THE IMPACT OF MULTIFOCUSED INTERVENTIONS ON SHARPS INJURY RATES AT AN ACUTE-CARE HOSPITAL

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ABSTRACT

OBJECTIVE: To determine the impact of a multifocused interventional program on sharps injury rates.

DESIGN: Sharps injury data were collected prospectively over a 9-year period (1990-1998). Pre- and postinterventional rates were compared after the implementation of sharps injury prevention interventions, which consisted of administrative, work-practice, and engineering controls (ie, the introduction of an anti-needlestick intravenous catheter and a new sharps disposal system).

SETTING: Sharps injury data were collected from healthcare workers employed by a mid-sized, acute-care community hospital.

RESULTS: Preinterventional annual sharps injury incidence rates decreased significantly from 82 sharps injuries/1,000 worked full-time–equivalent employees (WFTE) to 24 sharps injuries/1,000 WFTE employees postintervention ($P<.0001$), representing a 70% decline in incidence rate overall. Over the course of the study, the incidence rate for sharps injuries related to intravenous lines declined by 93%, hollow-bore needlesticks decreased by 75%, and non–hollow-bore injuries decreased by 25%.

CONCLUSION: The implementation of a multifocused interventional program led to a significant and sustained decrease in the overall rate of sharps injuries in hospital-based healthcare workers (*Infect Control Hosp Epidemiol* 1999;20:806-811).

Despite many interventions designed to limit needlesticks and other sharps injuries through administrative, regulatory, work-practice, and engineering controls, it is estimated that there still are between 800,000 and 1 million needlesticks and other sharps injuries to healthcare workers (HCWs) in the United States each year.[1] These injuries represent an important source of bloodborne pathogen exposure for HCWs. As of June 1998, the Centers for Disease Control and Prevention reported 54 HCWs with documented human immunodeficiency virus (HIV) seroconversion following occupational exposure, plus an additional 114 cases of HIV infection in HCWs that most likely are the result of occupational exposure.[2] The risk of contracting HIV and other bloodborne pathogens by HCWs, given a contaminated needlestick exposure, has been estimated at 0.3% to 0.4% for HIV, 10% to 35% for hepatitis B virus, and 1.2% to 10% for hepatitis C virus.[3-11] It is, therefore, important to continue to emphasize and evaluate bloodborne pathogen risk reduction measures.

Several new engineering controls, such as safety needle devices, have been developed over the past few years, and many of these show promise in reducing needlestick-related bloodborne pathogen exposures.[12-16] However, based on the findings from earlier HCW studies, engineering controls are probably most effective, and effectively used, when they are part of an overall bloodborne pathogens risk-reduction program.[17-18] HCWs are more likely to adopt safe work practices, including the safe and effective use of anti-needlestick devices, if they perceive a strong safety climate with a demonstrable organizational commitment to safety.[19-22] Therefore, a multifocused approach incorporating administrative controls (ie, enhancing safety climate), work practice controls, and engineering controls should be beneficial in the overall reduction of sharps injuries. The goal of this study was to determine the impact, if any, of a multifocused intervention on the number of sharps injuries experienced by the HCWs of a community hospital.

METHODS

In 1991, senior administrators of a 450-bed acute-care community hospital in the Greater Washington, DC, area created an anti-needlestick and sharps injuries task force under the guidance of the Infection Control and Safety committees. This task force was charged with the development of a comprehensive program to reduce the incidence of sharps injuries. Its recommendations were introduced during 1992. To evaluate the program's effectiveness, a

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review was conducted of the sharps injury data, which in turn culminated in this report.

Sharps injury data were collected over a 9-year period, from 1990 to 1998, with data collected during 1990 and 1991 serving as the baseline. In 1992, the multifocused intervention program was implemented, with data collected in 1992 considered transitional data. The data from 1993 to 1998 serve as postinterventional data and allow for the assessment of the effectiveness of the interventions over the 9-year period.

Interventions

Two engineering controls were introduced in 1992: a needleless system for intravenous (IV) therapy and a new facility-wide sharps disposal system. Both systems were implemented throughout the hospital, and, over the course of 2 months, all alternative systems were phased out. The introduction of both systems was accompanied by facility-wide training programs, unit-specific training, and train-the-trainer programs aimed at managers. The new sharps disposal system included conveniently locating numerous impervious sharps containers throughout the hospital. Unlike the hospital's previous containers, the new ones had extra-wide mouths for ease of use. In addition to the improvements in the containers and in their placement, one of the most attractive features of the new system was the built-in "change-out" protocol. The nursing staff previously had been responsible for changing out full containers, but under the new system, sharps containers were changed on a frequent schedule by contracted employees of a sharps disposal firm. A change-out schedule was devised, so that containers were emptied before they had an opportunity to be overfilled. A clear (see-through) area at the top of the containers allowed for a visual check.

