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Sharps Injuries: the Risks and Relevance to Plastic Surgeons

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Abstract

Surgeons are at risk for injury in the operating room daily. Despite the ubiquity of occupational hazards, injuries remain prevalent and expensive. Although occupational hazards can include musculoskeletal conditions, psychosocial stress, radiation exposure, and the risk of communicable diseases, sharps injuries remain the most common among surgeons in practice and the most frequent route of transmission of blood-borne pathogens. Therefore, increased attention to the health, economical, personal and social implications of these injuries is essential for appropriate management and future prevention.

Keywords

sharps injuries; occupational health; blood-borne infections

Introduction

In the United States, 4 million healthcare workers are at risk for infection with blood-borne pathogens, and nearly 400,000 sharps injuries occur annually.^{1,2} Surgeons comprise approximately 25% of these workers, and are at the highest risk in the operating room of acquiring a sharps injury. Although the majority of these injuries result only in temporary pain and discomfort, they may also lead to lifelong disability and illness. Despite healthcare policies designed to protect healthcare workers, injuries remain common, and nearly all surgeons report sustaining a sharps injury in their career.^{3,4} Nonetheless, many clinicians fail to report injuries due to misconceptions regarding risk, prophylaxis and treatment.⁵ This review will highlight the scope of sharps injuries among surgeons, potential strategies for prevention, and the evolution of healthcare policy designed to protect clinicians.

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Risk of communicable diseases

In 1984, the first case of human immunodeficiency virus (HIV) transmitted to a healthcare worker through a needlestick injury was reported, sparking heightened awareness of the potential risk of blood borne pathogens associated with these injuries.⁶ Today, over 20 blood borne pathogens have been identified as transmissible through sharps injuries, with HIV, hepatitis B virus (HBV) and hepatitis C virus (HCV) posing the highest risk of morbidity and mortality.⁷

The probability of seroconversion depends on the type of exposure, the volume and concentration of the inoculum, and the associated health and immunogenicity of the healthcare worker. Infection with HIV has been long-feared among healthcare workers due to its progression to autoimmune deficiency syndrome (AIDS) and the lack of a known cure. However, prospective studies reveal that the risk of seroconversion following exposure to HIV from a needlestick injury is approximately 0.3%, and even lower when the exposure is confined to mucous membrane or cutaneous exposures. (Table 1) Hepatitis B virus (HBV) is also transmitted through percutaneous or mucosal exposure to contaminated blood. However, the risk of seroconversion following needlestick injuries is much higher compared with HIV, estimated to be between 23–62%.^{7,9} Furthermore, HBV can remain infective in dried blood for several days, and bodily fluids with high titers of hepatitis B antigen have the greatest risk for infectivity.¹⁰ Finally, hepatitis C virus (HCV) transmission occurs through percutaneous or mucosal exposure, and infectivity depends on the viral load in the inoculum. Although the overall risk of seroconversion following needlestick injury is low, around 1.8%, approximately 50 to 150 new cases are reported in healthcare workers each year and the majority of these infections will progress to chronic infection.¹⁰ Although HIV, HBV, and HCV remain the most dreaded risks of needlestick injury, other blood-borne pathogens exist, including syphilis, malaria, and herpes. The prevalence of infection related to these organisms is uncommon clinically, but the variety of potential pathogens underscores the importance of safe practices and standards in all healthcare settings.

Economic burden

Given the large number of healthcare workers at risk and the pervasiveness of sharp instruments used in the operating room, the costs associated with sharps injuries to a single institution are enormous. Costs related to sharps injuries encompass reporting procedures, laboratory testing, follow-up, and post-exposure prophylaxis, and the cost due to a single injury ranges from \$71–\$4,838, largely depending on the potential exposure from the source patient.¹¹ For example, the average cost of a needle stick exposure from a patient without any known blood borne illness is \$376. However, for injuries sustained from an HIV infected patient, the cost rises exorbitantly to approximately \$2456. Because the reported incidence of needlestick injuries is estimated to be approximately 800 injuries per 1000 healthcare workers annually, these costs quickly compound for an individual institution, and result in national expenditures of over \$65 million annually.^{12,13}

Psychological Burden

Beyond the financial costs of these injuries, many surgeons experience significant anxiety, depression and fear following a sharps injury.¹⁴ For example, a study of recently exposed nurses and physicians reveals that anxiety, depression, insomnia, anorexia, and career regret are common, and persist long after the injury and clearance from the possibility of infection. Physicians and nurses frequently report feeling angry regarding their exposure, and resentment regarding the risks of working in healthcare for up to a year following the injury.^{15,16} In addition to the psychological stress these injuries pose for the individual, they also cause significant stress among the family members of the injured individual. Individuals commonly report feeling shame and fear when disclosing the injury to their partners, and the possibility of exposure to their family members.¹³

Risk factors for sharps injuries

Who is injured?

