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EPINet™ Report:

Blood and Body Fluid Exposures to Skin and Mucous Membrances

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Introduction

Percutaneous injuries, needlesticks in particular, are generally recognized as the most common mechanism of bloodborne pathogen transmission among healthcare workers. However, contact of workers' skin and mucous membrane with infected blood from patients has also been associated with documented seroconversions to bloodborne pathogens, although with lower frequency than percutaneous injuries.¹⁻³ Only 4 out of 61 documented cases of occupational HIV infection reported internationally were linked to skin or mucous membrane contact with blood.⁴ There are several possible explanations for these relatively small numbers, including a lower transmission rate following mucocutaneous exposures. But another factor may be the difficulty in attributing an infection to a specific skin or mucous membrane exposure.

Blood and body fluid (BBF) exposures are so common in many clinical settings,

such as emergency departments and obstetrics, that healthcare workers are not likely to report an event they view as a routine occurrence. Thus, some occupational infections

resulting from routine and repeated contact with BBF are probably not recognized or documented as such. Cases of occupational HIV infection have been reported in which there was a history of contact with HIV-contaminated (or potentially contaminated) blood or lab samples, but in which no percutaneous injury or other specific exposure was recalled.⁵ Some studies have shown higher prevalence rates of bloodborne pathogens in healthcare workers employed in exposure-intensive settings than in control groups or in the general population, providing indirect evidence that transmission may occur despite the lack of documented seroconversions.⁶⁻¹⁰ These reports illustrate the difficulty of linking exposure events to infections, and may in part explain why relatively few documented cases of bloodborne pathogen transmission via mucocutaneous route are found in the medical literature.



control groups or in the general population, providing indirect evidence that transmission may occur despite the lack of documented seroconversions.⁶⁻¹⁰ These reports illustrate the difficulty of linking exposure events to infections, and may in part explain why relatively few documented cases of bloodborne pathogen transmission via mucocutaneous route are found in the medical literature.

Blood and Bloody Fluid Exposures (cont.)

The healthcare worker's first line of defense against exposure to BBF is personal protective equipment (PPE), including gloves, liquid-resistant gowns, face masks, face shields, goggles, head covers, shoe covers, and other more specialized garments. In the United States, recommendations for the appropriate use of PPE are described in the policy of universal precautions, first published by the Centers for Disease Control in 1987 and enacted as a mandatory national standard in December 1991.^{5,11} The effectiveness of PPE depends on whether the design of the protective garments matches the distribution of BBF contact, whether the garment material is adequately liquid resistant, and whether the appropriate garments are worn when needed. When BBF exposures occur, they reflect either non-compliance with PPE requirements, a failure of protective garments to provide an adequate barrier, or unanticipated circumstances that the healthcare worker was unable to prepare for—a common situation in the complex environment of a hospital.

Skin or mucous membrane contact with patients' BBF is frequent in most health care institutions. In a survey of workers in a hospital's clinical laboratories—a highly regulated environment—respondents reported an average of 4.6 BBF contacts per year. Only 2% reported their most recent BBF contact to their employee health department, a much higher underreporting rate than is generally noted for percutaneous injuries.¹² A similar survey conducted among personnel in an emergency department—a less predictable and more body fluid-intensive environment—revealed an average of 56.5 BBF contacts per person

per year. Only 4% reported their most recent BBF contact to employee health.¹³ Not all incidents, however, were considered at-risk exposures because the vast majority of BBF contacts in both the clinical labs and the emergency department were to intact skin only (95% and 88%, respectively). Of BBF contacts to non-intact skin or mucous membranes among emergency department personnel, 38% were reported to employee health. In the same study, 39% of emergency department personnel reported their most recent percutaneous injury to employee health. This comparison suggests that underreporting rates for BBF contacts to non-intact skin or mucous membranes may be similar to underreporting rates for percutaneous injuries.

Data originating from employee health records represent only a small fraction of actual BBF contacts occurring in clinical areas, and are more likely to include incidents that involve BBF contact with non-intact skin or mucous membranes. When interpreting these data, potential reporting biases must be kept in mind. Nevertheless, employee health records provide a valuable source of information for defining the characteristics of body fluid contact and the circumstances under which they occur. These data are also useful for monitoring compliance with current policies, and are especially important for identifying prevention opportunities and emerging exposure risks.

