Preventing Sharps Injuries in the Operating Room

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In the past, percutaneous injuries and mucocutaneous exposures were considered to be an accepted occupational hazard for the surgeon. Although the potential for injury, exposure, and contraction of blood-borne disease was well known, there were no attempts to reduce risk of such events. When the human immunodeficiency virus was described in 1981 we began to pay greater attention to health care worker safety in the operating room. In 1983 the Centers for Disease Control and Prevention (CDC) recommended "caution" when handling body fluids from patients suspected of having AIDS. Initially HIV and AIDS were considered to be rare and confined to particular groups at high risk. This inaccurate notion changed rapidly as the disease reached epidemic proportions, and by 1987 the CDC recommended "Universal Precautions,"[1] which state that blood and body fluid precautions be used with all patients. It was at this time that the CDC made their first recommendations for use of appropriate barrier protection and against resheathing contaminated needles. In 1991 The Occupational Safety and Health Administration required use of Universal Precautions with the enactment of the Bloodborne Pathogen Standard.[2] This standard has been revised and updated several times, most recently in 2001.[3] Although discovery of AIDS and HIV was the driving force behind development of Universal Precautions, it is widely appreciated that many serious illnesses can be contracted through contact with contaminated blood and body fluids. Unfortunately the published literature indicates that surgeons demonstrate poor compliance with Universal Precautions.[4] Perhaps even more unfortunate is the failure of Universal Precautions and the Bloodborne Pathogen Standard to fully address the needs of the high-risk operating room environment. Injuries to surgeons and scrub personnel continue to occur.

The operating room environment is unique because of the carefully orchestrated team approach to surgical care. Surgeons, scrub nurses, and operating room technicians work very closely together handling the same instruments in a confined space. Consequently, surgeons and scrub personnel are injured in similar ways with similar equipment and not infrequently by each other. A team approach to safety in the operating room is critical if injury rates are to be reduced.

No competing interests declared.

Received March 25, 2004; Accepted April 15, 2004.

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Injury patterns in the operating room

To develop strategies for reduction of contaminated percutaneous injuries to members of the operating team, it is important to examine the patterns of injuries in the operating room (OR).

The skin or mucous membranes of OR personnel may have contact with patient blood in as many as 50% of operations (reported range 6.4% to 50%).[5,6] Cuts or needle sticks may occur in as many as 15% of operations (reported range 1.7% to 15%).[5,6] Risk increases with longer, more invasive, higher blood loss procedures.[5-9] Surgeons and first assistants are at highest risk for injury.[10] They suffer as many as 59.1% of injuries in the OR.[10] Scrub nurses and scrub technicians sustain the second highest frequency of injuries in the OR (19.1%), followed by anesthesiologists (6.2%) and circulating nurses (6%).[10] The remainder of injuries are sustained by various other groups, including medical students. Although risk of injury and exposure is different for various personnel, risk in the OR is never zero (Table 1).

Suture needles are the most frequent source of injury and are involved in as many as 77% of injuries.[11] Interestingly, although the largest number of injuries occurs with curved suture needles, straight suture needle use has a considerably higher rate of injuries per number of needles used.[12]

Many suture needle injuries occur during suturing of muscle and fascia (during wound closure), particularly while using the fingers to manipulate needles and tissue.[10,11] Up to 16% of injuries occur while passing sharp instruments hand-to-hand (range 6% to 16%).[6,10,11,13] Most injuries are self-inflicted but a notable number, perhaps as many as 24%, are inflicted by a coworker.[11] The most common body part injured is the nondomi-

ISSN 1072-7515/04/$30.00
doi:10.1016/j.jamcollsurg.2004.04.018

Abbreviations and Acronyms
CDC = Centers for Disease Control and Prevention
HCV = hepatitis C virus
HFT = hands-free technique
OR = operating room
PEP = postexposure prophylaxis

nant hand.[10,11,13] One-third of devices that cause injuries come in contact with the patient after the injury to the health care worker, so there is also risk of disease transmission from surgeon to patient.[9,11] Fortunately, relatively few (about 0.5%) injuries to surgeons are "high risk," which is defined as injuries from hollow bore vascular access needles.[10] Unfortunately, surgeons fail to report as many as 70% of their injuries and do not participate in recommended postexposure strategies.[4]

OR-specific engineering controls and work practices

Double gloving

Most, if not all, surgeons have encountered blood on their hands or fingers at the conclusion of a procedure without awareness of suffering an injury or the occurrence of a breech of the glove barrier by any other method (glove puncture, tear, or failure). It is obvious to most practitioners that glove barrier failure is common. In fact, the US Food and Drug Administration permits 2.5% of new unused sterile gloves to fail standardized quality control testing.[14]