Administrative controls also were implemented as follows: (1) An intensive educational effort was undertaken that included mandatory annual training in general infection control and sharps injury prevention issues for all hospital employees; (2) employee health programs were enhanced and expanded; and (3) the injury reporting process was expedited, and employee concerns regarding confidentiality were identified and addressed. The anti-needlestick and sharps task force, through its activities and high visibility, also became an important indicator of management's demonstrated commitment to safety. The work-practice controls that were implemented (such as the prohibition against two-handed recapping and the safe use of anti-needlestick devices) were encouraged by incorporating compliance measures into both employees' and managers' job performance evaluations.

Data Collection

Sharps injury data were collected using a detailed exposure questionnaire, which all exposed workers were asked to complete as soon as possible after experiencing a sharps injury. Reporting was mandatory for hospital employees, and incentives (eg, free confidential testing, rapid turnaround time, and support counseling for both employees and family members) were provided to encourage reporting. The questionnaire, which remained the same throughout the study period, included questions about the time of the occurrence, type of sharp device used, mechanism of injury, and type of personal protective equipment in use at the time of injury. Results from the questionnaires and any serological tests ordered were maintained confidentially by the Employee Health Office and entered into a data-management program for later analysis.

Determination of Rate

To determine the rate of sharps injuries for hospital employees (physicians and house staff were not included because of difficulties determining a reasonable and consistent denominator), payroll records were used to calculate the number of worked full-time–equivalent (WFTE) employees for each of the study years. Worked full-time equivalency was calculated as the number of hours worked and paid by payroll, converted to an 8-hour workday or 2,080 hours per person-year. The sharps injury rate then was calculated as follows: 1,000×average number of sharps injuries per year/WFTE. Significance was determined using binomial probabilities for incidence rate data (STATA Corp, College Station, TX).

RESULTS

Data were collected on a total of 693 sharps injuries reported by an annual average of 2,300 employees (approximately 1,500 WFTE/y) over a period of 9 years (1990-1998); roughly 85% of all employees were either healthcare providers (clinical or laboratory) or ancillary workers at risk for sharps injuries. Sharps injuries were most frequently reported by registered nurses and licensed practical nurses, followed by technicians and support staff. No substantial differences were noted in the demographic profile of the exposed HCWs pre- and postintervention. Day of the week was not associated with sharps injury risk. Sharps injuries were significantly more likely to occur early in the day (6AM-12PM) rather than later in the day, probably reflecting more patient interactions (eg, blood draws) during the early hours. The number of consecutive hours on duty was not associated with an increased risk for sharps injury. The most common body fluid involved was blood, accounting for more than 95% of the reported exposures.

Sharps Injuries

From 1990 to 1998, an overall decrease in the rate of sharps injuries was noted; the rate declined significantly from 82 sharps injuries per 1,000 WFTE (1990-1991) to 24 sharps injuries per 1,000 WFTE (1997-1998), representing more than a two-thirds decrease ($P<.0001$). The total number of sharps injuries for the 2-year period prior to the interventions (1990 and 1991) was 243. In 1992, the transitional year, there were 101 sharps injuries and 139 in the subsequent 2-year period (1993-1994). Sharps injuries have continued to decline (Table 1), with 79 sharps injuries for the most recent 2-year period (1997-1998) compared with 243

TABLE 1
693 SHARPS INJURIES: EXPOSURE DATA, 1990 TO 1998

	1990-1991 Preinterventional Period		1992 Interventional Period	1993-1994 First Postinterventional Period		1995-1996 Second Postinterventional Period		1997-1998 Third Postinterventional Period	
Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
No. of sharps injuries/y	122	121	101	79	60	69	62	44	35
Total sharps injuries for each period	243		101	139		131		79	
No. of WFTE each period	2,976		1,315	3,130		3,520		3,252	
Total sharps injury rate/1,000 WFTE, by period	82		77	44		37		24	