Findings in a Nine-Hospital Network

Nine hospitals which voluntarily participate in a data-sharing network contributed data for this report; they are located in six states in the eastern half of the U.S. All hospitals use the EPINet system for tracking both percutaneous injuries and blood and body fluid exposures in their institutions; they report their data quar-

terly to the University of Virginia. The cumulative total average daily census for the nine hospitals is 4,886 occupied beds. The present study includes descriptions of BBF exposures reported to the employee health department of each institution during a 24-month period from September 1992 through August 1994.

There were 1,150 BBF reports during that two-year interval, which accounted for 24% of all reports (including both sharp object injuries and BBF contacts). **The average annual reported BBF exposure rate was 12 BBF exposures per 100 hospital beds.** Healthcare workers were permitted to file exposure reports regardless of the seriousness of the incident. Therefore, the data include a mix of high-risk incidents (i.e., blood contact with non-intact skin), and lower-risk incidents (i.e., saliva contact with intact skin).

Job categories of workers reporting BBF contacts

Nurses reported 52% of all incidents, far more than workers in any other job category (**Figure 1**). This reflects the large number of nurses employed, as well as the frequent patient contact required of nurses. Attendants and physicians (mainly residents) reported 9% of incidents each. Other job categories, including laboratory technicians, respiratory therapists, phlebotomists, intravenous nurses, and nursing and medical students, together accounted for 16% of cases.

Of interest were personnel whose job classification was listed as "other". Thirteen percent of incidents fell into this category. Seven percent were healthcare workers to whom universal precautions clearly apply, such as paramedics, perfusionists, home health aides, housekeeping and laundry workers, and radiology students. However, the remaining cases (6.3%) in-

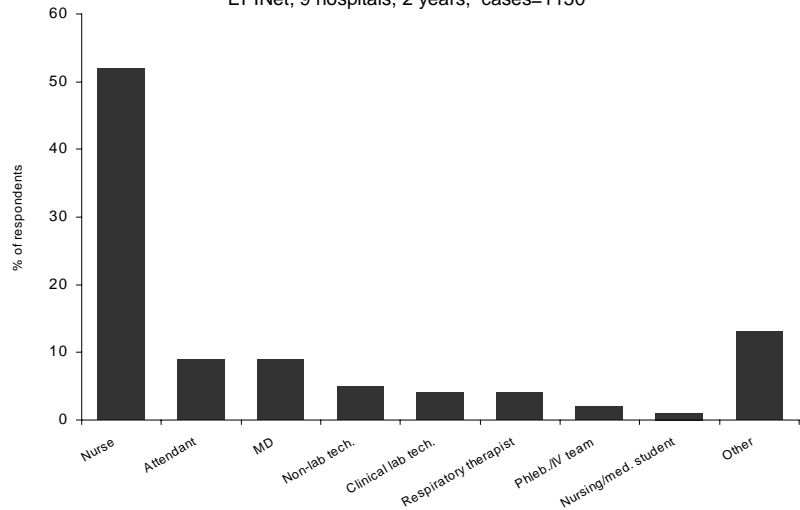
involved personnel who might not anticipate exposure to patients' body fluids, and are not likely to be prepared for body fluid contact. The most numerous in this category were physical or occupational therapists (20 cases), and security personnel (20 cases). There were 9 incidents reported by clerical personnel, and 8 incidents reported by mental health workers. One or two incidents each were reported by a wide variety of other personnel not providing direct patient care, including two audiologists, two athletic trainers, an electrician, a chaplain, a child care director, a food service worker, an information systems technician, a systems analyst, a psychologist, a teacher's aide, a teacher, a translator, and a volunteer. These incidents suggest that personnel who do not provide patient care are sometimes at risk of exposure to patients' BBF. Some categories of personnel, especially physical and occupational therapists and security guards, should receive routine in-service training in universal precautions, and be instructed to anticipate situations in which BBF contact may occur.