The practice of wearing two pairs of gloves offers a high degree of protection from this common event. Perforation rates as high as 61% for thoracic surgeons and 40% for scrub nurses have been reported.[15] Initial intraoperative glove perforation occurs an average of 40 minutes[15,16] into a procedure and is not detected by the surgeon in as many as 83% of cases.[17] On the other hand, although puncture of the outer glove is common, corresponding punctures of both the inner and outer gloves are rare. Double gloving reduces risk of exposure to patient blood by as much as 87% when the outer glove is punctured.[18-22] Volume of blood on a solid suture needle is reduced as much as 95% when passing through two glove layers, thereby reducing viral load in the event of a contaminated percutaneous injury.[23] Because of the occult nature of intraoperative glove failures, double gloving may prevent prolonged occult hand contact with patient blood. Using electronic detection of glove barrier failure, one study estimates that surgeons wearing a single pair of gloves would have contact with patient blood for 42 hours for every 100 hours of operating time.[19] There are several reports in the literature that indicate better barrier protection might protect the patient from exposure to blood-borne pathogens from members of the operating team.[24-28]

Despite a large body of data supporting double gloving, a major drawback of this intervention is the lack of surgeons' acceptance. There is a widespread perception that double gloving reduces hand sensitivity and dexterity, but this issue has not been widely examined. One study compared knot-tying ability and moving two-point discrimination (under nonsurgical conditions) between single- and double-gloved surgeons and found no difference.[29] A more recent study demonstrated decreased hand sensibility when evaluating pressure sensitivity and moving two-point discrimination but static two-point discrimination was not impaired.[30] Subjective evaluations comparing surgeon comfort, sensitivity, and dexterity with single and double gloves indicated subjective impairment of all parameters,[31] and surgeons who are involved in clinical studies with double gloving remove the outer glove before the end of operation in about 26% of cases.[32] Surgeons who always or usually double glove report that a period of 1 to 120 days (2 days in most cases) is required to fully adapt to its use and surgeons who routinely double glove report decreased hand sensation much less frequently than those who do not.[4] It appears that a period of adaptation and "retraining" is required for practitioners to be comfortable with the technique.

In summary, there is a large body of literature that supports recommendation of routine use of double

Table 1. Distribution of Needlestick Exposures among Operating Room Personnel

Job category	Total needlestick exposures (%)
Surgeons	59.1
Scrub nurses	19.1
Anesthesiologists	6.2
Circulating nurses	6.0
Medical students	3.1
Attendants	0.8
Other	5.7

Data from: Jagger J, Bentley M, Tereskerz P. A study of patterns and prevention of blood exposures in OR personnel. AORN J 67:979–981, 983–974, 986–977 passim.

gloves during operations after an appropriate period of adaptation.

The neutral zone

The neutral zone has been defined as "a previously agreed on location on the field where sharps are placed from which the surgeon or scrub can retrieve them. So hand-to-hand passing of sharps is limited."[33] Use of the neutral zone to transfer sharps (otherwise known as the hands-free technique [HFT]) has been proposed as a method to reduce health care workers' exposure to blood during operations (Occupational Safety and Health Administration standards interpretation and compliance letters 2-5-93) and is recommended in the literature of two professional organizations, the American College of Surgeons and the Association of Perioperative Registered Nurses.

> The American College of Surgeons:
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> Avoid accidents and self-wounding with sharp instruments by following these measures: Do not recap needles, use needleless systems when possible, use cautery and stapling devices when possible, and *pass sharp instruments in metal trays during operative procedures*.[34]
>
> The Association of Perioperative Registered Nurses:
>
> Surgical team members should use hands-free techniques whenever possible and practical instead of passing needles and other sharp items hand to hand. . . . Changes in surgical practice to minimize manual manipulation of sharps (ie, no touch techniques) can have a major impact on these injuries. . . . Creation of a neutral zone (ie, where instruments are put down and picked up, rather than passed hand to hand) may decrease injuries from sharp instruments.[35]

There are very limited data about the efficacy of the HFT in reducing sharps injuries in the operating room. Wright and colleagues[13] reviewed 249 glove tears and 70 sharp injuries and reported that only 6% of injuries occurred during instrument passage. These data suggest that even if HFT reduced sharps injuries during instrument passages between scrub nurse and surgeon, this benefit would only avoid a small percentage of total sharps injuries during operations. Benefits of HFT have been assessed by one randomized prospective study,[36] which demonstrated no reduction of incidence of glove perforations with use of HFT compared with control during 156 cesarean sections. In contrast, a recent study of 3,765 operations[33] reported that when HFT was judged by the scrub nurse to have been used $\geq$ 75% of the time during the operation, there was a 59% reduction in "incidents" (defined as sharps injuries, cutaneous blood exposure, or glove tears) in operations with a blood loss of $\geq$ 100 mL.

In summary, use of HFT is recommended by several leading professional organizations and by many hospitals as a safety measure to reduce sharps injuries during operations. Despite this recommendation, its use is not widespread (42% in the Stringer study), and its effectiveness in reducing sharps injuries is questionable. More research is required to validate the present recommendations that HFT be widely used.

Table 2. Distribution of Needlestick Exposures by Type of Needle Used

Type of needle	Injuries per 1,000 needles used
Blunt suture	0
Straight suture	14.2
Curved suture	1.9

Data from: Evaluation of blunt suture needles in preventing percutaneous injuries among health-care workers during gynecologic surgical procedures—New York City, March 1993–June 1994. MMWR Morb Mortal Wkly Rep 1997;46:25–29.

