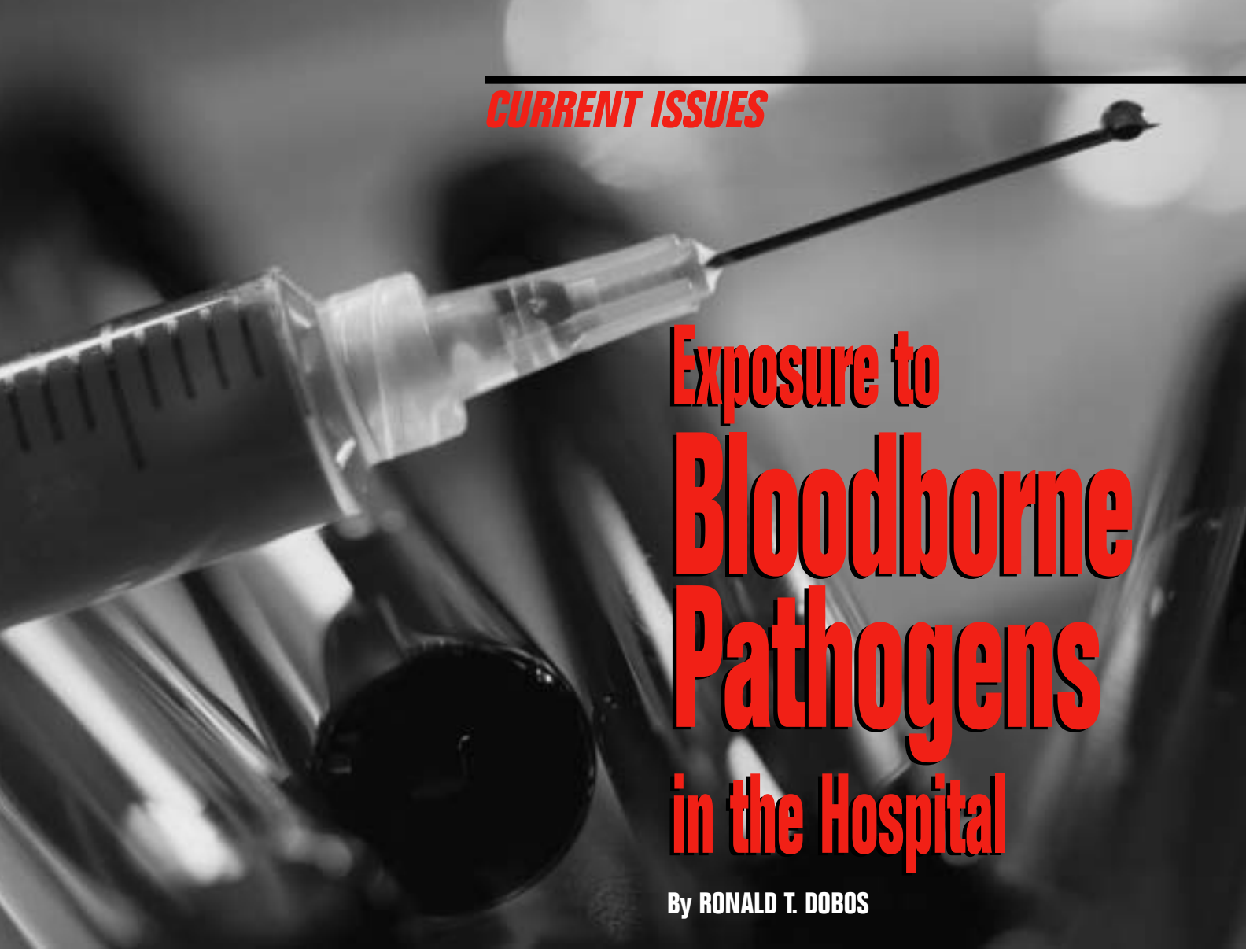

Exposure to Bloodborne Pathogens in the Hospital

By RONALD T. DOBOS

In recent years, studies have been conducted to assess the exposure of hospital employees to bloodborne pathogens. Although the primary route of exposure is blood-to-blood contact, research has determined that various modes of transmission—including inhalation, inoculation, and contact with an open wound, mucous membrane or non-intact skin—are possible.

THE RESEARCH

Studies have found that blood-containing aerosols are generated by common surgical procedures performed in the operating room (OR) (Heinsohn and Jewett 446+; Jewett, et al 228+). These aerosols can then be inhaled by OR personnel. Other studies have reported that intact infectious viral DNA was liberated into the air with the vapor of laser-treated verrucae (tumors of the skin's epidermis); and that blood to which human immunodeficiency virus (HIV) had been added became aerosolized by surgical power instruments and that this blood contained viable HIV (Sawchuck 41+; Johnson 47+).