No. and % of sharps injury by category	n	%	n	%	n	%	n	%	n	%
Injured employees (by occupation)										
Nurse	173	71	76	75	95	68	88	67	57	72
Other	70	29	25	25	44	32	43	33	22	28
Type of sharp involved in injury										
Hollow-bore needle	196	81	70	69	88	64	89	71	53	68
Solid needle	10	4	13	13	22	16	23	18	14	18
Surgical instrument	16	7	10	10	18	13	7	6	7	9
Glass	2	1	3	3	5	4	1	1	3	4
Other	18	7	5	5	5	4	6	5	1	1
Missing data	1	—	0	—	1	—	5	—	1	—
Injury risk factors										
Recapping	22	9	10	10	10	7	6	5	3	4
Intravenous line-related	43	18	18	18	8	6	5	4	4	5
Patient movement	26	11	8	8	19	14	16	13	9	11
Caused by coworker actions	19	8	10	10	19	14	15	12	15	19
Improper disposal	41	17	12	12	18	13	22	17	23	29
During cleaning or reprocessing	59	24	26	25	31	22	46	37	19	24
Other	32	13	17	17	33	24	16	13	6	8
Missing data	1	—	0	—	1	—	5	—	0	—

Abbreviation: WFTE, worked full-time–equivalent employees.

sharps injuries for the 2-year preinterventional period (a 70% decline). Importantly, the number of hollow-bore needlesticks (the type of sharps injury with the greatest risk of infection), declined at an even greater rate, from 196 (6.5/1,000 WFTE) in the preinterventional period to 53 (1.6/1,000 WFTE) in the most recent 2-year period, representing a 75% decline ($P<.05$; Figure).

Flushing or injecting of IV lines and handling of secondary lines accounted initially for 18% of all sharps injuries (43/243), whereas the total number of IV-associated injuries in each of the three 2-year postinterventional periods was 8, 5, and 4, respectively, representing an overall decrease of 92% in sharps injuries related to lines.

In the preintervention period, 10 sharps injuries were caused by "solid" (non–hollow-bore) needles (ie, suture needles); in the most recent postintervention period, 14 injuries involved these devices, which does not represent a significant change in the rate of these types of injuries.

Because one of the specific interventions was a new needle disposal system, injuries associated with disposal were of interest. Over the 9-year period, the overall absolute number of injuries from improper disposal declined by 50%. The effectiveness of the sharps disposal interventions also may have led to decreases in injuries attributed to unsafe work practices (eg, recapping). The number of needlesticks related to recapping declined by 88% ($P<.0001$) from the 1990 through 1991 to the 1997 through 1998 period. Administrative controls (eg, improvements in overall safety climate) also may have affected recapping, but this is difficult to evaluate.

Significant decreases in sharps injuries were noted in every single category of risk factors (Table 2), except those caused by coworker actions. Interestingly, improvements in overall use of personal protective equipment also were noted; appropriate glove use, as reported by exposed workers, increased significantly, from 50% during 1990 and 1991 to 81% during 1997 and 1998 ($P<.05$).

DISCUSSION

Jagger and coworkers have documented the importance of engineering controls in eliminating or minimizing