Location of BBF contacts

Forty-five percent of reported exposures occurred in patient rooms, a substantially higher percentage than in any other area of the hospital (Figure 2). This may reflect the high proportion of care that is provided in patient rooms. The operating room accounted for 11% of all reports. Although blood contact is relatively frequent in the blood-intensive environment of surgery, reporting an exposure to employee health is often considered inconvenient because personnel are not free to file a report until after the surgical procedure is complete. The remaining incidents were widely distributed among intensive and emergency care areas, diagnostic and treat-

Figure 1. Job Categories of Workers Reporting Blood and Body Fluid Exposures

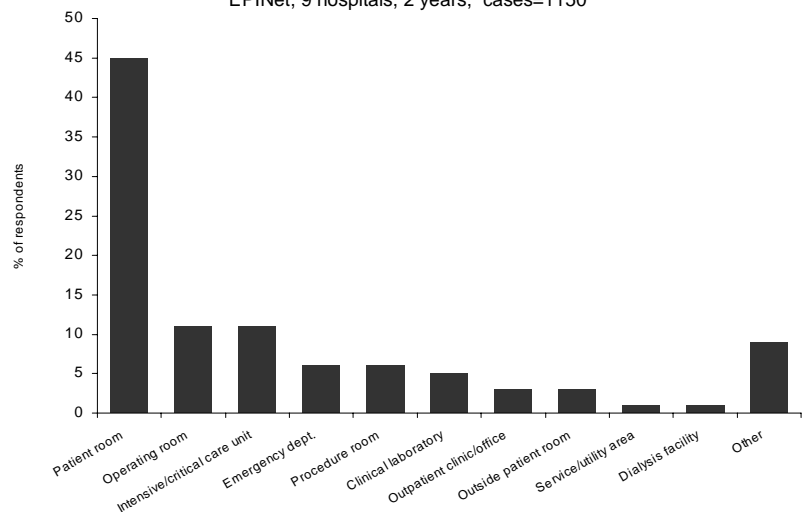
EPINet, 9 hospitals, 2 years, cases=1150



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Figure 2. Location of Blood and Body Fluid Contact

EPINet, 9 hospitals, 2 years, cases=1150



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ment procedure areas, and clinical laboratories where blood and body fluid specimens are continually handled.

Ninety-seven incidents (9%) were described as occurring in "other areas" of the hospital. Many of these incidents occurred in a non-treatment area, such as a cafeteria, bathroom, gym, elevator, pediatric activity room, pharmacy, equipment repair room, autopsy/pathology lab, or research lab. Twenty-four cases occurred outside of hospitals, including six incidents in emergency

transport helicopters. Other incidents occurred in patient homes (during home care), in parking lots, on the sidewalk, at hospital fair grounds, and at accident scenes. These cases illustrate the complex and varied interactions between hospital personnel and patients.

Body fluids involved in exposures

Fifty-nine percent of incidents involved blood or blood products (Figure 3 - next page). A wide variety of other fluids were identified

Table 1. Percent of Workers with Hand Exposures, Comparing Workers Wearing Gloves to Workers not Wearing Gloves at the Time of Exposure

	# in group	# w/ hand exposures	% w/ hand exposures
Did not wear gloves	420	166	40%
Wore gloves	723	63	9%

Table 2. Percent of Workers with Eye Exposures, Comparing Workers With and Without Eyewear at the Time of Exposure

	# in group	# w/ eye exposures	% w/ eye exposures
No eyewear	918	485	53%
Wore eyeglasses	173	76	44%
Wore goggles or faceshield	58	18	31%

Table 3. Percent of Workers with Torso or Arm Exposures, Comparing Workers With and Without Cover Garments at the Time of Exposure

	# in group	# w/ torso/arm exposures	% w/ torso/arm exposures
No cover garment	881	145	16%
Wore cloth lab coat	132	21	16%
Wore surgical/ protective gown	128	11	9%

Blood and Blody Fluid Exposures (cont.)

in the remaining 41% of cases. Urine was the second most frequent body fluid reported (8%), followed by vomit, saliva, and sputum (5% each). Gastric fluids, feces, peritoneal fluid, pleural fluid, and amniotic fluid together accounted for 7% of reports. Fifteen percent of reports did not fall into any of the provided categories and involved fluids such as abdominal irrigation fluids, bile, abscess and cyst drainage fluids, seminal fluid, endotracheal secretions, nasal secretions, vaginal secretions, wound discharge, and inoculated culture medium.

