American Journal of Infection Control 40 (2012) 354-8

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Disposal of sharps medical waste in the United States: Impact of recommendations and regulations, 1987-2007

Jane Perry MA [a,*], Janine Jagger MPH, PhD [a], Ginger Parker MBA [a], Elayne Kornblatt Phillips RN, MPH, PhD [a], Ahmed Gomaa MD [b]

[a] International Healthcare Worker Safety Center, Division of Infectious Diseases, Department of Medicine, University of Virginia Health System, Charlottesville, VA
[b] Surveillance Branch, Division of Surveillance, Hazard Evaluations, and Field Studies, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Cincinnati, OH

Key Words:
Needlestick
Bloodborne pathogen exposure
Health care worker safety
Percutaneous injury

Background: To gauge the impact of regulatory-driven improvements in sharps disposal practices in the United States over the last 2 decades, we analyzed percutaneous injury (PI) data from a national surveillance network from 2 periods, 1993-1994 and 2006-2007, to see whether changes in disposal-related injury patterns could be detected.

Methods: Data were derived from the EPINet Sharps Injury Surveillance Research Group, established in 1993 and coordinated by the International Healthcare Worker Safety Center at the University of Virginia. For the period 1993-1994, 69 hospitals contributed data; the combined average daily census for the 2 years was 24,495, and the total number of PIs reported was 7,854. For the period 2006-2007, 33 hospitals contributed data; the combined average daily census was 6,800, and the total number of PIs reported was 1901.

Results: In 1992-1993, 36.8% of PIs reported were related to disposal of sharp devices. In 2006-2007, this proportion was 19.3%, a 53% decline.

Conclusions: This comparison provides evidence that implementation of point-of-use, puncture-resistant sharps disposal containers, combined with large-scale use of safety-engineered sharp devices, has resulted in a marked decline in sharps disposal–related injury rates in the United States. The protocol for removing and replacing full sharps disposal containers remains a critical part of disposal safety.

For as long as the risk of needlesticks and percutaneous injuries (PIs) among health care workers (HCWs) has been of major concern, the safe disposal of used needles and sharp devices has been recognized as an important factor in minimizing the risk of occupational injury. Effective management of sharps disposal and the sharps waste stream affects not only clinical HCWs and others who work in hospitals, such as housekeeping and maintenance staff, but also waste handlers and laundry personnel who work outside hospitals. In the United States, recommendations for the safe disposal of contaminated sharp devices were among the earliest needlestick prevention measures promoted by the Centers for Disease Control and Prevention (CDC) (Table 1). These recommendations were first laid out in 1983 and then consolidated in 1987 and 1988 as part of Universal Precautions to prevent transmission of HIV, hepatitis B, and other bloodborne pathogens.[1-3] The CDC has specified that sharp medical devices should be discarded in puncture-resistant disposal containers placed near the point of use. These guidelines became an enforceable national workplace standard in December 1991, when the Occupational Safety and Health Administration (OSHA) enacted a bloodborne pathogens standard (BPS), which established minimum design and performance elements for sharps disposal containers (SDCs), including the requirement that they be "easily accessible to personnel and located as close as is feasible to the immediate area where sharps are used or can be reasonably anticipated to be found."[4] In 1993, the Food and Drug Administration issued guidance for premarket notification [510(k)] submissions for sharps containers.[5] In 1998, the National Institute for Occupational Safety and Health issued

* Address correspondence to Jane Perry, MA, IHWSC, PO Box 800764, University of Virginia, Charlottesville, VA 22908-0764.
E-mail address: janeperry@virginia.edu (J. Perry).

This article was written as part of a larger research project on sharps disposal and sharps disposal containers in the United States and other countries, produced under contract to the National Institute for Occupational Safety and Health (Requisition 211-2009-M-29912).