Of all healthcare providers, surgeons are at greatest risk of incurring a sharps injury. Approximately 25% of all needlestick injuries occur in the operating room, and 59% occur among surgeons.^{1,17–19} On average, surgeons report a rate of approximately 11 injuries over a 3-year time period.²⁰ Unfortunately, medical students and surgery residents are the most vulnerable. Among medical students, 59% have suffered a needlestick injury by the time of their graduation, with a median number of 2 injuries per student.²¹ In a recent survey of surgical residents, 83% reported that they had sustained a needlestick injury, with an average number of 7 injuries during residency. Over half of surgery residents reported they had suffered a high-risk exposure from injuries, and trainees report feeling rushed, inexperienced, and fatigued as contributing factors to their injuries.²²

How do injuries occur?

Self-inflicted sharps injuries due to syringe needles are most common (36%) followed by suture needles (18.5%).^{19,23} Approximately 60% occur while suturing muscle and fascia, and 41% while suturing skin and other tissue.²⁴ Most injuries occur using curved suture needles, as these are more commonly used during procedures, but straight needles are associated with a higher overall risk of injury.¹⁷ Scalpel injuries are less common, and typically occur during the passage of instruments (65%) rather than while using the instruments (29%).²⁴

Although the causes of needlestick injuries vary widely, multiple studies demonstrate that both fatigue and inexperience play critical roles. For example, in a survey of physicians in training, 23% of injuries were attributed to long work hours and sleep deprivation (Table 2).²⁵ Among nurses, shifts greater than 13 hours and those scheduled during weekends or evenings were correlated with a significantly higher risk of sustaining an injury.²⁶ Similar findings have been observed among physician trainees. For example, 50% of injuries suffered by residents occur after working more than 8 hours, and 24% occur after working more than 12 hours. Injuries are also more likely to occur during evening or night shifts.²⁷ However, physicians in training appear to be more vulnerable to the effects of sleep deprivation and fatigue compared with other healthcare professionals such as nurses and

phlebotomy technologists. For example, trainees were nearly 3 times as likely to incur a injury compared with other healthcare workers, attributable to longer working hours and fewer hours of sleep prior to the injury.²⁵

Management of Injuries

Post-exposure prophylaxis

Standardized guidelines for prophylaxis following exposure to HIV, Hepatitis B and C viruses exist, and the timing of prophylaxis is essential. (Table 1) Unfortunately, many providers lack sufficient knowledge regarding the correct timing and dosage of post-exposure prophylaxis, which can lead to a delay in adequate therapy. For clinicians who are exposed to HIV, post-exposure prophylaxis depends on the infection status of the source patient and type of injury, and may require treatment directed by an infectious disease specialist. However, for any exposure from a patient who is potentially HIV positive, prophylaxis should be initiated within hours of exposure.⁹ Clinicians who have received a full hepatitis B vaccine series but who have not received post-vaccination testing should receive a vaccine booster dose if they have suffered a needlestick injury from a hepatitis B antigen seropositive patient. For clinicians who have not completed the vaccine series, both hepatitis B immunoglobulin and the vaccine should be given as soon as possible, within 24 hours of exposure. For hepatitis C exposures, individuals should undergo immediate testing for anti-HCV antibodies, and confirmatory immunoassays for HCV-RNA. Repeat testing at 6 weeks, 3 months and 6 months is recommended in known HCV exposure cases, in order to account for the lag between infection and seroconversion.²⁹ Treatment for seroconversion usually consists of 24 to 48 weeks of interferon therapy with or without ribavirin.¹⁰

Reporting

Despite the high prevalence of sharps injuries, most remain unreported.³⁰ For example, 70% of surgeons in practice report that they never or rarely report injuries.²⁰ Surgeons most commonly cite a lack of time and misconceptions regarding the injury risk as the reasons for failing to report an injury. Less than half of surgeons correctly describe the risk of seroconversion following pathogen exposure, and report only slight or moderate concern regarding the risk of seroconversion.²⁰ Among trainees, nearly 50% of injuries are not reported, including high-risk injuries with known exposure to HIV, hepatitis B or C (16%).^{21,22,31} Surgical residents and medical students report lack of time and a perceived lack of utility from reporting as the primary reasons they failed to report injuries.^{21,22,31}

Although the overall risk of seroconversion from sharps injuries is low, the implications for missed injuries are profound. Timely injury reporting facilitates medical evaluation including testing and prophylactic treatment when necessary. Additionally, appropriate reporting allows for counseling and education regarding the risk of exposure, as well as preventing secondary transmission to patients and other individuals.^{32,33} Finally, failing to document an injury resulting in seroconversion can lead to difficulty with future insurance coverage and worker's compensation.² From a societal perspective, underestimating injuries may result in missed opportunities for healthcare policy interventions and misappropriation of resources for these injuries. Several strategies have been proposed to improve reporting of

injuries. For example, establishment of 24-hour phone access “hotlines” can facilitate initial care for injured clinicians.³⁴ In the operating room, incorporating potential injuries as a part of the postoperative “debriefing” routine can improve reporting.^{35,36} Finally, incorporating on-line, confidential reporting systems available to all clinicians may ease the burden and stigma associated with these injuries.³⁷

