is positively related to turnover; sources of low satisfaction include feeling overloaded, relations with co-workers, career stage of nurse, and factors interfering with patient care

- Women have strayed away from nursing as other opportunities in the work force became available
- Nurses feel underpaid
- Available workforce from which to obtain potential nurses is decreasing as 'baby boom' generation retires
- Faculty retirement is affecting educational opportunities for potential nurses
- Lack of attention to a nurse's level of expertise may facilitate burnout
- Hospital workers are among the highest in the work force to experience job-related injuries and illnesses; being overworked contributes to health and safety concerns
- Nurse managers should be able to identify factors in the working environment which hasten low job satisfaction
- Nurses with effective supervision experienced improvements in managing work related stress

Implications of Findings

- Many factors, such as concerns with educational system, nurse satisfaction, societal influences, and changes within health care due to economic influences, are contributing to the nursing shortage
- Changes, including better pay and recognition of a nurses' qualities, need to be made to improve the working environment of nurses so they remain in their positions

Bell, C., Graven, S., Shepley, M., Rubin, H., & Ulrich, R. (1997). Pre-symposium workshop: Panel Discussion. *Journal of Healthcare Design*, 9, 21-24.

Focus of Article

- To discuss the implications of design in healthcare.

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities in general.

Recommendations for Healthcare Setting

Environments should appeal to a person's senses

- Facilities should be designed around the specific needs of patients
- Design and construction plans must demonstrate operational efficiency and save money
- Facilities should be patient friendly and provide high-tech, high-intensive treatment
- Researchers should measure more than one patient outcome
- Patients should be asked which outcomes are most important to them; the medical community, designers, and behav-

ioral scientists should be surveyed to determine which outcomes have changed

- Stressors related to the environment may be due to the design, but are also due to organizational factors - lack of communication and information from health care providers ranks among the top ten stressors

Implications of Findings

- To create an environment in which patient outcomes are positive, a collaboration needs to occur between researchers, designers, and the medical community
- The quality of care provided to patients should be a central focus in design

Bobrow, M. & Thomas, J. (2000). Inpatient care facilities. In Kobus, R. et al., *Building type basics for healthcare facilities* (pp. 131-192). New York: John Wiley & Sons.

Focus of Article

- To describe efficient designs of patient rooms and nursing units

Type of Healthcare Facility

- The material presented in this chapter applies, in general, to acute care facilities in the United States, though it could apply to all acute care facilities

Recommendations for Healthcare Setting

- Patient room is seen as a place where the patient and family members can have control of their lives and their environment; room looked upon as a place of privacy, safety, and sanctuary
- Nursing unit is an extension of this environment, and provides a family support system
- Primary goal of nursing design is to minimize the distance traveled by nurses as well as the range of distance between patient rooms and the nurse work core
- Efficient nursing plans include groupings of concentric pods and the use of bedside computers
- Examples of previously used nursing unit designs include the double corridor plan, the compact rectangular plan, and the compact circular plan
- Double corridor design places nursing support area between two corridors; combination of one central work core with some support functions dispersed; design was efficient but distances from ends of floor created problems when staffing limited
- Compact regular plan more flexible than circular unit regarding ratio of patient rooms to support space; exterior dimensions easily changed on each side while maintaining same bed count

- Compact circular plan reduces travel time of nurses and is efficient; problem is number and size of rooms are dictated by program requirements which control circle diameter
- Patient rooms have evolved from open wards to single- and double-occupancy rooms; single-occupancy rooms are favored because patients are given privacy in these rooms and these rooms can be used for isolation purposes; medication errors are also reduced with a reduction in patient transfers
- Patients prefer single-occupancy rooms because they are given greater privacy, space is provided for family members, and patients are able to control their environment, such as lighting and temperature
- Universal rooms are large enough to accommodate various bedside treatments and are situated to allow for maximum patient visibility by nurses
- Patient care units should be decentralized into smaller clusters that contain decentralized nursing substations, provide increased visibility of patient beds and reduced congestion
- Nurse servers should be located adjacent to patient rooms to provide immediate access to supplies
- Traffic on the unit should be reduced through the use of supply holding areas and through the use of large patient rooms that can accommodate family members
- Each patient care floor should consist of two to three patient units; support shared by all units on the floor should be included

Implications of Findings

- Efficient hospital design includes clusters of single-occupancy patient rooms and nursing substations to serve these clusters
- Decentralized nursing stations reduce congestion and provide greater patient visibility

Carpman, J. R., & Grant, M.A. (1993). *Design that cares: Planning health facilities for patients and visitors 2nd edition*. San Francisco, CA: Jossey-Bass.

Focus of Article

- To describe the design process and features of hospitals.

Type of Healthcare Facility

- The information presented in this book applies to all acute care facilities

Recommendations for Healthcare Setting

- Central to designing facilities are wayfinding, physical comfort of individuals, regulation of amount of contact patients have with others, and support of the psychological needs of the patients
- If wayfinding is unsuccessful, patients become disoriented; employees may experience stress, and thus absenteeism, if they are continually trying to find their way

- Architects should consider the functional needs and the burden that building complexity places on a person's wayfinding abilities
- Large facilities should have ongoing staff training programs in giving directions
- Staff should have visual access to diagnostic and treatment areas to help patients feel secure if they need anything
- Patient rooms should have a door or interior window between the room and hallway to provide visual monitoring by nurses and to give patients a visual link into the hallway

Implications of Findings

- Wayfinding should be a priority in design, because if done poorly, it could cause stress for both patients and staff
- Visibility between patients and staff could help patients feel secure and less anxious
- No mention was made in regards to specific nursing unit design

Cawood, C. (1993). *Nursing units and common staffing problems*. In D. K. Hamilton (Ed.) *Unit 2000: Patient beds for the future. A nursing unit design symposium* (pp. 103-109). Houston: Watkins Carter Hamilton Architects, Inc.

Focus of Article

- To discuss the designs of nursing units

Type of Healthcare Facility

- The designs identified in this component of the symposium apply to Rochester Methodist Hospital in Rochester, MN, Scott and White Hospital in Temple, Texas, and the Kaiser Foundation hospital in Panorama City, California.

Recommendations for Healthcare Setting

- Smaller patient units are more costly per patient per day, as a higher mix of registered nurses is used and patients with higher than average acuity are being treated
- One possible unit design is radial. This design reduces travel distances and times in comparison to single- and double-corridor units
- The majority of nurses, if given the choice, would prefer to work on radial units
- Radial units cannot accommodate a sufficient number of private rooms without wasting a large amount of central core space; lateral expansion of these units is also difficult
- The triangular shape decreases travel distances while enabling a capacity of 30 to 36 beds; helps to reduce staffing problems
- Utilization of two nursing stations in triangular design helps to increase visibility into more patient rooms
- Flexibility in functionality of patient rooms and nursing units is critical to any nursing unit design

Implications of Findings

- With the increase in demand of private rooms, radial units are no longer an effective design, as this design cannot accommodate a large number of private rooms
- Triangular designs may offer greater flexibility and reduce staffing problems

Christensen, K. E. An impact analysis framework for calculating the costs of staff disorientation in hospitals. Hospital Orientation Project. Wayfinding in Hospital Environments: A school of Architecture and Urban Planning Report Series. Unpublished manuscript, University of California, Los Angeles.

Focus of Article

- To present a framework for calculating both the direct and indirect costs resulting from staff disorientation in hospitals
- To draft a research focus for the UCLA hospital disorientation study

Type of Healthcare Facility

- The material presented in this review pertains to the UCLA Medical Center in Los Angeles, California.

Recommendations for Healthcare Setting

- Direct costs of disorientation include time lost finding one's way, time spent giving directions, and time spent learning new routines
- Indirect costs of disorientation include absenteeism, personal turnover, and personnel retraining
- Impact analysis framework includes profiling, projecting and measuring impacts, and identifying mitigation efforts
- Profiling serves as a "before" measure – before impacts of design change are made
- Projection considers the impact from a perspective of including and not including design changes
- Mitigation efforts offset adverse impacts (ex. improving signage system, relocating departments, monitoring disorientation costs)
- Complexity index can be used to rate the degree of complexity in aggregate of popular or critical routes used in the hospital
- Confusability index calculates direct and indirect dollar costs associated with staff disorientation

Implications of Findings

- Changes in hospital design can produce anxiety and stress among staff as they have to learn new routes in the hospital and have to help others find their way. With the added stress, the hospital suffers both direct and indirect costs.

- Hospitals need to take into account how changes will affect the staff and whether the benefits of the new design outweigh the costs

Cronk, J. D. (2002). Ergonomics in an order entry facility. U. S. Pharmacist, 27(9).

Focus of Article

- To describe ergonomic changes made to a medical facility to eliminate unnecessary stressors and improve health and safety.

