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Impact of Needlestick Safety & Prevention Act (HR5178) on Hospital Worker Injury

National Institute for Occupational Safety and Health (NIOSH)

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List of Terms and Abbreviations

FTE	Full Time Equivalents
OSHA	Occupational Safety and Health Administration
CDC	Centers for Disease Control and Prevention
GAO	U.S. Government Accountability Office
NSPA	Needlestick Safety and Prevention Act
HCW	Health care worker
PI	Percutaneous injury
EPINet	Exposure Prevention Information Network

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Abstract

Percutaneous injuries from contaminated sharp devices remain an important issue for healthcare workers despite improvements over the past two decades. H.R.5178 (the Needlestick Safety and Prevention Act), enacted in 2000, was intended to protect a high-risk population from injury while performing routine, albeit hazardous procedures. This study quantified changes in hospital worker injury rates associated with the legislation.

We employed a historical prospective study design, using surveillance data maintained at the University of Virginia International Healthcare Worker Safety Center. We tracked annual injury rates from 1995 through 2005 (reflecting 23,908 reported injuries from 85 hospitals across 10 states).

In addition to calculating changes in overall rates, we estimated job-specific annual injury rates for nurses, the employee group experiencing the largest number of occupational sharps injuries. We analyzed the changes in rates using various denominators (FTEs, beds, admissions). We also examined the change in proportion of injury rates attributable to safety-engineered devices.

We observed no decrease in the pre-legislation period, followed by a significant decrease ($P<0.001$) in 2001for all injury rate analyses. Subsequent injury rates remained well below pre-legislation rates. The decrease varied somewhat (38%-42%) based on the denominator, but the pattern was very similar for all denominators. Nurses experienced a decreased proportion of injuries compared to other workers.

Concomitant with the decrease in injuries was an increase in the proportion of injuries from safety-engineered devices. This parallels a steep rise in the sales and use of safety-engineered devices following the legislation, resulting in a larger proportion of a smaller number and rate of injuries. During the period of decreased injury rates, OSHA also reported an increase in citations and fines related to violations of the Bloodborne Pathogens Standard

Using the CDC's national estimate of 385,000 annual hospital needlestick injuries [based on 1997-98 injury data], and the GAO's national estimate of $500-$3000 for the cost of needlestick injury follow-up, and a conservative estimate of 36% reduction in needlesticks after the legislation, we estimate an annual reduction of 138,600 needlesticks. Cost savings from follow-up that would have been required are estimated at $69M - $415M for each year since the legislation.

These findings add to the body of evidence supporting the use of mandates coupled with enforcement in improving healthcare worker safety. The association between increases in safety-engineered devices and reduction in sharps injuries reinforces the importance of continued development and adoption of safety-engineered devices. Collaboration among device manufacturers and healthcare workers will likely produce the best devices. There are policy implications for the healthcare industry and for worker safety and health related to morbidity and mortality of occupational bloodborne pathogen exposure, costs of injury follow-up, in-service educational requirements and the transition from hospital to non-hospital locus of care delivery.

Practitioners, educators, administrators, researchers, device manufacturers and policy makers each have a role in addressing the remaining challenges in the U.S., and in collaborating with colleagues in the global community. Protecting the health of the healthcare workforce is critical to preserving the healthcare infrastructure and the availability of healthcare resources.

Section 1

Significant Findings: We observed an increasing trend in percutaneous injury rates during the years preceding the Needlestick Safety and Prevention Act (NSPA). In the year following the legislation, 2001, we observed a significant decrease of ~40% in percutaneous injury rates ($P<0.001$). Although there was some variation in subsequent years, rates never approached those in pre-legislation years.

The drop in the year following the legislation ranged from 36-43%, depending on the denominator used to calculate percutaneous injury rates (FTEs, beds, admissions). The pattern, as described above, was very similar for all denominators. Nurses experienced a decreasing proportion of all injuries compared to all other groups. Concomitant with a significant decrease in injury rates was an increase in the proportion of injuries attributed to safety-engineered devices in the years following the legislation. Safety-engineered device injuries comprised a larger proportion of fewer injuries.

Using the CDC's national estimate of hospital percutaneous injuries and the Government Accounting Office's national estimate of cost of needlestick follow-up, and applying the lowest estimate of reduction in needlesticks observed, we estimate an annual reduction of 138,600 needlesticks in each year since the legislation. This translates to a savings in follow-up costs for each year ranging from \$69M-\$415M annually, or \$345M-\$2+B over the first five years.

Translation of Findings: The findings strongly support the use of legislation and accompanying enforcement to increase workplace and worker safety. The legislation required amendments to the Occupational Safety and Health Administration's 1991 Bloodborne Pathogens Standard, including purchase of safety-engineered devices, annual review of exposure control plans, inclusion of front-line employees in evaluating and selecting devices, and maintaining a sharps injury log. This forced a focus on worker safety in healthcare facilities. In addition, the Occupational Safety and Health Administration increased its monitoring and citation of hospital activities related to violation of the new Standard. These are all reflected in the study findings.

That no significant decrease in injury rates occurred in the period observed prior to the legislation disputes the idea that rates were already on a downward trend, and the legislation simply bisected this trend or perhaps accelerated it. While these findings cannot establish cause and effect, it is hard to imagine another factor that occurred in that particular year that would explain the findings. The 1991 Standard addressed some of the same issues and any earlier impact was felt prior to the period observed here. Similarly, safety-engineered devices were already on the market, but market penetration had remained low for many of these devices.