Strategies for Prevention

Fortunately, the majority of sharps injuries are preventable. (Table 3) Engineered safety devices such as protective covers or retraction devices can prevent up to 56% of sharps injuries, and adherence to standardized sharps-handling guidelines can prevent up to 52% of injuries.^{36,38–40} These prevention strategies are enhanced by involving clinicians in the choice for safety devices, educating providers regarding their use, and increasing awareness regarding the need for routine safety precautions and devices.

Perhaps the clearest strategy for prevention is the elimination of sharp instruments whenever possible. Examples of sharps alternatives include electrocautery, staplers, adhesives, and blunt tipped needles. For example, a recent study of general surgery procedures examined the use of sharpless techniques in several commonly performed procedures, including laparotomies, lymph node and breast biopsies, and wound debridements. The majority (87%) of procedures could be completed without the use of sharp instruments, with the highest rates of conversion to sharps use among laparotomy procedures.⁴¹ In 2005, the American College of Surgeons endorsed the adoption of blunt-tipped suture needles for all procedures.⁴² Since their development, blunt suture needles have been most commonly used to suture muscle and fascia during abdominal wall closure, where nearly 60% of needlestick injuries occur, and can decrease the incidence of needlestick injuries by up to 70%.^{24,43} However, blunt tipped needles require greater force for suture placement and are often rated by surgeons as cumbersome. Additionally, electrocautery can be used to create skin incisions rather than scalpel blades. For example, for laparotomy or neck lymphadenectomy incisions, the use of cautery is correlated with faster operative times, lower blood loss, and reduced pain with similar rates of wound infection and aesthetic appearance compared with scalpel use.^{44,47}

The use of sharpless instruments has also been examined among reconstructive surgical procedures. For example, the piezoelectric scalpel is a feasible alternative for creating osteotomies in hand and craniofacial surgical procedures, and minimizes thermal injury to the adjacent soft tissues and neurovascular structures.^{48–50} The PEAK PlasmaBlade is an electrosurgical scalpel alternative that relies on brief pulses of high radiofrequency energy to create energy with an insulated electrode. Its advantages also include minimal thermal injury to surrounding tissues, and it is associated with similar inflammation and scarring compared with a conventional scalpel. A final example is the use of stapling devices to approximate the dermis.⁵¹ The INSORB stapler allows surgeons to place absorbable staples to reapproximate the dermis, and avoids the use of suture needles.⁵² Although adopting novel techniques is expensive and requires additional learning, these efforts are important in order to introduce sharps alternative that help surgeons to operate in a safer, more efficient manner.

Despite these innovations, it is nearly impossible to completely eliminate sharps from the operating room, and other preventive strategies exist. For example, creating a neutral zone, or a predetermined, dedicated space to pass sharp instruments, rather than hand-to-hand passing, can reduce sharps injuries by up to 60%.^{1,17,53} However, these techniques are used by surgeons and operating room nurses only 40% of the time, despite their potential to improve safety for individuals involved in the procedure.⁵⁴ Protection of scalpel blade through retractable blades and specialized covers can also reduce up to 70% of injuries. However, little data exists regarding the integration and cost of safety devices in the operating room.¹⁹ In addition to instrument-modification strategies, double-gloving can reduce the risk of infection following inoculation due to sharps injuries by minimizing the volume of blood transferred to the skin. For example, the volume of inoculum through a single layer of latex is approximately 0.064 microL, compared with 0.011 microL through 2 layers, which is a nearly 6-fold decrease.^{55–58} Furthermore, double-gloving can be used to alert the surgeon to glove failure.⁵⁹ Surgeons are often unaware of glove perforations, particularly minute perforations, which can be detected with double-gloving. For example, 77% of perforations can be detected with indicator under gloves, compared with only 21% in standard double-gloving, and even less with single glove techniques.⁶⁰ Finally, in addition to reducing the risk of communicable diseases, double-gloving may also reduce surgical site infections, and the risk of infection increases from 2.9% with intact gloves to 12.7% with perforated gloves.⁶¹