Blunt suture needles

Straight suture needles pose the greatest risk-per-needle of sharps injury to the surgeon, yet as many as 59% of suture needle injuries occur during suturing of muscle and fascia with curved suture needles[10] (Table 2).

To decrease this risk of needle-stick injury to the surgeon, use of blunt suture needles has been proposed and studied. Four prospective randomized trials have demonstrated notable benefits from use of blunt suture needles. Wright and colleagues[37] reported that use of blunt needles during hip arthroplasty considerably decreased glove perforations. Mingoli and colleagues[38] reported that blunt needles reduce sharp injuries sevenfold in emergency abdominal procedures. Rice[39] reported no glove perforations or needle sticks (versus 16% and 6% rates, respectively, with sharp needles) using blunt suture needles in 68 total hip replacements. Hartley and colleagues[40] reported a substantial decrease in glove puncture rates (38% versus 6.5%) with use of blunt suture needles.

Several case series also support the safety and usability of blunt suture needles. Dauleh and colleagues[41] re-

ported blunt suture needles eliminated needle-stick injury to surgeons' hands and were technically satisfactory in abdominal wall closure, hernia repair, and even colonic anastomosis. In a 1994 report, the CDC indicated that use of blunt suture needles reduced percutaneous injuries from 1.9:1,000 for curved suture needles to 0:1,000 for blunt needles.[12] Monz and colleagues[42] reported ease of use and no percutaneous injuries with use of blunt needles in 50 cases of abdominal wound closure.

In conclusion, there is compelling published evidence to support routine use of blunt suture needles to minimize sharps injuries during closure of fascia and muscle. With more experience, these needles may be found to be safe and useful in the suture other types of tissues.

Recommendation for management of occupational exposure to HIV, hepatitis B virus, and hepatitis C virus

The CDC Updated US Public Health Service Guideline for the Management of Occupational Exposures to hepatitis B virus, hepatitis C virus (HCV), and HIV and Recommendations for Postexposure Prophylaxis 2001 are as follows:

Recommendations of hepatitis B virus postexposure management include initiation of the hepatitis B vaccine series to any susceptible, unvaccinated person who sustains an occupational blood or body fluid exposure. Postexposure prophylaxis (PEP) with hepatitis B immune globulin or hepatitis B vaccine series should be considered for occupational exposures after the evaluation of the hepatitis B surface antigen status of the source and the vaccination and vaccine-response status of the exposed person.

Immune globulin and antiviral agents (eg, interferon with or without ribavirin) are not recommended for PEP of HCV. For HCV postexposure management, the HCV status of the source and the exposed person should be determined, and for a health care practitioner exposed to an HCV-positive source, followup hepatitis delta virus testing should be performed to determine if infection develops.

Information about primary HIV infection indicates that systemic infection does not occur immediately, leaving a brief window of opportunity during which postexposure antiretroviral intervention might modify or prevent viral replication. PEP should be initiated as soon as possible. The interval within which PEP should be initiated for optimal efficacy is not known. Animal studies have demonstrated the importance of starting PEP soon after an exposure. Postexposure prophylaxis should be initiated within 1 to 2 hours after exposure. Institutional polices should take into account the clinical demands placed on the practitioner during operation. Consideration should be given to making the initial doses of prophylactic medications available within the operating room suite in the event the clinical situation does not permit the surgeon to seek immediate care.

Recommendations for HIV PEP include a basic 4-week regimen of two drugs (zidovudine and lamivudine; lamivudine and stavudine; or dinaosine and stavudine) for most HIV exposures and an expanded regimen that includes the addition of a third drug for HIV exposures that pose an increased risk for transmission. When the source person's virus is known or suspected to be resistant to one or more of the drugs considered for the PEP regimen, the selection of drugs to which the source person's virus is unlikely to be resistant is recommended.

Summary

Sharps injuries remain a considerable health risk for surgeons and nurses in the operating room. Education is of paramount importance in making health care workers aware of this important health care issue and a number of educational web sites and resources are available to assist in this endeavor, including:

1. International Sharps Injury Prevention Society—Education, information and product knowledge to help reduce the number of sharps injuries. http://www.isips.org
2. International Healthcare Worker Safety Center EPInet—Exposure Prevention Information Network. http://www.med.virginia.edu/medcntr/centers/epinet/
3. Joint Commission for Accreditation of Healthcare Organizations Sentinel Alert Preventing Needle stick and Sharps Injuries Issue 22, August 2001. http://www.jcaho.org/about+us/news+letters/sentinel+event+alert/sea_22.htm
4. Davis MS. Advanced Precautions for Today's O.R. 2001 Edition. The Operating Room Professional's Handbook for the Prevention of Sharps Injuries and Bloodborne Pathogen Exposures. Sweinbinder Publications, LLC, Atlanta, GA.

The published literature strongly supports routine use of double gloving and blunt suture needles for fascial closure as recommended techniques for reducing sharps injuries in the operating room. There is insufficient ev-

idence at present to recommend routine use of HFT for the purpose of reducing sharps injuries in the operating room.

Appendix

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