Type of Healthcare Facility

- The material presented in this article applies to Summit Medical Center in Hermitage, Tennessee.

Recommendations for Healthcare Setting

- Problem was unnecessary time was spent in processing prescriptions due to interruptions, delays, clarifications and other processes needed to handle hard copies of orders
- Resolution involved physically isolating order entry from other function in the inpatient pharmacy
- Computerized digital-scanning devices were installed at every location where physician orders were generated; eliminated distortion associated with facsimiles or NCR copies; reduced costs by eliminating multi-part order forms
- Ergonomic concepts involved eliminating crowding, cramping, disorganization, and poor lighting

Implications of Findings

- Costs were reduced and employee satisfaction increased in an ergonomic order entry facility which incorporates the use of computerized scanning technology.

Ewens, A. (2003). Changes in nursing identities: Supporting a successful transition. Journal of Nursing Management, 11, 224-228.

Focus of Article

- To examine the role of nurse managers in delivering the National Health Service agenda.

Type of Healthcare Facility

- The information in this article pertains to hospitals in England.

Recommendations for Healthcare Setting

- Nurses are likely to take advantage of the opportunities offered to them to develop and extend the scope of their duties.
- Nurses are more likely to leave their roles if they feel they are being held back by their organization.

- When nurse managers are flexible and willing to delegate power, nurses have increased autonomy, job satisfaction, and commitment.

Implications of Findings

- Nurses are willing to take on new roles, but they need the support of nurse managers and the organization to adjust to their new duties.
- No mention was made in regards to specific nursing unit design

Greenberg, L.A. (2000). Planning a nurse station for clinical function. <http://www.hermanmiller.com/healthcare>

Focus of Article

- To describe the design of a nursing station allowing for clinical function

Type of Healthcare Facility

- The material presented in this article applies to acute care facilities in general.

Recommendations for Healthcare Setting

- Inpatient centralized nurse stations have highest concentration of people in smallest area
- As complexity of clinical functions or patient acuity increases, clinically related functions intensify
- Each nursing station has functional requirements: unit secretary area, nursing staff zone, and physician work zone
- Charting space needs to be allocated in the nursing unit; there should be enough slots for every bed on the unit and a few additional slots on the chart storage rack
- In Emergency Departments, visibility is critical to treatment and trauma rooms
- In Patient Care units, staff need to be able to see activity surrounding the station
- In Critical Care units, nurses should have visual access to observe all patients
- Patient confidentiality should be maintained
- Aesthetically pleasing nursing station can provide calmer work environment and can be less intimidating for patients and visitors to approach

Implications of Findings

- Careful planning of a nursing station can result in less chaos, better ergonomics, regulation compliance, pleasant aesthetics, and a design that can change as equipment, technology, and work functions change

Gulak, M. B. (1991). Architectural guidelines for state psychiatric hospitals. *Hospital and Community Psychiatry*, 42, 705-707.

Focus of Article

- To describe design guidelines regarding the architectural needs of psychiatric patients

Type of Healthcare Facility

- The material presented in this article applies to psychiatric hospitals.

Recommendations for Healthcare Setting

- Design of a psychiatric hospital is frequently not guided by behavioral goals
- Clear indications should be made regarding a room's intended use
- Rooms should provide environments that related to activities in the home
- Distinct visual differentiation should be made between walls, floors, and ceilings
- Spaces should be provided which support social interaction
- Distinctive colors should be used to enhance activities and space
- A variety of materials should be used which provide different tactile and visual experiences
- Lighting should be used in a manner that enhances the intended use of a particular space

Implications of Findings

- By improving the architectural design, including the use of colors, providing space for social interaction, and using a variety of materials to stimulate the senses, the environment can become a tool in the therapeutic process and can increase the potential for a patient's recovery
- No mention was made in regards to specific nursing unit design

Hosking, S. & Haggard, L. (1999). Departmental components of the average hospital. In S. Hosking and L. Haggard, *Healing the hospital environment: Design, management and maintenance of healthcare premises* (pp.53-82). London: Routledge

Focus of Article

- To describe components of the hospital including the advantages and disadvantages of the Nightingale and bay wards

Type of Healthcare Facility

- The material presented in this chapter applies to all acute care facilities

Recommendations for Healthcare Setting

- In the Nightingale ward, beds are arranged down each side of a long, narrow ward. The nursing station is located on one end of the ward, while the convalescent bay is located at the other end. Nurses are able to monitor patients with relative ease. This ward became unpopular; however, because the patients' need for privacy was not met
- Newer designs include bay wards, which subdivide wards into four-, six-, or eight-bed bays. This type of design offers patients more privacy and intimacy, and it is more flexible
- In bay wards, patients can be clustered according to sex or illness
- Disadvantage of the bay ward is patients' view of the nurses is limited, and thus, the patient is unaware of what the nurse is doing; can increase the patients' anxiety if they are trying to call the nurse and the nurse does not respond quickly
- Patients also feel confined to their bay and are hesitant to approach other patients not on their bay
- New sources of noise appear on bay ward through the use of more equipment and open and longer visiting hours.
- Nurses also find it harder to be more vigilant about the noise

Implications of Findings

- The Nightingale ward, though offering high visibility of patients, does not meet a patient's need for privacy
- The Bay wards allow for greater visibility and flexibility, but are noisier and have less patient visibility than the Nightingale ward

Joint Commission of Accreditation of Healthcare Organizations (JCAHO) (2002). *Healthcare at the crossroad: Strategies for addressing the evolving nursing crisis.* Oakbrook Terrace, IL: Joint Commission of Accreditation of Healthcare Organizations

Focus of Article

- To address the nursing shortage in American hospitals.

Type of Healthcare Facility

- The information presented applies to hospitals in the United States.

Recommendations for Healthcare Setting

- 90% of long term care organizations lack nurse staffing to provide basic care
- When nursing levels are high, patients suffer fewer complications, fewer adverse events, shorter lengths of stay, and lower mortality.
- Hospitals should create organizational cultures of retention, bolster nursing educational infrastructure, and establish financial incentives for investing in nursing

- Hospitals that are able to retain nurses have higher quality measures. When nurses leave, hospital costs rise and profitability, productivity, efficiency, and quality decrease.
- Hospitals should adopt competitive compensation and benefit packages for nursing staff & minimize the amount of paperwork and administrative duties nurses must complete
- A zero-tolerance policy should be implemented regarding abusive behaviors towards nurses by physicians and other health care staff
- Staff effectiveness should be measured, analyzed, and improved upon
- Staff levels should be set based upon their competency and skills and patient acuity; overtime should be limited to emergencies
- Ergonomic technology should be adopted to reduce risks of injury
- Federal funding should be increased for nursing education
- Nurses should be provided with low-cost opportunities to achieve higher education
- Team training should be emphasized in education programs
- Nursing career ladders should be created based on education levels, training, and experience
- Federal funding should be provided for nursing services
- Federal funding should continue based on achievement of standardized criteria and goals

Implications of Findings

- To address the nursing shortage, hospitals need to create a culture of retention, nursing schools need greater funding, and successes in hospitals should be documented and rewarded.
- Adequate staffing levels are key to providing high quality patient care
- No mention was made in regards to specific nursing unit design
- Leaman, A., & Bordass, B. (2000). Productivity in buildings: The killer variables. In D.

Clemence-Croom (Ed.), *Creating the productive workplace* (pp. 165-191). London: Spon Press.

Focus of Article

- The purpose of this chapter is to identify features in the design of the workplace which influence productivity

Type of Healthcare Facility

- The material presented in this article apply to office buildings.

Recommendations for Healthcare Setting

- Buildings are likely to perform better when the management strategy is developed from the outset of the design and a clear understanding of the client requirements is obtained
- Variables that have a critical impact on the overall functionality of a system, and thus productivity, include personal control, responsiveness, building control, and workgroups
- People's perceptions of control over their environment affects their comfort and satisfaction; main concern of occupants of buildings but designers and developers reluctant to act on concerns
- Buildings which work well have capability to meet people's needs in anticipation or as they arise
- Buildings tend to have poor levels of perceived control because have relatively low levels of building management
- Crucial depth-of-space is approximately 15m from wall to wall; deeper the building gets, overall satisfaction and productivity tend to decline
- As building size increases, more functions are performed and more people occupy the building, but operational complexity increases, creating likelihood of failure
- Productivity is higher in smaller and more integrated workgroups; as workgroups get larger, mapping between environmental controls and activities disintegrates and other colleagues' wishes need to be considered
- Best strategies include keeping workgroups small and well integrated, keeping sources of distractions to a minimum, not interfering with sources of wanted information, and design and manage work setting so normal setting is reasonably comfortable, safe, and healthy

Implications of Findings

- Office spaces work best when opportunities exist for personal control, when a rapid response environment is available, a shallow plan form is utilized, and when activities fit the services which are supposed to support them

Lu, H., While, A. E., & Barriball, K. L. (2005). Job satisfaction among nurses: A literature review. *International Journal of Nursing Studies*, 42, 211-227.

