The risk of infection in anaesthetic practice

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Hospitals are a potentially dangerous environment for both patients and employees. The operating suite is no exception. Patients are exposed to multiple physical, chemical and microbial hazards and in turn anaesthetists and other personnel are exposed to both environmental hazards and hazards associated with patient care. Exposures may also occur outside the operating room in other areas of the hospital as well. Patterson *et al.* have recently reviewed occupational hazards to hospital personnel.¹

While physical and chemical hazards for anaesthesia personnel are important, infectious diseases may also cause significant morbidity and occasional mortality. Fortunately, most infectious hazards can be avoided by appropriate use of available immunizations and adherence to standard infection control practices. This paper reviews the transmission of infection to anaesthesia personnel and, while a risk-free environment can never be totally obtained, suggests appropriate methods by which infectious hazards can be minimized in the operating suite.

Modes of transmission

Modes of transmission of microorganisms from patient or the environment to the anaesthetist are very limited (Table I). The most hazardous, and fortunately the rarest means by which microorganisms are transmitted to the health care worker is the airborne route. Airborne spread has rarely been documented in the hospital, but highly infectious agents such as *Mycobacterium tuberculosis* and varicella zoster virus can occasionally be transmitted in this fashion. Respiratory droplet spread is a variation of airborne spread but by definition the virulent organism is transmitted in respiratory droplets within a one metre range. *Mycobacterium tuberculosis*, *Bordetella pertussis*, and rubella (measles) are most commonly transmitted in this fashion.

Ingestion of microorganisms typically causes enteric illness such as salmonellosis or shigellosis. It is some-

times difficult to separate food or water-borne transmission from direct contact transmission for these enteric pathogens.

Percutaneous transmission occurs when direct inoculation of the microorganism through the normally protective skin or mucous membrane occurs. Needlestick injuries, administration of a contaminated transfusion or parenteral drug abuse can lead to hepatitis B, non-A, non-B hepatitis and human immunodeficiency virus (HIV) infection. Once again, it may be difficult to separate percutaneous transmission from direct contact transmission with highly virulent microorganisms.

Direct contact transmission assumes that the normal barriers to infection, such as skin, mucous membranes may not totally exclude transmission of infection. One example would be the transmission of herpes simplex virus through sexual contact or contact of hands with an open lesion or secretions (herpetic whitlow). Alternatively, microorganisms may be carried to the site of infection by the hands, such as occurs with *Staphylococcus aureus* or agents causing conjunctivitis. Direct contact transmission can be difficult to distinguish from droplet spread, faecal/oral transmission or percutaneous transmission. Fortunately, infection control guidelines often encompass all modes of transmission for individual agents. For all practical purposes, in the practice of anaesthesia, infectious agents are transmitted only by percutaneous, direct contact and respiratory spread.

Specific microorganisms

Many pathogenic microorganisms are of potential or real importance to anaesthesia personnel. Parasites, protozoa or fungi are unlikely to be transmitted in the operating room setting and will not be discussed. *Sarcoptes scabiei*, the agent of scabies, can be spread in the hospital, particularly when an unsuspected case of Norwegian scabies is hospitalized. However demonstration of transmission in the operating room of this agent has not been reported.

Similarly, bacterial pathogens spread by ingestion such as *Salmonella* sp. and *Shigella* sp. are of little practical

TABLE I Modes of spread of microorganisms to health care workers

Mode	Example
Airborne	Varicella zoster virus
Direct contact	Herpes simplex virus
Droplet	<i>M. tuberculosis</i>
Ingestion	<i>Salmonella</i> sp.
Percutaneous	Hepatitis B

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importance to anaesthetists. All health care workers, including anaesthetists, may unwillingly participate in institutional outbreaks of these infections sometimes associated with hospital cafeterias or other restaurant facilities; however, transmission in the operating room is unlikely.

A list of microorganisms potentially transmissible to anaesthesia personnel is summarized in Table II. Some are discussed in depth below, by classification and in order of their relative importance.

Viral Pathogens

HEPATITIS B

Hepatitis B is the most important viral infection to which anaesthesia personnel are exposed. Surveys of serological markers of infection in anaesthesia personnel range between 10 and 30 per cent.^{2,3} Studies of hepatitis B markers in other high-risk workers suggest that direct exposure to blood is the major risk factor and that age and duration of employment are other risk factors (suggesting that experience does not afford protection from infection). Anecdotal case reports of clinical hepatitis B in anaesthesia personnel are common^{4,5} but most infections are not associated with clinical illness. The incidence of fulminant hepatitis and other chronic sequelae of hepatitis B in anaesthesia personnel is unknown, but is likely to be similar to patterns of illness in other populations studied.

