Nosocomial killer

The spring of 2003 proved deadly for Healthcare workers fighting the SARS outbreak in Toronto, Canada. A single index patient who traveled from Hong Kong to Toronto spawned a SARS epidemic that eventually infected 375 people, killing 44 of them including a doctor and two nurses. More than 72% of those who had SARS in Ontario contracted it *inside* hospitals.[1]

How did it happen? Can the virus be transmitted through the air? Could a similar pathogen such as pandemic avian influenza become airborne? These questions sparked a renewed interest in airborne transmission of disease.

Researchers hit the books

A comprehensive review of medical studies published between 1960 and 2005 yielded nearly 200 papers that involved airborne transmission of disease.[2] This body of literature was analyzed by a multi-disciplinary team of 15 experts in epidemiology, virology, environmental health and engineering. The panel focused on 40 papers that specifically dealt with the contribution of airflow and ventilation in spreading airborne disease.

Of the 40 papers, 18 were found to be 'non-conclusive' in respect to the panels' rigorous criteria. 12 were found 'partly conclusive' and 10 were 'conclusive':

> "Among the 10 studies considered to be conclusive, five showed an association between airflow patterns and the spread of diseases...a few secondary cases or even a large number of cases at a considerable distance away from the index patient were shown to be infected via an airborne transmission route. **It is also interesting that all the outbreaks investigated in the five studies occurred in hospitals or pediatric offices, suggesting the importance of air environments in healthcare settings**."

Researchers confidently concluded that they had found their link between ventilation air flows and disease transmission:

> "Within the contemporary limitations of the conclusive studies chosen here, there is **strong and sufficient evidence to demonstrate the association between ventilation and the control of airflow directions in buildings and the transmission and spread of infectious diseases** such as measles, TB, chickenpox, anthrax, influenza, smallpox, and SARS."

Other researchers have recently arrived at similar conclusions

A recent paper[3] by microbiologist Raymond Tellier of Toronto's Hospital for Sick Children calls the evidence for aerosol transmission of influenza virus, "…compelling." This review, published in the CDC's Emerging Infectious Diseases journal examines an on-going debate over the relative importance of aerosols versus large droplets in the transmission of disease:

> "Despite extensive searches, I have not found a study that proves the notion that large-droplet transmission is predominant and that aerosol transmission is negligible (or nonexistent)."
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> "Indeed, the relevant chapters of many reference books, written by recognized authorities, refer to aerosols as an important mode of transmission for influenza…"

A growing consensus

There is a growing awareness amongst Infection Control professionals that nosocomial infections are an environmental problem with multiple causes. While contact transmission may predominate, "…it appears likely that the contribution made by airborne microorganisms towards nosocomial infection is greater than is currently recognised."[4]

The role of airborne transmission is underscored by the professional organizations that recommend air disinfection as a supplement to traditional ventilation and filtration in hospitals. Guidelines from ASHRAE[5], the AIA[6] and the CDC[7] recommend the use of Ultraviolet Germicidal Irradiation in hospitals.

Ventilation systems as disease dispensers

Hospitals use ventilation systems for more than temperature control. Ventilation effectively transfers pathogens from inside the building, to the outside. When ventilation systems malfunction or are contaminated, they can transfer pathogens *within* the building.

In 1962 a controlled experiment proved that ventilation ducts could effectively transmit infectious tuberculosis bacterium from a hospital ward to a test chamber with lab animals.[8] Other examples of ventilation transmitting disease include measles outbreaks in a pediatric office[9] and a school building[10], as well as an eruption of TB aboard a closed ventilation Navy ship.[11]

Ventilation that is poorly designed or malfunctioning can also spread disease. The exhaust from an isolation room was able to re-enter a British hospital through a partially opened window causing MRSA infection in six patients.[12] 13 children in a pediatric ward contracted chickenpox due to an inoperative HVAC system in a nearby ward.[13] Researchers studying the largest nosocomial outbreak of SARS in Hong Kong concluded that an unbalanced HVAC system contributed to additional SARS infections within a hospital.[14]

These findings are echoed by observations in the EPA's Fact Sheet on Ventilation:[15]

> "An HVAC system that is properly designed, installed, maintained, and operated is essential to providing healthful indoor air; a poorly maintained system can generate and disperse air pollutants."

