



**PROCEEDINGS OF THE  
NATIONAL SHARPS INJURY PREVENTION MEETING**

SEPTEMBER 12, 2005  
CROWNE PLAZA ATLANTA AIRPORT HOTEL  
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Disclaimer: The findings and conclusions in this report have not been formally disseminated by the Centers for Disease Control and Prevention and should not be construed to represent any agency determination or policy.

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## Contents

List of Participants	ii
Executive Summary	v
Introduction: Toward Eliminating Sharps Injuries	1
Presentation Summaries	
Sharps Injuries in U.S. Hospital-Based Healthcare Personnel	3
Current History of the Occupational Safety and Health Administration's (OSHA's) Bloodborne Pathogen Standard	8
Sharps Injury Surveillance and Prevention Legislation in Massachusetts: Why Was It Successful?	11
Safer Needle Devices: What Is Available, What Is Needed?	14
Efficacy of Sharps Injury Prevention Devices	16
Influence of Organizational Factors on Sharps Injuries in Healthcare Personnel	18
Needlestick Injuries in Medical Residents: A Model for Prevention	19
Veterans Health Administration (VHA) and Bloodborne Pathogens Root-Cause Analysis to Examine Sharps Injuries and Near-Misses	22
Next Steps	24
References	26



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## Executive Summary

Occupational exposures to bloodborne pathogens as a result of injuries from needles and other sharp objects are an important public health concern. It is estimated that hospital-based healthcare personnel sustain 385,000 sharps injuries annually in the United States. Numerous risk factors and prevention strategies have been identified and implemented in order to reduce sharps injuries in healthcare settings. One notable prevention milestone was the passage of the Needlestick Safety and Prevention Act in 2001. In response to this Act, OSHA revised the Bloodborne Pathogens Standard, 29 CFR 1910.1030. The revised standard clarifies the need for employers to select safer needle devices and to involve frontline employees in identifying and choosing these devices. The updated Standard also requires employers to maintain a log of injuries from contaminated sharps.

The U.S. Centers for Disease Control and Prevention (CDC) convened a National Sharps Injury Prevention Meeting on September 12, 2005, in Atlanta, Georgia. The purpose of this meeting was to review sharps injury prevention efforts (particularly since the passage of the Needlestick Safety and Prevention Act in 2001); identify gaps in prevention efforts; and assist CDC in creating a national action plan for eliminating sharps injuries in the United States. Nearly forty representatives from federal and state agencies, healthcare professional associations, healthcare facilities, medical device manufacturers, and other key stakeholder groups participated in the meeting. The meeting was funded by the CDC Foundation through an unrestricted education grant from the Safety Institute, Premier Inc.

A series of presentations from representatives of CDC, U.S. Occupational Safety and Health Administration (OSHA); Massachusetts Department of Public Health; Safety Institute, Premier Inc.; and U.S. Department of Veterans Affairs (VA) provided detailed information about the epidemiology of sharps injuries, relevant surveillance systems, enforcement and regulatory efforts to prevent sharps injuries, education and training programs, and enhancements of sharps injury prevention program processes. In addition, each presenter was invited to comment on the presence of gaps in knowledge or prevention efforts as they pertained to the subject area of the presenter. These comments were used as a springboard for discussions about recognized knowledge and prevention gaps as well as efforts that are needed to address these gaps in order to eliminate sharps injuries.

The principal outcome of the meeting was the formation of four working groups to address surveillance issues, human and organizational factors related to sharps injuries, education and training topics, and device development, implementation, and diffusion issues. Working groups were charged with identifying priority areas and action steps specific to their topic area. These topic-specific action plans will be combined into a National Sharps Injury Prevention Action Plan to be disseminated at a later date.



## **Introduction: Toward eliminating sharps injuries**

Healthcare personnel are at increased risk of occupational exposure to bloodborne pathogens from needlesticks and injuries from other sharp objects. Hospital-based U.S. healthcare personnel sustain approximately 385,000 percutaneous injuries from needles and other sharps devices each year - equivalent to more than 1,000 injuries a day. This figure does not include sharps injuries that may have occurred in non-hospital settings, such as in private medical and dental offices, in home healthcare settings, and long-term care facilities.

Direct and indirect costs associated with sharps injuries can be substantial. The estimated cost of treating a healthcare professional exposed to blood or other potentially infectious material can range from hundreds to thousands of dollars per exposure, depending on the treatment provided.<sup>1-5</sup> Additional costs may stem from drug toxicity suffered during treatment, lost time from work, and the potential societal costs associated with active human immunodeficiency virus (HIV) or hepatitis C infections - such as a reduction in productivity, associated medical care, and the cost of litigation. Occupational exposures to bloodborne pathogens also take an emotional toll that is more difficult to quantify, but no less significant.<sup>5-7</sup>

Efforts to increase awareness of potential hazards and sharps injuries and related prevention efforts began in the early 1980s. These early efforts focused on educating healthcare personnel, adopting procedures to avoid recapping of used needles, and developing safer protocols and systems for sharps disposal. In 1987, the U.S. Centers for Disease Control and Prevention (CDC) issued recommendations for Universal Precautions that included guidance on sharps injury prevention.<sup>8</sup> Universal Precautions, intended to reduce exposures, rely on barriers (e.g., protective gloves) and work-practice controls to prevent sharps injuries. Despite these recommendations, there was only limited success in reducing the incidence of sharps injuries due to suboptimal adherence to recommendations, and because most protective clothing are not impenetrable by needles.<sup>9-17</sup> Thus, additional interventions were needed to make further gains in preventing sharps injuries.

A landmark 1988 study demonstrated that sharp devices that require manipulation or disassembly after use were associated with higher rates of occupational injuries.<sup>18</sup> Hollow-bore needles are of particular concern, because they contain residual blood and therefore increase the risk of transmission of HIV and other bloodborne viruses. A wide variety of sharp devices with engineered sharps injury prevention features have since been developed to more fully protect healthcare personnel. Additionally, the issuance of the Bloodborne Pathogen Standard by the Occupational Safety and Health Administration (OSHA) in 1991 provided specific protections to employees who were occupationally exposed to bloodborne pathogens. This Standard mandated that employers identify employees at risk for occupational exposure to bloodborne pathogens, and provide them with training, hepatitis B vaccination, personal protective equipment (e.g., gloves, gowns, and eye protection), safer devices, and appropriate follow-up in the event of an



exposure incident. A revision of this Standard in 2000 also mandated that employers seek input from frontline personnel when selecting and evaluating devices with sharps injury prevention features and establish a sharps injury log. As of 2005, 21 states have enacted needlestick injury prevention laws that mirror the revised OSHA Standard.