Items worn at the time of exposure

In 87% of all cases, BBF exposure was to an unprotected body area (**Figure 4**), indicating that in the majority of cases, an appropriate protective garment was not worn at the time of contact. In 10% of cases BBF exposure occurred at the gap be-

tween garments, often at the wrist between a glove and sleeve. In 8% of cases BBF soaked through clothing, and in 3% of cases BBF penetrated protective garments.

Gloves were worn at the time of BBF exposure in two-thirds of reported incidents, and were therefore the most commonly worn protective garment. However, hands were the second most frequent body area (after the face) exposed to blood and body fluids. **Table 1** shows the frequency of BBF contact with hands in workers who were wearing gloves at the time of exposure as compared to those who were not. The difference was statistically significant ($\chi^2=157$, $P<.0001$). These data demonstrate the protective benefit that gloves provide against BBF exposure to hands, but they also show that gloves do not always provide total protection for the hands.

Eyeglasses (non-protective) were worn by 15% of workers at the time of BBF exposure, but protective eyewear, including goggles or faceshields, was worn at the time of exposure in only 5% of cases. **Table 2** shows the relative frequency of BBF exposure to eyes in workers with different levels of eye

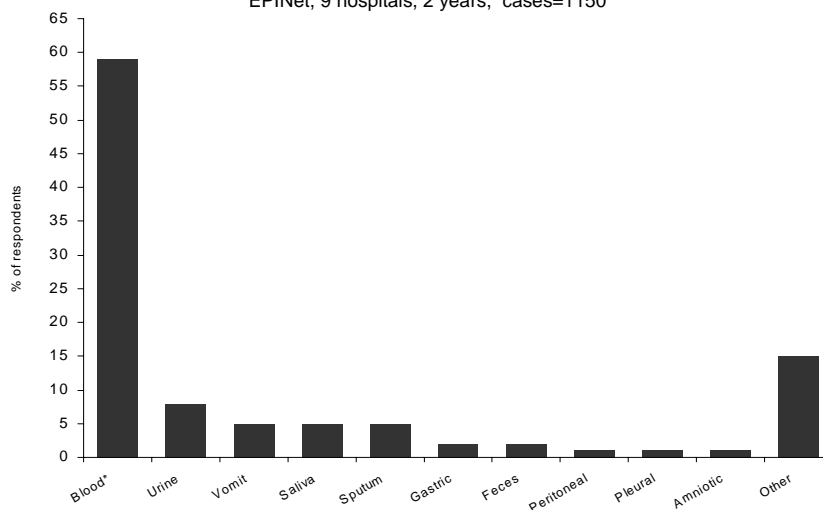
protection at the time of exposure. There was an apparent gradient showing a decreasing frequency in eye exposures with increasing levels of eye protection. The difference in frequency of eye exposures among those wearing goggles or faceshields versus those wearing no eyewear was statistically significant ($\chi^2=10.4$, $p=.001$). This comparison strongly supports the benefit of goggles and faceshields as protective eyewear. There was also a lower frequency of eye exposures among those wearing eyeglasses in comparison to those with no eyewear ($\chi^2=2.6$, $p=.03$). However, the difference in frequency of eye exposures among those wearing eyeglasses versus those wearing goggles or faceshields was somewhat less than that required for statistical significance ($\chi^2=3.0$, $p=.08$).

Despite their relative effectiveness, even goggles and faceshields do not provide absolute protection for the eyes, since 31% of healthcare workers wearing them at the time of exposure nevertheless sustained BBF contact to the eyes. This finding suggests the need to reevaluate the design of protective eyewear to more effectively shield the eyes from contact with body fluids.

The infrequent use of cover gar-

Figure 3. Body Fluids Involved in Exposures

EPINet, 9 hospitals, 2 years, cases=1150



*Includes blood products

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ments for the torso and arms was notable. Only 11% of healthcare workers were wearing protective or surgical gowns at the time of BBF contact; another 11% of workers wore cloth lab coats. **Table 3** shows that healthcare workers wearing a surgical-type fluid-resistant gown at the time of exposure sustained the fewest torso or arm exposures. The difference in frequency of torso or arm exposures among workers wearing surgical-type gowns and those wearing no cover garment was statistically significant ($\chi^2=5.3, p=.02$).