Conflict of interest: None to report.

doi:10.1016/j.ajic.2011.04.328

Table 1
US federal government policies and guidelines relevant to SDCs, 1987-2000

1987	CDC issues Recommendations for Prevention of Human Immunodeficiency Virus Transmission in Health Care Settings[2]: "After [sharp items] are used…[they] should be placed in puncture-resistant containers for disposal; the puncture-resistant containers should be located as close as practical to the use area."
1988	CDC issues Universal Precautions for Prevention of Transmission of Human Immunodeficiency Virus, Hepatitis B Virus, and other Bloodborne Pathogens in Health Care Settings[3]: "After [sharp items] are used…[they] should be placed in puncture-resistant containers for disposal; the puncture-resistant containers should be located as close as practical to the use area."
1991	OSHA issues BPS[4]: Includes instructions on safe disposal of contaminated sharps to minimize risk of bloodborne disease transmission: • "Immediately or as soon as possible after use, contaminated reusable sharps shall be placed in appropriate containers…. These containers shall be (a) puncture resistant; (b) labeled or color-coded; (c) leakproof on the sides and bottom." [1910.1030(d)(2)(viii)] • "During use, containers for contaminated sharps shall be: (i) Easily accessible to personnel and located as close as is feasible to the immediate area where sharps are used or can be reasonably anticipated to be found (eg, laundries);…(iii) Replaced routinely and not be allowed to be overfill." [1910.1030(d)(4)(iii)(A)(2)]
1993	Food and Drug Administration issues Guidance on the Content and Format of Premarket Notification [510(k)] Submission for Sharps Containers[5]: Reiterates sharps disposal container design criteria from the 1991 OSHA BPS.
1998	NIOSH issues Selecting, Evaluating and Using Sharps Disposal Containers[6]: Includes criteria for function, accessibility, visibility and accommodation of sharps containers.
2000	US Congress passes Needlestick Safety and Prevention Act (HR 5178)[7]: The law "sets forth in greater detail [the] requirement that employers identify, evaluate, and make use of effective safer medical devices." The dramatic increase in use of safety-engineered sharp medical devices in the United States that follows the law's passage helps reduce sharps injury risk associated with disposal.

a guidance document titled "Selecting, Evaluating and Using Sharps Disposal Containers" that included detailed criteria for function, accessibility, visibility, and accommodation.[6]

In the United States, it is now standard to find SDCs located in each patient room in clinical units, rather than at central locations such as nurses' stations. Flimsy disposal containers have been removed from the market, and over the last 2 decades manufacturers have improved the overall design of SDCs with such features as increased puncture resistance, 1-way openings, and mechanisms to prevent overfilling. In addition to these improvements, safety-engineered sharp medical devices, which were mandated by the Needlestick Safety and Prevention Act in 2000,[7] have significantly reduced sharps injury rates.[8] However, it is well documented that safety features on sharp devices are not activated uniformly,[9-11] and thus the secure containment of contaminated medical sharps in appropriately designed SDCs remains an important part of sharps safety policy, even where laws mandate safety-engineered sharps.

METHODS

To gauge the impact of regulatory-driven improvements in sharps disposal in the United States over the last 2 decades, needlestick and sharps injury data from a national network from 2 time periods, 1993-1994 and 2006-2007, were compared to see what changes in disposal-related injury patterns could be detected. Data were provided by the EPINet Needlestick Injury and Blood and Body Fluid Exposure Surveillance Research Group coordinated by the International Healthcare Worker Safety Center at the University of Virginia Health System. EPINet is a standardized sharps injury surveillance tool (including forms and software for entering and analyzing exposure data) developed by the Center in 1992 and adopted by many hospitals in the United States, as well as by health care facilities in some 80 countries worldwide.[12] The center has collected data since 1993 from a subset of US hospitals that participate voluntarily in an EPINet research network. Most of the hospitals are part of a South Carolina statewide network coordinated by Palmetto Hospital Trust Services; others are located in the Pacific Northwest, Florida, Indiana, Nebraska, Ohio, Pennsylvania, and Virginia. (A complete list of hospitals is available at http://www.healthsystem.virginia.edu/internet/epinet/EPINetHospitalList.cfm.) The EPINet sharps injury research database contains more than 34,000 incident reports. Although the EPINet network has been ongoing since 1993, some hospitals have dropped out of the network, and others have joined since it was established.