The CDC remains committed to preventing sharps injuries. CDC's National Institute for Occupational Safety and Health (NIOSH) issued an Alert on Preventing Needlestick Injuries in Healthcare Settings, and has provided crucial funding opportunities to research factors that may lead to sharps injuries in healthcare settings. The CDC's National Center for Infectious Diseases (NCID) has established the National Surveillance System for Healthcare Workers (NaSH) to assist in monitoring sharps injury trends in healthcare settings. NCID has also produced a *Workbook for Designing, Implementing, and Evaluating a Sharps Injury Prevention Program* (available online at <http://www.cdc.gov/sharpssafety>) to provide guidance to those at healthcare organizations who oversee personnel safety. Furthermore, NCID has identified elimination of needlestick injuries among healthcare personnel as one of its seven healthcare safety challenges.<sup>19</sup>

This meeting provided a forum for the overview of current sharps injury prevention strategies, identification of gaps in knowledge and research on sharps injuries, and identification of action steps to guide future activities. During the meeting current research on organizational factors contributing to sharps injuries, education and training of healthcare professionals in sharps injury prevention, evaluation of safer sharps devices, and analytic methods to determine the causes of sharps injuries were also reviewed. Information gained from this meeting will be used to guide future activities related to the elimination of sharps injuries in healthcare settings.





## Presentation Summaries

### **Scott Grytdal, Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention**

#### ***Sharps Injuries Among U.S. Hospital-Based Healthcare Personnel***

Epidemiologic trends in sharps injuries among U.S. healthcare personnel were summarized from four sharps injury surveillance systems:

The Exposure Prevention Information Network (EPINet™), developed in 1991 by Dr. Janine Jagger of the International Healthcare Worker Safety Center (IHWSC) at the University of Virginia, was the first such system to collect information on sharps injuries and exposures to blood and body fluids. Currently, more than 1,500 hospitals use EPINet™, free of charge. Approximately 70 of these hospitals submit injury data for inclusion in EPINet™'s annual report on sharps injuries.<sup>20</sup>

In 1995, the CDC established the National Surveillance System for Healthcare Workers (NaSH). NaSH collects demographic and other baseline data on healthcare personnel; information on exposures to blood and other body fluids; and follow-up and post-exposure prophylaxis information from healthcare professionals exposed to blood and other bodily fluids. NaSH also gathers data from surveys of healthcare personnel to assess the underreporting of sharps injuries. Since its inception, approximately 80 healthcare facilities in 28 states have participated in NaSH.

The Automated Safety Incident Surveillance and Tracking System (ASISTS) was deployed by the Veteran's Health Administration (VHA) in 1998 to track and manage information on occupational injuries, improve employee health, and reduce workers' compensation costs. ASISTS engages a variety of departments, including occupational safety, employee health, workers' compensation, and infection control, in reporting and handling sharps injuries. All VHA facilities are required to participate in the ASISTS program.

The Massachusetts Sharps Injury Surveillance System (MSISS) was developed in 2001 by the Massachusetts Department of Health (MDPH) in response to state legislation requiring hospitals to report sharps injuries to the MDPH annually. MSISS collects sharps injury data, but no demographic or other data, from approximately 100 MDPH-licensed hospitals.

#### ***Key statistics from surveillance systems***

Collectively, more than 37,000 sharps injuries were reported to the four surveillance systems from 2000 through 2004. Nurses reported the majority (41 percent) of these injuries, followed by physicians (25 percent) and technicians (18 percent). The work locations associated with the greatest proportion of sharps injuries were operating or procedure rooms (36 percent) and inpatient wards (28 percent); intensive care units accounted for 9 percent of reported sharps



injuries, and emergency departments and outpatient areas each accounted for 7 percent of sharps injuries.

Hollow-bore needles including hypodermic needles or syringes accounted for 53 percent and 29 percent, respectively, of all reported sharps injuries. Over two-thirds (70 percent) of all sharps injuries occurred when conventional, or non-safety, devices were used; 22 percent occurred when safety devices were used. Devices intended for use in suturing, percutaneous blood sampling, and administering injections were associated with 52 percent of all sharps injuries. However, nearly one-quarter of all reported injuries occurred while using devices for “other or unknown” purposes, making it difficult to characterize the risk associated with various procedures. Based on NaSH and MSISS data, 44 percent of reported injuries occurred while a device was in use; 37 percent of injuries occurred immediately after device use, but prior to disposal; and 14 percent occurred during or after disposal. Sharps injuries occurring prior to, during, or following device disposal are potentially preventable with safer work practices.

### ***Identifying trends in hollow-bore needlestick injuries (NSIs)***

CDC analyzed data from 23 hospitals that continuously participated in the NaSH system between 2000 and 2003 to identify trends in hollow-bore NSIs and to determine the preventability of these NSIs. NSI rates were used to assess changes in NSIs over time; these rates were identified by dividing the number of injuries by the number of staffed beds as provided by American Hospital Association annual surveys. A hierarchical algorithm was used to categorize the preventability of hollow-bore NSIs using information such as device that was used or caused the injury; purpose of device use at the time of injury; circumstances surrounding the injury; time of injury in relation to device use; and information about safer needle devices (SNDs), such as the type of SND used and time of injury in relation to activation of the safety feature. NSIs were classified as preventable if: 1) a needle was used unnecessarily; 2) a safety feature was used improperly; 3) an SND alternative was available; 4) a safer work practice could have prevented the NSI; or 5) a device was disposed of improperly. NSIs that were caused by patient-related factors (e.g., a patient moved while the needle was being used or removed) were considered non-preventable. The preventability of NSIs which contained unclear information was classified as undetermined.