Of special note was the finding that cloth lab coats provided no protective benefit since the same proportion of torso or arm exposures were reported in those who wore cloth lab coats as in those who wore no protective garment. The design of traditional lab coats is mismatched to the bodily distribution of BBF exposures. Lab coats are front-opening, and are frequently worn open; even when buttoned, the V-neck design leaves the upper torso unprotected. The open cuffs also leave forearms and wrists—common areas of BBF exposure—unprotected. Traditional lab coats are made of loose-weave cotton or cotton-polyester blends, fabrics that are not designed to be resistant to liquid penetration. Cotton is actually an absorbent material that wicks liquid through fabric, potentially *increasing* the amount of body fluid coming into direct contact with a healthcare worker's skin.

Quantity of body fluid

Workers were asked to describe the quantity of blood or body fluid that came into contact with their skin or mucous membranes. In most cases (86%), the quantity was less than 5cc of fluid. In 10% of cases the reported BBF quantity was from 5cc to 50cc. In only 3% of cases was BBF quantity

Figure 4. Items Worn at the Time of Exposure

EPINet, 9 hospitals, 2 years, cases=1150

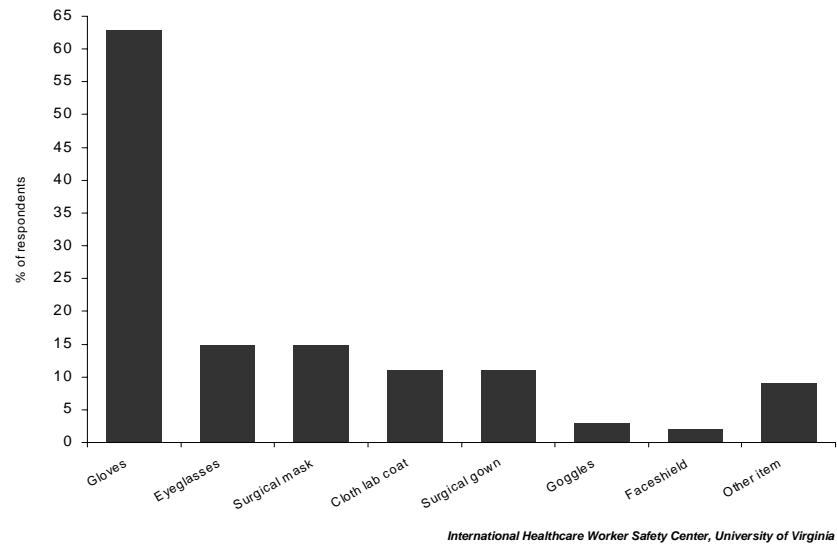
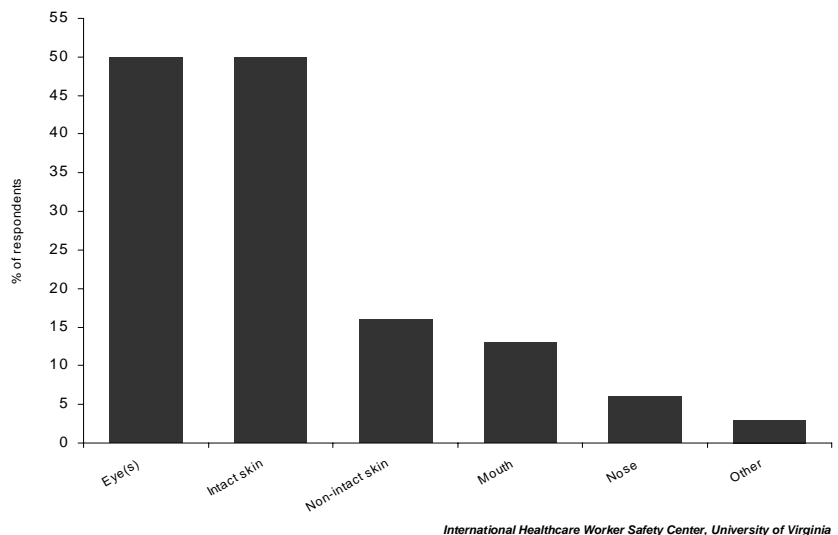


Figure 5. Type of Skin or Mucous Membrane Exposed

EPINet, 9 hospitals, 2 years, cases=1150



greater than 50cc. The quantity of BBF (especially blood) coming into contact with a healthcare worker, however, is not necessarily correlated with the risk of pathogen transmission. A small quantity of infected blood on non-intact skin or conjunctiva, for example, may have a higher risk of pathogen transmission than a larger quantity of blood on intact skin.