For the 1993-1994 period, 69 hospitals (19 teaching and 50 nonteaching) contributed data on PIs that were reported to their employee or occupational health department. The hospitals had a combined average daily census of 24,495 for the period, and reported a total of 7,854 PIs. For the 2006-2007 period, 33 hospitals (9 teaching and 24 nonteaching) contributed data; the combined average daily census was 6,800, and a total of 1,901 PIs were reported.

RESULTS

Injuries occurring in patient rooms and outside patient rooms (eg, in hallways) most likely reflect the adequacy of point-of-use disposal systems. Figure 1 compares the locations of injuries in 1993-1994 and 2006-2007, calculating the rate of injury per 100 occupied beds for each location. For 1993-1994, the PI rate was 11.05 per 100 occupied beds for patient rooms and 0.75 for outside patient rooms. For 2006-2007, these respective rates were 6.67 and 0.23, representing declines of 40% for patient rooms and 69% for outside patient rooms. The data for patient rooms show a clear drop in disposal-related injuries at the point of use. This is likely due to the combined effects of improved design and placement of SDCs and widespread implementation of safety-engineered devices.

The rate of injury for utility/service areas, where injuries are most likely to be caused by improper disposal, were 0.74 and 0.20 for the 2 periods—a decline of 73%.

Figure 2 compares the points during the use/disposal cycle at which PIs occurred in the 2 study periods. Note the dramatic reversal in the proportion of injuries occurring during device use versus those occurring after use/during disposal/after disposal in the 2006-2007 data. Again, this likely reflects the widespread implementation of safety-engineered devices after 2000, which have the potential (assuming activation of the protective mechanism) to prevent injuries occurring after use of the device, including during the disposal process, but are less relevant to injuries occurring during use. As a result, injuries occurring during use now constitute the largest proportion of injuries. The greatest proportional declines were seen in categories related to disposal, including (1) other after use and before disposal (eg, in transit to trash, cleaning, sorting); (2) device left on or near an SDC; (3) while

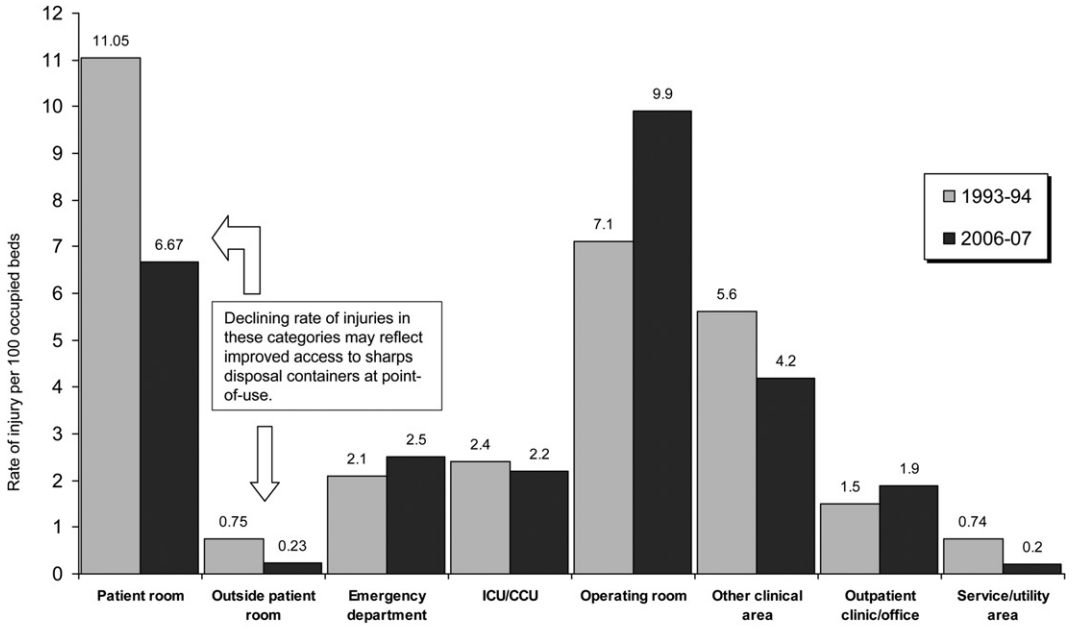

Fig 1. Hospital location of sharps injuries: Comparison of US EPINet data, 1993-1994 and 2006-2007.