The use of various denominators reflects lack of common agreement on how best to measure injury rates. While our Center commonly uses beds as a denominator, because that is what is reported to EPINet, we understand that beds are not at risk of getting injured, and that if there were no patients in the bed, there was little or no risk of worker injury. Use of admissions

considers bed turnover and occupancy. Using FTEs focuses the rate on staffing and injuries related to workforce. The fact that the pattern of results across denominators was nearly identical suggests that the denominators are highly correlated and/or that the impact of the legislation was sufficiently robust to mask any differences in the denominator. It also gives some confidence in the findings of earlier studies on hospital injury rates using these other denominators.

The disproportionately favorable impact on nurses may suggest that nurses are more conscientious about using safe practices, including disposal and device selection; or that nurses are, as required by NSPA, included in the identification, evaluation and selection of safety devices; or that safety-engineered devices on the market are used more by nurses than others. Considering that nurses have historically experienced the largest number of percutaneous injuries, this larger percentage drop represents a large decrease in overall number of injuries.

The correlation between the decrease in injuries and the increased proportion of injuries from safety-engineered devices suggests that the diffusion and adoption of safety-engineered devices may have influenced the drop in rates. If fewer non-safety devices are used, then fewer injuries from them can be experienced. Only a comparison of injury rates from safety- and non-safety devices, with devices purchased or used as the denominator, could address the differences in device-specific injury rates. We did not have that type of denominator data.

The estimate of savings begins to address hospitals' concerns about the increased costs of safety-engineered devices. These savings estimates are only for immediate follow-up costs; they do not include long-term costs of care following seroconversion, or the costs of lost work time or emotional stress. Also, we would expect the cost differential to dissipate over time as safety device production volume increases.

Outcomes/Impact: Potential outcomes – These findings have the potential to influence legislation internationally. Energy surrounding proposed legislation similar to NSPA is percolating in many countries. Documenting quantitative evidence of successful impact (both in terms of injury reduction and cost savings) can provide leverage to those who are proposing this legislation.

Intermediate outcomes-As a result of presenting and publishing the study findings, providers, especially nurses, have taken action to participate in device selection and to demand participation if it was not solicited.

End outcomes-when policy makers, healthcare providers, manufacturers and administrators agree on the value of a change in practice policy, legislative mandates and enforcement can increase the likelihood of appropriate action. Since percutaneous injuries are the major route of bloodborne pathogen transmission, reduction in these injuries can reasonably be expected to reduce subsequent morbidity and mortality. Such documentation is beyond the scope of this study.

Section 2

Educational Report

The K award required Dr. Phillips to develop expertise in occupational health and injury prevention. From October through December, 2008, Dr. Phillips completed the following courses at Johns Hopkins School of Public Health in Baltimore:

Health Policy II: Public Health Policy Formulation

Epidemiology Methods in Injury Control

Graduate Seminar in Injury Research and Policy

Confronting the Burden of Injuries: A Global Perspective

Introduction to Ergonomics

Principles of Occupational and Environmental Hygiene

She arranged an Independent study with Susan Baker, Professor of Health and Public Policy; Director, NIAAA Training Program in Alcohol, Injury, & Violence; former director, Johns Hopkins Center for Injury Research and Policy; and a world-renowned epidemiologist specializing in injury prevention.

In addition, Dr. Phillips trained in IRB and data protection. This included three online courses: Privacy, Compliance, Ethics, Electronic Security Mandatory Retraining; and CITI courses on Human Research and Social and Behavioral Research. She also enrolled in IRB 101, which provides an overview of the ethics and regulations of research involving human subjects.

Scientific Report

Background

The healthcare industry is one of the largest in the U.S., and its role in maintaining the health of the population is critical. When healthcare workers' (HCWs) ability to work is compromised, it compromises not just the industry but the population's health. For this reason and others, occupational health risks faced by HCWs are a significant public health issue. Blood exposure as an occupational risk is long-standing, but a large-scale effort to address it in the U.S. did not begin until the 1980s. Of all occupational risks to HCWs, bloodborne pathogen exposure is among the most life-threatening. Infection transmission most often occurs via percutaneous

injuries (PIs) from contaminated sharp devices. Approximately 385,000 PIs occur annually in U.S. hospitals (estimate based on data from 1997-1998).[1]

Transmission rates from contaminated sharp device injuries are estimated at 6%-30% for HBV, 0.3% for HIV and 0.5% for HCV. [2-4] Pathogen-specific prevention and treatment advances, such as the hepatitis B vaccine and antiretroviral post-exposure prophylaxis for HIV, have had a significant impact in reducing infections from these two pathogens.[5,6] In addition, treatment during the acute phase of HCV infection (within six months of infection) is associated with a high rate of infection resolution, preventing progression to chronic HCV infection.

Concurrent with these pathogen-specific efforts, energy has been devoted to reducing the incidence of all blood and body-fluid exposures. Early prevention efforts focused mainly on three areas: implementing the Centers for Disease Control and Prevention (CDC)'s 1982 recommendation not to recap needles,[7-9] reducing risk from disposal-related injuries by improving the design and placement of sharps disposal containers,[10-12] and educating HCWs to be more careful in handling sharp devices.[13] In 1988, one of the earliest epidemiologic studies of device-related sharps injuries was published.[14] It set forth product design principles for safer devices that are still in use today. Over the next decade, medical device manufacturers were issued more than 2,000 U.S. patents for safety-engineered needles and sharp medical devices.[15]

To document blood exposure risks and to assist healthcare institutions in complying with the recordkeeping requirements of Occupational Safety and Health Administration (OSHA)'s 1991 Bloodborne Pathogens Standard,[16] the Exposure Prevention Information Network (EPINet), a sharps injury surveillance system, was introduced.[17] In 1992, the first multi-hospital data-sharing sharps injury surveillance network was established at the University of Virginia International Healthcare Worker Safety Center, with healthcare facilities voluntarily contributing EPINet exposure data.[18] In addition to assisting facilities in establishing safety priorities, and aiding manufacturers in developing safer devices, these data were used repeatedly to identify national trends in sharps injuries.

