SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

To investigate the rates, determinants, and effects of natural ventilation in health care settings.

DESIGN IMPLICATIONS

Natural ventilation may have certain advantages over mechanical ventilation, especially in developing countries with low resources and challenges in maintenance.

The biggest advantage of mechanical systems over natural ventilation is the ability to create negative pressure. This may be countered by careful placement of the high contagion areas on the layout- confining them to the uppermost floors of the building and downwind of other rooms or the nursing station.

Natural Ventilation for the Prevention of Airborne Contagion

Escombe, R.R., Oeser, C.I., Gilman, R.H., Navincopa, M., Martinez, C., Chacaltana, J., Rodriguez, R., Moore, D.J., Friedland, J.S., Evans, C.A.

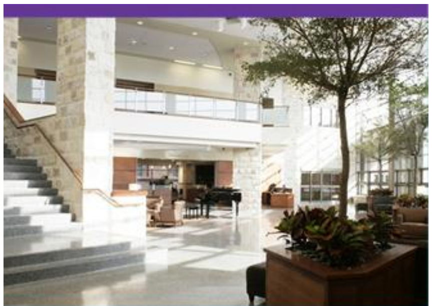
2007 | PlOS Medicine
Volume 4, Issue 2, Page e68

Key Concepts/Context

Controlling the break of nosocomial infections is arguably the highest priority in hospitals. Institutional transmission of airborne infections, such as Tubercolosis (TB) are, additionally, a public health concern. This is particularly true for developing countries, or other resource-limited settings where protective measures such as negative-pressure isolation rooms, which have become the norm in more modern settings, are difficult to implement. The global statistics on TB are staggering at 1.8 million deaths a year. In resource limited countries natural ventilation can offer a low-cost alternative to more sophisticated mechanical ventilation systems. This study was carried out in Lima Peru with five "old-fashioned" hospitals (built before 1950) and three "modern" facilities (built between 1970-1990), with natural ventilation, and twelve mechanically ventilated rooms built post-2000. Determinants of natural ventilation were evaluated, and mathematical modelling was used to evaluate the effect of natural ventilation on airborne TB transmission.

Methods

In the eight hospitals 70 naturally ventilated clinical rooms where infectious patients are likely to be encountered were studied. These included respiratory isolation rooms, TB wards, respiratory wards, general medical wards, outpatient consulting rooms, waiting rooms, and emergency departments. These rooms were compared with 12 mechanically ventilated negative-pressure respiratory isolation rooms built post-2000. Ventilation was measured using a carbon dioxide tracer gas technique in 368 experiments. Architectural and environmental variables were measured. The following architectural features and environmental variables were recorded: area of windows and doors open; presence of open windows or doors on opposite walls to facilitate the through flow of air; ceiling height; floor area;



The Center for Health Design: Moving Healthcare Forward

The Center for Health Design advances best practices and empowers healthcare leaders with quality research providing the value of design in improving patient and performance outcomes in healthcare facility planning, design, and construction, optimizing the healthcare experience and contributing to superior patient, staff, and performance outcomes.

Learn more at www.healthdesign.org

elevation of the room above ground level; temperature; relative humidity; and wind speed. For each experiment, infection risk was estimated for TB exposure using the Wells-Riley model of airborne infection.

Findings

Opening windows and doors provided median ventilation of 28 air changes/hour (ACH), significantly more than double that of mechanically ventilated negative-pressure rooms ventilated at the 12 ACH recommended for high-risk areas, and 18 times that with windows and doors closed.

Facilities built more than 50 years ago, characterized by large windows and high ceilings, had greater ventilation than modern naturally ventilated rooms (40 versus 17 ACH). Even within the lowest quartile of wind speeds, natural ventilation exceeded mechanical ventilation. All results were statistically significant.

The Wells-Riley airborne infection model predicted that in mechanically ventilated rooms 39% of susceptible individuals would become infected following 24 h of exposure to untreated TB patients of infectiousness characterized in a well-documented outbreak. This infection rate compared with 33% in modern and 11% in pre-1950 naturally ventilated facilities with windows and doors open.

Authors concluded that Opening windows and doors maximizes natural ventilation so that the risk of airborne contagion is much lower than with costly, maintenance-requiring mechanical ventilation systems. Natural ventilation costs little and is maintenance free, and is particularly suited to limited-resource settings and tropical climates, where the burden of TB and institutional TB transmission is highest. In settings where respiratory isolation is difficult and climate permits, windows and doors should be opened to reduce the risk of airborne contagion.

Limitations

Author introduced limitations include:

1. Smaller number of mechanically ventilated rooms (12) compared to naturally ventilated rooms (70)
2. Mechanical ventilation was assumed to have optimal ventilation as per guidelines although in real world settings systems may operate at less than recommended levels
3. There are some inherent limitations with the Wells-Riley airborne infection model used

Additionally, authors found that in the mechanically ventilated rooms, air extraction and supply fans were unprotected by filters, motors were poorly maintained, and fan blades were corroded and clogged with deposits, which may have impacted the results.