Oncology Clinic Corridor | Rebecca and John Moores Cancer Center
UC San Diego Medical Center, La Jolla, CA. Zimmer Gunsul Frasca Partnership. Photography: © Robert Canfield

Evidence-Based Design 1

The built environment is a powerful force in patient care. If properly designed, it enables care providers to do their work more effectively, and it has the potential to enhance patient safety. However, it's not a standalone. There is a continuous interplay between a building, its layout, and the work that is carried on within the walls. The workflow and care-delivery processes and the choreography of patients as they interact with the building and the caregivers must be in harmony. Aspects of this are discussed throughout this book in various chapters.

One can look at evidence-based design (EBD) in a narrow context as focusing only on research affecting the built environment or, in a more expansive context, as research coming from the neurosciences or lean design or a number of healthcare system research initiatives designed to improve patient outcomes. Design is a term that can be applied to care processes, architecture, the act of crafting the experience for patients as they interface with the medical center, or one can design a guest-relations program.

This is a time for great optimism. Never, in the past 30 years, have so many individuals, organizations, and regulatory agencies focused so intently on improving both the physical environment for patients as well as aspects of patient safety.

WHAT IS EVIDENCE-BASED DESIGN?

The Center for Health Design (CHD) defines EBD as "the deliberate attempt to base building decisions on the best available research evidence with the goal of improving outcomes and of continuing to monitor the success or failure for subsequent decision-making." An evidence-based model can be used for all design decisions. A report published by CHD (Ulrich et al. 2004) is a foundation for EBD. Some 650 studies (actually more than 1,000 in the current compilation) published in peer-reviewed journals can be sorted into three broad categories: safety, reduction of stress, and ecological health. (A separate abstracts table is available at the CHD website at www.healthdesign.org.) Although most of the recent evidence has come from patient safety and clinical outcomes, sources of evidence may come from widely varying domains including organizational and financial performance.

In some respects, it can be said that the concept of healing environments has evolved into EBD, but it's mainly in the area of reduction of stress that this overlap occurs. Research that underpins the concept of a healing or psychologically supportive environment is drawn from the neurosciences, evolutionary biology, psychoneuroimmunology (the effect of the emotions on the immune system), and environmental psychology. Some of these studies are part of the EBD report (Ulrich et al. 2004), but EBD goes beyond the healing environments dimension to consider the effect of the built environment on patient clinical outcomes in the areas of staff stress and fatigue, patient stress, and facility operational efficiency and productivity to improve quality and patient safety.

Evidence-Based Design Certification

Implementation of EBD requires that design professionals, healthcare planners, and healthcare organization management teams be familiar with the process to follow to identify research; create hypotheses; gather, implement, and report the data associated with their projects. To this end, CHD is inaugurating, early in 2008, a credentialing program called Evidence-based Design Assessment and Certification (EDAC). This will help healthcare organizations identify knowledgeable, certified practitioners. Once accredited, an individual will have an obligation to employ an EBD process in his or her work.

Key components of EDAC certification include:

1. Meaningful collaboration with the client/users
2. Recognizing and responding to the unique context of each project
3. Using best available credible evidence from a variety of sources
4. Using critical thinking to interpret the implications of the research on design decisions
5. Honoring a sacred trust to protect public safety and health
6. Commitment to share findings with the world

The Four Levels of Evidence-Based Practice

Hamilton (2003) identifies four levels of evidence-based practice, each successive level requiring more rigor and commitment.

Level-one practitioners

These practitioners stay current on literature in the field and interpret the meaning of evidence as it relates to the project at hand. They are learning from others as well as developing new examples for others.

Level-two practitioners

These practitioners take another step by hypothesizing the expected outcomes of design interventions and plan to subsequently measure the results. In this case, the design is less subjective and more challenging. The designer must understand the research and be able to interpret its implications and then be able to logically connect the design decision to an outcome that can be measured. This reduces the number of arbitrary design decisions and delivers solutions linked to outcomes. The designer must be prepared, however, to accurately report the findings regardless of whether successful or not. Sometimes there will be other discoveries that come out of this process in addition to the hypothesis being tested.

Level-three practitioners

Not only do these practitioners keep current with the literature, create hypotheses about intended outcomes, and measure results, they also report or publish their findings publicly. This may include speaking at conferences or getting articles published. This invites the scrutiny and possible criticism of others who may disagree with the findings and subsequently may lead the practitioner to become more rigorous in his or her approach. Or a designer may collaborate with a researcher to derive the benefit of working with someone who understands qualitative and quantitative research methods.

Level-four practitioners

These practitioners follow all of the steps previously mentioned but then attempt to get the research published in peer-reviewed journals. This generally requires that a design professional collaborate with scholars in academic or professional settings who understand the rigor of what is required to get an article accepted by a journal. This is the type of research that advances the field of evidence.