Engineering new solutions

Think of the heating ventilation and air conditioning system (HVAC) as your hospital's lungs. Both systems bring in fresh air, filter it and distribute it—expelling used air and unwanted contaminants. Just as bacteria, fungi and viruses infect your lungs, these same pathogens can infect your HVAC system.

The studies referenced in this paper show that diseases such as SARS and influenza can be transmitted via the air and that HVAC systems can spread airborne disease within a building. VIGILAIR® Systems, Inc engineers solutions that disinfect HVAC systems and break the chain of airborne transmission.

Installed within the air handlers of a building, VIGILAIR® Systems utilize high efficiency filtration and ultraviolet germicidal irradiation (UVGI) to deactivate and remove microorganisms before they are circulated back into patient care areas. In addition to significantly reducing the microbial load of indoor air, UVGI cleans fouled cooling coils which leads to greater efficiency and energy savings.

Progressive infection control professionals are starting to implement 'bundling' strategies to prevent hospital acquired infections (HAI). This development reflects the fact that infection control is an environmental battle requiring complementary tactics employed on several fronts.

While there are no silver bullets available, infection control professionals are increasingly adding VIGILAIR® to their arsenal as a new weapon in their fight against HAI.

References

1. The SARS Commission. Spring of Fear. Commission to investigate the introduction and spread of SARS in Ontario 2006; Volume 1:1-7.
2. Li Y, et al. Role of ventilation in airborne transmission of infectious agents in the built environment—a multidisciplinary systematic review. Indoor Air 2007; 17: 2-18.
3. Tellier R. Review of aerosol transmission of influenza A virus. Emerging Infectious Diseases 2006; 12: 1657-1662.
4. Beggs CB. The airborne transmission of infection in hospital buildings: fact or fiction? Indoor and Built Environment 2003; 12: 9-18.
5. American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc. ASHRAE Handbook: HVAC Applications, Fundamentals,1999;Chapter 7
6. The American Institute of Architects. Guidelines for Design and Construction of Hospitals and Health Care Facilities. AIA Press 2001.
7. Centers for Disease Control. Guidelines for Preventing the Transmission of Mycobacterium Tuberculosis in Health-Care Facilities. MMWR October 28, 1994 /43(RR13); 1-132
8. Riley, R.L, et al. Infectiousness of air from a tuberculosis ward: ultraviolet irradiation of infected air: comparative infectiousness of different patients. Am. Rev. Respiratory Disease 1962; 85:511–525.
9. Bloch AB, et al. Measles outbreak in a pediatric practice: airborne transmission in an office setting. Pediatrics 1985;75:676–683.
10. Riley EC, et al. Airborne spread of measles in a suburban elementary school. American Journal of Epidemiology 1978; 107:421–432.
11. DiStasio AJ, et al. The investigation of a tuberculosis outbreak in the closed environment of a U.S. Navy ship. Military Medicine 1987;155, 347–351.
12. Cotterill S, et al. An unusual source for an outbreak of methicillin-resistant Staphylococcus aureus on an intensive therapy unit. Journal of Hospital Infection 1996;32:207–216.
13. Leclair JM, et al. Airborne transmission of chickenpox in a hospital. New England Journal of Medicine 1980;302:450–453.
14. Yu ITS, et al. Temporal-spatial analysis of severe acute respiratory syndrome among hospital inpatients. Clinical Infectious Disease 2005;40:1237–1243.
15. Environmental Protection Agency. Fact Sheet: Ventilation and Air Quality in Offices. Indoor Environments Division Document ID:EPA 402-F-94-003.

Pathogens that may be transmitted via the air