TABLE II Microorganisms potentially transmissible to anaesthesia personnel from patient or environment

<i>Organisms</i>	<i>Mode of transmission</i>
<i>Viruses</i>	
Hepatitis B*	Percutaneous
Hepatitis A*	Ingestion
Non-A, non-B hepatitis	Percutaneous
Human immunodeficiency virus	Percutaneous
Herpes simplex virus	Direct contact
Adenovirus*	Direct contact/droplet
Varicella zoster	Airborne/droplet
Rubella*	Droplet
Rubeola (measles)*	Droplet
RSV	Droplet/direct contact
Mumps*	Droplet
CMV	? Direct contact
Influenza A*/B	Droplet
<i>Bacteria</i>	
<i>Neisseria meningitidis</i> *	Droplet
<i>Mycobacterium tuberculosis</i>	Droplet/airborne
<i>B. pertussis</i> *	Droplet
<i>Salmonella</i> sp.	Ingestion
<i>Shigella</i> sp.	Ingestion
<i>T. pallidum</i>	Direct contact
<i>Legionella</i> sp.	Airborne/?ingestion

*Passive and/or active immunization for these agents is available.

Development of hepatitis B following documented exposures from blood or body fluid on patients known to be hepatitis B surface-antigen positive and e-antigen positive is likely to be as high as 20–30 per cent in the absence of immunoprophylaxis. Because most infections occur from exposures to patients not known to be carrying the virus, the importance of minimizing exposure to blood and body fluids should be emphasized. The recent introduction of universal blood and body fluid precautions because of concerns about human immunodeficiency virus (HIV) infection should significantly lower the rate of hepatitis B among hospital personnel as an added benefit.

All anaesthesia personnel should be actively immunized against hepatitis B with either the vaccine processed from the sera of hepatitis B carriers (Heptavax®) or the new recombinant vaccine (Recombivax®). Both vaccines are safe and effective, providing immunity to hepatitis B for at least five years. Because of the high incidence of hepatitis B markers in anaesthesia personnel, it may be cost effective to determine the serologic status prior to immunization. Pre-existing hepatitis B antibody or chronic hepatitis B carriage would eliminate the need for immunization. Unfortunately, studies of hospital personnel determined to be at high risk for hepatitis B infection suggest that acceptance of immunization is suboptimal.⁶

HUMAN IMMUNODEFICIENCY VIRUS (HIV)

This virus is much less infectious than hepatitis B as it is present in far smaller quantities in the serum of infected patients in comparison to hepatitis B. However, there is no current immunization against HIV and the sequelae of the infection may be more serious. No case reports of transmission of the human immunodeficiency virus to anaesthesia personnel are available but the issues of AIDS and anaesthesia have been reviewed recently.^{7–9} A number of anecdotal case reports of transmission of HIV in the health care setting have been published. However, several large prospective studies of health care workers in the United States¹⁰ and in Canada¹¹ have not documented infection in anaesthesia personnel from work-related exposures, although information from these surveys has not been stratified by medical or surgical specialty (RA Marcus, K. Elmslie, personal communications). These prospective studies suggest that percutaneous exposure to blood or body fluids has a risk of infection of between 1–10/1000 in comparison to hepatitis B where the risk may be as high as 100–300/1000 exposures.

Because the epidemiology of HIV infection is similar to that for hepatitis B, the introduction of universal blood and body fluid precautions should go far in eliminating the risk of HIV transmission to anaesthesia personnel. However this will require changes in the traditional practice of

many anaesthetists who have not used gloves when starting intravenous or intraarterial lines or who don't wear eye glasses or goggles for intubations. Mandatory screening programs for hospital admissions or for patients undergoing surgery are not currently recommended as a means to limit exposure to HIV in the operating room.

NON-A, NON-B HEPATITIS

Non-A, non-B hepatitis has been transmitted in the health care setting,^{12,13} and is the most important cause of transfusion-associated hepatitis today. More than one agent is responsible and at least one form of the infection has epidemiologic similarities to hepatitis B. No anaesthesia personnel have been reported to have acquired this infection, but this infection should be as common or more common than hepatitis B in anaesthesia personnel. Because the epidemiology is similar to hepatitis B, universal blood and body fluid precautions should limit the acquisition of non-A, non-B hepatitis in anaesthetic practice.