Compliance

Although preventive strategies exist, their success ultimately relies on clinician compliance. Following the passage of the Needlestick Safety and Prevention Act in 2000, the rate of injuries in the operating room did not decline, but slightly increased from 6.3 to 6.8 injuries per 100 patients.¹ Although the reasons for this are multifactorial, introducing preventive strategies and sharps alternatives into practice in the operating room is challenging. Surgeons report that safety scalpels do not have the weight and feel of traditional scalpels, and safety sheaths can have mechanical problems preventing their use.⁶² Other reasons that physicians cite lack of compliance include unavailable or ineffective safety devices, and the need to perform urgent procedures for critically ill patients.^{63–64} In addition to instrument barriers, many surgeons are also reluctant to adopt the practice of double gloving. Surgeons are more likely to use maximal protection for major invasive procedures or high-risk cases but less frequently during minor procedures.⁶⁵ Surgeons commonly cite a lack of dexterity and blunted sensation as the most common reasons for avoiding double gloving.⁶⁶ However, studies of surgeons in practice have revealed no significant difference in dexterity or manual 2-point discrimination with the use of double gloves.⁶⁷ Despite an adaptation period of up to 120 days, the majority of surgeons are able to adjust to the practice of double gloving without noticeable change in their performance.^{68,69}

From an institutional perspective, the financial costs associated with education, training, and adoption of newer alternatives can also prevent the implementation of safety measures.^{70,71} Safety-engineered devices are more expensive than their traditional counterparts, and typically require training to ensure correct use.⁷² Despite these increased initial costs, the

implementation of these devices has been shown to be cost-effective, and successfully reduce the rates of sharps injuries within an institution.^{72,76}

Development of Healthcare Policy

With the emergence of the HIV/AIDS epidemic in the early 1980s, the potential risk of blood borne pathogens to clinicians became evident, and the concept of Universal Precautions was introduced. In 1987, the Universal Precautions Act was enacted as a series of standardized control measures in which every patient should be considered to be a potential source for blood borne infections, given the potential 6 to 9 month lag time between infection and a positive seroconversion. In 1991, the Occupational Safety and Health Administration expanded these regulations to require employers to provide a written plan for handling sharps and preventing sharps injuries. In subsequent years, these guidelines have been modified to include the use of technologies that make sharp instruments safer for handling, provide vaccines for healthcare workers, and ensure that healthcare workers have access to post exposure prophylaxis. In 2000, the Needlestick Safety and Prevention Act mandated that safety-engineered devices are available to all healthcare workers who were at risk of blood-borne illnesses due to needlestick injuries. Employees are required to review sharps-safety precautions annually with employees, and collect detailed information regarding each injury that occurs in a healthcare worker. Encouragingly, after the Needlestick Safety and Prevention Act, the overall incidence of needlestick injuries in all clinical settings declined by 38%.^{1,77}

Conclusions

Although most surgeons are aware of the potential risks of occupational exposure, they are often not informed of current safety practices, advances in technology, and recent guidelines designed to protect clinicians from the infectious risk of sharps injuries. Targeting educational initiatives during medical school and training may improve knowledge among surgeons of the safest ways to practice in the operating room, and ensuring compliance among all surgeons in practice can reduce the economic and psychosocial burden of these highly prevalent injuries.

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Table 1

Potential Blood Borne Pathogens and Post-Exposure Prophylaxis

Blood-borne pathogen	Risk of seroconversion	Post-exposure prophylaxis
Hepatitis B Virus	30%	Hepatitis B Immunoglobulin and vaccination booster depending on the vaccination status of the clinician; ideal timing of therapy initiated within 24 hours of injury
Hepatitis C Virus	10%	Initial testing to evaluate for the presence of chronic infection, followed by reevaluation in 4–6 months
Human Immunodeficiency Virus	0.3%	Antiretroviral drugs with two or more drug regimen depending on the infection status of the source

Other pathogens: blastomycosis, brucellosis, cryptococcosis, diphtheria, gonorrhea, herpes, malaria, mycobacteriosis, mycoplasma caviae, Rocky Mountain spotted fever, sporotrichosis, staphylococcus, streptococcus, syphilis, toxoplasmosis, tuberculosis

Table 2

Predisposing Factors for Sharps Injuries in the Operating Room

Type	Example
Physician factors	Fatigue Inexperience Prolonged work hours Noncompliance with safety precautions Lack of knowledge regarding safety precautions
Instrument factors	Lack of safety devices Failure of safety devices Type of instrument Type of needle
Environment factors	Emergent cases Patient instability Procedure duration Evening/night procedures

Table 3

Preventive Strategies for Occupational Hazards in Operating Room

Strategy	Example
Sharps alternatives	Blunt suture needles Staples, adhesive strips and tissue adhesives Electronic/Harmonic/Laser scalpel, electrocautery
Safety devices	Retractable needle and scalpel blades
Neutral zone	Predetermined, dedicated space to pass sharps during surgery
Double gloving	Two gloves Indicator inner glove + outer glove
Protective facial wear	Goggles with appropriate fit with vent and anti-fog coated Face shields protecting crown and chin Disposable plastic glasses Surgical mask