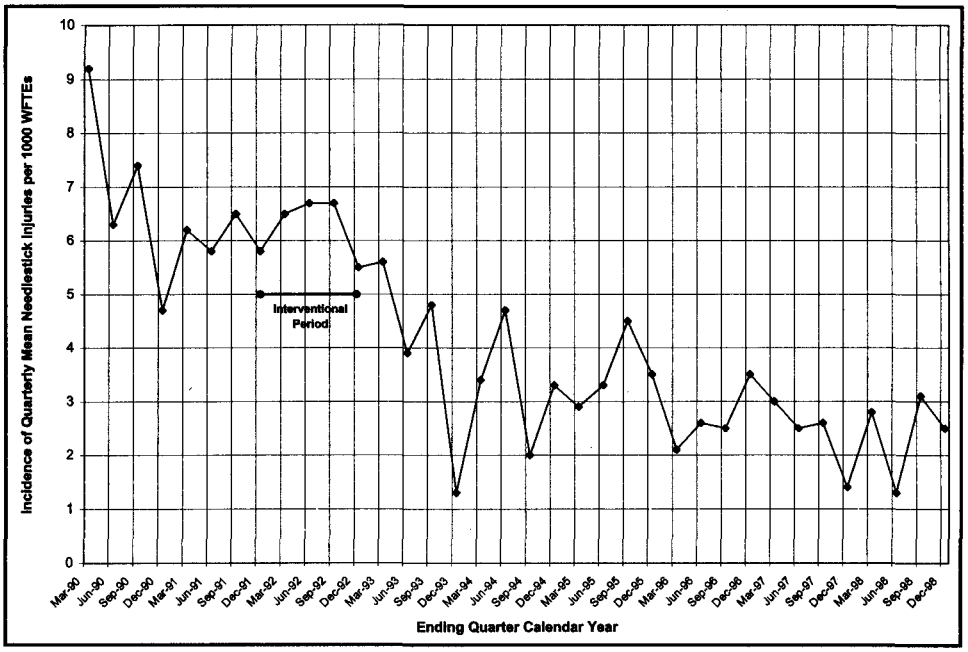

FIGURE. Needlestick injuries per 1,000 worked full-time-equivalent employees.

needlestick injuries, and other researchers also have reported significant decreases in needlesticks after introducing needleless IV systems, with decreases in line-related injuries ranging from 54% to 88%.[12-14,23,24] This study's decline of 92% in intravenous line-associated injuries adds further evidence to support the effectiveness of these systems. The introduction of the needleless system had an immediate impact on hollow-bore needlesticks and has nearly eliminated line-related injuries. The rate of intravenous-related needlesticks declined from 14 per 1,000 WFTE to 1 per 1,000 WFTE.

In contrast, previous studies have shown equivocal results following the implementation of other engineering interventions, such as those designed to reduce the risk of disposal-related needlestick injury. Ribner found an overall increase in needlestick injuries after a puncture-resistant disposal system was installed.[17] Similarly, a study by Linnemann showed that the installation of new needle disposal containers changed the type, but not the overall rate, of needlestick injuries.[16] Our study found that the implementation of a new sharps disposal system resulted in a significant decline in the rate of disposal-related sharps injuries. A study by Weltman and colleagues suggested that ergonomic issues are important in disposal-related needlestick injuries. They noted that injuries were significantly associated with a floor-to-disposal unit height of greater than 4 feet.[25] In our study, ergonomic factors (eg, height of the container, placement within the room for easy access, etc) were considered when placing the containers to facilitate their use, and this may have helped to reduce the rate of such exposures.[26] Recently, these factors have been well defined and published in a government document.[27] However, it is important to note that, in our study, disposal-related sharps injuries still accounted for approximately one third of all remaining sharps injuries in this hospital.

Our results show that there has been a decline in a wide range of sharps injuries, including several categories that were not specifically targeted by the interventions, and this may reflect the indirect impact of the interventions. For example, there may have been fewer patient-movement–related injuries because of the safer needleless IV system in place. Because of the convenience of the sharps containers, fewer needles may have made their way downstream, where they could present a risk for ancillary workers. This may explain the decrease in sharps injuries seen in the cleaning, processing, miscellaneous, and other categories (which includes injuries to laundry, reprocessing, maintenance, and housekeeping staff). The improvements in the sharps disposal system also may have made recapping unnecessary, thus resulting in fewer recapping injuries. In fact, the only risk factor for sharps injuries that did not improve was the "coworker action" category. Many of these occurred in the operating room, and unfortunately none of the interventions either directly or indirectly led to improvements in that area. Similarly, the number of injuries caused by solid needles (ie, suture needles) increased, which may reflect an increase in surgical and emergency procedures or better reporting of these types of injuries. The interventions did not target hollow-bore or suture needles, because suitable safety-featured substitutes were not identified at that time by the hospital's safety-product task force. These two devices represented 85% of all sharps injuries in the preintervention period and 86% in the most recent postintervention period. The task force has recently evaluated newer safety devices, targeting these inherently risky devices, and, once implemented, we expect to see significant declines in sharps injuries in these categories as well.

There were several other important, if less tangible, benefits derived from the implementation of the multifo-

TABLE 2
FACTORS RELATED TO NEEDLESTICK INJURIES: COMPARISON OF PRE- AND POSTINTERVENTIONAL DATA

Factor	1990-1991 Preintervention Period n	1990-1991 Preintervention Period Rate/1,000 WFTE	1997-1998 Postintervention Period n	1997-1998 Postintervention Period Rate/1,000 WFTE	% Decline	P
Recapping	22	7.3	3	.84	88	<.0001
Intravenous line-related	43	14.4	4	1.1	92	<.0001
Patient movement	26	8.7	9	2.5	68	<.01
Caused by coworker actions	19	6.4	15	4.6	28	NS
Improper disposal	41	1.4	23	0.7	50	<.01
During cleaning or repackaging	59	1.9	19	0.5	70	<.0001
Other	32	1.0	6	0.2	83	<.0001
Missing data	1		0			
Total	243		79		70	<.0001

Abbreviation: NS, not significant; WFTE, worked full-time–equivalent employees per year.

cused interventions. For example, in addition to improved glove use, improved compliance with the Occupational Safety and Health Administration Bloodborne Pathogen Standard was documented during the hospital's annual departmental safety surveys and monthly walk-through inspections.