Type of skin or mucous membrane exposed

Healthcare workers indicated the type of skin or mucous membrane

exposed to BBF (**Figure 5**). In some cases more than one type per exposure was reported. BBF contact with intact skin occurred in 50% of reported incidents, and with non-intact skin in 16% of incidents. Mucosa of the mouth was involved in 13% of incidents and mucosa of the nose in 6% of incidents.

Of note was the high percentage of incidents (50%) which involved BBF exposures to the eyes. This finding suggests a bias in the type of incidents that healthcare workers report to employee health; an illustration of this potential bias

Blood and Body Fluid Exposures (cont.)

is shown in **Figure 6**. A survey was conducted of all healthcare workers in an emergency department of a university hospital (one of the nine participating EPINet hospitals).¹³ Seventy-eight respondents were asked to describe the most recent BBF exposure they recalled regardless of the severity of the exposure. The bodily distribution of BBF exposures they described in 68 exposure incidents is shown in Figure 6 (left side). For purposes of comparison, the BBF exposures (65) reported by emergency department personnel in the nine-hospital database was selected and the bodily distribution of BBF contacts was plotted (Figure 6, right side). While the head and face were involved in only 9% of the BBF incidents most recently recalled in the survey, 51% of incidents reported to employee health involved BBF contact with the head and face. One possible explanation for this bias is that exposures to the face are often alarming or repulsive, intruding upon the senses of sight, smell, and even taste. It is likely that shocking events, which would include body fluid exposures to the face, have a greater probability of being reported.

One mechanism of facial exposures was identified that has not been previously described in the literature. A review of 222 detailed descriptions of facial exposures from one of the nine EPINet hospitals showed that 14 different incidents (6%) involved patients spitting into the faces of healthcare workers. Most of these incidents occurred when restraining combative patients; protective faceshields, therefore, should be considered appropriate protective equipment in such situations.

Mechanism of exposure

In 49% of all cases reported to employee health, the BBF exposure was the result of direct patient contact (**Figure 7**). An unexpected find-

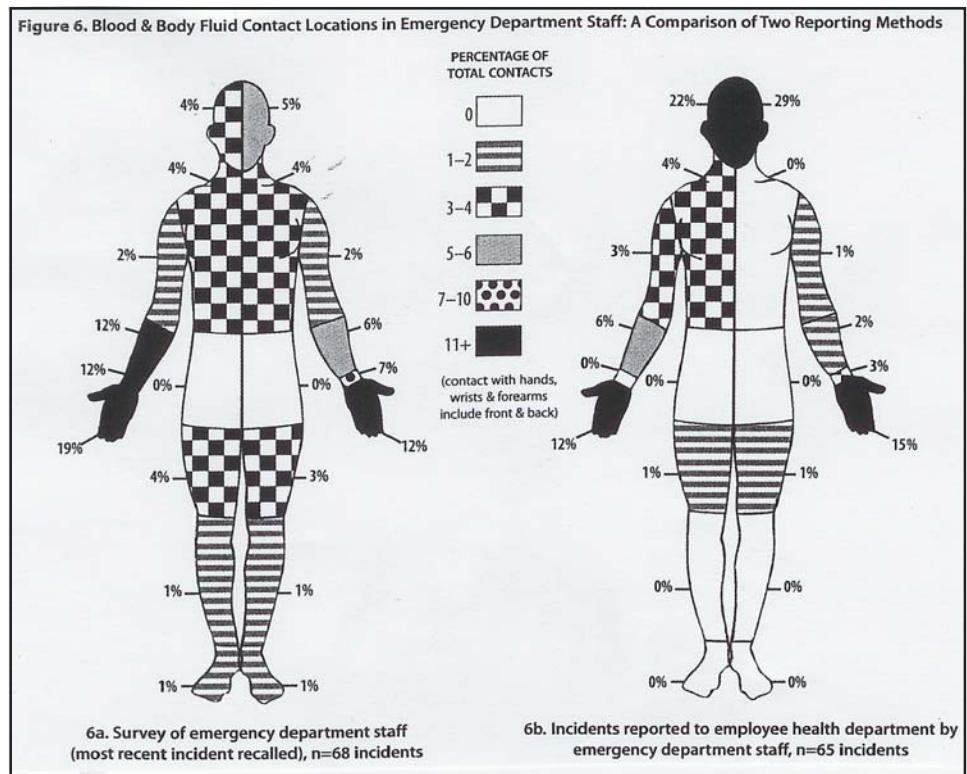
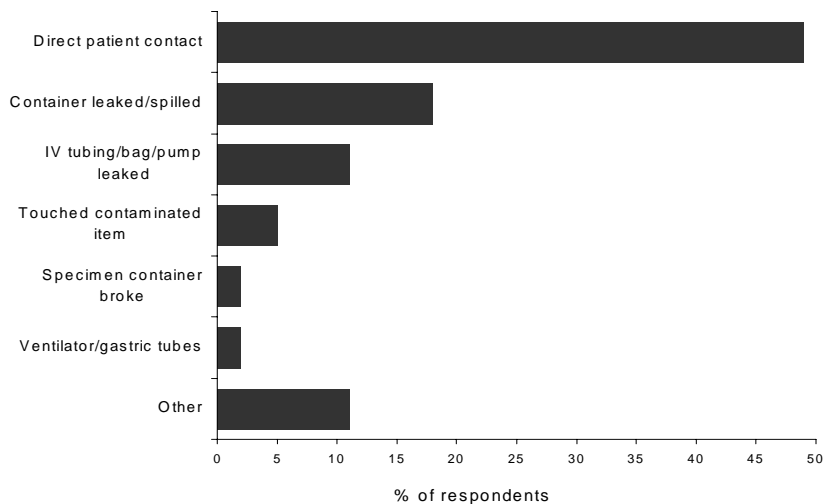