Hamilton labels "level-zero practitioners" as those individuals who understand the notion of EBD, but limit their study to isolated comments from magazine articles or conference presentations, using them subjectively to support their design, then claiming that the design is evidence-based. Without hypotheses and measurement, these individuals complete a project and search for positive outcomes. Since there was never a hypothesis, the necessary causal relationship is missing, thus, it's not evidence-based.

How Strong Is the Evidence?

The CHD report by Ulrich et al. (2004) identified more than 650 studies (more than 1,000 in the current compilation) in peer-reviewed journals that establish how hospital design can impact clinical outcomes. A graphic scorecard was developed to express, at a glance, the strength of the evidence (Center for Health Design 2005). Within each outcome area, bars are used to denote the quantity of studies that meet the criteria.

Topics with four or five bars are those for which the researchers found many strong studies linking environmental factors with the outcome. These are considered high action areas.

Topics with three bars are those that have relatively fewer studies associated with them; however, these are high-importance outcome areas in which additional research is needed.

Topics with one or two bars have few studies associated with them or few studies that conclusively provide a link between environmental factors and the outcome. These are important areas where additional research is needed.

Figures 1.1 through 1.4 depict the scorecards for quality, patient safety, patient stress, and staff stress, respectively.

	Topics with four or five blue bars are those where the researchers found many good studies linking environmental factors with the outcome or fewer strong studies that provided convergent evidence linking the environmental factor with the outcome. These are considered high action areas.
	Topics with three blue bars are those which have relatively fewer studies associated with them. However, these are high importance outcome areas and ones in which additional research in needed.
	Topics with one or two blue bars (e.g. reducing staff turnover, increasing handwashing compliance among staff) have few studies associated with them or few studies that conclusively provide a link between environmental factors and the outcome. These are important areas where there is need for additional research.

Quality Scorecard — **Figure 1.1**

Improve overall healthcare quality and reduce cost

Reduce length of patient stay
Reduce drugs (see patient safety)
Patient room transfers: number and costs
Re-hospitalization or readmission rates
Staff work effectiveness; patient care time per shift
Patient satisfaction with quality of care
Patient satisfaction with staff quality

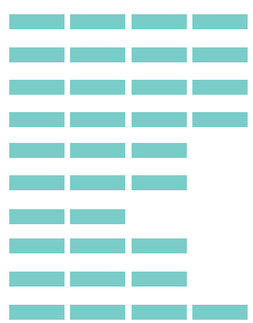
Patient Safety Scorecard — **Figure 1.2**

Improve patient safety and quality of care

Reduce nosocomial infection (airborne)
Reduce nosocomial infection (contact)
Reduce medication errors
Reduce patient falls
Improve quality of communication (patient → staff)
Improve quality of communication (staff → staff)
Improve quality of communication (staff → patient)
Improve quality of communication (patient → family)
Increase handwashing compliance by staff
Improve confidentiality of patient information

Patient Stress Scorecard — **Figure 1.3**

Reduce stress, improve quality of life and healing for patients and families



Reduce noise stress
Reduce spatial disorientation
Improve sleep
Increase social support
Reduce depression
Improve circadian rhythms
Reduce pain (intake of pain drugs and reported pain)
Reduce helplessness and empower patients & families
Provide positive distraction
Patient stress (emotional duress, anxiety, depression)

Staff Stress Scorecard — **Figure 1.4**

Reduce staff stress/fatigue, increase effectiveness in delivering care

Reduce noise stress
Improve medication processing and delivery times
Improve workplace, job satisfaction
Reduce turnover
Reduce fatigue
Work effectiveness; patient care time per shift
Improve satisfaction

More Blue Bars = More Research Available

BENEFITS OF A HEALING (REDUCED-STRESS) ENVIRONMENT

At the start of this chapter, the interface between what has been called a healing environment and what is now called EBD was explained. In short, there is overlap in that most of the research associated with healing environments (also defined by Ulrich as "psychologically supportive design") falls into five categories, all with the common thread of stress reduction. Many of these studies are part of the EBD report (Ulrich et al. 2004), but some are not because the EBD report focuses on the impact of the built environment on clinical outcomes. Many studies from the neurosciences or evolutionary biology are not linked to the built environment but rather to the impact of various stressors on human physiology and biochemistry.

Here's an example: Pert (1997) discusses how our thoughts influence our biochemistry from moment to moment. She does research in neuropeptides and has documented the effects of stressors on the immune system. Although a scientist may take issue with generalizing this to the effects of the built environment, it would seem that anything that makes patients feel comfortable, including the setting in which a medical procedure takes place, would impact their thoughts and biochemistry. In fact, there is research in the EBD report (Ulrich et al. 2004) indicating that this has credibility, as explained below.