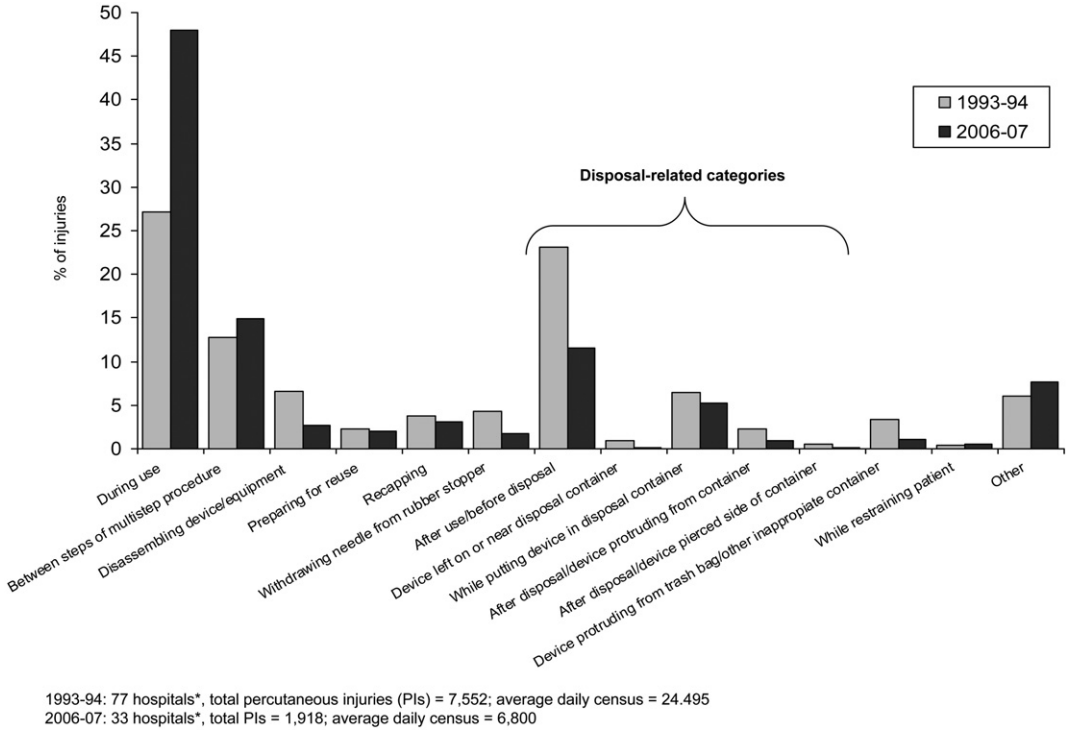

Fig 2. When PIs occurred: Comparison of US EPINet data, 1993-1994 and 2006-2007.

placing a device into an SDC; (4) after disposal, stuck by a device protruding from the SDC opening (usually attributable to overfilling of the SDC, highlighting the importance of effective hospital policies on regular and frequent waste removal); (5) device piercing the side of the SDC; and (6) device protruding from a trash bag or other inappropriate waste container, as often occurs when a needle pierces a plastic bag while trash is being removed from patient rooms or other clinical areas. The injuries in categories 2 and 6 are caused by inappropriate disposal practices on the part of the original user of the sharp device.