Figure 7. Mechanism of Blood and Body Fluid Exposures

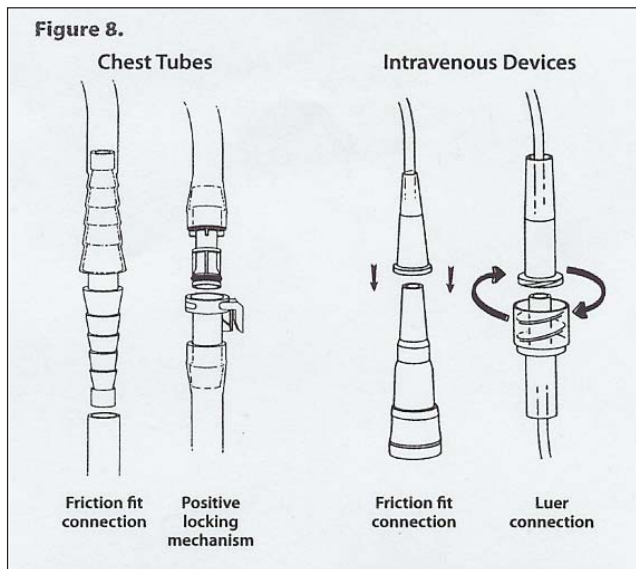
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ing, however, was that in most of the remaining cases (nearly 50%), a medical device or product served as a vehicle of exposure. In 18% of cases a specimen container or other type of body fluid container, such as a suction canister, leaked or spilled. In 2% of cases a specimen container such as a vacuum tube broke. In 5% of cases healthcare workers touched contaminated items such as soiled

drapes, laboratory equipment, or surgical instruments. Incidents in the "other" category involved splashes, squirts, or sprays with a variety of devices and items, including syringes, chemstrips, drainage bags, wound dressings, and wash basins; these incidents occurred while irrigating, washing, injecting, disconnecting equipment components, or emptying body fluid containers.



Eleven percent of cases involved tubes, bags or pumps mainly associated with intravenous, arterial, or central lines, equipment used to pump blood under pressure, and urinary drainage devices. Exposures occurred when vascular lines were removed, when junctions in the tubing circuits separated, when lines were flushed under pressure, and when stopcock ports were inadvertently turned to open position.

Two percent of exposures involved elastic tubing, such as is used for gastric and endotracheal tubes. Exposures often occurred during extubation when residual fluid in the rubbery tubing was flung in unpredictable directions. Other exposures occurred when disconnecting tubing segments; as the tubing was pulled apart, it snapped and sprayed droplets of fluid.