Research indicates that speedier recovery time at home may occur as a result of a less stressful hospital experience (Kiecolt-Glaser et al. 1998). In fact, physical comfort in the hospital setting may even reduce mortality and morbidity. Patients in this setting may require fewer narcotic pain medications, have less anxiety and depression, and have fewer postsurgical complications (Kiecolt-Glaser et al. 1998). A more comfortable, less stressful hospital experience leads to higher patient satisfaction which, in turn, is linked to increased patient compliance with drug regimens and recommended postsurgical care, including follow-up visits—all of which potentially affect clinical outcomes (Kiecolt-Glaser et al. 1998).

Feelings and Biochemistry: An Instant Feedback Loop

The most effective path to creating a healing (stress-reducing) environment is to inform design decisions by research. In recent years, the neurosciences have provided considerable insight into how the immune system can be experimentally suppressed or enhanced by a variety of interventions, and we have learned that feelings are inseparable from biochemistry. Our thoughts influence our physiology. What we perceive, think, and how well we cope are all set in motion by messages from the brain to the rest of the body.

One could say that our brains are writing a prescription for our bodies every minute of every day. Feeling sad or disheartened produces hormones that may affect the functioning of internal organs (Pert 1990; 1997). It doesn't require much of a leap to see how the healthcare environment—the total milieu—can influence one's emotional state and, according to neuroscientist Pert (1997), these messages can affect cell biology. In a number of studies, greater self-reported anxiety and stress are related to more postoperative pain (Kiecolt-Glaser et al. 1998).

Physiology of Stress

In 1956, Austrian physician and scientist Hans Selye pioneered a new frontier with his revolutionary discoveries about stress. His research demonstrated that hormones released during stress participate in the development of many degenerative diseases including brain hemorrhage, hardening of the arteries, coronary thrombosis, certain types of high blood pressure, kidney failure, arthritis, peptic ulcers, and cancer (Selye 1956).

His definition of stress refers to wear and tear on the body resulting from attempts to cope with environmental stressors; this was a new concept of mental and physical illness. He meticulously documented the enormously complex series of interactions between almost all systems of the body as a reaction to stress. Measurable and highly predictable physiological changes take place as a reaction to psychological and environmental stress (Frankenhaeuser 1980; Lazarus 1999; Rabin 1999), and this is the basis for the emerging field of psychoneuroimmunology (PNI). PNI is a term that refers to the role that the emotions play in the origin of physical diseases associated with immunological dysfunctions, especially autoimmune diseases as well as cancer, infections, and allergies. When people are under stress, their immune systems function less effectively (Kennedy, Glaser, and Kiecolt-Glaser 1990; Solomon 1990; Pert 1990; Pert 1997; Rabin 1999).

Stress involves the nervous system and the endocrine system. These two systems provide links between mind and body. Music has been known to have an analgesic or painkilling effect when pleasure centers of the brain stimulate the pituitary gland to release endorphins, the body's natural opiate (Campbell 1997; Taylor 1997). Many medical centers have experimented with aromatherapy (the inhaling of specific fragrances) to reduce nausea, decrease the amount of anesthesia needed in surgery, decrease pain, and lower blood pressure. Scent activates the limbic system, the emotional center of the brain. It should be noted that these are essential oils, highly distilled essences of herbs and flowers, quite different from the commercial fragrances marketed to consumers in stores selling products for the skin or bath.

Coping with stress

Stress results from any situation that requires behavioral adjustment such as invasions of privacy, no control over noise, acute or chronic pain, separation from family and things familiar, feelings of helplessness, and loss of control over events and the immediate environment. Add to this worries about medical errors—much in the news lately—and whether one's insurance will reimburse the costs of care, and it's easy to understand the high levels of stress and anxiety that can ensue. Under stress, muscle tension increases; all forms of pain are worsened because hormones produced during stress lower the threshold for pain; blood pressure and respiration increase; and the overproduction of stress hormones can cause cardiac arrhythmias, depression, and insomnia as well as delay wound healing (Kiecolt-Glaser 1998). It's interesting to note that the negative effects of stress can be measured hours after the stressful event occurred. Worse yet, stress impacts the immune system, which is perhaps the most compelling reason to design environments that reduce stress and help patients relax and feel comfortable.

Strategies for Reducing Stress in the Healthcare Environment

For a number of years the goal of healthcare facility design has been to create healing environments. Sometimes well-meaning individuals interpret this as the application of wallcovering, nice colors, carpet, and artwork. While these cosmetic features may create a certain ambience that is pleasing to patients, a healing environment is one that is based on research in the following areas.

Connection to nature

A large body of research is consistent with the proposition that humans are hard-wired to appreciate and benefit from exposure to nature. Based on our evolutionary past and the landscape features that were important for survival, research shows that humans have a deep need to connect to nature and that even a brief view of a garden or interaction with a water element, for example, can have immediate physiological benefits in terms of reducing stress and anxiety (Ulrich 1984; Ulrich 1999; Parsons and Hartig 2000). Patients who were shown a video of nature scenes (forest, flowers, ocean, waterfalls) during burn dressing changes had significantly reduced anxiety and pain intensity (Ulrich 1991; Miller et al. 1992, as reported in Ulrich et al. 2004).