Focus of Article

- To examine literature pertaining to job satisfaction among nurses

Type of Healthcare Facility

- The material presented in this paper applies to acute care facilities.

Recommendations for Healthcare Setting

- Sources of job satisfaction include physical working condi-

tions, relationships with co-workers, pay, promotion, job security, responsibility, and recognition from managers

- Job satisfaction is a significant predictor of nursing absenteeism, burnout, turnover, and intention to quit
- Job satisfaction is related to job stress, role conflict, and organizational and professional commitment

Implications of Findings

- Job satisfaction impacts the turnover rates of nurses. Lower levels of satisfaction are related to higher absenteeism, burnout and turnover. When the environment in which a nurse works in is perceived as positive, they are less likely to experience job stress.
- No mention was made in regards to specific nursing unit design.

Miller, R. L. & Swensson, E. S. (1995). *The patient care unit. New directions in hospital and health-care facility design* (pp.177-208). New York: McGraw-Hill, Inc.

Focus of Article

- To describe trends in the design of hospitals

Type of Healthcare Facility

- The material presented in this chapter applies to acute care facilities in the United States

Recommendations for Healthcare Setting

- Patient-focused care was given momentum from the development of the Planetree model in 1978, which sought to improve the human quality of patient care. The open ward is essentially obsolete due to a team approach to care as well as technological developments
- Patient room should be a humane environment, which
 - provides the patient with privacy, dignity, cleanliness, and security, among other factors
- Needs of the nurses, at times, conflicts with the needs of patients; ex. need to have easy access to patients and the ability to see patients may impact a patient's privacy
- In patient-centered care facilities, rooms are larger and of single-occupancy
- Large space allows for the performance of procedures in the rooms and it reduces the necessity of transporting the patient to various specialists
- Larger room is also feasible economically; in the long run, the rooms can be used for rehabilitation and elderly housing or for other programs
- Flexibility increases through the use of disabled-access bathrooms; enables all patients to use the rooms at all times
- A design incorporating a cluster of beds, which can readily

be supervised by a nursing team, is recommended; easily managed to accommodate fluctuating patient populations

- Bedside computers enable more detailed and frequent updating of patient charts to occur

Implications of Findings

- Patient-focused care incorporates single-occupancy rooms which provide for increased flexibility and adaptability to care for an array of patients. A humane environment is created for patients focusing on their privacy, dignity, and security.

Nightingale, F. (1859). *Notes on nursing: What it is and what it is not.* London: John W. Parker & Son.

Focus of Article

- To describe how hospital design can promote effective nursing.

Type of Healthcare Facility

- The material presented in this book applies to acute care facilities.

Recommendations for Healthcare Setting

- Nursing involves the proper use of fresh air, light, warmth, cleanliness, quiet, and selection of diet
- Ventilation is critical to a patient's health – it should be kept pure without causing the patient chills; air from windows is freshest – proper number of windows is necessary
- Poor management can undermine a patient's health; nurses need to manage what they do when they are on duty
- Unnecessary noise, intermittent noise, and sudden, sharp noises can create excitement in a patient and can harm the patient's recovery; these noises do more harm than loud, continuous noises
- Patients who are not confined to their room and who have options in activities are in better spirits
- Direct sunlight is second in importance to ventilation for a patient
- Heavy, dark, thick window curtains should hardly ever be used
- Nurses should be clean and keep their patient clean; hands should be cleaned with chlorinated water
- To remove dust, everything should be wiped with a damp cloth
- Carpets should be avoided in a patient's room – dirty carpets infect the room
- Ventilation will be affected if hospitals are not clean

Implications of Findings

- Proper ventilation and adequate lighting are essential to a patient's recovery.
- Nurses need to ensure their patient's room is clean and they must wash their hands when dealing with patients

- A patient's recovery would be improved if not confined in the room all day

Noskin, G.A., & Petersen, L. R. (2001). *Engineering infection control through facility design. Emerging Infectious Diseases, 7(2), 354-357.*

Focus of Article

- To describe the significant historical impacts in hospital design which helped to prevent the acquisition and spreading of infections

Type of Healthcare Facility

- The material presented in this article applies to all acute care facilities.

Recommendations for Healthcare Setting

- Ignaz Semmelweis, based on his observations with baby deliveries, suggested that disinfecting hands could prevent the transmission of infection to a pregnant patient
- Florence Nightingale stated that double wards prevented nurses from observing all their patients simultaneously; believed open windows interfered with hospital ventilation; thought the sick should be isolated and that hospitals should not be more than two stories high – taller buildings interfered with sunlight and ventilation
- Norton Folsom believed that properly separating patients and appropriate ventilation were critical to hospital design
- Asa Bacon thought the most efficient hospital would have all private rooms
- In constructing a new facility, risk assessments should be made to determine the potential risk for transmission of microorganisms
- Installation of HEPA filters can help prevent the transmission of Aspergillosis
- Patients at risk for Tuberculosis should be placed in an isolated room with negative airflow
- To prevent Legionellosis, hospital water should be disinfected
- Carpets should be avoided in high risk areas; they should be vacuumed daily and periodically steam cleaned
- Wall coverings should be fluid resistant and easily cleaned
- Hand washing is the most important method of preventing hospital infections

Implications of Findings

- In designing and constructing a new facility, it is necessary to take measures, such as installing HEPA filters and disinfecting water; in ensuring the risk of the transmission of infection is minimal
- Compliance with hand washing is critical to preventing the spread of hospital infections

Olds, A. R. (1978). Psychological considerations in humanizing the physical environment of pediatric outpatient and hospital settings. In E. Gellert (Ed.) *Psychosocial aspects of pediatric care* (pp. 111-131). New York: Grune & Stratton, Inc.

Focus of Article

- To describe the physical environment of pediatric settings.

Type of Healthcare Facility

- The material presented in this article applies to pediatric outpatient and hospital settings.

Recommendations for Healthcare Setting

- Pediatric settings should not aggravate existing levels of distress and anxiety
- Pediatric environment affects three psychological needs of children, patients, and staff: need to feel comfortable, need to feel in control, and need to be purposefully active
- Warm, welcoming, and friendly environments appeal to the senses
- Patients should feel that they belong; they should be able to easily make their way through the building and they should have activities to perform which grant them some control
- While waiting, parents and children should have options for activity, engagement, and interaction
- Playrooms should bring children together socially and should be child-oriented

Implications of Findings

- The pediatric facilities should provide an environment in which both the parents and children feel they belong. They should feel comfortable, have a certain degree of control over their surroundings, and should have the opportunity to interact with others.

Rabinowitz, P. M. (2005). Is noise bad for your health? *The Lancet*, 365, 1908-1909.

Focus of Article

- To discuss the negative implications of excessive noise

Type of Healthcare Facility

- The material in this article applies to all acute care facilities.

Recommendations for Healthcare Setting

- Prolonged exposure to excessive noise levels in the workplace can lead to permanent high-frequency hearing loss
- Noise may act with other environmental factors, such as crowding, to increase stress

Implications of Findings

- A noisy environment can interfere with communication between staff and patients and disrupt sleep patterns of patients
- Measures need to be taken to ensure noise levels in hospitals are at an adequate level

Rubin, H. (1997). The relationship between environmental design and patient medical outcomes. *Journal of Healthcare Design*, 9, 13-14.

Focus of Article

- To describe factors affecting the relationship between environmental design and patient outcomes

Type of Healthcare Facility

- The material presented in this article applies to all acute care facilities.

Recommendations for Healthcare Setting

- Factors in the environment that can affect a patient include room scale and size, environmental control by the patient, lighting, color, texture, artwork, air, ventilation, and noise
- When evaluating studies, consideration should be made regarding whether the study was blind, the patient population included, and outcome measures
- To determine how design affects health outcomes, patients who are most likely to benefit from the design should be identified; literature should be reviewed; an environment should be built where data comparing patients and interventions is possible

Implications of Findings

- The physical environment may improve clinical outcomes, but to date, the evidence is not conclusive

Shumaker, S.A. & Pequegnat, W. (1989). Hospital design, health providers, and the delivery of effective health care. In E. H. Zube & G.T. Moore (Eds.), *Advances in environment, behavior, and design*, Vol. 2 (pp. 161-199). New York: Plenum.

Focus of Article

- To discuss the impact that hospital design has on patients and nurses.

Type of Healthcare Facility

- The information presented applies to acute care facilities.