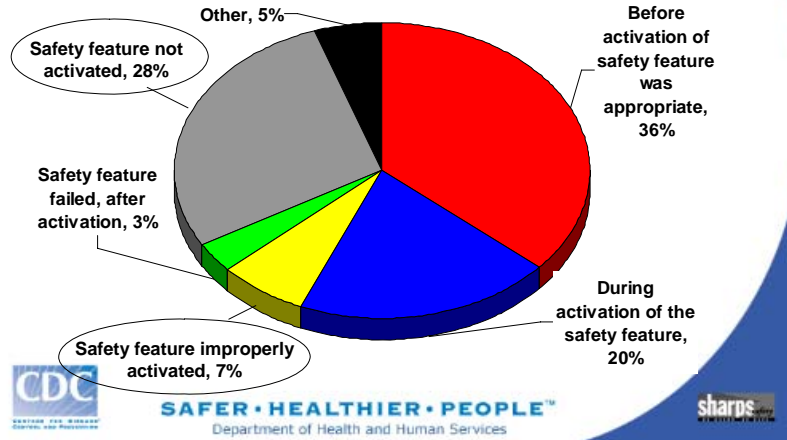
A total of 4,750 hollow-bore NSIs were reported to NaSH by the study facilities between 2000 through 2003. A 8.2% decrease in the rate of hollow-bore NSI was observed from 2000 to 2003 (from 13.59 NSI per staffed bed in 2000 to 12.48 NSI per staffed bed in 2003). Furthermore, a substantial increase was observed in the proportion of hollow-bore NSIs attributed to SNDs (from 13% in 2000 to 37% in 2003).

The circumstances of SND-related hollow-bore NSIs were examined. Thirty-six percent of SND-related injuries occurred before activation of a safety feature was appropriate. However,



over one-third (35%) of SND-associated NSIs occurred due to lack of use or improper use of SND safety features (Figure 1).

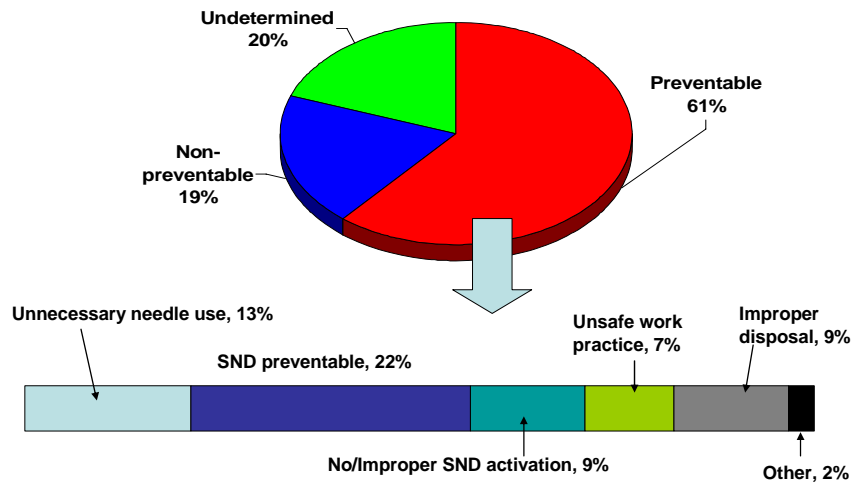
Figure 1: Circumstances of Safety Device-Related Hollow-Bore NSI, NaSH, 2000-2003  
(n=1,130)



Overall, 61 percent of NSIs were classified as preventable, of which 22 percent might have been prevented if an SND had been used (Figure 2). The total number and rate of preventable NSIs reported to NaSH decreased from 8.6 preventable NSI per 100 staffed beds in 2000 to 7.4 preventable NSI per 100 staffed beds in 2003. The proportions of preventable NSI attributed to the unnecessary use of needles, use of conventional (non-SND) needle devices, and improper disposal of needles significantly decreased from 2000 to 2003 (Figure 3). Conversely, the proportion of preventable NSI attributed to unsafe work practices and improper or no activation of a safety feature increased during this time period. The proportion of NSIs considered non-preventable also increased between 2000 and 2003.

**Figure 2: Preventability of Reported Hollow-Bore NSI, NaSH, 2000-2003**

(n=4,723)



**Figure 3: Annual Trends in Preventable NSI, NaSH, 2000-2003**

Preventability category	Year				Trend test p-value
	2000	2001	2002	2003	
Unnecessary needle use	11.6	8	7.6	6.8	<0.001
SND available	32.5	26.3	21.7	20.7	<0.001
Improper disposal	10.4	11.4	9.9	6.3	0.001
Unsafe work practice	6	6.4	6.1	8.9	0.011
No/Improper activation of safety feature	3.6	4.6	8.4	8.6	<0.001
Undetermined	14.4	19.1	21.9	22.1	<0.001
Non-preventable	21.5	24.2	24.5	26.5	0.008



***Addressing the limitations of current surveillance systems***

The surveillance systems currently in use provide an impressive array of information about the extent and types of sharps injuries commonly seen in U.S. hospitals. Nevertheless, these systems have limitations. Each of the surveillance systems that were highlighted in this presentation, with the exception of the ASISTS system, are restricted geographically. Most systems collect data primarily from large, urban hospitals (MSISS is an exception). Information about injuries related to the use of safety devices may be incomplete in some systems. Furthermore, there are no standardized methods of collecting, classifying, and analyzing sharps injury data, including denominators for sharps injury rates.

The representativeness of existing systems could be improved by the inclusion of smaller hospitals, and hospitals in a broader geographic area. Surveillance systems also could be implemented in nursing homes, home health agencies, and other non-hospital healthcare delivery venues. In addition, experts on sharps injury surveillance and prevention could identify a minimum set of data elements for all systems to standardize and simplify data collection and analysis and allow appropriate comparisons across systems.



**Elise Handelman, Occupational Safety and Health Administration (OSHA)**  
***Current History of OSHA's Bloodborne Pathogen Standard***

In December 1991, the Occupational Safety and Health Administration (OSHA) published the Bloodborne Pathogens Standard (BPS)—a landmark piece of legislation aimed at protecting healthcare personnel from occupational exposures to contaminated blood and other potentially infectious materials containing pathogens such as HIV, hepatitis B virus (HBV), and hepatitis C virus (HCV).

Compliance with the BPS is credited with a significant reduction in the risk of occupational exposure to bloodborne pathogens during the 1990s. Nevertheless, sharps injuries among healthcare personnel remain a serious problem. In March 2000, CDC estimated that more than 385,000 percutaneous exposures to contaminated blood occur annually in U.S. hospitals.

***Strengthening the BPS—revisions and new definitions***

In response to the Needlestick Safety and Prevention Act of November 2000, OSHA revised the Bloodborne Pathogens Standard, 29 CFR 1910.1030. The revised Standard, published in 2001, clarifies the need for employers to select safer needle devices and to involve front-line employees in identifying and choosing these devices. The updated Standard also requires most employers to maintain a log of injuries from contaminated sharps.