HERPES SIMPLEX VIRUS

Herpetic whitlow, usually caused by herpes simplex virus, Type 1, is a frequently found and often misdiagnosed infection in hospital personnel.¹⁴ Herpes simplex virus is excreted in the oral secretions of severely ill patients whether active lesions are present or not. Herpetic whitlow is especially common in personnel whose ungloved hands are exposed to oral secretions. Respiratory therapists, dentists, and anaesthetists are at high risk and a case report has been published of this condition in an anaesthetist.¹⁵ Percutaneous inoculation does not seem to be necessary as with HIV or hepatitis B, although disruption of skin around the nailbed may play some role in promoting the acquisition of infection.

Although no vaccine is currently available for preventing this occupational hazard, oral acyclovir may be helpful in minimizing morbidity associated with recurrent outbreaks or in preventing frequently occurring outbreaks. Universal blood and body fluid precautions with appropriate gloving should prevent this annoying infection. Gloving is also mandatory to prevent the spread of infection to patients¹⁶ when active lesions are present.

VARICELLA-ZOSTER VIRUS (VZV)

Varicella zoster virus (VZV), another human herpes virus, appears to be much more contagious than herpes simplex virus and in addition to direct contact spread, airborne and droplet spread of this infection are common. Fortunately, over 90 per cent of the general population acquires life-long immunity during childhood to this

infection and nosocomial acquisition of VZV infection is rare.

Outbreaks of nosocomial VZV have been frequently reported but primarily affect children¹⁷ or severely immunosuppressed patients.¹⁸ It is possible and reported that varicella can occur in non-immune staff, however.^{17,18} Whether hospital employees should be screened for prior immunity to VZV by skin test or serology is controversial¹⁹ but anaesthesia personnel should be aware of the risk of infection during intubation of patients with active shingles, disseminated varicella, or varicella pneumonia. Where possible, anaesthesia personnel not immune to varicella should be excluded from patient contact where airborne or droplet spread is likely. Otherwise masks, gloves, and gowns should be mandatory, and may help limit transmission to non-immune staff.

RUBEOLA (MEASLES)

The transmission of measles in hospital settings has been reviewed recently.²⁰ Approximately one-quarter of measles cases transmitted in hospital are to personnel rather than to patients. Index cases are usually patients and rarely are other staff responsible for transmission to other hospital staff. Although measles is spread by the respiratory droplet route, data are not available to confirm the risk to anaesthesia personnel from procedures involving intubation. Most individuals born before 1957 are considered immune and immunization for those born after this date is recommended. In surveys, up to ten per cent of hospital employees are non-immune and routine measles immunization should be mandatory on employment for personnel who have no record of immunization and were born after 1957.

RUBELLA

Rubella, another immunizable childhood disease, has also been transmitted in the hospital setting²¹⁻²² and is more likely than measles to spread from staff to other staff, rather than from patient to staff. No specific discussion of the risk to anaesthesia personnel has been published. However up to 15 per cent of all hospital employees are not immune to rubella and rubella antibody screening for new hospital employees with subsequent immunization of susceptibles is recommended. Unfortunately, physicians have been notoriously poor responders to suggestions that they be immunized for rubella²³ as well as for hepatitis B.

CYTOMEGALOVIRUS (CMV)

Human cytomegalovirus (CMV) infection is extremely common; 60-80 per cent of the population over the age of 30 possess CMV antibody reflecting previous and now

latent infection. Excretion of CMV by hospitalized patients is common but studies of cytomegalovirus as an occupational hazard to nursing and other hospital personnel have not demonstrated an increased risk of infection.^{24,25} No studies to demonstrate an increased risk of primary cytomegalovirus infection in anaesthesia personnel have been published but the risk is also probably low. Restriction endonuclease analyses of paired isolates where transmission from patient to worker have been suspected often show that infection was acquired outside the hospital. Direct contact transmission should be eliminated by both the institution of universal blood and body fluid precautions as well as careful hand washing before and after patient care.

RESPIRATORY VIRUSES

Nosocomial outbreaks of adenovirus^{26,27} respiratory syncytial virus²⁸ and influenza²⁹ infections have been reported. Adenovirus conjunctivitis appears to be a more common problem than respiratory tract infection while the other viruses cause primarily lower and upper respiratory tract infection respectively. In particular, influenza A and B outbreaks may cause significant morbidity and absenteeism, if not mortality among hospital employees. Anaesthesia personnel have not been specifically identified as a risk group but intimate exposure to respiratory secretions would suggest that the risk might be higher than for other employees with less direct exposure. Masking, gloves and careful hand washing should be employed when undifferentiated respiratory tract infection is present in the patient being cared for by the anaesthetist.