Injuries occurring after use but before disposal represent disposal failures. Lack of an SDC at the point of use can increase the likelihood of contaminated needles and sharps being left on beds, tables, or floors, or of injuries occurring as used devices are carried to an SDC or during room cleaning. It should be noted that the current version of EPINet has an added category, "device left on

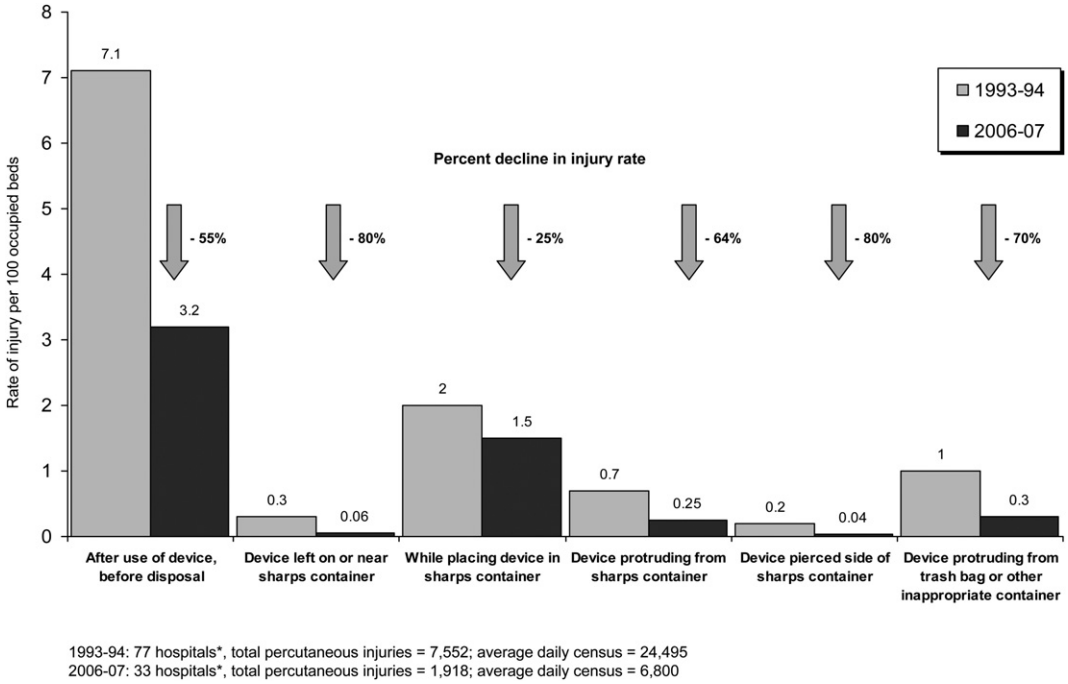

Fig 3. When disposal-related sharps injuries occurred: Comparison of US EPINet data, 1993-1994 and 2006-2007.

floor, table, bed or other inappropriate place," which did not exist in the 1993-1994 version; incidents in this category in the 2006-2007 data were folded into the "after use/before disposal" category.

In 1992-1993, a total of 36.8% of PIs fell into these disposal-related categories, with the largest proportion (23.1%) in the "after use/before disposal" category. In contrast, in 2006-2007, 19.3% of PIs were related to disposal, with 11.6% of injuries in the "after use/before disposal" category.

Figure 3 shows injury rates per 100 occupied beds for each of the disposal-related categories. Comparing combined PI rates for all disposal-related categories for the 2 periods revealed a 53% decline between 1993-1994 and 2006-2007. Declines in injury rates were seen in every disposal-related category, with the greatest decreases in the "device left on or near SCD" and "device pierced side of SDC" categories (80% decline each) and the lowest in the categories "while putting device in SDC" (25% decline) and "after use/before disposal" (55% decline).

Injuries from devices piercing the side of SDCs were the least frequent disposal-related injuries in the 1993-1994 data and were even rarer in 2006-2007, with an injury rate of 0.04 per 100 occupied beds ($n = 3$). The American Society for Testing and Materials industry standard for SDC puncture resistance, issued in 2001,[13] has produced uniformity in this important design criterion for all commercial SDCs units sold in the United States. These data provide evidence in support of the current standard.