Although the requirement for use of safer devices was a part of the original Standard, the revisions clarified several key terms. For example, OSHA defines an engineering control as any device - including disposal containers, sharps with engineered sharps injury protections (SESIPs), and needleless systems - that isolates or removes the bloodborne hazard from the workplace. SESIP refers to any non-needle sharp or needle with a built-in safety feature to reduce the risk of exposure. Needleless systems include any device that does not use a needle to collect bodily fluids, administer medication or fluids, or perform other procedures with the potential for percutaneous exposure. Employers are responsible for choosing and implementing the appropriate engineering controls for their facilities.

***Identifying problem areas and measuring results***

OSHA monitors annual trends in the number of inspections that are performed and the number of BPS violations. From 1991 through 1998, the most frequently cited violation was lack of an exposure control plan (Table 1). In contrast, failure to use engineering controls was rarely cited. Following OSHA's BPS revisions, failure to use engineering controls became the most frequently cited problem (Table 2). Other frequently cited problems included failure to update exposure control plans, failure to provide hepatitis B vaccinations, improper disposal of contaminated sharps, and lack of input from non-managerial employees. While the number of hospitals inspected remained relatively constant from 2000 to 2003, the number of inspections with violations increased. Approximately 60% of OSHA inspections are initiated due to



complaints; the number of hospital-associated complaints doubled from 55 in 2002 to 103 in 2003.

Table 1: Bloodborne Pathogen Standard (BPS) Violations by Frequency Fiscal Years 1991-1998

Rank	Paragraph	Description
1	(c)(1)(i)	Written Program (Exposure Control Plan [ECP])
2	(g)(2)(i)	Employee Training
3	(f)(2)(i)	Hepatitis B Virus (HBV) Vaccine
4	(c)(1)(ii)(b)	ECP Implemented
5	(f)(2)(iv)	Signed HBV Declination Form
6	(d)(3)(i)	Personal Protective Equipment (PPE) Provided by Employer
31	(d)(2)(i)	Use of Engineering Controls





Table 2: Bloodborne Pathogen Standard (BPS)  
Violations by Frequency  
Fiscal Years 2001-2004

Rank	Paragraph	Description
1	(d)(2)(i)	Use of Engineering Controls
2	(c)(1)(iv)	Review/Update Exposure Control Plan (ECP), Engineering Controls
3	(f)(2)(i)	Hepatitis B Virus (HBV) Vaccine
4	(d)(4)(iii) (A)(2)	Discarding contaminated sharps
5	(C) (1)(v)	Input from non-managerial employees



***Future activities***

OSHA continues to use inspection data to identify problem areas. The agency also hopes to build or enhance relationships with groups, such as the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), which can promote adherence to the BPS. In order to target outreach more effectively, data are needed regarding compliance with the BPS in specific segments of healthcare delivery, including emergency departments, operating rooms, ambulatory care centers, physician offices, and rural healthcare organizations.

Ms. Handelman acknowledged a need for research on the behavioral, cultural, and environmental factors that may be associated with sharps injuries. A need for training that is more participatory and focused on principles of adult learning was also acknowledged.





**Angela Laramie, Massachusetts Department of Public Health (MDPH)**  
***Sharps Injury Surveillance and Prevention Legislation in Massachusetts: Why Was It Successful?***

Occasionally, tragic personal experiences give rise to important legislation. This was the case in Massachusetts after Karen Daly, President of the Massachusetts Nurses Association, suffered a percutaneous injury that inspired her to author legislation aimed at reducing sharps injuries in the workplace.

The number of states with sharps injury prevention laws increased from one (California) in 1998 to twenty-one in 2002 (Table 1). Indeed, the timing of the Massachusetts sharps injury legislation paralleled the Federal Government’s path. The state law went into effect in August 2000, just before the Federal Government passed the Needlestick Safety and Prevention Act. Revisions to the Occupational Safety and Health Administration (OSHA) Bloodborne Pathogen Standard (BPS) were published in early 2001, just before the MDPH promulgated a series of regulations as required by the legislation.

**Table 1: States with sharps injury prevention legislation  
1998-2002**

<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>
California	Tennessee	West Virginia	Arkansas
	Maryland	Minnesota	Missouri
	New Jersey	Maine	Rhode Island
	Texas	Georgia	Pennsylvania
		Iowa	
		New Hampshire	
		Alaska	
		Connecticut	
		Oklahoma	
		Ohio	
		Massachusetts	
		New York	



### ***MDPH regulations and reactions***

The scope of Massachusetts' sharps injury regulations mirrored the federal BPS revisions. Under the sharps injury law, the MDPH required hospitals to:

- Incorporate the use of safe needles and sharps devices into engineering and work-practice controls.
- Maintain a written exposure control plan that includes procedures for selecting safety devices.
- Maintain a sharps injury log.
- Use data for continuous quality improvement.
- Provide an annual summary to the MDPH.

The MDPH was charged with establishing a Sharps Injury Prevention Advisory Committee. The committee represents a variety of stakeholders such as hospitals, unions, and professional organizations. In addition, the MDPH was required to develop and maintain a list of needleless systems.

Most stakeholders were supportive of the new legislation, which had the potential to improve the safety of healthcare personnel. However, some stakeholders expressed concerns about the state government's lack of funding for this mandate, regulatory burden increase on hospitals, and scope (too wide or too limited) of the proposed legislation.

### ***Documenting the problem using MSISS***

The legislation prompted the MDPH to look for ways to document the magnitude of the sharps injury problem in the state. Thus, the MDPH developed the Massachusetts Sharps Injury Surveillance System (MSISS) in 2001. MSISS data are used to identify statewide trends in sharps injuries and specific hazards in various areas of the hospital. MSISS data also can be used to identify the risk of percutaneous injury posed by specific procedures and devices.

The Massachusetts sharps injury surveillance system has achieved 100 percent participation by MDPH-licensed hospitals each year since 2002. In 2002:

- more than 3,400 sharps injuries were reported to the MSISS by a total of 101 hospitals; injuries per hospital ranged from 0 to 431;
- 97 percent of injuries occurred at acute-care facilities;
- 61 percent of sharps injuries occurred when conventional devices were used, while 26 percent occurred when safety devices were used (safety device information was unknown or unavailable for the remaining 13 percent of injuries);
- hypodermic and suture needles were the devices most often used without engineering controls.



Site visits by Bureau of Healthcare Quality surveyors pointed to the limitations of hospitals' exposure control plans, particularly the provisions for evaluating the circumstances of the injury and procedures for soliciting employee input on device selection and evaluation. Other areas of concern identified by the MSISS include inadequate critical analysis of each exposure incident and a lack of clear procedures regarding defective equipment.