Vaccines are available for a few adenovirus strains but are not currently recommended for general use. Vaccines for respiratory syncytial virus are under development. When epidemic influenza A or B is identified in the community, immunization with the current vaccine formulation is recommended for all hospital personnel.³⁰ Anaesthesia personnel with underlying medical conditions may also be eligible for yearly immunization whether epidemic disease is present or not. Short-term chemoprophylaxis with amantadine may be warranted as an adjunct to immunization during explosive outbreaks of influenza A in the hospital.³⁰ This may prevent or ameliorate infection until immunization provides immunity at seven to ten days.

MUMPS

Outbreaks of nosocomial mumps virus infection are exceedingly rare and transmission appears to be by direct contact with respiratory secretions.³² Spread to hospital personnel has not been documented but is theoretically possible. Anaesthesia personnel with a largely paediatric

practice should be aware of potential exposures to mumps virus and in the absence of a history of immunity, should consider immunization.

Bacterial diseases

Several bacterial diseases have been transmitted in the health care setting. Because effective treatments are often available for bacterial infections, health care workers express less concern about potential exposures to bacterial pathogens than to hepatitis B or HIV infection. However, the use of appropriate infection control procedures effective in preventing viral infections should also minimize the risk of acquiring bacterial pathogens as well.

MYCOBACTERIUM TUBERCULOSIS

Patients with active cavitary pulmonary tuberculosis can be extremely effective disseminators of *Mycobacterium tuberculosis* in the hospital environment.³³ While droplet spread is more common, airborne spread of tuberculosis has been documented in the hospital setting.³⁴ A review of nosocomial tuberculosis specifically in physicians has been published.³⁵ Highest rates of infection, as documented by tuberculin tests, were in the primary care specialties. Anaesthetists while not specifically identified in published studies, probably have an overall prevalence of infection of ten per cent. Almost 50 per cent of exposures that lead to skin test conversion are not identified and yearly conversion rates for tuberculosis (with geographic differences) approach two per cent per year. Under these circumstances, anaesthesia personnel should be skin tested when beginning their employment and then yearly. In areas where tuberculosis appears to be very rare, yearly skin testing may not be warranted for anaesthesia personnel. Yearly chest roentgenograms are not indicated in tuberculin negative patients and repeat skin testing of tuberculin positive individuals is not necessary. The use of BCG immunization is controversial and is probably not warranted in North America except under circumstances of predictably high exposure to populations with high rates of infection (for example native communities).

BORDETELLA PERTUSSIS

Outbreaks of pertussis among patients and staff in paediatric hospitals have been described³⁶ and can cause serious morbidity. Anaesthesia personnel have not been specifically identified as cases in such outbreaks but may be exposed. Adults may be susceptible despite adequate childhood immunization presumably because of waning immunity.

Because this problem is rare, no specific precautions are necessary and outbreaks when identified should be

managed by the use of prophylactic erythromycin and appropriate isolation. Adult immunization with the currently available pertussis vaccine is controversial because of the frequent and significant side effects associated with immunization of adults.³⁶ Newer vaccines will be available soon and may be useful in preventing nosocomial spread of *Bordetella pertussis* when outbreaks are identified.

NEISSERIA MENINGITIDIS

Anaesthesia personnel may be called to assist in intubation of patients with fulminant meningococemia or meningococcal meningitis. In addition exposures to patients with *Neisseria meningitidis* pneumonia in the ICU may occur on occasion. Evidence suggesting nosocomial transmission of meningococci^{37,38} is scanty but hospital personnel exposed to respiratory secretions of these patients are theoretically at risk of developing invasive meningococcal disease. Respiratory isolation is appropriate and rifampin chemoprophylaxis may be used when obvious respiratory droplet/close contact exposures have occurred. Pharyngeal carriage of meningococci is common in the general population and throat swabs are not useful in confirming exposure.

Although vaccines against several serotypes of *Neisseria meningitidis* are available, routine pre-exposure use of these vaccines in anaesthesia personnel or other employees is not warranted. Selective use of type-specific vaccines in the setting of community outbreaks of meningococcal disease are warranted as an adjunct to chemoprophylaxis and may be used in hospital employees where significant exposure has occurred.

Summary

Infectious hazards to anaesthesia personnel are real but the appropriate use of immunization, universal blood and body fluid precautions, and respiratory precautions where appropriate, should minimize the risk of infection at work. In particular, the resistance of physicians to immunization, especially to hepatitis B, needs to be changed. Protection against other blood-borne pathogens for which immunization is not available, such as HIV, may also depend on the willingness of anaesthesia personnel to accept and carry out recommendations for universal blood and body fluid precautions. Regulatory agencies and compensation boards are likely to look closely at adherence to established guidelines when determining benefits for work-related infections. Complaints that the routine use of gloves interferes with anaesthetic practice are frequent but unacceptable in the current climate and it behooves the profession to ensure that compliance with currently accepted infection control guidelines is complete.

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