ORIGINAL ARTICLE

Sharps Injuries among Employees of Acute Care Hospitals in Massachusetts, 2002–2007

Angela K. Laramie, MPH;[1] Vivian C. Pun, MPH;[1] Shona C. Fang, ScD;[2] David Kriebel, ScD;[3] Letitia Davis, ScD[1]

OBJECTIVE. Sharps with engineered sharps injury protections (SESIPs) have been found to reduce risk of sharps injuries (SIs). We examined trends in SI rates among employees of acute care hospitals in Massachusetts, including the impact of SESIPs on SI trends during 2002–2007.

DESIGN. Prospective surveillance.

SETTING. Seventy-six acute care hospitals licensed by the Massachusetts Department of Public Health.

PARTICIPANTS. Employees of acute care hospitals who reported SIs to their employers.

METHODS. Data on SIs in acute care hospitals collected by the Massachusetts Sharps Injury Surveillance System were used to examine trends in SI rates over time by occupation, hospital size, and device. Negative binomial regression was used to assess trends.

RESULTS. During 2002–2007, 16,158 SIs among employees of 76 acute care hospitals were reported to the surveillance system. The annual SI rate decreased by 22%, with an annual decline of 4.7% ($P < .001$). Rates declined significantly among nurses (−7.2% per year; $P < .001$) but not among physicians (−0.9% per year; $P = .553$). SI rates associated with winged steel needles and hypodermic needles and syringes also declined significantly as the proportion of injuries involving devices with sharps injury prevention features increased during the same time period.

CONCLUSION. SI rates involving devices for which SESIPs are widely available and appear to be increasingly used have declined. The continued use of devices lacking SI protections for which SESIPs are available needs to be addressed. The extent to which injuries involving SESIPs are due to flaws in design or lack of experience and training must be examined.

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Sharps injuries (SIs) in healthcare settings are frequent events with rare but serious negative outcomes. The Centers for Disease Control and Prevention (CDC) estimates that there are more than 384,000 SIs to hospital-based healthcare workers (HCWs) in the United States annually—more than 1,000 injuries each day.[1] SIs have been associated with occupational transmission of hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and more than 20 other pathogens.[2] Estimated risks of infection due to injuries with contaminated sharps involving a source known to be positive for HBV, HCV, or HIV are 23%–62%,[3] 0%–10%,[4-7] and 0.3%,[8] respectively.[9] Postexposure management, including costs of testing source patients and injured employees, counseling, and postexposure prophylaxis, was estimated in 2003 dollars to range from $71 to $4,838 per injury.[10] These estimated costs do not take into account other factors such as the emotional or economic effects on workers and their families, which are difficult to quantify.

SIs are preventable. In workplaces where risk of blood exposure exists, the Occupational Health and Safety Administration (OSHA) Bloodborne Pathogen Standard requires employers to implement comprehensive plans to reduce SIs and other bloodborne pathogen exposures. A cornerstone of the standard is the use of sharps with engineered sharps injury protections (SESIPs),[2] which have been demonstrated in previous studies to prevent SIs.[11,12] According to the CDC, SIs can be prevented by eliminating unnecessary use of needles and other sharps devices, using SESIPs, implementing safe work practices, educating and training HCWs, and promoting a culture of safety in the work environment.[13] Surveillance of SIs among workers is also a critical component of a comprehensive prevention strategy.

In Massachusetts, health care is the largest industry, employing more than 490,000 people, 38% of whom work in hospitals.[14] In 2000, several months before the federal Needlestick Safety and Prevention Act, the Massachusetts legislature enacted "An Act Relative to Needlestick Injury Prevention."[15] Pursuant to the legislation, the Massachusetts Department of Public Health (MDPH) promulgated regulations regarding sharps injury surveillance and prevention.[16]

Affiliations: 1. Massachusetts Department of Public Health Occupational Health Surveillance Program, Boston, Massachusetts; 2. Harvard School of Public Health, Boston, Massachusetts; 3. University of Massachusetts Lowell, Lowell, Massachusetts.

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Like the OSHA Bloodborne Pathogen Standard, the regulations require that hospitals use SESIPs and record SIs among workers. In addition, hospitals are required to submit SI logs annually to the Sharps Injury Surveillance System at the MDPH. This surveillance system, developed with input from both hospital employer representatives and hospital employee representatives, provides a comprehensive descriptive epidemiology of SIs among hospital workers to inform prevention efforts. Here we examine trends in SI rates among employees of acute care hospitals in Massachusetts, including the impact of SESIPs on SI trends during 2002–2007, the first 6 years for which surveillance data were available.