Control (choice)

A considerable number of studies have documented that when individuals have options or choices, it reduces stress and enables them to feel more in control (Winkel and Holahan 1986; Evans and Cohen 1987; Steptoe and Appels 1989). A healing environment will offer as many choices and options to patients as possible in every setting, whether it is an outpatient waiting room or critical care unit. During hospitalization, patients have little control over significant, possibly life-altering events, such as surgery. Stressors that are perceived as unpredictable and uncontrollable are often associated with elevated stress hormones that may persist for several days prior to the procedure (Baum, Cohen, and Hall 1993, as reported in Kiecolt-Glaser et al. 1998). The ability to quickly return to one's neuroendocrine baseline after the event is beneficial for good health.

Viewed in this context, postsurgical recovery should be in a setting that is free of environmental stressors such as noise or a roommate who snores, and one should be able to enjoy nature programming on a wide-screen television and order favorite foods from a room-service menu as one recuperates. Access to guided imagery videos for postsurgical stress reduction, therapeutic touch, and a variety of other highly successful low-cost interventions should be made available.

Social support

It has been well documented that access to friends and family contributes to emotional and psychological well-being. According to Kiecolt-Glaser and colleagues (1998), social support is directly related to dimensions of autonomic, endocrine, and immune function, with family ties appearing to be a key source of support relevant to physiological functioning. Whether it is a social support group for breast cancer survivors or a family member sleeping overnight in a patient's room, sympathy and compassion offered by caring individuals are essential (Cohen and Syme 1985; Sarason and Sarason 1985; Ulrich 1991; Frampton, Gilpin, and Charmel 2003).

For example, myocardial infarction patients with high social support have more favorable recovery rates (Ulrich 1991). Male coronary bypass patients who received greater spousal support used less pain medication, were discharged from the surgical intensive care unit sooner, and spent fewer days in the hospital (Kulik and Mahler 1989, as reported in Kiecolt-Glaser et al. 1998).

Positive distraction

Humans are multisensory beings; research in the neurosciences demonstrates that various types of sensory experiences can actually be therapeutic and can boost the immune system (Pope 1995; Taylor 1997). Specific types of music, engaging moments spent in front of an aquarium or water feature, meditation, guided imagery, and visualization all provide distraction from pain and opportunities for developing coping skills (Ulrich 1991).

Elimination of environmental stressors

A growing body of environmental research indicates that stressors in the built environment can add to the burden of illness. Noise is perhaps the most deleterious of these, and hospital nursing units are notoriously noisy (Ulrich et al. 2004; Joseph 2007). Poor air quality and glare from direct (as opposed to indirect) light sources are other examples. In theory, much of this can be controlled by the owner and the design team working collaboratively (Ulrich 1991; Ulrich et al. 2004).

The acceptance of complementary therapies

There are, in fact, a range of complementary therapies in addition to music and aromatherapy—massage, acupuncture, meditation, art therapy, guided imagery, biofeedback, yoga, herbal medicine, and others—that have gained prominence in recent years and have been the subject of studies funded by the National Institutes of Health (NIH). Many of these are used to reduce stress and to restore harmony or balance.

Grants from the NIH are grouped into five major domains (National Center for Complementary and Alternative Medicine):

1. Alternative medical systems
2. Mind-body interventions
3. Biologically based treatments
4. Manipulation and body-based methods
5. Energy therapies

Collectively, diverse approaches to healthcare that fall outside conventional allopathic (Western) medicine are referred to as CAM, complementary and alternative medicine. Alternative medicine is used instead of conventional treatment, whereas complementary medicine is interwoven with conventional care. An extension of this is integrated medicine, which combines conventional medical treatment with evidence-based CAM, therapies known to be safe and effective.

The American Hospital Association hosts an annual conference on integrative medicine in which the focus is largely the business case—how to anchor these programs within the context of core services to achieve a more holistic approach to well-being. Healthcare organizations throughout the nation have implemented some or all of these low-cost, highly effective modalities.

NEUROSCIENCE PROVIDES INSIGHTS

The 1990s were often referred to as the Decade of the Brain in recognition of great strides made during that period in many areas of research as well as the ability to precisely locate areas of the brain responsible for various activities. This was in part made possible by improved imaging modalities such as PET scanners and functional MRI, which produce striking images showing specific parts of the brain that are activated when a person is asked to think about a certain subject. The brain holds many secrets yet to be revealed; despite the many successes, scientists express frustration about how much is still a mystery. The Neurosciences Institute in La Jolla, California, on its website (www.nsi.edu), refers to the brain as "the single most complex organ in the universe." The interaction between the mind and the brain is still hotly debated. How does the mind emerge from the brain? Is the mind a process that uses the brain as its instrument to experience the world? An excellent collection of readings on the brain can be found in Ornstein and Swencionis (1990).