Recommendations for Healthcare Setting

- Nursing role is associated with stress; have high level of responsibility with limited control; deal with competing demands of health care workers, patients, and visitors

- Organizational climate, supervisory style, and work-group relations primary determinants of stress for nurses; related to job satisfaction
- Radial design of nursing unit enabled nurses to spend more time with patients
- Nurses are more familiar with hospital layout than patients; may affect patients negatively because nurses adjust to negative aspects of the hospital environment
- Patients may have better control of environment because have own personal space in room; nurses normally do not have a specific space belonging to them
- Being in a stressful environment can lead to burnout and high staff turnovers; can also lead to patient stress

Implications of Findings

- Environmental design can be critical in creating and reducing stress levels of both nurses and patients.
- Radial designs are preferred among nurses as they are able to spend more time with patients
- When an environment is stressful, patients may experience stress and nurses can experience burnout, leading to high levels of turnover
- No mention was made in regards to specific nursing unit design

Sutherland, V., & Cooper, C. L. (2000). Stress and the changing nature of work. In D. Clemence-Croom (Ed.), *Creating the productive workplace* (pp. 77-90). London: Spon Press.

Focus of Article

- The purpose of this chapter is to identify sources of stress which impact productivity.

Type of Healthcare Facility

- The material presented in this chapter applies to the work place in general.

Recommendations for Healthcare Setting

- Health, well-being, and quality of work life associated with performance and productivity
- Change requires adaptation and is, thus, stressful
- Costs of mismanaged stress high as result impacts such as ill-health, premature death, poor performance, low levels of motivation, poor safety performance, and delayed recovery from illness or accident
- Time pressures, deadlines pressures, uneven distribution of resources, and heavy volume of work are potential stressors
- Role ambiguity and role conflict can result with changes to role structure
- Career stressors include feeling undervalued and frustrated in attaining sense of achievement

- Threats to freedom, autonomy, and decision-making are potential sources of stress
- Employee support for work environment likely when organization characterized by presence of form of profit, job security, development of group cohesiveness, and guaranteed individual rights
- Both the organization and individual should be involved in stress management
- Job rotation and job share opportunities prevent people from being exposed to high-stress job for substantial lengths of time
- Preventive stress management strategies include assertiveness training, improved coping skills, leadership skills training, and time management skills
- Curative stress management strategies include provision of employee assistance programs, counseling services, development of social support networks, and opportunities for career sabbatical

Implications of Findings

- Stress has a negative effect on performance and productivity, and thus, stress management strategies should be in place to improve employee outcomes

Tradewell, G. B. (1993). Contemporary nursing unit configuration. In D. K. Hamilton (Ed.) *Unit 2000: Patient beds for the future. A nursing unit design symposium* (pp. 191-215). Houston: Watkins Carter Hamilton Architects, Inc.

Focus of Article

- To describe the design of patient care units

Type of Healthcare Facility

- The material presented in this chapter applies to all acute care facilities

Recommendations for Healthcare Setting

- The Nightingale ward is a basic open ward design. Nurses are located among patients and the support stations are located outside the ward. This type of ward contains approximately 30 to 32 beds and visibility of all patients was the goal of this design
- The Continental or single- and double-corridor design contains patient rooms along one or both sides of the corridor. Instead of an open ward, rooms contain 4 to 6 beds. The unit also contains a central nursing station and support space supplies the unit
- In the Racetrack design, patient rooms are located further apart and support spaces are located between two corridors. Nurses do not favor this design because travel distances are high, visualization of the corridors is poor; one nursing station supports a large number of patients, and only one clean and one soiled utility room is provided

- The cluster design encompasses patient rooms around nursing substations. One nursing station is dedicated as the central nursing station
- Travel distances are fairly short in the triangular design which typically hold approximately 30 beds
- The criteria that must be met to create a good design include the organization of patient rooms, observation of patients, number of nursing stations needed, distribution of support space, flexibility, and travel distances
- Nurses will be attracted to working in an environment where they are able to perform what they have been trained to do
- Hospitals could save costs through the use of trained non-professional staff; patients would have shorter lengths of stay, fewer errors are likely to occur, and staff would be likely to stay in an environment that promotes their abilities

Implications of Findings

- Ward design must encompass factors such as the organization of patient rooms, the number of nursing stations needed, flexibility, and visibility of patients.
- Room occupancy varies among the designs, and preferences were not specified

Tuttas, C.A. (2003). Decreasing nurse staffing costs in a hospital setting: Development and support of core staff stability. *Journal of Nursing Care Quality*, 18(3), 226-240.

Focus of Article

- To examine how the nursing shortage is a source of financial strain on hospitals.

Type of Healthcare Facility

- The material presented in this article applies an acute care setting in South Florida.

Recommendations for Healthcare Setting

- Fewer post-operative complications occur in patients where there are more registered nurses than in hospitals with fewer registered nurses
- Number of graduating nurses will not meet current or future needs if changes are not made to current patient care delivery
- Cost to hospitals continuing to use agency staff will increase; hospitals should reduce the use of agency staffing
- Cost of nurse staffing is one of greatest sources of expense in hospital budget
- Nursing and hospital administrators must implement strategies to enforce responsibility and accountability among personnel
- Lower paid, non professional staff, can relieve the burden on professional nurses if properly educated and supervised
- Hospitals could have a Lead Nursing Assistant to ensure assigned tasks that do not require a professional nurse are completed; the Lead Nursing Assistant reports to the Charge nurse
- The role of the Lead Nursing Assistant could be customized for any nursing department

Implications of Findings

- If hospitals would train and supervise nonprofessional staff to assist Registered Nurses, patient care would improve as would the morale of the staff
- No mention was made in regards to nursing unit layout.

Verderber, S. & Fine, D. J. (2000). Reinventing the patient room. In S. Verderber & D. Fine, *Healthcare architecture in an era of radical transformation* (pp. 195-222). New Haven, CT:Yale University Press.

Focus of Article

- To describe the design of patient care units

Type of Healthcare Facility

- The material presented in this chapter applies to acute care facilities in the United States and Europe

Recommendations for Healthcare Setting

- Hospital design has shifted from traditional open wards to the use of private rooms
- Single-occupancy rooms were deemed by the U.S. General Accounting office to be the most cost-efficient in terms of day-to-day operations and initial construction costs
- Nightingale hospitals were deemed inefficient due to the excess vertical movement between floors, the difficulty of expansion, and the basic changes in overall service mix of hospitals
- Cluster unit minimized the distances traveled by nurses and enabled nurses to deliver a higher-level of care than the traditional linear unit
- Use of high-tech equipment and furnishings affected room design in terms of bed positioning, ceiling height, closets, overall size of the rooms, and window positioning
- Planetree movement incorporated the participation of the patients and their family members. An emphasis was placed on education, personalization, and the demystification of the illness
- Planetree determined that patients were denied supportive human relationships, physical comfort, and independence in the hospital environment
- Transformational rooms can be converted and reverted to their initial stage

- Bedside computers enable nurses to input patient data immediately and give patients access to their medical information
- Private patient rooms are made larger to accommodate equipment, such as the bedside computers, as well as family members

Implications of Findings

- Patient rooms have evolved from open wards to private patient rooms giving patients a more humane environment with greater physical comfort
- Cluster units enable nurses to deliver better care to their patients than the linear units

Whole Building Design Guide Productive Committee. (2005, February 1). Productive. <http://www.wbdg.org/design/productive.php>

Focus of Article

- To describe how the work environment can affect staff productivity.

Type of Healthcare Facility

- The material in this article applies to the working environment in general.

Recommendations for Healthcare Setting

- Quality and suitability of workspace affects productivity and well-being of users
- Worker productivity is linked to compensation levels, management practices, and environment comfort
- Productivity depends on worker well-being and satisfaction with the physical environment
- Five fundamental principles of building design are: promote health and well-being, provide comfortable environments (provide highest levels achievable of visual, acoustic, and thermal comforts), design for the changing nature of work (provide spaces with flexibility and technology to promote new ways of working), integrate technological tools, and assure reliable systems and spaces.

Implications of Findings

- Worker productivity improves in a work environment which is flexible, comfortable, reliable, and focuses on a worker's well-being.