These data also helped to leverage support for stronger regulations and legislation to protect HCWs, including the Needlestick Safety and Prevention Act (NSPA)—landmark legislation requiring employers to provide safety-engineered devices for employees who are at

risk for bloodborne pathogen exposure, to include frontline workers in selecting these devices, to review exposure-control plans at least annually, ensuring that they reflect advances in sharps-safety technology, and to maintain sharps-injury logs with specific injury details. [19] The NSPA also mandated that OSHA revise the Bloodborne Pathogens Standard in 2001, incorporating these requirements. [20]

OSHA's 1991 Bloodborne Pathogens Standard already required much of what was included in the legislation, but PI rates had continued unabated throughout the 1990's. Given the evidence for the effectiveness of safety-engineered sharp devices in reducing PIs in device-specific trials, it follows that hospital-wide PI rates should decline when safety devices are substituted for their conventional counterparts in large numbers. After the enactment of the NSPA in 2000, evidence for such declines began to be reported. A study conducted in a New York City hospital reported a 58% decline in the incidence of PIs in the year after the law went into effect, with an even larger decline—71%—for injuries from hollow-bore needles.[21] A comparison of PI data from 1993 and 2001 in a teaching hospital network showed a 51% decrease in PIs among nurses.[22]

These findings suggest that the implementation of safety-engineered devices, as mandated by the NSPA, had the intended effect of accelerating the transition from conventional to safety needles and reducing sharps injuries to HCWs. The CDC declared the elimination of needlesticks to HCWs one of its seven "Healthcare Safety Challenges." [23] However, there had not been a comprehensive analysis of multi-hospital, multi-state PI data to systematically characterize the changes in PIs, and the impact of federal regulations and legislation on the occupational risk of sharp injuries. This research was intended to fill that gap.

Aims

The aim of the study was to document the impact of H.R. 5178, the Needlestick Safety and Prevention Act (NSPA) on hospital HCWs' injuries. This is reflected in the main study hypothesis:

H1 PI rates among HCWs will decrease significantly after the enactment of the NSPA in 2000.

Since there is no universally accepted denominator for calculating injury rates, we intended to examine PI rates using three denominators: hospital beds, admissions and full-time-equivalents (FTEs). Patterns of change would be compared across denominators.

We also analyzed PI rate changes taking into consideration regional variation, job categories, hospital types, hospital departments and specific devices. For comparative purposes, mucocutaneous (non-intact skin and mucous membrane) exposure rates, which were not directly addressed by the NSPA, would be assessed for the same time frame.

In a fourth year no-cost extension, the following additional activities were proposed:

estimating the national dollars saved as a result of the reduction in needlestick injuries,

analyzing "on-the-ground" information and observations describing activities in hospitals during the transition period, and

delivering a webinar on sharps safety, based on nurse-specific study findings, in collaboration with the American Nurses Association.

Methodology

Study Design

We employed a historical prospective design, using EPINet data from the sharps injury database maintained by the International Healthcare Worker Safety Center at the University of Virginia. Data from the years 1995 to 2005 were selected, reflecting 23,908 injuries from 85 hospitals in ten states. (Note: The number of participating hospitals varies from year to year; there have been drop-outs and add-ins [24]). Despite the fact that it is a completely voluntary network, it is the largest and longest-standing surveillance database of PIs and blood and body fluid exposures to hospital HCWs in the U.S and participating hospitals vary in terms of size, ownership, teaching status.

The University of Virginia IRB approved this study.

Variables

EPINet incident report forms capture injuries from needles and other sharp devices ("sharps injuries"). Question responses describe the job title of the worker, the type of device involved, the location in the hospital where the injury occurred and a description of the incident. EPINet also includes reports of mucocutaneous exposures. All data were stripped of personal identifiers and merged into an aggregate database.

We used three different hospital-based denominators: number of staffed beds, number of admissions, and number of full time equivalent workers (FTEs). FTEs include all personnel employed by the institution, whether or not they have occupational blood exposure risk. Denominator values were obtained from the American Hospital Association's Annual Survey Report for each hospital for each year selected. [25] We also included in the analysis geographic region (northeast, midwest, south, west) [26], type of hospital (teaching, non-teaching), and population density (metropolitan or non-metropolitan) [27]as potentially confounding variables.

We did not have valid denominator data to calculate job-specific rates, but the U.S. Department of Labor, Bureau of Labor Statistics, reports that 30% of general medical hospital employees are nurses [28]. We estimated number of nurses using 30% of FTEs for each hospital, and used that as a denominator to calculate nurse-specific injury rates.

We determined safety-device related injuries from "yes" indications on the incident form. ["If the item causing the injury was a needle or sharp medical device, was it a "safety design" with a shielded, recessed, retractable or blunted needle or blade?"]. We use those numbers to calculate the proportion of all sharps injuries attributed to safety devices.