METHODS

Surveillance Design

The Massachusetts Sharps Injury Surveillance System collects data annually on SIs to HCWs in all acute and nonacute care hospitals licensed by MDPH, as well as any satellite units operating under a hospital license. HCWs include all individuals providing services in the hospital, regardless of compensation, including hospital employees, employees of other agencies working in the hospital, and students.

A sharp is defined as any object, including but not limited to needle devices, scalpels, lancets, broken glass, and broken capillary tubes, that can penetrate the skin or any part of the body. A reportable exposure incident is defined as any percutaneous injury from a sharp that is contaminated or potentially contaminated with blood or potentially infectious materials and that occurred in the course of a hospital worker's job duties.

SESIPs are defined as nonneedle or needle devices used for withdrawing body fluids, accessing a vein or artery, or administering medications or other fluids, with built-in safety features or mechanisms that effectively reduce the risk of an exposure incident.[2] For the purpose of this study, nonneedle or needle devices without SI protections are referred to as non-SESIPs. Each device involved in a SI is categorized as SESIP, non-SESIP, or unknown.

MDPH requires hospitals to record detailed information on each SI. Hospitals submit these data annually using a form that includes "pick lists" for variables based on lists developed by the CDC National Surveillance System for Health Care Workers.[17] Once received, data are coded electronically and reviewed manually to assure coding accuracy. The surveillance system is described in detail elsewhere.[18]

For each hospital and each year, we obtained information on the number of licensed beds from the MDPH Division of Health Care Quality in addition to teaching status and number of full-time (2,000 hours) employee equivalents (FTEs) in each acute care hospital from the Massachusetts Division of Health Care Finance and Policy.

Study Population

All 79 acute care hospitals and 20 nonacute care hospitals reported annually, giving a total of 19,485 reported SIs during 2002–2007. Employment data were not available for workers of nonacute care hospitals (499 SIs, 3%), workers at 3 acute care hospitals (295 SIs, 1.5%), as well as nonemployee practitioners (1,511 SIs, 8%), students (544 SIs, 3%), and other workers (478 SIs, 3%). Thus, SIs sustained by these workers were excluded, and the final analysis included SIs among employees of the 76 acute care hospitals for which employment data were available to calculate rates. Ninety-three percent of the employees included were clinical workers (eg, physicians, nurses, technicians, and dental and other medical staff), and 7% were nonclinical (eg, support services, administrative, counselors, pharmacists, and researchers). The distributions of injuries among workers excluded from analysis

TABLE 1. Sharps Injuries among Employees of Acute Care Hospitals, Massachusetts, 2002–2007

	No. (%)[a]
State total	16,158
Occupation	
Nurse	6,640 (41)
Physician	4,618 (29)
Technician[b]	3,458 (21)
Other occupations	1,405 (9)
Department where incident occurred	
Operating and procedure rooms	6,586 (41)
Inpatient units	3,765 (23)
Emergency department	1,447 (9)
Intensive care units	1,390 (9)
Other departments	2,888 (18)
Procedure for which device was used	
Injection	3,707 (23)
Blood procedures	3,131 (19)
Suturing	3,083 (19)
Line procedures	1,600 (10)
Other procedures	3,448 (21)
When and how the injury occurred	
Before use of the item	203 (1)
During use of the item	6,722 (42)
Collision with worker or sharp	1,743 (11)
Suturing	1,619 (10)
Manipulating needle in patient	1,123 (7)
Other	2,237 (14)
After use, before disposal	5,838 (36)
Collision with worker or sharp	1,324 (8)
Handling or passing equipment	1,060 (7)
During cleanup	838 (5)
Other	2,614 (16)
During or after disposal of item	2,278 (14)
During sharps disposal	1,147 (7)
Improper disposal	1,101 (7)
Other	30 (<1)

[a] Percentages may be less than 100% because "unknown, not answered, or nonclassifiable," which comprised less than 7% in each category, is not listed.
[b] Technicians included but were not limited to clinical laboratory, hemodialysis, morgue, operating or surgical room, phlebotomist, psychiatric, radiologic, and respiratory therapist or technician.