The MSISS has several strengths. It provides a comprehensive census of hospitals, rather than a sample; therefore, these data are not biased by voluntary hospital reporting. In addition, the system assists hospitals with adhering to OSHA BPS requirements and offers a model for other healthcare settings, and perhaps other states.

Nevertheless, MSISS faces several challenges: funding, which is currently obtained from the National Institute of Occupational Safety and Health (NIOSH), is constrained; data may be distorted by underreporting of sharps injuries by affected healthcare personnel; the system lacks appropriate denominators for measuring injury rates.

*“The MSISS...provides a comprehensive census of hospitals... and offers a model for other healthcare settings...”* –  
**Angela Laramie, Massachusetts  
Department of Public Health**

#### ***Future directions***

The MDPH legislation has set the stage for future efforts in surveillance and prevention of sharps injuries. Findings from the MSISS suggest the need to research the extent of underreporting of sharps injuries, as well as to include surveillance of seroconversion rates. Data from MSISS could be: 1) used to foster collaborations with medical, dental, and nursing schools in educating students about sharps injury prevention and improving post-exposure management; 2) adapted to examine sharps injuries outside of the hospital setting; and 3) used to offer guidance in selecting and categorizing safety devices.



**Cathie Gosnell, Safety Institute, Premier Inc.**  
***Safer Needle Devices: What Is Available, What Is Needed?***

Medical device manufacturers have responded to federal and state legislators' call for safer alternatives to conventional sharp instruments. A wide variety of safer needle devices (SNDs) have been introduced to the market since 1989. The revisions to the BPS in 2000 led to a significant increase in the number of new SNDs available on the market.

Some of the SNDs that are now available include:

- Safety syringes and needles for hypodermic devices
- Pre-filled medication syringes
- Safety IV catheters and needleless IV systems
- Safety and closed-system blood-collection devices
- Safety Huber needles
- Safety blades, scalpels, suture needles, and surgical sharps protection devices
- Hemodialysis safety needle sets
- Safety procedure trays
- Sharps protection and disposal devices

**Selected websites with information about available safer needle devices:**

- [www.med.virginia.edu/medcntr/centers/epinet/safetydevice.html](http://www.med.virginia.edu/medcntr/centers/epinet/safetydevice.html)
- [www.dhs.ca.gov/ohb/SHARPS/disclaim.html](http://www.dhs.ca.gov/ohb/SHARPS/disclaim.html)
- <http://www.nappsi.org/safety.shtml>
- <http://www.isips.org/>
- <http://www.ecri.org/>

**Notice: CDC does not necessarily endorse the views or information presented on these sites. Furthermore, CDC does not endorse any commercial products or information that may be presented or advertised on the sites that are listed.**

***Acceptance of SNDs***

Several factors can affect the utilization of SNDs. For example, surgical staff reported that many safety blades and scalpels were inadequate replacements for conventional devices as they lacked the weight and precision necessary for use in a surgical procedure. This feedback prompted manufacturers to improve the design and construction of safety scalpels, which is likely to increase their utilization in the operating room.



Efficacy, clinician comfort, ease of use, and cost are among the important factors affecting SND utilization. Purchasers and manufacturers of medical devices must work together to develop SNDs that offer an even greater benefit over conventional devices before such safety devices are more widely accepted.

More engineered safer devices (e.g., safer specialty blades, surgical instruments, and biopsy needles) are needed for the operating room, where a significant number of sharps injuries are sustained. Other device types that would benefit from additional safety technology include introducer needles, spinal and epidural needles, arterial-line needles, and specialty needles. Manufacturers must proactively obtain feedback on SNDs from device users and incorporate this feedback into device designs to improve SND utilization and performance.



**Gina Pugliese, Safety Institute, Premier Inc.**  
***Efficacy of Sharps Injury Prevention Devices***

Historically, preventing exposure to bloodborne pathogens has focused on the development and proper use of disposal units, creating safer work environments, and training healthcare personnel to avoid cutting, bending, and clipping needles. In addition, the OSHA Bloodborne Pathogen Standard required all healthcare personnel to be vaccinated against hepatitis B virus (HBV). Together, these measures have led to a precipitous decline in HBV infections since 1991.

Despite the success in reducing HBV infections, an alarming number of sharps injuries continued to be reported during the 1990s. Regulators and healthcare personnel began to suspect that some devices presented a greater risk of injury than others. Revisions to the BPS addressed these concerns, placing greater emphasis on the use of non-needle devices and sharps with engineering controls to prevent percutaneous exposures.

Posted on Premier Inc.'s Safety Institute website ([www.premierinc.com/safety](http://www.premierinc.com/safety)) is a summary of approximately 70 published studies on the efficacy of SNDs and educational or training programs in preventing sharps injuries. These study results demonstrate the complexity of measuring the efficacy of SNDs.

***Factors affecting the efficacy and performance of SNDs***

Human factors that have been found to contribute to preventable sharps injuries, include:

- Anger (e.g., conflict with another employee or patient)
- Distractions during a procedure or noise in the operating room
- Multiple attempts for procedures such as catheter placement or lumbar puncture
- Rushing (e.g., due to low staffing ratios)
- Fatigue
- Lack of patient cooperation

The Safety Institute conducted field evaluations to identify preferred performance considerations in choosing SNDs. The studies, completed in 2001, evaluated more than 34,000 safety syringes and phlebotomy devices at 30 U.S. hospitals. Clinicians identified the top four performance considerations for syringes as dose accuracy; reliability of the device's safety feature; the ability to keep hands behind the needle; and visibility of the medication/infusate. The four most important performance considerations for phlebotomy devices were a reliable safety feature; ease of use; ease of disposal in a sharps container; and no interference with blood draws. The study also found that although the large majority (roughly 80 percent) of clinicians believed these devices would help protect them from sharps injuries, safety mechanisms were not always reported to have been activated. Additional information about this study is available at Premier's



Safety Institute website at: [www.premierinc.com/quality-safety/tools-services/safety/topics/needlestick/device\\_evaluations.jsp](http://www.premierinc.com/quality-safety/tools-services/safety/topics/needlestick/device_evaluations.jsp)

***Improving research and prevention***

More research clearly has the potential to help healthcare personnel evaluate and select the most effective and appropriate SNDs. Additional emphasis must be placed on the rigorous design of future SND research activities in order to produce reliable and practical results. This is a challenge because of the large sample size needed to achieve statistical validity.