Analysis

To address our primary hypothesis, we calculated the annual rates of percutaneous injuries per 100 FTE hospital employees. This underestimates the true risk of those who are exposed to contaminated sharp devices, because 1) the denominator includes all employees, whether "at risk" or not and 2) only a portion of sharp injuries are reported. We used a change-point Poisson regression model, with the change point at the time of the implementation of the legislation. We controlled for region, type of hospital and density.

We calculated injury rates using three different denominators. Primary analyses included hospitals contributing data during the pre-legislation or post-legislation period and for which the annual denominator was available. In subsequent analyses, we imputed denominators in missing years based on a hospital's previous and subsequent reported values. For calculation of rates, we

excluded data from hospitals that were missing denominator values for all years. For calculation of totals and proportion, we included all injuries.

In applying statistical tests and calculating confidence intervals, we assumed that the number of injuries pre- and post-legislation followed a Poisson distribution. We compared hospital-specific differences in pre- and post-NSPA rates using the paired t-test. The chi-square test was used to compare differences in proportions.

While we did not have denominators for all job categories, we applied the 30% proportion described above to create a nursing denominator in order estimate nursing injury rates. We then calculated injury rates specifically for nurses during the pre- and post-NSPA period.

For additional analyses where we lacked denominators to calculate rates, we examined shifts in proportion of injuries. We looked at shifts in injuries according to job category, comparing nurses and physicians to all other groups combined; and at shifts according to the use-disposal cycle of device use and according to location in the hospital where injuries occurred. In addition, we calculated the proportion of injuries attributed to safety-engineered and conventional (non-safety) devices.

We replicated the analysis for the primary hypothesis, replacing mucocutaneous exposures for sharp injuries. This rate of mucocutaneous exposures per 100 FTEs was compared to the rates observed for percutaneous injuries.

Lastly, we applied our findings to national estimates of needlestick injuries and related costs. In estimating an overall injury reduction for the U.S., we used a national estimate of 384,325 needlestick injuries based on pre-legislation injury data [1]. (This underestimates the total number of healthcare worker injuries as it refers only to hospital workers, when at least half of all healthcare workers are in non-hospital settings[29]) We estimated a national reduction in injuries based on the observed reductions in our sample. In applying the national estimate of reductions to cost estimates, we applied the Government Accounting Office's estimate of needlestick follow-up costs, ranging from $500-$3000 [30].

Results

Overall

The pre-NSPA period (1995-2000) included a cumulative total of 184 years of data from 49 hospitals, representing 13,377 percutaneous injuries. The post-NSPA period (2001-2005) included 150 years of data from 45 hospitals, with a total of 5,379 injuries.

We observed a trend of increasing rates of injuries in the five years leading up to the NSPA, followed by a drop of about 38% (95% confidence interval, 35 to 41) in 2001 when the NSPA took effect(Figure 1). . Subsequent injury rates through 2005 showed an overall decreasing trend. Although there was some fluctuation, post-NSPA rates remained well below pre-NSPA rates.

All injury rates using different denominators

Using FTEs as the denominator, we calculated a rate of 4.00 injuries per 100 FTEs for the pre-NSPA period. The post-NSPA rate was 2.48 injuries per 100 FTEs, a rate ratio of 0.62 ($P<0.001$) (Figure 2). We obtained similar results for the other two denominators: a rate ratio of 0.64 ($P<0.001$) per 100 beds (Figure 3), and 0.57 ($P<0.001$) per 100 admissions (Figure 4).These results reflect 38% (FTEs), 36% (beds) and 43% (admissions) reductions from the pre- to post-NSPA periods.

Adjusting injury rates for type of hospital, region and density, the estimated decreases in rates from the pre- to post-NSPA years were 39% (FTEs), 33% (beds) and 39% (admissions). When data were reanalyzed, replacing missing denominators with values interpolated from previous and subsequent years, the results were nearly identical (reductions within 1%) to those using only years with reported values.

The trends in injury rates for all denominators were similar: small change in injury rates prior to the legislation, followed by a precipitous drop in rates in the year following the legislation. After 2001, with some fluctuation, injury rates remained well below pre-NSPA rates.

Nursing injuries

Without job-specific denominators, we were unable to compare rates among different groups. Nevertheless, we were able to estimate nursing injury rates, using a 30% of FTE denominator. (Figure 5) We also estimated changes in patterns among groups by examining the change in proportion of all PIs reported by nurses and all other groups. The proportion of injuries reported by nurses, although consistently the highest percent, decreased after the legislation,

suggesting that injury rates among nurses decreased at a faster rate than the overall rate of injuries. (Figure 6)

In examining the shift in patterns of injuries according to the use-disposal cycle, we found that there was a small decrease in proportion of injuries occurring before use of a device. (It should be noted that they are consistently the tiniest portion of reported injuries and are likely significantly underreported compared to other injuries because of the low risk of infection.) Where we see the biggest shift is from injuries after use to injuries during use. (Figure 7)

Proportion of injuries from safety devices

From 1995 through 2000, about ten percent of all injuries were attributable to safety devices; in 2001, post-NSPA, this proportion increased to twenty percent and continued to climb over the next four years, reaching 45 percent of overall injuries by 2005. Safety-engineered devices were a larger proportion of a much smaller injury rate.

Comparison to mucocutaneous exposures

In comparing mucocutaneous exposures (splashes and sprays) to PIs over the same time period, mucocutaneous exposures did not demonstrate the same degree of decrease in the years following the legislation as did the sharps injuries. [It should be noted that respondents consistently reported fewer than a third as many mucocutaneous exposures as PIs. The rates were quite low before and after the legislation.]