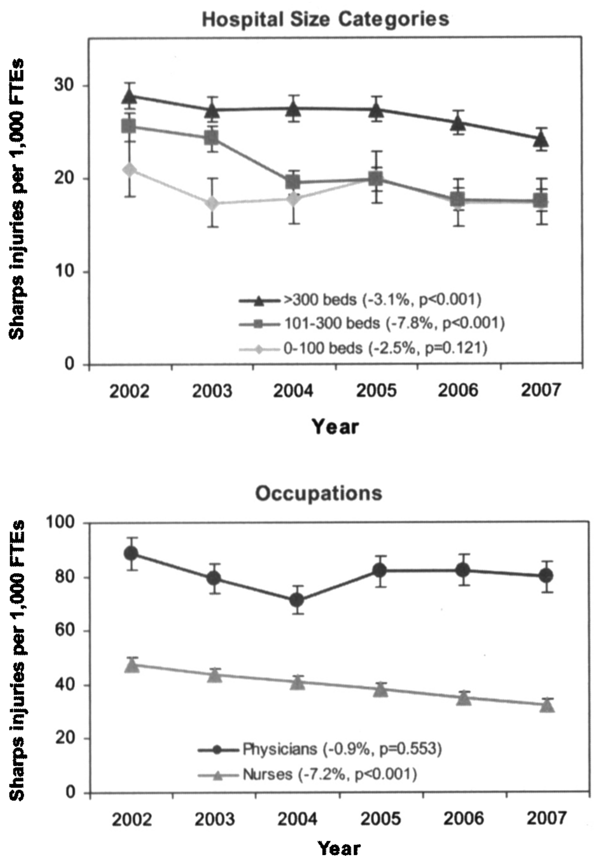

FIGURE 1. Annual rates of sharps injuries among employees of acute care hospitals by hospital size category (number of beds) and occupation, Massachusetts, 2002–2007.

were similar to those among employees included in the analysis with respect to injury characteristics such as department, procedure, and device type.

Statistical Analysis

We characterized the occurrence of SIs as counts, percentages, and rates. Annual SI rates by hospital size, as measured by the number of licensed beds (small, at most 100 beds, $n = 22$; medium, 101–300 beds, $n = 41$; large, more than 300 beds, $n = 13$), and teaching status were calculated. In addition, rates of injuries for selected occupations and associated with selected devices were calculated. Rates were expressed as the number of injuries per 1,000 FTEs.

We examined trends in injury rates over the 6-year period by using negative binominal regression modeling, with incidence rate as the dependent variable and year in linear form as the explanatory variable. We chose a negative binominal distribution to account for overdispersion of observations to correct for unmeasured variables.[19-21] Linear changes in rates of SIs over time were evaluated at the level of P less than or equal to .05. Annual percentage changes in injury rates were also calculated.

We were particularly interested in investigating the impact of SESIPs on SI trends. The most direct way to do this would be to calculate rates of SIs for different devices, using the number of devices as the denominator.[22] However, hospitals are not required to report the number of sharps devices used, and so this direct approach was not feasible. Therefore, SESIP effects were indirectly explored in 2 ways: first, we compared trends in rates of SIs associated with devices for which SESIPs are widely available (hypodermic needles and syringes, winged steel [butterfly] needles, and intravenous [IV] stylets), with trends in the rates of injuries associated with suture needles as the reference group. Unlike the other 3 devices, suture needles have few alternatives available. Although blunt-tip suture needles are identified by OSHA as an alternative to sharp-tip suture needles to reduce percutaneous injuries, their adoption has remained low, partly because of their limited application for suturing less dense tissue such as muscle and fascia.[23] Second, we compared the trends in rates of SIs with trends in the proportion of injuries associated with SESIPs over the same period. If SESIPs are effective, one would expect the SI rate to fall even as the proportion of injuries attributed to SESIPs rises. If only SESIPs are used, all injuries will involve SESIPs.

Associated 2-sided 95% confidence intervals (CIs) and P values for effect estimates from statistical models were calculated. The global χ^2 was used to compare distributions of categorical variables. All analyses were performed using SAS, version 9.1 (SAS Institute).