In other studies, measurable amounts of aerosols containing hemoglobin-associated particles (that is, red blood cells/blood) were detected in surgeons' breathing zones during hip replacement, back vertebral fusion, knee replacement and hip reconstruction surgeries. The aerosol concentration was highest when the surgical site was opened using electrocautery and irrigation/suction techniques; other procedures produced much lower concentrations of aerosols. This finding suggests that orthopedic surgeons—since their procedures are relatively more blood-/particulate-producing than other surgical services—are not uniquely exposed to blood-containing aerosols in the OR.

Aerodynamic particle sizes ranged from 3.5 to 21.3 microns (Yeh 151+). The size of the aerosols is important since respirable-size aerosols (less than 10 microns) can be inhaled and deposited into the gas exchange region of the lungs and transported into the bloodstream. Not all respirators or surgical masks can filter out respirable-size particles.

These studies demonstrate the potential for infection to OR personnel from blood-containing aerosols generated during common surgical procedures. These findings led to a call for increased use of respirators and other personal protective equipment (PPE). [Conrad provides a good discussion of these topics in her Aug. 1994 article, "Surgical and Other Aerosols: Protection in the Operating Room."]

The actual occurrence of infection due to exposure in the OR has been low, however, and airborne infectivity has never been documented as the mode of transmission. Among those members of the American Academy of Orthopaedic Surgeons who participated in a 1992 survey, none reported evidence of HIV infection (unless they had non-occupational exposure) (Tokars 489+).

Centers for Disease Control and Prevention (CDC) reports that through June 1998 in the U.S., only six possible cases of occupational transmission of HIV had been reported for surgeons, along with two documented and two possible cases for surgical technicians ("U.S. HIV and AIDS Surveillance Report" 24).

CDC does not currently maintain infection rates of OR personnel to hepatitis B

virus (HBV). Although airborne transmission of HBV is theoretically possible (since transmission can occur via mucosal surfaces), airborne transmission has not been found to be a significant mechanism of spread (Petersen 157+).

CDC concurs, stating, "Although the theoretical possibility of rare or low-risk alternative modes of transmission cannot be totally excluded, the only documented occupational risks of HBV and HIV infection are associated with parenteral and mucous membrane exposure to blood and tissue" (Update 353+; Recommendations 1S+).

Furthermore, "Although the potential for HBV transmission in the workplace setting is greater than for HIV, the modes of transmission are similar. Both have been transmitted in occupational settings *only* by percutaneous inoculation or contact with an open wound, nonintact skin or mucous membranes to blood, blood-contaminated body fluids or concentrated virus" (Guidelines 2-3).

NIOSH Alert: Needlestick Injuries

Healthcare workers who use or may be exposed to needles are at increased risk of needlestick injury." This warning is the basis for National Institute for Occupational Safety and Health's (NIOSH) latest Alert, "Preventing Needlestick Injuries in Healthcare Settings." The publication explains the risks of infection following a needlestick injury and illustrates how such injuries occur via five case reports. The document also outlines recommendations for employers and workers, and offers guidelines for evaluating and selecting needle devices with safety features. "Needlestick injuries can best be reduced when the use of improved engineering controls is incorporated into a comprehensive program involving workers," NIOSH states. To obtain a copy of the Alert, DHHS Publication No. 2000-108, call (800) 356-4674 or visit www.cdc.gov/niosh.

THE RISK OF INFECTION & PREVENTIVE MEASURES

What is the risk of infection? "Of persons who have not had prior hepatitis B vaccination or post-exposure prophylaxis, six to 30 percent of persons who receive a needlestick exposure from a hepatitis B surface antigen (HbsAG-positive) individual will become infected. Risk of infection with HIV following one needlestick exposure to blood from a patient known to be infected with HIV is approximately 0.5 percent. Although inadequately quantified, the risk from exposure of nonintact skin or mucous membranes is likely to be far less than that from percutaneous inoculation" (Guidelines 2). The risk from inhalation has not yet been quantified and may remain unquantifiable.

What steps can healthcare facilities take to reduce exposure to airborne contaminants? One study reported that surgically produced aerosols in a laboratory setting OR were removed from the breathing zone of personnel more effectively by cross-flow (laminar) ventilation than by an impinging (downward) airflow onto the operating table (Buchanan and Dunn-Rankin 393+). The researchers used computer simulations to map the course of individual particles through the OR. According to their tests, impinging airflow allowed particles to linger, increasing their potential for inhalation by OR personnel.

The study also found that in addition to ventilation system design (using 20 room air changes per hour as the standard), placement of flow obstructions and contaminant sources can influence the removal of aerosols from the OR. However, the researchers noted that contaminant transport within an OR is dependent on the room's unique characteristics (e.g., heat loads from patients, staff, spotlights, material placement and activity). Therefore, each must be investigated in order to accurately assess conditions (Buchanan and Dunn-Rankin 393+).