Discussion

Overall, there is strong evidence of an impact of the NSPA on decreasing hospital worker injuries. Although safety conditions prior to 1995 may have resulted in reductions in the rates of percutaneous injuries prior to the patterns we observed (e.g. OSHA's Bloodborne Pathogens Standard, which required safer practices, had been in effect since 1991, and early adoption of safety-engineered sharp devices also occurred before the passage of the NSPA), a significant decrease in injury rates did not occur until the year after passage of the NSPA, suggesting that the legislation had an independent effect. This was concomitant with a steep market increase in sales of safety-engineered devices and an increase in the number of OSHA citations for violation

of the revised standard for handling bloodborne pathogens — two factors directly linked to the legislation.

For all three denominators (FTEs, staffed beds and admissions), changes in PI rates for hospital healthcare workers decreased significantly in the year following enactment of the NSPA, a reduction that was sustained over the five years following the legislation. The pattern similarity suggests that these denominators may be correlated and therefore produce comparable outcomes, or that differences among these variables are masked by the powerful impact of the legislation. The conclusion of each analysis, though, is slightly different, explaining injury risk as a function of hospital size, patient turnover, and number of employees. The importance of these differences in worker injuries also alludes to the advantage of a national PI database with multiple denominators, so that various aspects of the needlestick issue can be assessed universally, rather than in local studies with a limited number of variables.

The pattern we observed for proportion of injuries attributable to safety devices was relatively stable (and low) before the legislation with an increasing proportion in the years after. That pattern of safety-device proportion of injuries also parallels the national market share of safety devices. An increase in proportion of injuries attributable to safety devices does not represent a contradiction; any time a sharp device is used, whether conventional or safety, the risk of injury exists. If all sharp devices used in clinical settings were safety-engineered, they would cause 100 percent of sharps injuries, but we would expect the overall injury rate to be even lower than the rates observed here. In all likelihood, the adoption of safety-engineered devices directly influenced the decrease in injury rates observed.

The legislation appeared to have had a disproportionately positive effect on nurses. Since nurses have the largest number of PIs, a higher-than-average reduction in their injuries can have a marked impact on overall injuries. The shift (decrease) in proportion of injuries occurring after use of a sharp device may be a function of better location and puncture-resistance of disposal containers as well as the use of safety-engineered devices that typically protect after the sharp is used.

Although we found lower injury rates for safety devices than for non-safety (not shown), it should be noted that the denominators used here remained relatively stable for each hospital

across the study period, while other injury-related factors changed dramatically. Because the sales and presumed use of safety devices increased substantially in the post-NSPA period, and the sales of non-safety devices decreased, a safety / non-safety device-specific analysis (using safety and non-safety device purchase data as the denominator) might have demonstrated an even greater difference between the rates. Unfortunately, we were unable to obtain relevant purchasing data.

The difference between mucocutaneous exposures and PIs is consistent with the expectation that there would be less impact on mucocutaneous exposures because they were not directly addressed by the legislation. However, it is likely that exposures were reported less often than injuries because exposures are less likely to be noticed (except to the eyes), and are often self-assessed as having a low risk of infection.

We attempted unsuccessfully to create a new national estimate of injuries based on replicating the Panlilio paper [1]. This turned out to be much more complicated than we anticipated, and we did not receive a response from the authors we contacted. Using a cruder method, we were able to estimate a national reduction in injuries in the post-legislative period based on the reductions in injury rates we observed. Using the most conservative (lowest) injury rate reduction among the three denominators examined, 36%, we calculated that 138,357 needlestick injuries were prevented in each year of the post-NSPA period. A 2000 GAO report estimates the cost of needlestick follow –up ranging from $500 to $3000 [30]. These costs include only follow-up costs of reported percutaneous injuries. They do not include treatment costs of infected healthcare workers, wages and time lost, emotional distress or loss of life. We also did not factor in the higher cost of safety-engineered devices, which may be gradually declining with the increase in production volume. Using these estimated costs of needlesticks, we calculated a savings range of $69-$415 million related to injury follow-up costs for each year since 2001 or $345 million - $2+ billion in the first five years.

Our attempt to get systematic "on-the-ground" information and observations describing activities in hospitals during the transition period were stymied. The individual who is currently responsible for EPINet reporting is often not the person who was present during the transition period after the NSPA. We are left with anecdotes that suggest there was an increase in purchase of safety-engineered devices, despite the increased cost, and a significant increase in attention to

prevention of sharps injuries, consistent with the law. We are not confident in drawing conclusions based on these reports.

As promised, in collaboration with the American Nurses Association, a webinar on sharps safety was delivered highlighting nurse-specific study findings. Attendance was good and many questions were asked during the presentation. In addition, presenters agreed to respond to questions on-line after the conclusion of the webinar.

Aside from the observed success at reducing injuries, many issues remain in establishing the safest conditions for healthcare workers. Workers continue to get injured from sharp devices, and we need to understand where the opportunities are to intervene. We should examine the current educational requirements related to sharps safety and bloodborne pathogen transmission prevention for health care students and those already practicing. How do we continue to adjust to new devices within the context of the procedures being performed? How do we ensure that non-hospital workers are protected to the same extent as hospital workers? This includes not only home health workers and ambulatory staff, but contract laundry and house-keeping workers. These workers are covered under the Standard and the NSPA, but enforcement has not been as consistent. For what procedures do we still have no safety-engineered alternatives? How can we work with medical device companies to address these gaps? Lastly, how can we translate what we have learned in the U.S. to workers in poorer countries with fewer resources? These workers are often at the greatest risk of all because of high prevalence of bloodborne pathogens and low vaccination rates, limited personal protective equipment, inadequate sharps disposal systems and few safety-engineered devices.