RESULTS

A total of 16,158 SIs were sustained by employees of 76 Massachusetts acute care hospitals during 2002–2007 and reported to the Massachusetts Sharps Injury Surveillance System—an average of 2,693 injuries per year. Nurses reported the most SIs (41%), followed by physicians (29%); a substantial proportion also occurred among technicians (21%) (Table 1). Operating and procedure rooms were the most frequent locations of SIs (41%), followed by inpatient units (excluding intensive care units) (23%). Injection procedures accounted for 23% of the injuries, while blood procedures (eg, percutaneous venous puncture) and suturing each accounted for 19% of the injuries. An additional 10% occurred as line procedures (eg, inserting central or peripheral IV) were performed. Further, injuries occurred most often after use of the device (50%), which includes 36% occurring after use but before disposal and 14% occurring during or after disposal.

The annual rate of SIs decreased by 22% from 26.7 per 1,000 FTEs (95% CI, 25.8–27.7) in 2002 to 20.8 per 1,000 FTEs (95% CI, 20.0–21.6) in 2007. The annual percentage decline in the SI rate was 4.7% ($P < .001$). However, rates and their changes over time varied by hospital size and occupation (Figure 1). Large hospitals had a consistently higher SI rate than did medium-sized and small hospitals. The rate

TABLE 2. Sharps Injuries among Employees of Acute Care Hospitals by Occupation of Employee and Type of Device Involved, Massachusetts, 2002–2007

		Occupation, no. (%)[a]			
	Total	Nurse	Physician	Technician	All others[b]
State total	16,158	6,640	4,618	3,458	1,442
Device involved in the injury					
Hypodermic needle and syringe	4,822 (30)	2,939 (44)	1,071 (23)	534 (15)	278 (19)
Suture needle	3,110 (19)	573 (9)	1,784 (39)	647 (19)	106 (7)
Winged steel needle	1,707 (11)	753 (11)	97 (2)	700 (22)	157 (11)
Scalpel blade	1,177 (7)	236 (4)	528 (12)	330 (10)	83 (6)
Intravenous stylet	872 (5)	531 (8)	231 (5)	71 (2)	39 (3)
Vacuum tube collection holder and needle	791 (5)	358 (5)	20 (<1)	361 (10)	52 (4)
Other devices	3,340 (21)	1,175 (18)	834 (18)	749 (22)	582 (40)
Unknown, not answered, or nonclassifiable	339 (2)	75 (1)	53 (1)	66 (2)	145 (10)

NOTE. Results shown are from the global χ^2 test ($P < .001$).
[a] Percentage may be greater or less than 100% as a result of the rounding of figures.
[b] "All others" comprised support services, other medical staff, other, unknown, not answered, and nonclassifiable occupations.

of decline was steeper in medium-sized hospitals (7.8% per year) than in large hospitals (3.1% per year), while in small hospitals there was no significant change in the SI rates over the 6-year period.

Although nurses reported the most SIs, the rate of SIs per 1,000 FTEs was consistently higher among physicians (Figure 1). Furthermore, there was no significant change in the rate of SIs among physicians, while there was a significant decline of 7.2% per year among nurses.

Overall, the type of device most frequently involved in SIs was hypodermic needles and syringes (30%). The distribution of injuries by device differed by occupation ($P < .001$), reflective of the types of procedures performed by each occupation. Among nurses, hypodermic needles and syringes accounted for 44% of SIs, making them by far the most common device involved. Among physicians, suture needles were involved most often (39%), followed by hypodermic needles and syringes (23%) (Table 2). Among technicians, injuries occurred most often with IV stylet (22%), followed by suture needles (19%) and hypodermic needles and syringes (15%).

The rate of SIs decreased steadily and significantly for 2 types of devices, hypodermic needles and syringes and winged steel needles—for which SESIPs were widely available and appear to be increasingly used (Figure 2). Specifically, for hypodermic needles and syringes, the SI rate decreased 3.5% per year from 7.0 to 5.8 injuries per 1,000 FTEs. During the same time, the proportion of injuries involving hypodermic needles and syringes with sharps injury prevention features steadily increased—from 36% to 71.1%. A similar pattern was observed for winged steel needles, where the rate of injuries significantly decreased 4.5% per year, from 2.7 to 2.1 injuries per 1,000 FTEs, while the proportion of injuries involving SESIPs increased (74% in 2002 to 92% in 2007). This is the pattern one would expect if SESIPs are largely effective in preventing SIs.

In contrast to those 2 devices, there was no significant decline in the rate of SIs associated with IV stylets (average annual rate, 1.2 per 1,000 FTEs), nor was there a consistent increase in the proportion of injuries involving SESIPs over time.