Neurophysiology—Tapping into the Body's Own Pharmacopoeia

One of the most thought-provoking and insightful presentations on healing and healing environments was given by visionary hospital chief executive officer Patrick Linton (1992), whose originality of thought in 1991 defined and laid the foundation for a care delivery model that would tap into the "tremendously powerful healing potentials within each human being." Linton based his ideas on the research being done in psychoneuroimmunology (PNI), which he explains in the aforementioned presentation. Because this research is fundamental to understanding the science behind the intuitive notions people have about why certain types of environments are healing, a summary of observations follows, some from Linton (1992) and others as noted.

Psychoneuroimmunology

1. The mind and the brain, the nervous and endocrine systems, and the immune system are constantly interacting in a very dynamic way. To paraphrase Pert (1997): these systems are constantly having conversations with each other…what you are thinking at any moment is changing your biochemistry. Neuroscientist Esther Sternberg (2000) identifies the pathways connecting areas of the brain that are responsible for controlling immunity with those that generate feelings and emotions—how nerves, molecules, and hormones connect the brain and immune system.
2. Negative emotions may manifest as a physical disease, whereas positive emotions may positively affect one's health and, although this contention is controversial, in a variety of studies on cancer patients, they have been noted to reduce tumor growth, slow the progression of the disease, increase natural killer and T-cell activity, and increase antibody production (Linton 1992). Several large studies have found that happiness was a better predictor of future coronary problems than any other clinical variable (Rabin 1999; Lemonick 2005).
3. The brain and nervous system produce neurotransmitter cells that fit receptor cells like a lock and key. This connection engages the immune system. The same thing works in reverse. When the brain is engaged, it produces exactly the right "pharmaceuticals" needed, and they get to the correct place in just the precise dosage needed (Linton 1992).

Applying PNI to the effect of the built environment on a patient's experience of stress, neuroscientists have been able to document which areas of the brain are affected by the perception of a healing environment, a setting that feels comfortable or that provides pleasure (Rabin 2004). A pleasant environment keeps norepinephrine levels low so that patients actually experience less pain, have more restful sleep, less anger, less muscle tension, and lower risk of stroke (Rabin 2004). The other major stress hormone, cortisol, can actually damage neurons in the hippocampus and it also affects the rate of wound healing. Elevated levels of both norepinephrine and cortisol impair the immune system (Rabin 1999).

Neuroscience and Architecture

A collaboration between architects and scientists, initiated in 2003 by the American Institute of Architects (AIA), resulted in the Academy of Neuroscience for Architecture (www.anfarch.org). It is headquartered in San Diego because it is a nexus for neuroscience research. Scientists from the Salk Institute, the Neurosciences Institute (founded by Nobel laureate Gerald Edelman, MD, PhD,), and the University of California, San Diego's Division of Biologic Sciences, all located in La Jolla, California, are collaborating. The project's director of research planning, John Eberhard, has an office at the New School of Architecture in San Diego where neuroscience and architecture is a part of the curriculum. Although the focus of this research is not limited to healthcare facilities, this topic is expected to command considerable attention. Understanding how the brain experiences architecture is a complex undertaking.

As an example, the positive effects of natural light and window views are widely acknowledged but, from the research perspective, many questions remain unanswered (National Academy of Sciences 2002):

- What are the elements of visual stimulation that promote healing—light, movement, relief of boredom?
- Do these elements promote healing by blocking bad sensations?
- What neural pathways are activated by positive views?
- What are the hormonal responses to this activation, and how do they impact immune mediated diseases?
- Is memory involved in the beneficial effects of windows?

Heart Brain Medicine

In 2004, the Earl and Doris Bakken Heart Brain Institute was founded at the Cleveland Clinic Foundation. Bakken, the founder of Medtronic Inc., is well known for his affiliation with North Hawaii Community Hospital, a place where the spirituality of Hawaiian culture is integrated with architecture, the practice of medicine, and healing. The Heart Brain Institute will undertake research to explore the interconnections between cardiovascular and neurological medicine to establish a new field of medical knowledge. Instead of focusing on these two major organs as separate entities, it will support an interdisciplinary approach.

THE POWER OF THE BUILT ENVIRONMENT

Writing in the *Lancet* (August 2000), Colin Martin noted the correlation between evidence-based medicine and EBD. He predicted that "evidence-based design (EBD) is poised to emulate evidence-based medicine as a central tenet for healthcare in the 21st century." EBD focuses on the built environment, but, in addition, major forces guiding hospital design include patient safety, information technology interface, the family as a partner in care, and healing environments. They are actually overlapping in their impact.

For example, fewer patient falls are likely to occur when family is present. Breaches in patient safety exist as issues apart from the design of the built environment in the form of medication errors, nosocomial (hospital-acquired) infections, and so forth, but it is also known that a design issue—single bed rooms—and possibly the standardization of layout (avoiding mirror-image rooms) enhance patient safety (Chaudhury, Mahmood, and Valente 2003; Ulrich et al. 2004). In fact, single bed rooms have become the standard of care in the AIA *Guidelines for Design and Construction of Health Care Facilities* (2006). This is discussed in detail in Chapter 7.