**Scott Grytdal, CDC**

***Influence of Organizational Factors on Sharps Injuries in Healthcare Personnel***

In recent years, there has been a growing interest in understanding the safety culture within healthcare organizations. Yet, few studies have examined the possible relationship between sharps injuries and organizational factors such as nurse or infection control personnel staffing; the hospital's teaching status and size; the complexity of services offered; and perceptions of the hospital's safety culture.

A variety of characteristics may indicate the presence of a safety culture within a healthcare organization. Hospitals with a strong safety culture typically: 1) devote adequate resources to safety; 2) voice an institutional commitment to safety from the highest levels of the organization through mission statements and other widely distributed documents; 3) prioritize safety over productivity and efficiency; 4) encourage frequent and candid communication among healthcare employees and across all levels of the organization; and 5) maintain blame-free policies to encourage the reporting of errors.

***Preliminary research and future priorities***

Researchers are just beginning to focus on specific organizational issues that may have an impact on sharps injury rates. For example, nurses who work in units with low nurse-to-patient ratios are more likely to report the presence of sharps injury risk factors and sustain sharps injuries or near misses. Personnel in hospitals with high infection control professional-to-patient staffing ratios are more likely to follow safer sharps handling practices. Furthermore, healthcare personnel are more likely to adhere to Universal Precautions (UP) when they perceive a strong institutional commitment to safety, detect fewer job hindrances in complying with UP, and experience more frequent UP training throughout the year.

Results from these studies hint at the potential contribution of organizational factors to sharps injury prevention. However, the available studies cannot establish a causal link between organizational factors and sharps injuries due to their cross-sectional design. Furthermore, studies that focus on the possible link between organizational factors and UP compliance depend on self-reporting, a method that may not offer the most optimal or reliable data.

Additional studies are needed to identify possible relationships between organizational factors and specific behaviors such as acceptance and proper use of safety devices, staffing mix, and patient-safety initiatives.





**Annemarie Leyden, Veterans Health Administration (VHA) New York-Harbor Healthcare System**

***Needlestick Injuries in Medical Residents: A Model for Prevention***

In 2004, the VHA New York-Harbor Healthcare System launched a pilot initiative to prevent needlestick injuries among medical residents. The initiative was inspired by two events: In 1991, a VHA intern became infected with HIV from a syringe that was used on an AIDS patient. Another intern was exposed to HIV and HCV after sustaining a needlestick injury while inserting an intravenous safety catheter in a patient in 2002. While the intern did not become infected with HIV or HCV, the injury had an emotional impact on the intern.

***“There is no price for the emotional cost of suffering a needlestick injury and the anxiety generated from the thought of becoming positive for HIV, Hepatitis C, and/or hepatitis B.” –Intern who suffered an accidental needlestick***

A subsequent literature review revealed that fewer than 25 studies have examined NSIs in medical residents. Non-reporting rates were high in the few published studies, suggesting that those in need of post-exposure counseling and prevention training were not receiving these services. Moreover, none of the studies looked at prevention strategies. Yet, one survey of nearly 3,000 medical residents found that the risk of exposure to bloodborne pathogens increased with each year of training.

The VHA New York-Harbor Healthcare System collected data on sharps injuries at its Brooklyn Campus from 2002 through 2003. This study found that 65 percent of all sharps injuries at this campus occurred in residents, most often in the first three months of the academic year.

***Developing an educational intervention***

To combat the high incidence of sharps injuries among its residents, VHA New York-Harbor Healthcare System (Brooklyn Campus) developed an educational intervention to address injuries to internal medicine residents. VHA New York-Harbor Healthcare System obtained support from leaders, such as Dr. Michael Hodgson, Director of the VHA’s Occupational Safety and Health program, executives at the VHA New York-Harbor Healthcare System, and the State University of New York (SUNY) Residency Program Director.

The educational intervention was developed with input from an expert consultant, Dr. June Fisher, of Training for Development of Innovative Control Technologies, San Francisco, California. The VHA attending physicians who supervised residents and the chief residents also were actively involved in the program’s development. Focus groups with chief residents from three academic years were conducted to identify perceived barriers to safe work practices among residents. The barriers that were cited most often included workload issues, work organization,



minimal training in the use of safety devices, limited awareness of resident injuries, fear of repercussions for reporting injuries, and lack of clarity about reporting mechanisms.

VHA New York-Harbor Healthcare System (Brooklyn Campus) also established a multi-disciplinary task force to address organizational issues. The task force sought to increase organization-wide communications regarding sharps injuries, improve the reporting of sharps injuries among residents, improve post-exposure treatment, address specific work-environment issues, inventory all safety and conventional devices, and screen new safety devices.

The medical school also provided key support for the initiative. At each site, the school assigned a chief resident to respond to sharps injuries around the clock and guide injured residents through the reporting and treatment process. In addition, the school required chief residents to review all sharps injuries with the program director on a weekly basis to ascertain what could be learned about injury prevention.

### ***Piloting the intervention***

In the first phase of the pilot program, the expert consultant presented the educational component to the chief residents, supervising attending physician, and members of the task force. The educational component included an overview of the epidemiology of sharps injuries, OSHA requirements, and available safety devices. The chief resident and attending physician used this information to develop an orientation program including general statistics on sharps injuries and specific case studies from the Brooklyn campus. The educational component also included hands-on training in the evaluation of safety devices, use of simulation arms for practicing IV insertion, and task analysis. The chief resident and attending physician used this information to develop an orientation program containing general statistics on sharps injuries and specific cases from the Brooklyn campus.

In the second phase, the new chief resident presented an orientation for medical residents using local data on sharps injuries. Residents participated in hands-on practice sessions with safety devices for intravenous access and blood collection during Advanced Cardiac Life Support sessions. Funding from VA headquarters was used to provide a resource room with safety devices and models to simulate real-life clinical practice. Practice sessions were repeated monthly and as needed with each rotation. There was ongoing reinforcement of safety principles as residents were supervised in their daily practice.

In the third phase, the chief resident and nursing staff performed task analyses on three clinical units. The task analysis consisted of an inventory of all devices available on a given unit and a summary of procedures performed during a given time period. Results from this phase of the program prompted a request to eliminate unprotected devices.