One important limitation of the study was the difficulty in determining the impact of the individual interventions, since several interventions were implemented concurrently. Unfortunately, the hospital setting is not always conducive to conducting experimental research studies; the hospital administration wanted to reduce exposures as much as possible in the shortest amount of time, which required concurrent implementation of the control measures. While difficult to evaluate, we believe the effectiveness of the engineering interventions was enhanced by the supporting training and educational program. In fact, the training component was extremely important to the successful implementation of all of the interventions.

Another limitation of the study was its reliance on self-reported injuries, which raises the issue of underreporting and selection bias. Reporting of all exposures was required by hospital protocol and encouraged by offering free and confidential testing and follow-up as indicated; however, reporting was the individual's responsibility. Recall bias was limited by having the injured workers complete the questionnaire at the time they reported the injury and thus probably was not a material problem. A further limitation of the study was the lack of control over secular trends at the hospital. Over the course of 9 years, there was ample opportunity for many different factors, unrelated to the interventions, to influence needlestick rates. Again, this reflects the difficulty in conducting field research, especially long-term, well-controlled studies, in this setting.

This study demonstrates that a sustained, significant reduction in the number of sharps injuries experienced by hospital personnel can be achieved through a coordinated, multifocused interventional program. Although the overall annual number of sharps injuries decreased by over two thirds, a substantial number still remains. The interventions did not specifically address non–IV-related needlesticks, such as injection and solid-needle injuries, and these two types of devices now account for 86% of all sharps injuries in this hospital. The task force periodically reviewed potential safety-needle candidates, but, until fairly recently, none of the safety products it examined qualified for field trials (as per the hospital's product-evaluation protocol). As improved safety designs enter the market, new products will successfully target these and other remaining sharps injuries. Additional research is needed to identify effective interventions that continue to target both hollow-bore (injection) and non–hollow-bore needles, as well as injuries related to disposal mechanisms and unsafe work practices.[26,28] Interventions specifically targeting nurses also are needed, as nurses represent the single largest occupational group at risk. Studies evaluating the effectiveness of training programs, including device training programs, are sparse and should be conducted.[29]

In conclusion, we found that significant and sustained improvements were realized by this multifocused approach to sharps injury prevention. Continued efforts are needed to address this important public health problem further.

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Outbreak of West Nile-Like Virus Encephalitis, New York City

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An outbreak of arboviral encephalitis was first recognized in New York City in late August and has since been identified in neighboring counties in New York state. Although initially attributed to St Louis encephalitis (SLE) virus, based on positive serological findings in the cerebrospinal fluid and serum samples, the cause of the outbreak has been confirmed as a West Nile-like virus, based on the identification of virus in human, avian, and mosquito samples.

Prior to the outbreak, local health officials observed an increase in fatalities among New York City birds, especially crows. Testing of the birds by polymerase chain reaction and DNA sequencing isolated virus from the birds' tissue that indicated it was closely related to the West Nile virus (WNV).

As of September 28, a total of 17 confirmed and 29 probable human cases and 4 deaths have been reported from New York City and the surrounding area. Vector control measures were implemented, and surveillance for new human cases of WNV will continue until several weeks after the first frost, when mosquito activity is expected to subside.

Like the St Louis encephalitis virus, WNV is transmitted principally by the *Culex* species mosquito, but also can be transmitted by the *Aedes, Anopheles,* and other species. The predominance of urban *Culex* mosquitoes trapped during this outbreak suggests an important role for this species.

It is not clear whether the virus causing this outbreak is related to previous outbreaks in Israel in the 1950s, France and Romania in the 1960s, and South Africa in the 1970s, or if it is a new variant. Although it is not known when and how a West Nile-like virus was introduced into North America, international travel of infected persons to New York or transport by imported infected birds may have played a role.

FROM: Centers for Disease Control and Prevention. Outbreak of West Nile-like virus encephalitis, New York, 1999. *MMWR* 1999;28: 845-847.