Recapping injuries were not included among disposal-related injuries in this analysis, but nevertheless are indirectly related to disposal and bear some discussion. HCWs are more likely to recap a contaminated sharp device if the disposal site is located at a distance from the immediate point of use. Comparison of injury rates for recapping show that the rate decreased from 1.2 to 0.9 per 100 occupied beds between 1993-1994 and 2006-2007—a 25% decline. In the United States, recommendations against recapping were among the earliest precautions issued for the prevention of occupational exposures to bloodborne pathogens; the CDC discouraged recapping in recommendations published in 1983[1] and 1987,[2] and OSHA specifically prohibited it in its 1991 BPS.[4] Perhaps more significantly, the OSHA BPS also mandated placement of sharps disposal containers at the point of use. A 1988 study of sharps injuries in one hospital found that 33% of the injuries were due to recapping;[14] in contrast, in EPINet data from 1993-1994, 3.8% of injuries were due to recapping. It is likely, then, that the major shift in institutional policy and practices regarding recapping occurred between 1986 and 1992, and was closely tied to the movement to place SDCs in patient rooms during that period; this trend also was likely accelerated by the 1991 OSHA BPS.

Another way to gauge the impact of improvement in sharps disposal systems is by comparing the rates of injuries sustained by housekeepers during the 2 time periods, given that injuries to this occupational group are related almost exclusively to flaws or failures in device disposal. PI rates for housekeepers for the 2 time periods were 1.37 and 0.54 per 100 occupied beds, respectively—a 61% decline.

PIs sustained by housekeepers—a category that includes laundry workers in these data—bear special mention. These injuries create a disproportionate burden on the workers and their institutions; in most cases the source patient cannot be identified, so pathogen transmission must be considered a possibility in many cases where there is no actual risk. The psychological consequences and the lifestyle changes recommended until infection can be ruled out can have major impacts on the lives of affected individuals.[15] Furthermore, injuries to these service workers may be seriously underrepresented. In the United States, housekeeping and laundry services are often contracted out by hospitals to external agencies,[16] and injuries to these contract workers might not be reflected in hospital sharps injury data. Continued efforts—including training programs and monitoring of sharps disposal policies and practices within health care facilities, as well as further improvements in the safety engineering of disposal containers and medical devices—are needed to better protect those who are at the receiving end of the medical device waste stream.

An analysis of disposal-related injuries by occupational group conducted in 1995, using EPINet data from 1993-1994, indicated that disposal-related injuries in nurses occurred primarily after use

and before disposal and during the act of disposal, whereas injuries to housekeepers usually occurred after disposal.[17] This suggests that the work practices of one group affect the injury risk in other groups; for example, failure of housekeepers to promptly remove full SDCs increases the risk to other personnel, including nurses, of injury from devices protruding from SDC openings. Conversely, disposal of sharp devices in patient wastebaskets by nurses or other clinical personnel increases housekeepers' risk of injury from needles piercing plastic trash bags.

CONCLUSION

Our data support the notion that the widespread implementation of point-of-use, puncture-resistant SDCs, in combination with a significant increase in the use of safety-engineered sharp devices (which protect both users and waste handlers), have resulted in a large-scale decline in injury rates associated with sharps disposal in the United States. The combination of actively enforced regulations (OSHA BPS[4]), guidance documents and industry standards specifying SDC criteria (1998 NIOSH recommendations;[6] 2001 American Society for Testing and Materials standard[13]), and clinical practice recommendations (1987 CDC Universal Precautions[2,3]) have helped cut disposal-related injury rates by 53% since 1993.

The protocol for removing and replacing full SDCs remains a critical part of SDC safety. Sharp devices can protrude from the openings of most containers, and even SDCs that automatically shut when full can pose a hazard if an alternative SDC is not available for an HCW with a contaminated sharp. The monitoring, removal, and replacement of containers is an administrative responsibility that must be clearly delineated and enforced within each institution. Even given continued improvements in SDCs and sharp medical devices design, a strong institutional policy will remain a core component of sharps disposal safety.

We thank the hospitals that have participated in and contributed data to the US EPINet Sharps Injury Surveillance Research Group, coordinated by the International Healthcare Worker Safety Center at the University of Virginia, over the last 2 decades. A list of participating hospitals for the 1993-1994 and 2006-2007 periods is available at http://www.healthsystem.virginia.edu/internet/epinet/EPINetHospitalList.cfm.