For suture needles, for which alternatives with sharps injury prevention features are not widely available, the rate of SIs remained relatively high and constant over time (average annual rate, 4.2 per 1,000 FTEs). For these devices, the proportion of injuries involving SESIPs remained very small (ranging from 0.6% in 2002 to 2.4% in 2007).

DISCUSSION

In this study, we report on trends in SI rates among workers in acute care hospitals on the basis of statewide data. From 2002 through 2007, the first 6 years of surveillance in Massachusetts, the rate of reported SIs decreased substantially. This decrease was not uniform across groups examined; SI rates declined in large and midsized hospitals, among nurses, and for injuries associated with devices for which SESIPs are widely available and appeared to be increasingly used. In contrast, there was little evidence of a decrease in the rate in small hospitals, among physicians, or associated with suture needles.

A number of studies of SIs in different healthcare settings have found that many SIs are never reported.[24-28] Even though Massachusetts data come from a mandatory reporting system with excellent compliance at the hospital level, it is likely that not all employees reported their injuries. Thus, it is possible that reduced reporting by employees over time could explain the apparent trends in Figure 1. While possible, we find this explanation unlikely to account fully for the observed pattern.

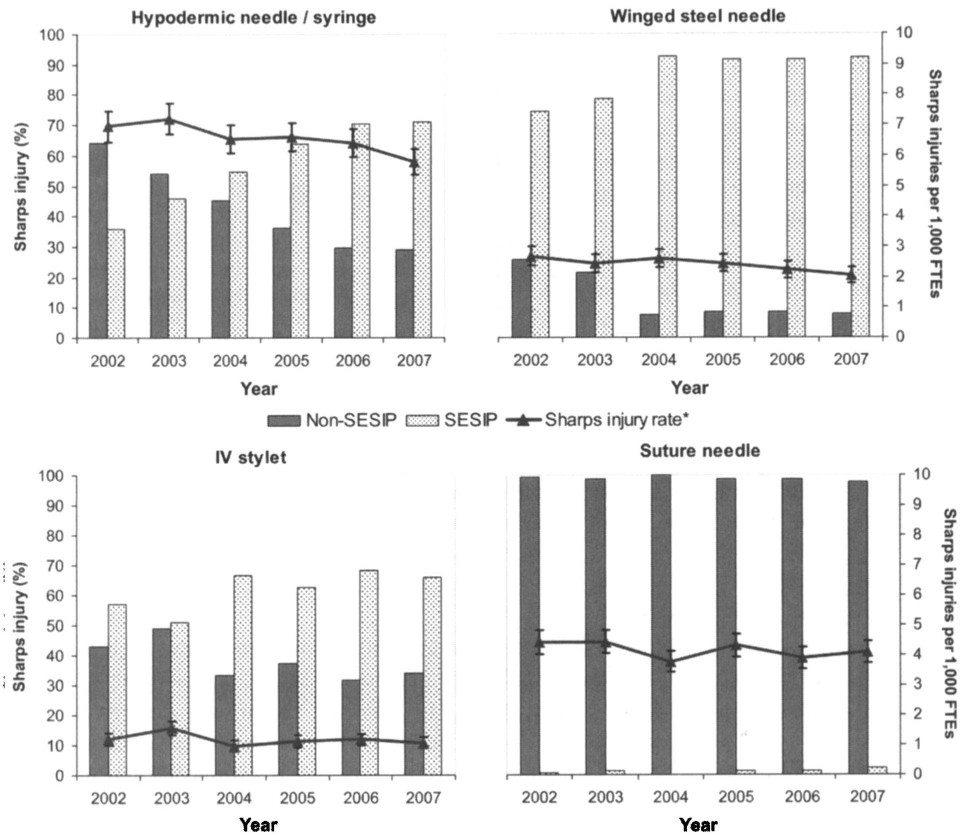

FIGURE 2. Annual rates of sharps injuries (SIs) among employees in acute care hospitals associated with selected devices and percentages of injuries due to sharps with engineered sharps injury protection (SESIPs) and non-SESIPs, Massachusetts, 2002–2007. Annual percentage change in SI rates is −3.5% ($P < .001$) for hypodermic needles and syringes, −4.5% ($P < .001$) for winged steel needles, −3.6% ($P = .238$) for intravenous stylets, and −1.9% ($P = .138$) for suture needles.