### ***Program evaluation and outcomes***

*Proceedings of the National Sharps Injury Prevention Meeting*  
September 12, 2005  
Atlanta, GA

Page 20



The program was successful in a number of important ways. From the perspective of institutional culture, the chief residents and attending physicians assumed ownership of the educational intervention and reinforced the notion of a safety culture in their daily interactions with residents. This led to a large number of residents returning to the resource room each month to practice clinical simulations that incorporated the use of safety devices and reinforced safe practices. As a result, the incidence of sharps injuries was reduced to one for academic years 2004 and 2005. Sharps injuries were entirely eliminated during the first three months of the academic year, when a clustering of injuries had been seen in previous years. The economic impact was an estimated cost savings to VHA New York-Harbor's Brooklyn campus of more than \$53,000 (based on the cost per needlestick injury suggested in 1998 by OSHA). In 2004, the educational intervention received the VA NY/NJ Healthcare Network Annual Safety and Health Award for outstanding achievement in promoting health and safety.



**Pamela Hirsch, Veterans Health Administration (VHA)**  
***VHA and Bloodborne Pathogens Root-Cause Analysis to Examine Sharps Injuries and Near-Misses***  
**(Presented by Judith Rosen, Palo Alto VHA Health System)**

In 2001, the VHA convened a team of experts on sharps injury prevention to determine the most effective methodology for collecting and analyzing data concerning occupational exposures to bloodborne pathogens.

First, the team looked at the three main forces currently driving the collection of sharps injury data: legislation aimed at preventing sharps injuries, measurement of direct costs associated with these events, and sharps safety accreditation requirements. The team noted the drawbacks associated with each of these data-collection points. The Occupational Safety and Health Administration (OSHA) Bloodborne Pathogen Standard (BPS) requires sharps injury logs to include the type and brand of device involved in the event, the department or work area where the event occurred, and an explanation of the injury—a subjective response that typically offers no conceptual framework for understanding the cause of the injury. Studies of direct costs associated with sharps injuries do not capture the cost of preventing and treating injuries in healthcare personnel who are ineligible for workers' compensation benefits (e.g., contract workers, medical residents, and trainees). Accreditation from the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) emphasizes patient, rather than personnel, safety. Because of these drawbacks in data collection, existing sharps injury databases either fail to capture the entire population of healthcare personnel in VHA hospitals or employ qualitative data-collection methods that often fail to reveal the source of the injury.

Next, the team administered a survey to VHA personnel to obtain a more accurate estimate of the number of sharps injuries and the use of safety and non-safety devices on each unit. The survey results indicated that VHA personnel sustained an estimated 35,000 to 45,000 exposures to bloodborne pathogens in 2001. Surgeons and dentists had the highest injury rates among the groups studied. A comparison of survey results with VHA's Automated Safety Incident Surveillance and Tracking System (ASISTS) data found underreporting rates of approximately 30 percent for registered and licensed nurses, and 15 percent for nurse assistants. Rates of blood exposures unrelated to devices with safer alternatives, including mucosal splashes, non-intact skin exposures, and injuries due to surgical sharps were substantially lower in units and facilities with a higher penetration of safer devices. This suggests that culture, whether as a consequence of training and awareness or as a driver for management support for safer device use, was at least as important as safer device use itself.

The survey results underscored the need to improve awareness and use of safety devices throughout the VHA, particularly among the personnel groups most vulnerable to sharps injuries. Additionally, the high underreporting rates among VHA nurses required further exploration.



### ***Improving sharps injury analysis at the VHA***

Following the survey, the VHA mandated the formation of multidisciplinary accident review boards (ARBs) at all of its facilities to examine all percutaneous exposures resulting in lost work time or illness. ARBs employ after-action reviews, an informal review technique commonly used by the Department of Defense, to identify potential causes of percutaneous exposures and illness, and to implement localized solutions. ARBs include senior VHA facility management, union representatives, and representatives from VHA facility programs responsible for employee health, safety, infectious disease, engineering, environmental management, workers' compensation, and human resources.

The VHA also conducts rigorous safety investigations—a variety of formalized data-collection methodologies that involve the use of fishtail diagrams, mapping, and other analytic techniques. One type of safety investigation is root-cause analysis (RCA). The VHA's National Center for Patient Safety uses RCA to determine the cause(s) of a single event or multiple, similar events. The RCA process is a tool for understanding what should have happened, what actually happened, differences between the desired and actual outcomes, and what could have been done to prevent the outcome.

### ***RCA pilot study***

The VHA has initiated a pilot study to develop a standardized RCA questionnaire specifically designed to investigate sharps injuries. Data collected from these questionnaires will be used to perform an aggregate RCA encompassing several VHA facilities, identify common sharps safety problems throughout the VHA, and implement VHA-wide solutions.

The RCA process begins when an injury is entered in the OSHA 300 log, which triggers an interview with the injured employee. The RCA team administers a structured survey with open- and closed-ended questions about a variety of factors commonly associated with sharps injuries, including communication, training, fatigue and scheduling issues, environment, equipment, rules, policies, procedures, and barriers to safe work practices.

Initial results from the VHA's pilot study suggest that several factors—including the physical position of the patient, supervision of medical students, use of multiple sharps in a surgical tray, sharing devices, and sharing or reusing needles and syringes for local anesthesia—are most frequently associated with sharps injuries.

At the end of the pilot study, the VHA plans to formalize its qualitative data collection and train occupational health staff in using the RCA methodology and questionnaire. In addition, the VHA will compare the efficacy of analyses using fishtail diagrams and the formal RCA (qualitative) questionnaire.



## Next Steps

### *Formation of Work Groups*

Participants in the National Sharps Injury Prevention Meeting took part in a brainstorming session to identify the most important obstacles to reducing the number of sharps injuries among healthcare personnel and to identify practical recommendations for improving sharps safety. The discussion culminated in the formation of four working groups to help prioritize and refine the actions discussed during the brainstorming session. These include the formation of work groups on sharps injury surveillance; education and other interventions to prevent sharps injuries; safety device development, implementation, and diffusion; and research on the relationships of human and organizational factors to sharps injuries.

Each work group was charged with:

- Determining short- (12-18 months) and long-term (3-5 years) prevention goals and action steps;
- Identifying research priorities;
- Identifying potential CDC and non-CDC partners, stakeholders, and experts to participate in the working groups.

The findings of the four work groups will comprise a National Sharps Injury Action Plan, to be distributed by the CDC.