References

1. Williams WW. Guideline for infection control in hospital personnel. Infect Control 1983;4(Suppl 4):326-49.
2. Centers for Disease Control and Prevention. Recommendations for prevention of HIV transmission in health-care settings. MMWR Morb Mortal Wkly Rep 1987;36(Suppl 2):1S-18S.
3. Centers for Disease Control and Prevention. Update: universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus, and other bloodborne pathogens in health-care settings. MMWR Morb Mortal Wkly Rep 1988;37:377-8.
4. Occupational Safety and Health Administration. Occupational exposure to bloodborne pathogens—OSHA: final rule. Fed Register 1991;56:64004-182.
5. Food and Drug Administration. Guidance on the content and format of premarket notification [510(k)] submission for sharps containers, October 1993. Available from: http://www.fda.gov/downloads/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/UCM081297.pdf. Accessed January 31, 2011.
6. National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. Selecting, evaluating, and using sharps disposal containers. Department of Health and Human Services, National Institute for Occupational Safety and Health Publication 97−111, January 1998. Available from: http://www.cdc.gov/niosh/sharps1.html. Accessed January 31, 2011.
7. Needlestick Safety and Prevention Act of 2000, Public Law 106-430, 114 Statute 1901, November 6, 2000.
8. Jagger J, Perry J, Gomaa A, Phillips EK. The impact of US policies to protect healthcare workers from bloodborne pathogens: the critical role of safety-engineered devices. J Infect Public Health 2008;1:62-71.
9. Alvarado-Ramy F, Beltrami EM, Short LJ, Srivastava PU, Henry K, Mendelson M, et al. A comprehensive approach to percutaneous injury prevention during phlebotomy: results of a multicenter study, 1993-1995. Infect Control Hosp Epidemiol 2003;24:97-104.
10. Chen LBY, Bailey E, Kogan G, Finkelstein LE, Mendelson MH. Prevention of needlestick injuries in healthcare workers: 27-month experience with a resheathable safety winged steel needle using CDC NaSH Database [abstract]. Infect Control Hosp Epidemiol 2000;21:108.
11. Mendelson MH, Chen LBY, Finkelstein LE, Bailey E, Kogan G. Evaluation of a safety IV catheter (Insyte Autoguard, Becton Dickinson) using the Centers for Disease Control and Prevention (CDC) National Surveillance System for Hospital Healthcare Workers database [abstract]. Infect Control Hosp Epidemiol 2000;21:111.
12. Jagger J, Cohen M, Blackwell B. EPINet: a tool for surveillance and prevention of blood exposures in health care settings. In: Charney W, editor. Essentials of modern hospital safety. Boca Raton [FL]: CRC Press; 1995. p. 223-39.
13. ASTM International. Standard specification for puncture resistance of materials used in containers for discarded medical needles and other sharps. ASTM designation F2132−01. September 2001. Available from: http://www.astm.org/Standards/F2132.htm. Accessed June 1, 2011.
14. Jagger J, Hunt EH, Brand-Elnaggar J, Pearson RD. Rates of needlestick injury caused by various devices in a university hospital. N Engl J Med 1988;319:284-8.
15. Worthington MG, Ross JJ, Bergeron EK. Posttraumatic stress disorder after occupational HIV exposure: two cases and a literature review. Infect Control Hosp Epidemiol 2006;27:215-7.
16. National Public Radio. Dirty work: washing hospital laundry. Air date: September 2, 2002. Transcript available from: http://www.npr.org/programs/morning/features/2002/aug/dirtywork/laundry/index.html. Accessed January 31, 2011.
17. Jagger J, Bentley MB. Disposal-related sharp-object injuries. In: Jagger J, Perry J, editors. Preventing occupational exposures to bloodborne pathogens: articles from Advances in Exposure Prevention, 1994-2003. Charlottesville [VA]: International Healthcare Worker Safety Center, University of Virginia; 2004. p. 37-41.