It is difficult to find a plausible reason why reporting would decline in larger hospitals but not smaller ones, among nurses but not physicians, and for some devices but not others. In contrast, it is not difficult to identify plausible explanations if this pattern represents real changes in SI rates. The decline among nurses but not physicians, for example, could be explained by differences in the types of devices used (Table 2) and the availability of SESIPs; physicians more often use suture needles and scalpels, for which SESIPs are less available.

It is not unreasonable to assume that there were actually increases in SI reporting by workers in Massachusetts hospitals following the 2001 requirements that hospitals develop comprehensive needlestick injury prevention programs and establishment of the statewide surveillance system. We are aware of several Massachusetts hospitals that implemented new procedures to document SIs. One hospital, for example, used observers in the operating room to facilitate reporting of SIs during surgery, which resulted in more SIs being reported. Any increases in reporting over time would mask an even steeper decline in the underlying SI rate.

The observed decline in SI rates over time is consistent with findings in other studies, most of which have been restricted to select occupations or devices in single hospitals or hospital systems.[11,12,29-34] Several of these studies were conducted in the 1990s. Whether present findings represent a continued steady decline in SI rates that began in the 1990s[35] following the initial OSHA Bloodborne Pathogen Standard or a more recent accelerated decline following state and federal regulatory changes in 2001 is not known because earlier data for Massachusetts hospitals are not available.

The use of SESIPs has been demonstrated to reduce SI risk in a number of studies.[11-13,29-32,34,35] As discussed, information about the number of devices used would provide useful denominators for calculating rates of injury for each type of device and in particular for comparing those with and without sharps injury prevention features. Because we lack these data, we must make inferences about the likely impact of the adoption of SESIPs on SI rates.

If we accept the increase in the proportion of injuries associated with SESIPs as an indicator of increased use of these devices, the correlations in the time trends of SI rates and adoption of devices are consistent with a protective SESIP effect. Rates of SIs from both hypodermic needles and syringes and winged steel needles declined as the proportion of devices with sharps injury prevention features increased. In contrast, there were no meaningful declines in the rates of SIs due to suture needles or IV stylets, neither of which showed strong trends in the increased adoption of SESIPs.

Increased adoption of SESIPs may also reflect increased hospital commitment to workplace safety more broadly, such as improvements in worker orientation and training, work practices, and worker involvement in device selection. These factors, in addition to the increased use of SESIPs, may have contributed to the observed decline in rates.[36] We did not have information to assess the relative contribution of these factors within this study.

The surveillance system is intended to provide information to guide prevention activities, and findings highlight several areas where additional efforts are needed. The steady rate of injuries involving suture needles underscores the need for a comprehensive approach to SI prevention, including the use of work practice and engineering controls. Work practices, such as the use of neutral zones to minimize hand-to-hand passing, verbal cueing, and double gloving, are crucial to reduce injuries involving suture needles.[37] Increased use of blunt suture needles, glues, and adhesive wound closure products would also decrease the number of suture-related injuries.[23]

Our results also point to the need to address the continued use of devices lacking sharps injury prevention features when SESIPs are available. In 2007, about 30% of SIs associated with hypodermic needles and syringes and IV stylets involved non-SESIPs. This 30% represents an opportunity for substantial reductions in risk through more extensive adoption of SESIPs in the provision of patient care. Numerous factors have been identified regarding the barriers to adoption, ranging from cost, device preference, and applicability to certain patient populations, as well as availability in kits.[38-40] Further research to understand the barriers to adoption of SESIPs is needed.

While our results suggest that SESIPs have had some benefit in reducing risk, they also raise questions about the effectiveness of currently available technology to prevent SIs. Looking again at Figure 2, we see that the proportion of SIs involving hypodermic needles and syringes with sharps injury prevention features doubled between 2002 and 2007, while the rate of SIs with these devices declined by only 3.5%. With winged steel needles, more than 90% of the devices involved in injuries had sharps injury prevention features, yet the SI rate remained at about 2 per 1,000 FTEs.

The extent to which injuries involving SESIPs are due to flaws in the design or lack of experience and training in using these newer devices must be examined. Additional research building on the recent study by Tosini et al[22] is needed on the comparative effectiveness of specific mechanisms of sharps injury prevention features in actual practice for the full range of sharps devices. Input from direct-care providers in the identification, selection, and evaluation of work practice and engineering controls is crucial to this process.

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Address correspondence to Angela K. Laramie, MPH, Massachusetts Department of Public Health, 250 Washington Street, Sixth Floor, Boston, MA 02108 (angela.laramie@state.ma.us).

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