Literature Review Table

Errors in the Acute Care Environment

Factors Affecting Errors	Key Issues	Degree of Evidence	Empirical Articles	NON-EMPIRICAL ARTICLES	
				Expert Opinion	Anecdotal Information
ENVIRONMENTAL VARIABLES					
Noise Positive Effects ✓ Negative Effects Mixed Results	Noise levels increasingly exceed recommended levels by World Health Organization Excess noise can result in negative symptoms for patients including stress levels Excess noise levels can increase stress levels for staff members and impair concentration and communication ,resulting in errors	★ ★ ★ ★ ★	Blomkvist, Eriksen, Theorell, Ulrich, & Rasmanis (2005); Hilton (1985); Hodge and Thompson (1990); Ganey (2003); Graven, 1997; Topf & Dillon (1988); Topf (1985) Berglund, Lindvall, & Schwela, 1999; Hosking & Haggard, 1999; Shumaker & Reizemstein (1982); Ulrich, Zimring, Quan, Joseph, & Choudhary (2004)	Grumet (1993); Lowers (1999); Neumann & Ruga, (1995); Weber (1995)	
Lighting ✓ Positive Effects Negative Effects Mixed Results	High illumination levels result in fewer errors Bright lights improve patient outcomes Exposure to sunlight results in improved health Increased exposure to natural light positively impacts work life of staff members	★ ★ ★ ★ ☆	Beauchem & Hays (1996); Benedetti, Colombo, Barbini, Campori, & Smeraldi (2001); Buchanan, Barker, Gibson, Jiang, & Pearson (1991); Mroczek, Mikitarian, Vietra, & Rotarius (2005); Walch, Rabin, Day, Williams, Choi, Kang (2004); Ulrich (1984);	Shumaker & Reizemstein (1982)	Lowers (1999); Weber (1995)
Color Positive Effects Negative Effects ✓ Mixed Results	Stimulating colors are best suited in recreation areas Cool colors are best suited in quiet areas as they promote concentration for staff members Intense colors improve visual organization Monochromatic color schemes can contribute to sensory deprivation Error rates may be higher in areas where the color is ill suited for the task at hand	★ ★ ☆ ☆ ☆	Hightower, Thomas, Stone, Brinkley, & Brown (1995)	Leibrock (2000); Malkin (1982, 1992); Mahnke (1996); Tofle, Schwarz, & Max-Royale (yr)	
Ergonomics/ Furniture/ Equipment Positive Effects Negative Effects ✓ Mixed Results	Ergonomic design is critical to efficiency Visual and tactile discrimination should be maximized through the use of appropriate materials Poor ergonomics are associated with higher absenteeism levels Automated medication entry systems have reduced errors	★ ★ ☆ ☆ ☆	Ali et al. (2005); Bates, Leape, Cullen, Laird, Petersen, Teich, et al., (1998); Borel & Rascati, (1995); Hui et al. (2001); Janowitz, Gillen, Ryan et al. (in press); Koppel, Metlay, Cohen, Abaluck, Localio, Kimmel, et al. (2005); Rothschild, Keohane, Cook, Orav, Burdick, Thompson, et al. (2005); Schwarz & Brodowy (1995); Shirley (1999);	Carayon, Alavardo, & Hundt (2003); Kroemer & Kroemer (2001);	Collins & Owen (1996); Cronk, 2002
Heating/ Ventilation/ Air Conditioning Positive Effects ✓ Negative Effects Mixed Results	Poor ventilation can increase the spread of infection Adequate ventilation and its maintenance are critical to ensure staff and patient safety	★ ★ ★ ★ ☆	Jiang, Huang, Xilong, Jinfeng, Wei, et al. (2003); Menzies, Fanning, Yuan, & FitzGerald (2000); Kumari, Haji, Keer, Hawkey, Duncanson, & Flower; (1998); Lundstrom, Pugliese, Bartley, Cox, & Guthier (2002);	Nightingale (1859); Sehulster & Chinn, 2003; Ulrich, Zimring, Quan, Joseph, & Choudhary (2004)	

Errors in the Acute Care Environment (cont.)

NON-EMPIRICAL ARTICLES					
Factors Affecting Errors	Key Issues	Degree of Evidence	Empirical Articles	Expert Opinion	Anecdotal Information
Design/Layout ✓ Positive Effects Negative Effects Mixed Results	Single-occupancy rooms improve patient outcomes in comparison to double-occupancy rooms Standardized patient rooms reduce errors Larger medication rooms with increased work space increase organization and lead to a reduction in errors Acuity adaptable rooms result in fewer errors and shorter lengths of stay	★ ★ ★ ☆ ☆	Hendrich, Fay, & Sorrells (2002); Janssen, Harris, Soolsma, Klein, & Seymour (2001);	Hill-Rom (2002); Page (2004); Reiling & Knutzen (2003); Reiling (2002); Spreckelmeyer (2004); Carayon, Alavardo, & Hundt (2003);	Ford (2004); Lowers (1999); Runy, (2004)
NON-ENVIRONMENTAL VARIABLES					
Fatigue/Long work hours Positive Effects ✓ Negative Effects Mixed Results	Long work hours are associated with increased errors and higher fatigue Fatigue results in slowed reaction time, reduced attention to detail, compromised problem solving, and errors of omission	★ ★ ★ ☆ ☆	Rogers, Hwang, Scott, Aiken, & Dinges (2004); Suzuki, Ohida, Kaneita, Yokoyama, & Uchiyama (2005)	Carayon & Gurses (2005); Institute of Medicine (2004); Krueger (1994); Page (2004)	
Stress Positive Effects ✓ Negative Effects Mixed Results	Stress can decrease confidence and increase anxiety	★ ☆ ☆ ☆ ☆	Meurier, Vincent, & Parmar (1997);		
Faulty Judgement Positive Effects ✓ Negative Effects Mixed Results	Lack of knowledge regarding medication can lead to errors Faulty logic can result in compromised patient care	★ ★ ☆ ☆ ☆	Benner, Sheets, Uris, Malloch, Schwed, & Jamison (2002); Leape, Bates, Cullen, Cooper, Demenaco, Gallivan et al., (1995); Tissot, Cornette, Demoly, Jacquet, Barale, & Capellier (1999); Woods & Doan-Johnson (2002)		
Staffing Levels Positive Effects ✓ Negative Effects Mixed Results	Low staffing levels are associated with increased errors Higher workloads are associated with increased rates of nosocomial infection and decreased patient satisfaction Inexperience may have a negative effect on patient care	★ ★ ★ ☆ ☆	Binnekade, Vromm, de Mol, & de Haan, (2003); Blendon et al., (2002); Hall, Doran, & Pink (2004); Morrison, Beckmann, Durie, Carless, & Gilles (2001); Nicklin & McVeety (2002); Whitman, Kim, Davidson, Wolf, & Wang (2002); Unruh (2003); Yang (2003)		
Error Reporting ✓ Positive Effects Negative Effects Mixed Results	Safe error reporting systems encourage staff to report errors Error reporting enables staff to learn from mistakes and prevent future errors from occurring	★ ★ ★ ☆ ☆	Benner, Sheets, Uris, Malloch, Schwed, & Jamison (2002); Silen-Lipponen, Tossavainen, Turunen, & Smith (2005)	Kohn, Corrigan, & Donaldson (2000b); Leape & Berwick (2000)	McClanahan, Goodwin, & Houser (2000); Paparella (2005)

Errors in the General Workplace

NON-EMPIRICAL ARTICLES					
Factors Affecting Errors	Key Issues	Degree of Evidence	Empirical Articles	Expert Opinion	Anecdotal Information
ENVIRONMENTAL VARIABLES					
Noise Positive Effects ✓ Negative Effects Mixed Results	Noise detrimental to performance & may lead to slips or errors Noise can lead to psychological distress Noise impedes concentration	★ ★ ★ ★ ★	Banbury & Berry (2005); Banbury & Berry (1998); Brill, Margulis, Konar, & BOSTI (1984); Hygge & Knez (2001); Kjellberg, Landstrom, Tesarz, Soderberg, & Akerlund (1996); Leather, Beale, & Sullivan (2003); McDonald & Ronayne (1989); Nurminem & Kurpa (1989); Sundstrom, Town, Rice, Osborn, & Brill (1994)	Sundstrom (1987)	
Inadequate Lighting Positive Effects ✓ Negative Effects Mixed Results	Lighting affects visibility Increased intensity of lighting necessary for difficult tasks Eyestrain result of poorly designed lighting Greater illumination reduces accidents Glare source of discomfort Greater control associated with greater satisfaction	★ ★ ★ ☆ ☆	Hygge & Knez (2001); Knez (1995); Marans & Yan (1989); Veitch & Newsham (2000); Veitch (1997)	Kroemer & Kroemer, 2001; Ruck, (1989a); Ruck, (1989b); Sundstrom (1987); Sundstrom & Sundstrom (1986);	Abdou (1997); Ebben, (2001);
Color Positive Effects Negative Effects ✓ Mixed Results	Color impacts mood, satisfaction, motivation, & performance Warm colors increase alertness while cool colors are relaxing Color affects accuracy	★ ★ ☆ ☆ ☆	Clark (1975); Kwallek & Lewis (1990); Stone (2003); Stone & English (1998); Brill, Margulis, Konar, & BOSTI (1984); Levy (1984)		Mahnke (1996); Wineman (1979);
Ergonomics/ Furniture/ Equipment Positive Effects Negative Effects ✓ Mixed Results	Workstation design impacts performance and well-being Postural discomfort is associated with working for long periods of time on a computer Ergonomics training is beneficial for employees	★ ★ ★ ☆ ☆	Cerny & Ucer (2004); Feuerstein, Nicolas, Huang, Dimberg, Ali, & Rogers (2004); Huang, Robertson, & Chang (2004); Liao & Drury (2000); Menozzi, Napflin, & Kreuger (1999)	Kroemer & Kroemer, (2001); Sundstrom (1987); Sundstrom & Sundstrom (1986);	Franco & Fusetti (2004); Faucett & Rempel (1996); Fogleman & Brogmus (1995); Karasek & Theorell, (1990); Schulze (2000);
Heating/ Ventilation/ Air Conditioning Positive Effects Negative Effects ✓ Mixed Results	Air quality is associated with performance and physical well-being Air quality can create dissatisfaction with the environment Mental performance associated with office temperature	★ ★ ★ ☆ ☆	Brasche, Bullinger, Schwab, Gebhart, Herzog, & Bischof, (2004); Brill, Margulis, Konar, & BOSTI (1984); Melikov, Pitchurov, Naydenov, & Langkilde (2005)	Kroemer & Kroemer, 2001; Sundstrom (1987); Sundstrom & Sundstrom (1986);	Bechtel & Churchman, 2002;
Design/ Layout Positive Effects Negative Effects ✓ Mixed Results	Control of environment related to increased satisfaction Lack of privacy leads to dissatisfaction High functional capacity buildings meet needs of users	★ ★ ☆ ☆ ☆	Marans & Spreckelmeyer (1982a); Marans & Spreckelmeyer (1982b); Spreckelmeyer (1987)	Leaman & Bordass (2000)	Lee & Brand (2005)