Hospitals have come to realize that their staffs need as much (if not more) protection from bloodborne pathogens as do patients. Contaminant-control strategies employed during OR laser procedures (and for waste anesthetic gases) include laminar flow and exhaust ventilation. In addition, because the laser plume has been shown to contain aerosolized infective material (among other contaminants), plume extractors (local exhaust ventilation) are used.

OTHER POTENTIAL EXPOSURES

The OR is only one location where exposure can occur. A recent article showed that applying basic occupational epidemiology principles and methods provides useful information on blood and body fluid exposures throughout the hospital.

The researchers reviewed all reported hospital staff exposures that occurred in an Army medical center from January 1992 through June 1995. An exposure was defined as "a clear recollection of direct contact with a patient's blood and/or body fluids either through a needlestick injury, contact through mucous membrane, or contact through chapped skin or an open wound." Inhalation exposure was not included. Key findings:

- Annual incidence of exposure was 382.5 per 1,000 healthcare workers requiring universal precautions training.
- House officers had the greatest risk from frequency of potential exposures.
- Patient wards were the most-frequent location of exposure (37 percent) followed by the operating room (21 percent).
- Hollow-bore needles (49 percent) and sharps (34 percent) were the medical instruments typically involved in exposure incidents.
- Recapping needles produced 6.2 percent of the reported injuries, while 13.7 percent involved needles with safety features such as shields, or recessed or retractable needles. Some 55.2 percent of injuries were moderate (skin puncture with some bleeding) or severe (deep wound with profuse bleeding).
- The most-common types of injuries: sharps: 85.3 percent; contact exposures: 13.6 percent; not defined: 1.1 percent.
- Of those exposed, 33 percent did not receive follow-up surveillance.

The researchers determined that exposure incidents were underreported by at least 25 percent. They also noted that house officers may have some misconceptions about HIV transmission; practice at-risk behaviors; and often make uninformed judgments about which patients are high/low-risk (Goob 20+).

SOLUTIONS

How can these exposure potentials be minimized?

1) Follow OSHA 1910.1030 (Bloodborne Pathogens) and CDC's *Guidelines for Prevention of Transmission of Human Immunodeficiency Virus and Hepatitis B Virus to Healthcare and Public-Safety Workers.*

2) Provide initial, intensive training as well as periodic retraining for house officers and other staff; this training should cover universal precautions and proper techniques for all procedures that require use of hollow-bore needles.

3) Encourage employees to report all exposure incidents and ensure follow-up surveillance.

4) Ensure that sharps containers are removed before they overflow.

5) Utilize engineering controls such as safety syringes and needleless IV access systems.

6) Use exhaust ventilation to remove contaminants from the breathing zone of OR staff.

CONCLUSION

Airborne transmission of HBV and HIV is not a significant mode of infection and no cases of such transmission have been documented to date. However, since common surgical procedures can produce potentially infectious blood-containing aerosols, laminar flow ventilation systems, combined with placement of people and equipment to reduce or eliminate turbulence, can be used to remove aerosols from the breathing zone of OR occupants. In addition, local exhaust ventilation (plume extractors) should be used.

Although aerosol contamination is theoretically possible, the primary sources of exposure to bloodborne pathogens are hollow-bore needles, sharps (punctures) and splash/contact. Research to date shows that following CDC guidelines for bloodborne pathogens—which call for engineering, administrative and educational controls—should minimize exposure incidents involving these sources. ■

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OSHA Issues Revised Bloodborne Pathogens Compliance Directive

OSHA recently issued a new compliance directive designed to minimize health risks faced by workers exposed to blood and other potentially infectious materials. It updates a 1992 directive and "reflects the availability of improved devices, better treatment following exposure and OSHA policy interpretations." Key revisions include:

- **Annual review of exposure control plan.** Employers must ensure that their plans reflect consideration and use of commercially available safer medical devices.
- **Engineering controls and work practices.** The new directive emphasizes use of effective engineering controls to include safer medical devices, work practices, administrative controls and personal protective equipment.
- **Reliance on relevant evidence.** The directive calls for employers to rely on relevant evidence in addition to FDA approval to ensure effectiveness of devices designed to prevent exposure to bloodborne pathogens.
- **Updated guidelines.** CDC's most-recent guidelines on vaccinations against HBV have been incorporated, as have the Centers' guidelines on post-exposure evaluation and follow-up for HIV and hepatitis C.
- **Employee training.** Whenever use of safer devices is implemented, employers must provide effective training and education. The directive stresses interactive training rather than reliance on films or videos.

"We must do everything we can to protect workers who may be at risk of exposure to bloodborne diseases," states Secretary of Labor Alexis Herman. "This directive doesn't place new requirements on employers, but it does recognize and emphasize the advances made in medical technology. And it reminds employers that they must use readily available technology in their safety and health programs."

For more information, visit OSHA's website at www.osha.gov.

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