Environment of Care

The "Environment of Care" chapter of the 2006 AIA *Guidelines*, which was developed with the input of CHD's Environmental Standards Council, identifies aspects of the overall care environment that influence patient outcomes and satisfaction as well as dignity, privacy, confidentiality, safety, patient and staff stress, and facility operations. Much of this is familiar to experienced healthcare design professionals, but it is most encouraging to see it established as the standard of care in an important document.

A few highlights

There is a major focus on the importance of natural light and views, access to gardens, and clarity of wayfinding. Giving the patient control over lighting and room temperature is emphasized, as are privacy, confidentiality, and reduction of noise. Cultural responsiveness is encouraged both in terms of the organization's internal culture as well as sensitivity to regional demographics. Finishes and color palettes, likewise, should address geographic appropriateness and be suitable for the patient population served. The value of sustainable design is also underscored in this chapter.

Water features are mentioned as they have become very popular, but they are also controversial due to the difficulty of managing infectious aerosols. They are not forbidden, but open water features are required to have this problem safely managed. In an appendix, it says that "open water features are not recommended within any enclosed space in healthcare environments."

Further, the AIA *Guidelines* (2006) state:

> If a water feature is provided, the design should limit human contact with the water and/or allow for the application of water disinfection systems. Materials used to fabricate the water feature should be resistant to chemical corrosion. Water features should be designed and constructed to minimize water droplet production. Exhaust ventilation should be provided directly above the water feature.

Clearly, the new AIA *Guidelines* will result in improved environments for patients. They give design professionals considerable support by elevating environmental amenities to the standard of care. In a value-engineering context, something that might have been easily dismissed as not essential to a project may be reevaluated as worthwhile.

RESEARCH—GETTING STARTED

It is easy to become overwhelmed by the sheer amount of reference material available: journal articles, books, magazine and newspaper articles, conference proceedings, and studies by various organizations such as the Institute for Healthcare Improvement, Institute for Family-Centered Care, or Planetree, to name a few.

Resources

Additional resources include infection-control data from the Centers for Disease Control and Prevention (CDC) or medical specialty professional organizations such as the Society of Critical Care Medicine. Online resources for accessing research journals include Medline and PubMed; Medscape provides a variety of articles on health topics; and a number of e-bulletins or newsletters are available from the Joint Commission (formerly known as the Joint Commission on Accreditation of Healthcare Organizations or JCAHO), The Center for Health Design (CHD) (www.healthdesign.org), and Premier Safety. The Institute of Medicine publishes data on quality and safety issues as does the Joint Commission. Hospitals for a Healthy Environment (www.H2e-online.org) and Healthcare Without Harm (www.noharm.org) are useful websites for pursuing green initiatives, as is the Green Guide for Health Care (www.gghc.org).

The Robert Wood Johnson Foundation (www.RWJF.org) offers a number of publications and resources associated with improving healthcare and has funded, with grants, various learning tools developed by CHD, including this book. *The Health Environments Research and Design Journal*, which published its inaugural issue in the fall of 2007, is the first interdisciplinary, peer-reviewed journal in the field of EBD for healthcare environments. As more issues are published, this will become an increasingly important resource.

The Environmental Design Research Association Journal should not be overlooked; although it is not focused specifically on healthcare, articles on wayfinding research and design for aging can often be found there as can studies related to man-environment issues (territoriality, attachment to place, and response to various types of environments). Other reference sources are association reports, manufacturers' testing information, and continuing education programs.

One caveat is that magazine and newspaper sources cannot be relied upon for accuracy in reporting research results unless it is clear that the writer has gone directly to the source as opposed to reporting information anecdotally from interviews. A good policy is to actually access and read the study or studies being discussed to be able to report the findings accurately. By so doing, one often discovers interesting tidbits.

For example, the findings may not have a high degree of validity for the specific population studied but it may have been highly significant for a subgroup of that population. One can never know this without reading the study. It's also important to know the number of persons in the study. Results from a study involving 15 subjects versus one involving 3,000 or 20,000 persons will have very different levels of significance. One would also want to know if there was a control group.

Dip a Toe in the Water

Start small. Ask clients what issues matter most to them. Hospitals already collect lots of data on quality and safety issues. Use this as a jumping-off point. Some hospitals have researchers on staff who can provide expertise. If not, there are advanced-degree nurses who monitor infection control and patient safety for the organization. They can be helpful in setting the research agenda and should be asked to commit to collecting postoccupancy data for comparison. CHD publishes a research matrix (Figure 1.5) that is used by its Pebble Project research partners to ensure uniformity of measurement and reporting to build a body of research using similar methodology. Start with the CHD report (Ulrich et al. 2004), selecting perhaps five studies to support each component of a design; then develop hypotheses based on this research platform that can later be tested. By doing this on each project, over time, a large number of studies will have become familiar and entered into a design firm's database.