Errors in the General Workplace (cont.)

Factors Affecting Errors	Key Issues	Degree of Evidence	Empirical Articles	NON-EMPIRICAL ARTICLES	
				Expert Opinion	Anecdotal Information
NONENVIRONMENTAL VARIABLES					
Factors Affecting Errors in the General Workplace				Positive	
Fatigue/ Long work hours Positive Effects ✓ Negative Effects Mixed Results	Fatigue leads to diminished capacity to work Shift work affects sleep	★ ★ ☆ ☆ ☆	Gander, Gregory, Graeber, Connell, Miller, & Rosekind (1998a); Gander, Gregory, Graeber, Connell, Miller, & Rosekind (1998b); Luna, French, & Mitcha (1997)	Page (2004)	
Stress Positive Effects ✓ Negative Effects Mixed Results	Stressors include time & deadline pressures & heavy work volume Job sharing and job rotation can reduce stress	☆ ☆ ☆ ☆ ☆		Sutherland & Cooper (2000)	
Age of worker Positive Effects Negative Effects ✓ Mixed Results	Older workers have more emotional reaction to errors and were less likely to correct errors without support	☆ ☆ ☆ ☆ ☆	Birdi & Zapf (1997)		

Patient Safety

						NON-EMPIRICAL ARTICLES	
Factors Affecting Errors	Key Issues	Degree of Evidence	Empirical Articles	Expert Opinion	Anecdotal Information		
ENVIRONMENTAL VARIABLES							
Noise Positive Effects ✓ Negative Effects Mixed Results	Excess noise levels can increase anxiety & pain perception and reduce sleep Overcrowding leads to excess noise Carpeted floors, sound-absorbing ceiling tiles & sound-attenuating surfaces aid in reducing noise levels	★ ★ ★ ☆ ☆	Nicklin & McVeety (2002)	Cabrera & Lee, 2004; Ulrich, Zimring, Quan, Joseph, & Choudhary, 2004; Nightingale 1859; Hosking & Haggard, 1999	Lowers, 1999; Rollins, 2004		
Adequate Lighting ✓ Positive Effects Negative Effects Mixed Results	Adequate lighting beneficial to patients and staff Natural light can reduce stress and improve safety	★ ☆ ☆ ☆ ☆	Shepley, 2002	Stichler, 2001	Rollins, 2004		
Adequate Ventilation ✓ Positive Effects Negative Effects Mixed Results	Proper ventilation can alleviate stress and improve patient outcomes Ventilation is associated with infection control	★ ★ ☆ ☆ ☆	Kumari, Haji, Keer, Hawkey, Duncanson, Flower; 1998	Sehulster & Chinn, 2003;	Brady, 2005; O'Connell & Humphreys, 2000; Rollins, 2004; Bilchik, 2002		
Design/ Layout Positive Effects Negative Effects ✓ Mixed Results	Design is associated with satisfaction with hospital stay Flaws in design can contribute to patient falls Acuity adaptable rooms are related with reduced transfers	★ ★ ★ ★ ★	Gotlieb, 2000, 2002; Hendrich, Fay, & Sorrells 2002, 2004; Dettenkofer; Seegers, Antes, Motschall, Schumacher, & Daschner 2004; Kibbler, Quick, & O'Neill, 1998;	Ulrich & Barach, 2006; Barach & Dickermann, 2006; Bilchik, 2002; Reiling, Breckbill, Murphy, McCullough, & Chernos, 2003; Reiling, Berry, Parker, & Coile Jr., 2004; Stichler (2001)	Gross, Sasson, Zarhy, & Zohar, 1998		
NONENVIRONMENTAL VARIABLES							
Poor Hand Hygiene Positive Effects ✓ Negative Effects Mixed Results	Poor handwashing compliance contributes to hospital acquired infections Understaffed units tend to have poorer compliance with hand hygiene	★ ★ ★ ★ ★	Preston, Larson, & Stamm, 1981; Vietri, Dooley, Davis, Longfield, Meier, & Whelen, 2004; Dettenkofer; Seegers, Antes, Motschall, Schumacher, & Daschner; 2004	Ulrich, Zimring, Quan, Joseph, & Choudhary, 2004	O'Connell & Humphreys, 2005; Sehulster & Chinn, 2003;		

Staff Health and Safety

Factors Affecting Errors	Key Issues	Degree of Evidence	Empirical Articles	NON-EMPIRICAL ARTICLES	
				Expert Opinion	Anecdotal Information
ENVIRONMENTAL VARIABLES					
Noise levels Positive Effects <input checked="" type="checkbox"/> Negative Effects Mixed Results	Noise levels are produced within hospitals and are well above suitable levels Greater degree of noise-induced stress is associated with higher levels of burnout	★ ★ ☆ ☆ ☆	Bayo, Garcia, & Garcia, 1995; Topf & Dillon, 1988		Williams, 1988
Ergonomic Devices <input checked="" type="checkbox"/> Positive Effects Negative Effects Mixed Results	Physical ailments may be result of poor economic design Proper ergonomic devices may reduce injuries	★ ★ ☆ ☆ ☆	Brady, Chester, Pierce, Salter, Schreck, & Radziewicz, 1993; Garg & Owen, 1992	Lundstrom, Pugliese, Bartley, Cox, & Guither, 2002	
Adequate Ventilation <input checked="" type="checkbox"/> Positive Effects Negative Effects Mixed Results	Inadequate ventilation may lead to increased infection rates Proper ventilation promotes health	★ ★ ☆ ☆ ☆	Menzies, Fanning, Yaun, & FitzGerald, 2000; Jiang, Huang, Xilong, Jinfeng, Wei, et al., 2003		
NONENVIRONMENTAL VARIABLES					
Poor hand hygiene Positive Effects <input checked="" type="checkbox"/> Negative Effects Mixed Results	Hand hygiene is critical to reducing infection rates Health care workers have poor compliance	★ ★ ☆ ☆ ☆	Larson, 1988; O'Malley & Varadharajan, & Lok, 2005; Pittet, Mourouga, & Perneger (1999)		McCaughey, 2005
Education regarding hand hygiene Positive Effects Negative Effects <input checked="" type="checkbox"/> Mixed Results	Educational campaigns may increase hand washing compliance	★ ★ ★ ☆ ☆	Arian, Ozgultekin, Tulunay, Turan, Oral, & Rosenthal, 2005; Muto, Siström, & Farr, 2000; Lockhart (2005)		Elliott, 1992; Pittet, 2004
Increasing the number of sinks & use of alcohol based products to improve hand hygiene Positive Effects Negative Effects <input checked="" type="checkbox"/> Mixed Results	Mixed results have been obtained regarding increasing the availability of sinks & alcohol based products	★ ★ ☆ ☆ ☆	Kaplan and McGuckin, 1986; Whitby & McLaws 2004; Cohen, Saimon, Cimiotti, & Larson, 2003; Gould, 1994; Gould & Ream, 1993; Muto, Siström, and Farr, 2000		