Conclusions

Our findings provide evidence that the NSPA contributed to the decline in PIs among U.S. hospital workers. This translates to a significant cost savings in follow-up of sharp injuries. Since percutaneous injuries are the most frequent transmission route of occupationally acquired infections due to bloodborne pathogens, a reduction in such injuries could be expected to result in a proportional decrease in occupational morbidity and mortality from these pathogens, but it is beyond the scope of this study and at present there are no national post-exposure surveillance

data to confirm this assumption. The findings support the concept that well-crafted legislation bolstered by effective enforcement can be a motivating factor in the transition to injury-control practices and technologies, resulting in a safer work environment and workforce. However, until we have replaced sharp medical devices with non-sharp alternatives, sharp injuries will continue to be a problem.

FIGURE 1

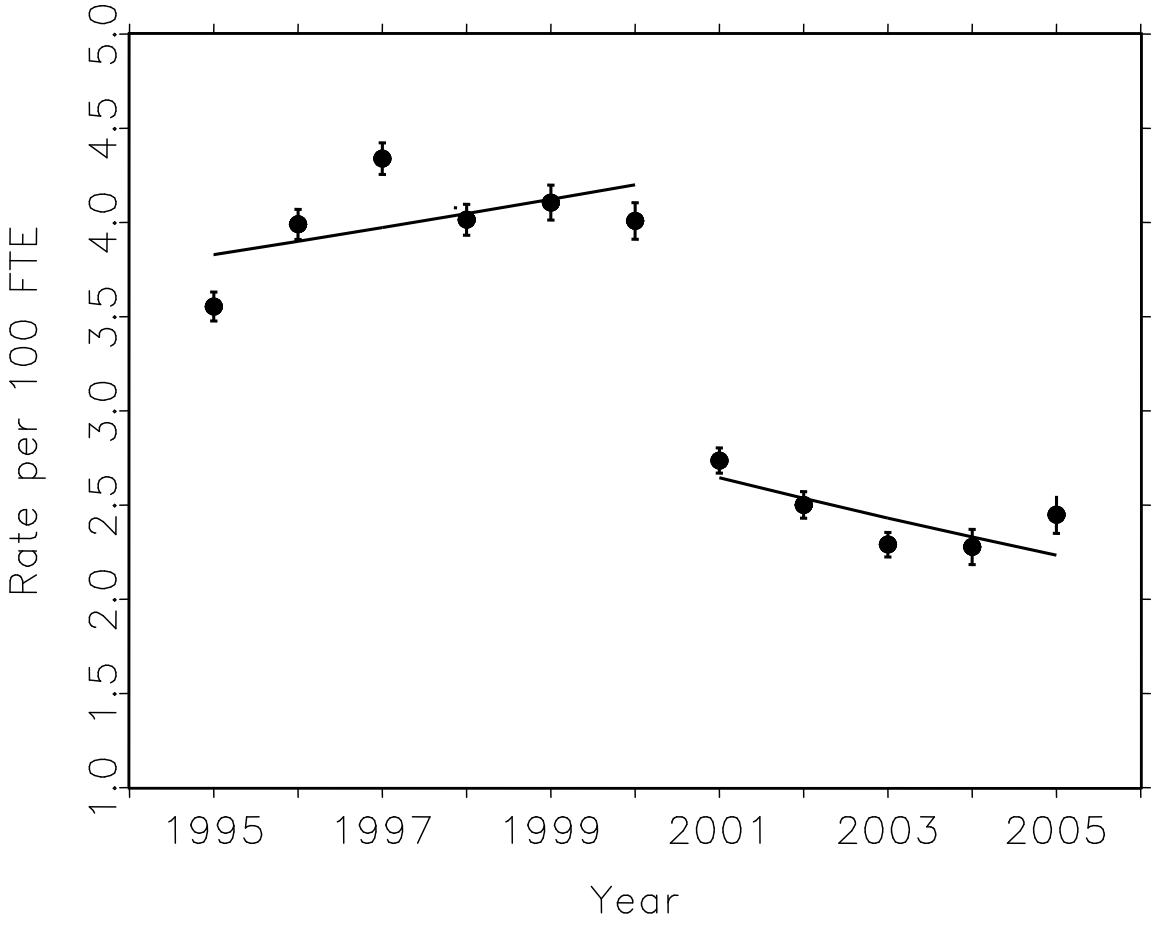

Rate per 100 FTE
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
1995
1997
1999
2001
2003
2005
Year

FIGURE 2

=injury rates from conventional (non-safety) devices.