A growing number of healthcare architecture firms are employing a director of research. This person is typically an architect with a doctoral degree in environmental design. The role of the director of research is to prepare a research platform for projects in development, to mentor the design staff, to review design concepts for compliance with the research, to develop hypotheses, and to gather clinical-outcomes safety data from the hospital that are relevant to the new units being designed (data from existing facilities). Six to twelve months after occupancy, the director of research will coordinate or conduct postoccupancy evaluations, supporting or refuting the hypotheses, as well as compare clinical and safety outcomes from the existing units (if data are available) with the new facilities. An excellent article explaining the role of practice-based design researchers and the many ways in which research can inform design can be accessed on the InformeDesign website (http://www.informedesign.umn.edu) (Geboy and Keller 2007).

Lyn Geboy, director of research and education for a large architectural firm, found it difficult to get architects interested in reading research. The daily demands of meeting deadlines in a busy practice left little time for accessing studies. Most architects have not been exposed to research-based training and design in school and may feel ill-at-ease reading and interpreting studies. Geboy created a six-page educational document (similar to an executive summary) of the EBD data and, realizing that architects find visuals appealing, she developed a graphic representation depicting, with small photos, the 12 environmental factors that affect outcomes and contribute to a healing environment (Geboy 2007). The images are arranged in a wheel to express that they are conceptually linked and should not be applied as elective options.

Pebble Project Matrix **Figure 1.5**

	Single Patient	Patient Groups	All Patients	Community	Staff	Organizational Culture	Family
Clinical, Observable Outcomes							
Safety Outcomes							
Economic Outcomes							
Patient-, Family-, Staff-Based Outcomes							
Sustainability							

The effects of the built environment are expected to impact five types of outcomes. The matrix relates outcomes to various stakeholders.
Source: Matrix courtesy of The Center for Health Design

InformeDesign

InformeDesign is an excellent web-based resource representing a collaboration between the University of Minnesota and the American Society of Interior Designers offering access to a wide number of studies on many design topics. Other offerings include a tutorial on research basics, a glossary of terms, and a monthly newsletter, *Implications*, that presents current research issues.

For those who are phobic about delving into research journals, in its database InformeDesign presents easy-to-understand research summaries of journal articles or studies which, by the way, are not limited to healthcare topics. Design criteria and key concepts are enumerated as are limitations of the study, followed by commentary and the full citation for the study. The traditional process of finding and reading the literature, interpreting the statistical analysis, and translating the research findings into design criteria, has been vastly simplified by InformeDesign to facilitate practitioners' use of research as a decision-making tool in the design process.

As one becomes more adventurous about reading research studies, going to the actual source and reviewing the study in its totality will yield a higher level of satisfaction and understanding. As an example, most studies of carpet performance that examine the issue of infection control fail to identify the specifications of the carpet. This is also true for the comparison products that are often identified as *sheet goods* or *sheet vinyl*, as if these generic terms covered all products. To make use of this research, designers need to know if the resilient flooring was sheet vinyl, linoleum, rubber flooring, or a hybrid in terms of composition. The thickness of the product, the finish, and the type of backing will also be of interest.

As for the generic term *carpet,* used in most studies, the fiber type should be described and whether it is solution-dyed, piece-dyed, or skein-dyed; whether it is cut pile, all loop, or loop and cut. And the pile height, stitch gauge, whether it is broadloom or carpet tile, and—very important—the type of backing should be described. Without this type of detail, studies involving flooring products are of little use to healthcare interior designers who are educated to understand the performance characteristics of specific products. A study comparing carpet versus hard-surface flooring sheds no light and also makes it impossible to replicate the study. By contrast, the study by Lankford et al. (2007) describes the finish materials being tested in enough detail to be very useful to interior designers and hospital environmental services managers. A good summary of these findings is offered by Leib and Rohde (2007).

Reading a journal article in its totality (as opposed to just citing the findings) allows one to understand how the study was conducted, the assumptions made by the investigators, and it provides a path to other journal articles on similar topics.

Research Methods "Classics"

Anyone who wishes to learn more about environmental psychology and research tools and techniques will want to read the new edition of *Inquiry by Design* (Zeisel 2005), *A Practical Guide to Behavioral Research* (Sommer and Sommer 2002), and the classic, *Post-Occupancy Evaluation* (Preiser, Rabinowitz, and White 1988). *Assessing Building Performance* is a recent book by Preiser and Vischer (2005).

Evidence-Based Design: The Corollary to Evidence-Based Medicine

Another approach to developing a research agenda for a project is offered by Hamilton and Watkins (2006), based on the classic text on evidence-based medicine by Straus, et al. (2005).