Design and Environmental Variables Related to Staff Outcomes

NON-EMPIRICAL ARTICLES

Factors Affecting Errors	Key Issues	Degree of Evidence	Empirical Articles	Expert Opinion	Anecdotal Information
ENVIRONMENTAL VARIABLES					
Noise Positive Effects ✓ Negative Effects Mixed Results	High noise levels impede communication between patients and staff Disturbing noise levels promote noise-induced stress which is associated with higher burnout levels	★ ★ ☆ ☆ ☆	Hodge & Thompson, 1990; Topf & Dillon, 1988;		Rabinowitz, 2005
Lighting Positive Effects Negative Effects ✓ Mixed Results	Exposure to daylight is associated with reduced levels of burnout Exposure to artificial lighting has a negative effect on nurses	★ ☆ ☆ ☆ ☆	Alimoglu & Donmez, 2005	Nightingale, 1859	Scott, 2004
Ventilation ✓ Positive Effects Negative Effects Mixed Results	Adequate ventilation helps minimize spread of infection	★ ☆ ☆ ☆ ☆		Nightingale, 1859	Noskin & Petersen, 2001
Wayfinding & Design ✓ Positive Effects Negative Effects Mixed Results	Poor wayfinding can lead to stress Job satisfaction is associated with nursing unit	★ ★ ★ ★ ☆	Halford & Leonard, 2003; Moeser, 1988; Sochalski (2001); Gillespie & Melby, 2003; Happell, Martin, & Pinikahana, 2003; Taylor & Barling, 2004; Renzi, Tabolli, Ianni, DiPietro, & Puddu, 2005	Carpman & Grant, 1993	
NONENVIRONMENTAL VARIABLES					
Staffing and Workload Positive Effects ✓ Negative Effects Mixed Results	Staff shortages have contributed to increased stress Dissatisfaction increases as number of patients per nurse increases Nurses feel they do not have enough time to complete their tasks and spend time with patients	★ ★ ★ ★ ★	Jenkins & Elliott, 2004; McVicar, 2003; Olofsson, Bengtsson, & Brink, 2003; Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Shaver & Lacey, 2003; Sochalski, 2004; Bowers, Luring, & Jackson, 2001; Olofsson, Bengtsson, & Brink, 2003; Upenieks, 1998; Bloom, Alexander, & Nuchols, 1997	Hendrich, 2006	Tuttas, 2003
Education and Experience Positive Effects Negative Effects ✓ Mixed Results	Nurses with higher education tend to be dissatisfied if hospitals not willing to meet their expectations Nurses with less experience have higher levels of stress Lower satisfaction associated with burnout	★ ★ ★ ★ ★	Ernst, Messmer, Franco, & Gonzalez, 2004; McVicar, 2003; Ma, Samuels, & Alexander, 2003; Cavanagh, 1992; Hoffman & Scott, 2003; Norbeck, 1985, Kalliath & Morris, 2002; Lane, Prestholdt, & Matthews, 1991; Vahey, Aiken, Sloane, Clarke, & Vargas, 2004; Leiter, Harvie, & Frizzell, 1998		Lu, While, & Barriball, 2005
Benefits ✓ Positive Effects Negative Effects Mixed Results	Satisfaction with pay and the organization leads to lower turnover rates	★ ☆ ☆ ☆ ☆	Cavanagh, 1992; Lum, Kervin, Clark, Reid, & Sirola, 1998; McVicar, 2003; Olofsson, Bengtsson, & Brink, 2003;		

Spaces in the Nursing Unit, Associated Activities, Potential Errors and Design Issues

Space	Activities	Potential Errors	Physical Environmental Issues	Recommended Design Issues
Pharmacy	<ul style="list-style-type: none"> Retrieving med order through tubes Ordering medication to wholesalers Sorting and labelling Locating meds and filling the patient med drawers 	<ul style="list-style-type: none"> Errors during interpretation/translation of orders from one document to another Medication labelling errors Selection of wrong medication 	<ul style="list-style-type: none"> Shelving of meds/IVs Lack of visibility Ergonomics 	<ul style="list-style-type: none"> Shelves that allow greater visibility of the medication bins Demarcation of various work spaces to reduce interruptions and distractions Accessibility and privacy
Medication Room	<ul style="list-style-type: none"> Dispensation Preparation of Meds and IV Fluids Spiking IV Fluids Pill Crushing Safety Checks 	<ul style="list-style-type: none"> Dispensing errors Preparation errors 	<ul style="list-style-type: none"> Multiple staff talking (distractions & interruptions) Noisy Staff fatigue Lack of adequate counter space Inadequate square footage Location vis-à-vis patient rooms may be challenging Potentially inadequate lighting 	<ul style="list-style-type: none"> Adequate counter space Reduced noise Adequate space for multiple activities (e.g., med. dispensation, preparation) Positive sensory stimulation through appropriate colors and other visual cues.
Clean Utility Room	<ul style="list-style-type: none"> Selecting supplies Pill crushing Pick up refrigerated bags Safety checks 	<ul style="list-style-type: none"> Selecting incorrect supply Error in safety checks 	<ul style="list-style-type: none"> Multiple staff talking (distractions & interruptions) Noisy Lack of adequate counter space Inadequate square footage Location vis-à-vis patient rooms may be challenging 	<ul style="list-style-type: none"> Adequate counter space Reduced noise Adequate space for multiple activities
Nurses Station	<ul style="list-style-type: none"> Charting Medication Administration Record Faxing medication request 	<ul style="list-style-type: none"> Medication ordering errors Errors in medication records Staff fatigue 	<ul style="list-style-type: none"> Noisy High traffic area (distractions and interruptions) Lack of visual access to patients Potentially inadequate lighting 	<ul style="list-style-type: none"> Sound absorbing materials Sound barrier in certain work spaces Computerized Physician Ordering Entry system (CPOE) Clinical decision support systems (CDSS)
Patient Room	<ul style="list-style-type: none"> Administering Meds. Electronic charting Hand-washing 	<ul style="list-style-type: none"> Medication administration errors Errors in medication administration records Time taken to locate power and respiratory outlets Staff Fatigue 	<ul style="list-style-type: none"> Accessibility to a sink Patient Access to bathroom Room Occupancy (Single vs. Double) Distance and support for patients room bed to the bathroom Layout of power and respiratory outlets Lighting contributes to errors 	<ul style="list-style-type: none"> Individual patient medication supply system Computerized Physician Ordering Entry system (CPOE) Computerized Medication Administration Records (MAR) Sink visually accessible and adjacent to the entry Supported access to bathroom from bed Consistent layout and equipment may reduce fatigue, inefficiencies, and errors Single-occupancy room for greater privacy and safety, and reduced error rates

Appendix A: Nursing Staff Survey

Reducing Nursing Error through Environmental Design

Nursing Staff Survey

Hospital ID# _____ (Please leave blank) Respondent ID# _____ (Please leave blank)

The purpose of this study is to explore the effect of the physical environment of nursing units on nursing errors, efficiency and fatigue. This survey asks you to respond to a series of questions about the physical environment and error/fatigue related issues. Findings from this study will help architects and interior designers to better design work environments that are more supportive of nursing tasks.

If you have any questions or comments about the study, please contact:

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Simon Fraser University

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Thank you very much for your input!

Nursing Units (NU)

NU1) Which of the following environmental characteristics in your current nursing unit is helpful or problematic in your work performance? (Please respond to each category)

	Type of nursing station in your current unit: Centralized			Decentralized	
	Helpful (5)	Somewhat Helpful (4)	Neither helpful nor problematic (3)	Somewhat Problematic (2)	Problematic (1)
a) Nursing Station Layout					
b) Availability of space in charting area					
c) Design of furniture in nursing station					
d) Arrangement of furniture in nursing station					
e) Privacy in nursing station					
f) Walking distance to patient rooms					
g) Visibility to all areas of the nursing unit					
h) Patient surveillance / monitoring					
i) Storage space for clean supplies					
j) Storage space for dirty supplies					
k) Location of storage area (clean & dirty)					
l) Location of medication room					
m) Size of medication room					
n) Medication dispensation method					
o) Handwashing and disinfection locations and protocols					
p) Noise level/acoustics					
q) Lighting in the space					
r) Heating and cooling					
s) Other (explain _____)					

ERRORS/ ADVERSE EVENTS (E)

E1) In your current work, which of the following types of medication errors happen more or less frequently?

	Very Frequently (5)	Somewhat Frequently (4)	Neither frequently nor rarely (3)	Somewhat Often (2)	Rarely (1)	Don't Know
i) Missed doses of medication						
ii) Wrong time of medication administration						
iii) IV medication rate too slow or too fast						
iv) Wrong concentration or dosage of medication delivered in IV						
v) Wrong route of medication administration						
vi) Wrong medication administered						
vii) Wrong medication delivered due to misidentification of patient						

E2) Which factors may contribute to these medication errors?