=injury rates from safety-engineered devices

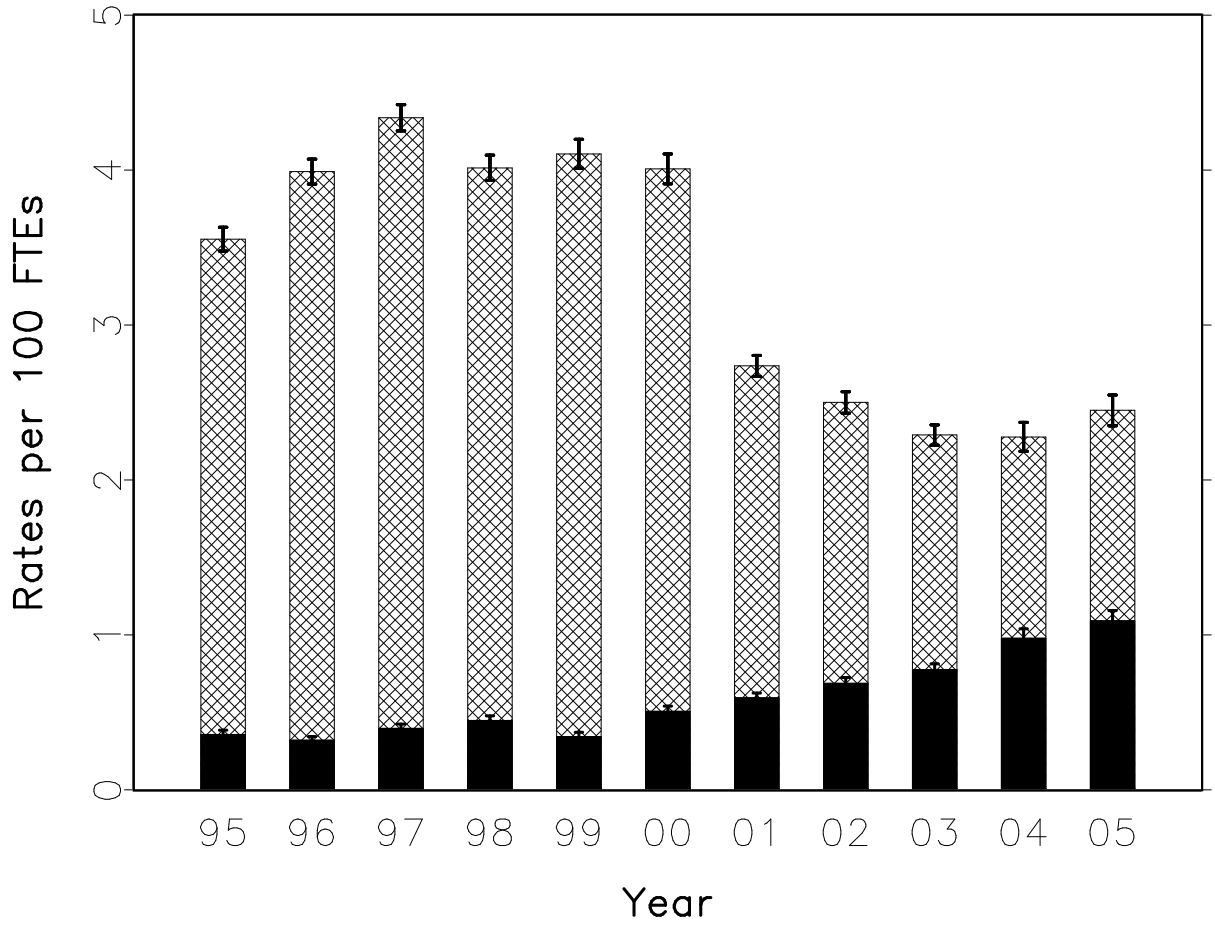


FIGURE 3

=injury rates from conventional (non-safety) devices.