Step 1: Convert need for information into answerable questions.
Step 2: Track down best evidence with which to answer questions.
Step 3: Critically appraise the evidence for validity and applicability.
Step 4: Integrate with clinical expertise and unique biology, values, and circumstances of the patient.
Step 5: Evaluate effectiveness and efficiency; seek ways of improvement.

In Exhibit 1.1 Hamilton and Watkins (2006) in their conference PowerPoint slides outline the process used at WHR Architects for employing EBD, including a breakdown of roles and tasks for facility users and design professionals.

Exhibit 1.1 Sample Evidence-Based Process

Project: Outpatient Chemotherapy Area

Design for Safety (Guiding Principle)

What is the most serious issue that should be resolved in this type of facility? Example: Drug mix errors

Gather the Evidence Based on Research Questions:

Research Question = Design Issue: *What evidence is there relating the environment to medication error, task reliability, safety, etc.?*

Critical Interpretation of the Evidence

Literature's relevance to this specific project and design concepts

Design Based on the Specific Relevant Evidence

Reduce distraction, noise reduction, effective task lighting, air quality, fresh-air movement, temperature control, supportive technology (bar-coding reconciliation, integration software)

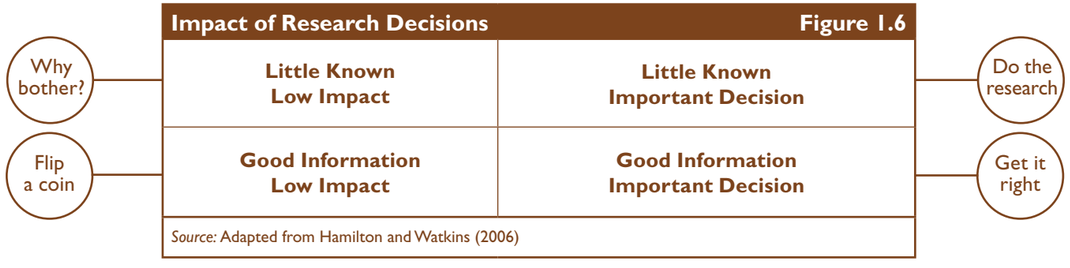
Implement the Design, Measure, and Report the Results

Hypothesis of design's intended impact proved or disproved by data

Will There Ever Be Definitive Evidence?

Occasionally there will be definitive evidence; some of the time studies will provide consensus, but this will be undermined by a number of studies with contradictory findings. What to do? Look for models analogous to the current project and contact experts for opinions about best practices. According to Hamilton (2004), "Evidence-based designers must use critical thinking to make rational inferences from a pool of information that will rarely fit precisely with their unique design situation. Nevertheless, an evidence-based healthcare project should result in demonstrated improvements in the healthcare organization's measures of clinical, economic, productivity, patient/staff satisfaction, or cultural success."

Figure 1.6 helps establish the criteria for the value of a potential research project.



Beware of false claims

Over the years, projects have sometimes been labeled a healing environment based on an art program (possibly not even one based on research) or a number of cosmetic changes in interior finishes. Healing environments sounds so nice, who wouldn't want to make a claim like this? However, several questions should be asked. Why would a specific design be expected to improve outcomes? Is the project anchored in research about reduction of stress for patients? Has anyone developed a hypothesis and attempted to measure outcomes before and after the interventions? Similar claims may, in the near future, be made about a project having been evidence-based. Articles are already starting to appear in magazines making this claim, and sometimes it is based on one or two research-based elements, but the project overall may miss the boat on many important issues. The evidence-based designation should be applied only when research has impacted the design with sufficient scope and hypotheses are tested in the process.

Despite this, there will be numerous aspects of design for which research does not exist and for which that project or hospital will be a pilot site to test ideas. Some projects may replicate studies to support or refute previous findings. According to Hamilton (2004), the minimum threshold for describing a project as evidence-based is the presence of hypotheses advanced and relevant measures to confirm or refute them.

It's the process of research that counts, not necessarily the results. Science is based on many trials, and many do not support the hypotheses. In fact, scientists often design studies to disprove a theory, as opposed to proving it. They try to find the flaw. But each successive evidence-based hospital project helps to build the body of knowledge that can be used by others. It's a laborious process that yields fruit after many years.

CONCLUDING REMARKS

The pursuit of EBD may lead to disappointment when hoped-for outcomes are not realized. This is the nature of scientific inquiry—design professionals should not internalize this as a failure; rather, they should congratulate themselves for having the courage to share the findings with colleagues. A hypothesis that is not supported is also valuable in adding to the body of knowledge. The expectation now is for hospitals to be transparent; should we expect any less of design professionals? Available research on a specific topic may reveal contradictory findings; this is not an easy process but the stakes are high. This is truly the dawn of a new era in healthcare architecture and design. Anyone who has been hospitalized or spent time with a very ill family member knows all too well the risks and anguish and what it means to be helpless and vulnerable. There are few callings higher than healthcare, whether one is a nurse, a physician, or a design professional working with providers to improve safety and performance.

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