	Very Frequently (5)	Somewhat Frequently (4)	Neither frequently nor rarely (3)	Somewhat Often (2)	Rarely (1)	Don't Know
i) Location of medication room						
ii) Small or inadequate size of medication room						
iii) Problematic organization of medical supplies						
iv) High level of noise						
v) Poor lighting in med room						
vi) Medication label unreadable or missing						
vii) Medication not documented on medication administration record						
viii) Lack of supplies (IV pumps, pill splicer)						
ix) Calculation errors (incorrect conversion, incorrect calculation)						
x) Other _____						

E3) In your current work experience, which of the following types of documentation errors happen more or less frequently?

	Very Frequent (5)	Somewhat Frequent (4)	Neither frequently nor rarely (3)	Somewhat Often (2)	Rarely (1)	Don't Know
i) Documenting in wrong patient's chart						
ii) Omission or partial information input in charts/records (e.g., lack of charting of observations)						
iii) Charting procedures or medications before they were completed						
iv) Other _____						

E4) Which factors contribute to these documentation errors?

	Very Frequently (5)	Somewhat Frequently (4)	Neither frequently nor rarely (3)	Somewhat Often (2)	Rarely (1)	Don't Know
i) Location of charting space						
ii) Small or inadequate size of charting space						
iii) Poor lighting						
iv) High level of noise						
v) Other _____						

E5) Are there other types of nursing errors (besides medication and documentation errors) that you are aware of? If yes, what are they?

E6) Please indicate how important you think each of the following is as CAUSE leading to nursing errors.

	Very Important (1)	Somewhat Important (2)	Not Very Important (3)	Not At All Important (4)
Staff and Organizational Issues				
a) Poor training of health professionals				
b) Overwork, stress, or fatigue of health professionals				
c) High nurse to patient ratio				
d) Health professionals not working together or not communicating as a team				
e) Poor supervision of health professionals				
f) Poor handwriting by health professionals				
g) Lack of computerized medical records				
h) High staff turnover				
i) Breach of infection precautions				
Physical Environmental Issues				
j) Inadequate lighting in nursing station				
k) Faulty heating, cooling and ventilation system in nursing unit				
l) Unergonomic furniture in nursing station				
m) Lack of privacy in nurses' work area				
n) Inappropriate space layout in the nursing unit				
o) Insufficient space for documentation for charting/record keeping				
s) Inadequate break room /Lack of break room				
t) Inappropriate location of medication room location				
u) Lack of space in medication room				
v) Inadequate/Inappropriate lighting in medication room				
w) High noise level/acoustical problems in nursing unit				
x) Faulty medication dispensation equipment				
y) Problematic location of nursing station(s)				
z) Other (Explain _____)				

E7) In your opinion, which are the top five SOLUTION that can prevent nursing errors and increase efficiency. (Rank in order of 1 to 5 for each category).

a) Staff and Organizational Issues	RANKING
1. Better training of health professionals	
2. Increasing the number of nurses per unit	
3. Reducing the work hours of nurses to avoid fatigue-related errors	
4. More use of computerized medical records	
5. More use of computers instead of paper records for ordering of drugs and medical tests	
6. Requiring hospitals to develop systems to avoid medical errors	
7. Automated medication dispensation system	
8. Other (explain _____)	

b) Physical Environmental Issues	RANKING
1. Appropriate lighting in nursing station	
2. Appropriate heating, cooling and ventilation system	
3. Ergonomic furniture in nursing station	
4. Adequate privacy in workspace	
5. Appropriate space layout in the nursing unit	
6. Sufficient space for documentation for charting/record keeping	
7. Break room providing adequate opportunity for rest	
8. Appropriate location of medication room	
9. Adequate space in medication room	
10. Adequate lighting in medication room	
11. Appropriate flooring	
12. Reduced level of noise in nursing unit	
13. Appropriate medication dispensation equipment	
14. Appropriate location of nursing station(s)	
15. Other (Explain _____)	

Job Performance and Satisfaction in Current Nursing Unit (JP)

JP1) How do your physical working conditions affect the way you do your job?

Help a great deal Help a little Make little difference Tend to make it difficult Very difficult

JP2) Please indicate your response to the following statements as it relates to your work.

	Agree (5)	Somewhat Agree (4)	Neutral (3)	Somewhat Disagree (2)	Disagree (1)
a) I feel emotionally drained from my work					
b) I feel used up at the end of the workday					
c) I feel tired when I get up in the morning and have to face another day on the job					
d) Working all day is really a strain for me					
e) I can effectively solve the problems that arise in my work					
f) I feel burned out from my work					
g) I feel I am making an effective contribution to what this hospital does					
h) I have become less interested in my work since I started this job					
i) I have become less enthusiastic about my work					
j) In my opinion, I am good at my job					
k) I feel exhilarated when I accomplish something at work					
l) I have accomplished many worthwhile things in this job					
m) I just want to do my job and not be bothered					
n) I have become more cynical about whether my work contributes anything					
o) I doubt the significance of my work					
p) At my work, I feel confident that I am effective at getting things done					

DEMOGRAPHICS (D)

D1) Gender Female Male

D2) Years/Months employed at current hospital _____

D3) What is your job designation?

Nurse Manager
 Charge Nurse
 Staff Nurse
 Nurse aide
 Clerk
 Other (explain _____)

D4) Number of years/months of experience in profession (in current and other institutions) _____

D5) Age range

18 to 25
 26 to 35
 36 to 45
 46 to 55
 56 to 65
 65+
 Cannot answer

D6) What is the staff to patient ratio in your medical/surgical unit(s)?

(If you work in more than one med.-surgical unit, please list separately with the name of the type of med/surgical unit beside each group of response)

	Ratio	
Day	1:	(Medical-surgical unit type _____)
Evening	1:	
Night	1:	

Day	1:	(Medical-surgical unit type _____)
Evening	1:	
Night	1:	

Appendix B: Focus Group Guide

How do the following factors in THE MEDICATION ROOM OR MEDICATION DISPENSATION AREA contribute to nursing performance, efficiency and errors?

Physical Environment and Location

- Location within nursing unit
- Space & layout
- Lighting and acoustics

Medication Dispensation

- Pyxis pros and cons (med and supply) (satellite Pyxis stations)
- Organization (of supplies/medications, labeling, cues etc.)
- Med storage in the patient room? (Charts and meds together at bedside?)

Automation

- Computer-based charting (benefits, location, design)
- Computer on wheels (COW)/outside the room/inside the room
- Lighting/noise

How do the following factors in the NURSING STATION AREA contribute to nursing performance, efficiency and errors?

- Location within nursing unit (centralized and decentralized) (small pods?)
- Walking distance
- Patient access and monitoring/ Privacy (open or closed)
- Staff interaction
- Acoustics, lighting, color, flooring material
- Charting/documentation space/ storage space
- Furniture /Ergonomics

How do the following factors in the PATIENT ROOM contribute to nursing performance, efficiency and errors?

- Location of sink
- Administering meds, etc.
- Layout of service panels
- Work area
- Consistency of layout (single-handed rooms)
- Double vs. single patient room
- Location of bathroom

DISCUSSION OF STAFF BREAK ROOM QUALITIES

Summary of Focus Group Session

DEMOGRAPHIC INFORMATION

Designation: _____

Think about our discussion today and then give your summary response:

5 environmental factors that contribute to nursing errors? In which location(s) can these errors occur (e.g., nursing station, patient room, med. room, etc)?

1. _____
2. _____
3. _____
4. _____
5. _____

5 environmental factors that contribute to medication errors? What are the locations where there errors may occur (e.g., pharmacy, med room, patient room, etc)?

1. _____
2. _____
3. _____
4. _____
5. _____

3 possible ways to reduce nursing errors through environmental changes

1. _____
2. _____
3. _____

3 possible ways to reduce medication errors through environmental changes

1. _____
2. _____
3. _____

If we need some clarification about your responses during data analysis, can we contact you?

If YES, your name & contact (email and/or telephone number):

Your name and contact information will remain confidential with us and will not be used in the research report.

Continuing Education Questions

1. How is “error” defined in the Institute of Medicine report? What are the two major types of errors according to James Reason? Which type might be more relevant for errors in healthcare settings?
2. What are the typical errors and adverse events in acute care?
3. What are the major physical environmental features that might contribute to errors?
4. What contextual factors need to be considered in order to understand occupational noise?
5. What areas of medication ordering, delivery, preparation and administration need to be considered for automation and use of technology?
6. What are the three major factors that contribute to medication errors?
7. In what ways the layout of the nursing unit might affect errors?
8. What are the pros and cons of decentralized nurses’ stations in terms of staff efficiency and fatigue?
9. What design issues could be taken into consideration in reducing errors?
10. What operational/non-environmental factors need to be examined that might be associated with staff fatigue, stress and errors?

PowerPoint

[Click here](#) to launch a 17 page PowerPoint presentation of this report.

Interview with Principal Investigators

[Click here](#) to play a 21:35 minute audio interview with the principal investigators. If the link does not play automatically, you will need to open through a media player such as Windows Media Player, Quick Time, or RealPlayer.