One product feature, the friction fit connection, was associated with several of the reported incidents. A friction fit is a connection in which two compatible parts are simply pushed together with enough force to secure the junction by friction. **Figure 8** shows a friction fit junction on chest tubes and on intravenous devices. Friction fit connections are found on many medical devices, and present a common hazard to device users as well as to patients. The se-

curity of the junction depends on whether there is a tight fit between the parts. Friction fit connections are prone to inadvertently giving way under certain circumstances, such as when pressure builds up inside the joined tubing segments or when tubing is jostled or manipulated.

During disassembly tubing segments joined by a friction fit must be pulled apart by force, which can result in a rebound motion of the hands and splattering of the fluid contents of the tubes. Alternatives to friction fit connections include the Luer lock, where the two parts are screwed together, and a positive lock, where the connecting parts snap together and are released by pressing a lever. Both of these locking mechanisms provide a junction that is more secure and reliable than a friction fit, and prevent rebound of the hands during disconnection.

Conclusions

Healthcare workers are still far from the ideal situation of being able to accurately anticipate and adequately prepare for exposure situations. At present, Universal Precautions recommendations are non-specific and discretionary, and provide little guidance for appropriate precautions under particular conditions. The future challenge will be to increase the efficacy of Universal Pre-

cautions by more accurately targeting precautions to specific risk situations. The data presented here do not address all the remaining questions on this issue, but they indicate several areas where improvements are needed, and provide the basis for the following recommendations:

- **Increase the availability and use of appropriate personal protective equipment.**

(a) Increase the use of gloves, because of the frequency of hand exposures and the documented transmission of bloodborne pathogens following hand contact with infected blood.

(b) Increase the use of faceshields and goggles, because of the frequency of exposures to the face and the documented transmission of bloodborne pathogens following contact with the mucosa of eyes, nose, and mouth. Face protection should be used when there is the potential for splashing or spraying of body fluids, when restraining combative patients, when in proximity to equipment that contains or pumps body fluid under pressure, and when in proximity to intubation or extubation procedures.

(c) The use of loose-weave cotton or cotton-blend cloth lab coats in areas where contact with patient body fluids is possible should be discontinued (**Figure 9**).

Blood and Bloody Fluid Exposures (cont.)

(d) The use of cover garments made of liquid-resistant material and providing a continuous barrier in the front (i.e., not front-opening or v-neck) should be encouraged. Cover garments should have long sleeves and snug cuffs that overlap with gloves in order to provide adequate protection for the arms.

• Identify and improve medical devices and products that act as vehicles of blood and body fluid exposures in health care settings.

(a) Specimen and other body fluid containers should have closures that provide a tight, positive-locking seal, and should be resistant to breakage.

(b) Equipment that pumps blood under pressure should have positive-locking junctions between connecting components, and should have pressure sensors linked to an alarm or pump cut-off, or an equivalent safeguard to prevent high-pressure ruptures of tubing.

(c) Reporting systems for healthcare worker exposures to blood and body fluids should explicitly identify products involved in exposures, in order to assist with future product selection, more effectively communicate with product manufacturers, and improve understanding of product design features that best protect healthcare workers.

• Reduce to a minimum the amount of patient blood and body fluids handled by healthcare workers. The quantities of blood and urine collected for laboratory tests, for example, often exceed the amounts required for testing.

• Expand the standardized surveillance of healthcare worker exposures to blood and body flu-

ids, in order to further define the circumstances and mechanisms of exposures, determine the frequency and risk of occupational infection transmission under different exposure conditions, and document the efficacy of specific prevention interventions. □

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The nine hospitals contributing data to this report were:

Florida Hospital (Orlando, FL); **Martha Jefferson Hospital** (Charlottesville, VA); **North Broward Hospital** (Ft. Lauderdale, FL); **St. Joseph Hospital** (Omaha, NE); **St. Vincent Hospital** (Erie, PA); **St. Vincent Hospital** (Indianapolis, IN); **Shands Hospital** (Gainesville, FL); **University Hospitals of Cleveland** (Cleveland, OH); **University of Virginia Hospitals** (Charlottesville, VA).