The work groups will address many of the topics and concerns voiced during the discussion session, including:

### *Sharps injury surveillance*

- Expand existing surveillance systems to include data from nonacute care facilities and from a representative sample of hospitals.
- Standardize the collection and analysis of data.
- Improve study and survey design.
  - Include a more targeted list of questions concerning specific barriers to sharps injury reduction, e.g., questions related to staffing or employee burden, budget constraints, etc., to improve data collection.
  - Capture data on near-misses.
  - Experiment with different denominators for rate-based reporting, e.g., person hours.
  - Find ways to improve reporting of injuries and exposures.
- Apply root-cause analysis (or other rigorous analytic techniques) to better understand long-standing problems, e.g., barriers to purchasing sharps safety devices.
- Share information on successful surveillance systems.
- Link data collection to dissemination of study results.



- Involve healthcare personnel in surveillance efforts.

### ***Education and training to prevent sharps injuries***

- Involve the Accreditation Council for Graduate Medical Education in future research and prevention programs.
- Include and expand sharps safety in the curricula of all health professional schools.
- Identify “champions” of sharps safety and widely disseminate lessons learned by these champions to larger audiences.
- Convene a meeting on sharps safety for chief residents from medical schools nationwide.
  - Meeting attendees will serve as ambassadors for sharps safety in their respective teaching hospitals.
  - Create a CDC Center of Excellence to award medical schools with successful education and intervention programs, and spur competition among hospitals.
- Conduct intra-departmental meetings to share information about best practices and barriers to preventing sharps injuries.
- Develop educational materials that give equal weight to healthcare worker safety and patient safety.
- Provide safety education to healthcare professionals trained on-site, including phlebotomists and medical assistants.

### ***Safety device development, implementation, and diffusion***

- Create toolkits that feature safety devices for frontline healthcare personnel.
- Identify a potential sponsor for a national device “fair.”
- Address impediments to the marketing and diffusion of safety devices.
  - Study the impact of group purchasing organizations.
- Develop prevention networks to implement pilot tests, systematically evaluate devices, and offer feedback to manufacturers on device development.
- Determine how to measure unintended consequences of safety devices or other prevention efforts that may be introduced in the future.

### ***Human and organizational factors***

- Study the economic and emotional impact of sharps injuries.
  - Gather cost data on purchasing safety devices, prophylaxis and treatment, lost work time, and the cost of HCV treatment.
- Gather appropriate denominators to benchmark and compare sharps injury rates across institutions.
- Expand research to nonacute care settings.
- Conduct a formal evaluation of the impact of sharps safety legislation on policy, injury rates, and sanctions.



## References

1. Jagger J, Bentley M, Juillet E. Direct cost of follow-up for percutaneous and mucocutaneous exposures to at-risk body fluids: data from two hospitals. *Adv Exp Prev* 1998; 3(3):1-3.
2. Holodnick CL, Barkauskas V. Reducing percutaneous injuries in the OR by educational methods. *AORN J* 2000; 72(3): 461-4, 468-72, 475-6.
3. United States General Accounting Office. Occupational safety: selected cost and benefit implications of needlestick prevention devices for hospitals. GAO-01-60R; November 17, 2000.
4. Orenstein R, Reynolds L, Karabaic M, Lamb A, Markowitz SM, Wong ES. Do protective devices prevent needlestick injuries among health care workers? *Am J Infect Control* 1995; 23(6):344-51.
5. Lee WC, Nicklasson L, Cobden D, Chen E, Conway D, Pashos CL. Short-term economic impact associated with occupational needlestick injuries among acute care nurses. *Curr Med Res Opin* 2005; 21(12): 1915-1922.
6. Gershon RR, Flanagan PA, Karkashian C, Grimes M, Wilburn S, Frerotte J, Guidera J, Pugliese G. Health care workers' experience with postexposure management of bloodborne pathogen exposures: a pilot study. *Am J Infect Control* 2000; 28: 421-8.
7. Meisenhelder JB. Accidental occupational exposure of intravenous nurses to human immunodeficiency virus: anticipating the consequences. *J Intraven Nurs* 1998; 21: 215-20.
8. Centers for Disease Control and Prevention. Recommendations for prevention of HIV transmission in health-care settings. *MMWR* 1987; 36(SU02); 001; Retrieved May 22, 2006, from <http://www.cdc.gov/mmwr/preview/mmwrhtml/00023587.htm>.
9. Osborne S. Influences on compliance with standard precautions among operating room nurses. *Am J Infect Control* 2003; 31(7): 415-23.
10. Kim LE, Jeffe DB, Evanoff BA, Murtha S, Freeman B, Fraser VJ. Improved compliance with universal precautions in the operating room following an educational intervention. *Infect Control Hosp Epidemiol* 2001; 22: 522-4.
11. Bennett G, Mansell I. Universal precautions: a survey of community nurses' experience and practice. *J Clin Nurs* 2004; 13: 413-21.





12. Gershon RRM, Karkashian CD, Vlahov D, Kummer L, Kasting C, Green-McKenzie J, Escamilla-Cejudo JA, Kendig N, Swetz A, Martin L. Compliance with universal precautions in correctional health care facilities. *J Occup Environ Med* 1999; 41(3): 181-9.
13. Saghafi L, Raselli P, Francillon C, Francioli P. Exposure to blood during various procedures: results of two surveys before and after the implementation of universal precautions. *Am J Infect Control* 1992; 20(2): 53-7.
14. Cutter J, Jordan S. Uptake of guidelines to avoid and report exposure to blood and body fluids. *J Adv Nurs* 2004; 46(4): 441-52.
15. Berguer R, Heller PJ. Preventing sharps injuries in the operating room. *J Am Coll Surg* 2004; 199(3):462-7.
16. Ferguson KJ, Waitzkin H, Beekmann SE, Doebbeling BN. Critical incidents of nonadherence with standard precautions guidelines among community hospital-based health care workers. *J Gen Intern Med* 2004; 19: 726-31.
17. Vaughn TE, McCoy KD, Beekmann SE, Woolson RF, Torner JC, Doebbeling BN. Factors promoting consistent adherence to safe needle precautions among hospital workers. *Infect Control Hosp Epidemiol* 2004; 25(7):548-55.
18. Jagger J, Hunt EH, Brand-Elnaggar J, Pearson R. Rates of needlestick injury caused by various devices in a university hospital. *N Engl J Med* 1988;319:284-8.
19. Centers for Disease Control and Prevention. CDC's 7 healthcare safety challenges. Retrieved May 22, 2006, from [http://www.cdc.gov/ncidod/dhqp/about\\_challenges.html](http://www.cdc.gov/ncidod/dhqp/about_challenges.html).
20. International Healthcare Worker Safety Center. Exposure Prevention Information Network. Retrieved August 17, 2005, from <http://www.healthsystem.virginia.edu/internet/epinet/epinet4.cfm>.