=injury rates from safety-engineered devices

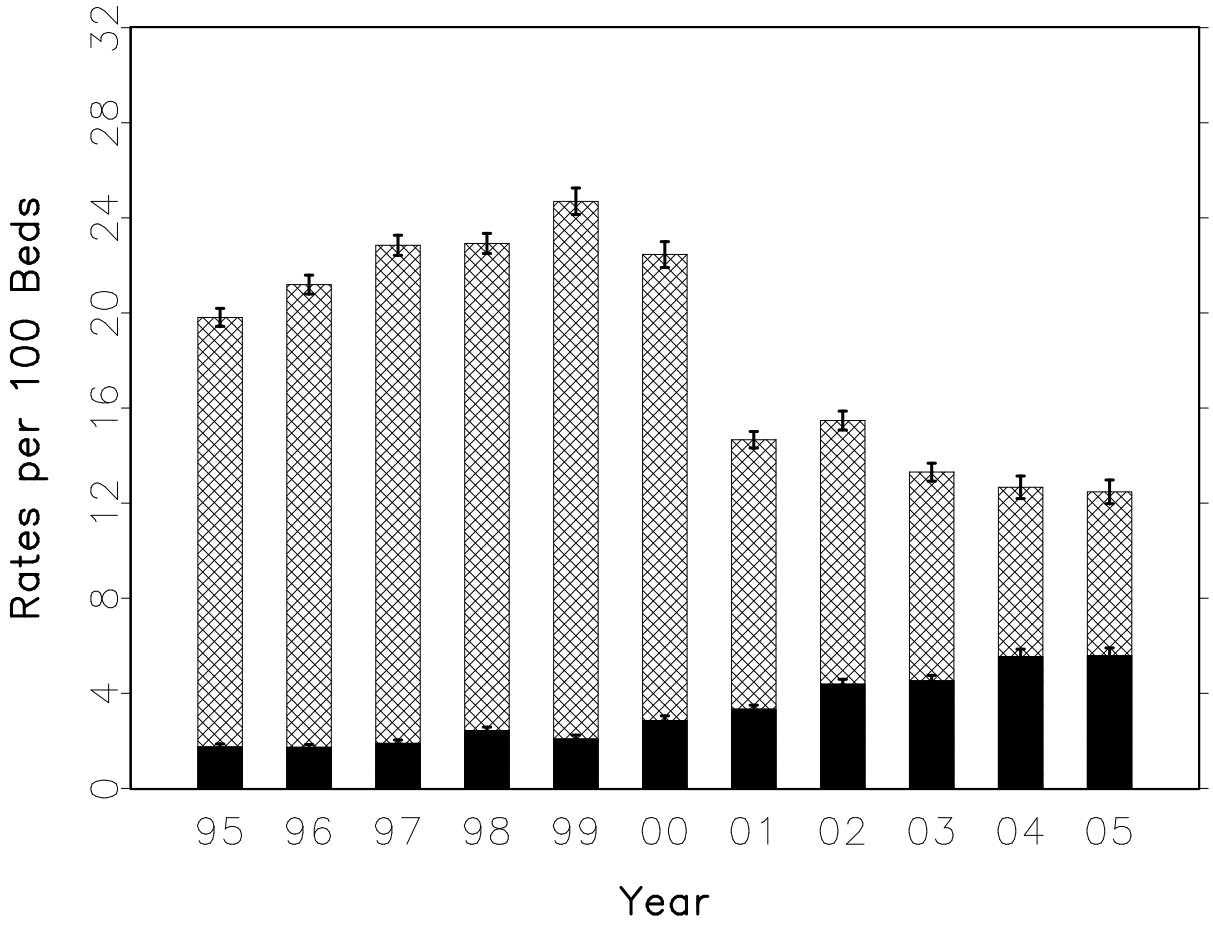


FIGURE 4

=injury rates from conventional (non-safety) devices.

=injury rates from safety-engineered devices

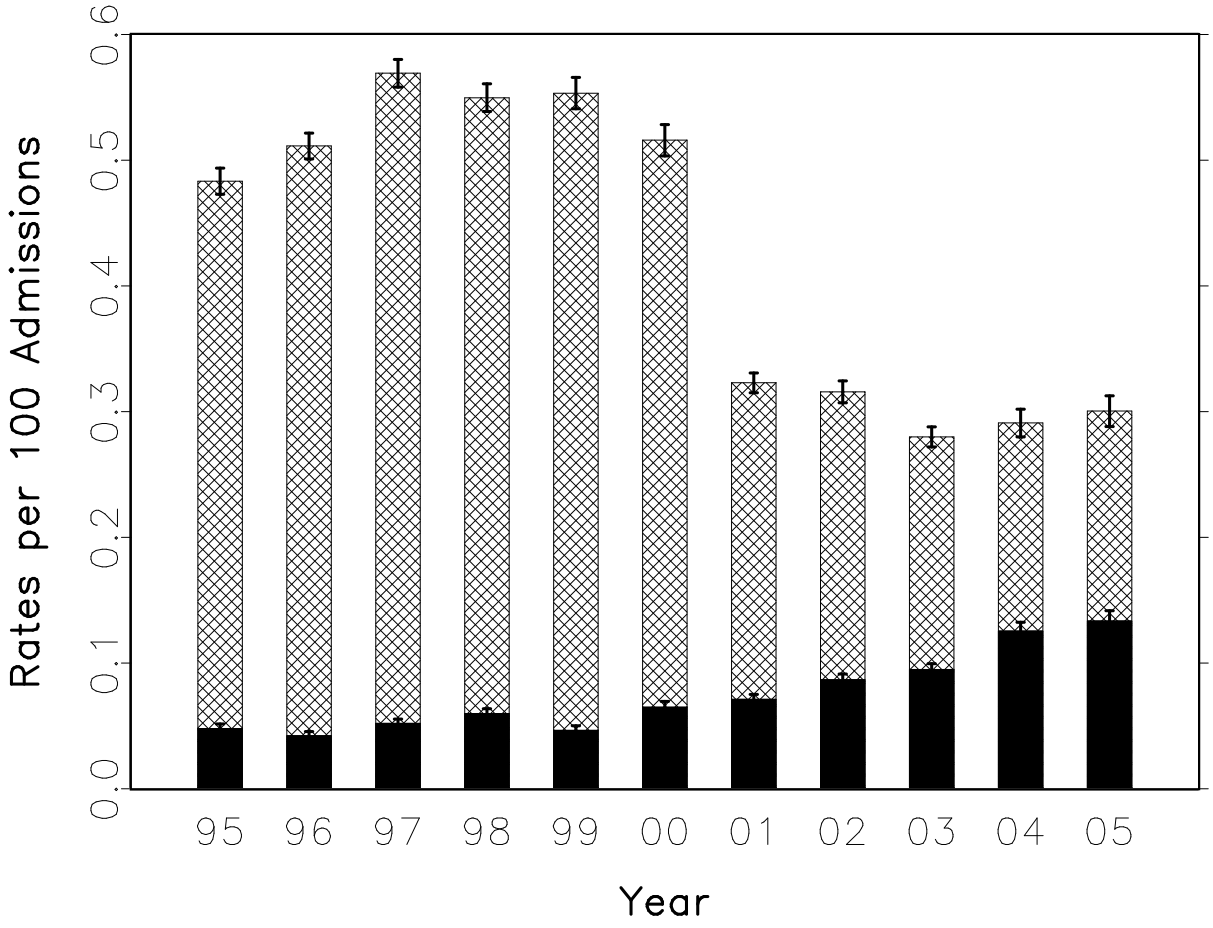


FIGURE 5

Rates of injury for nurses (numerator = nursing injuries reported /denominator = 30% of all hospital FTEs)

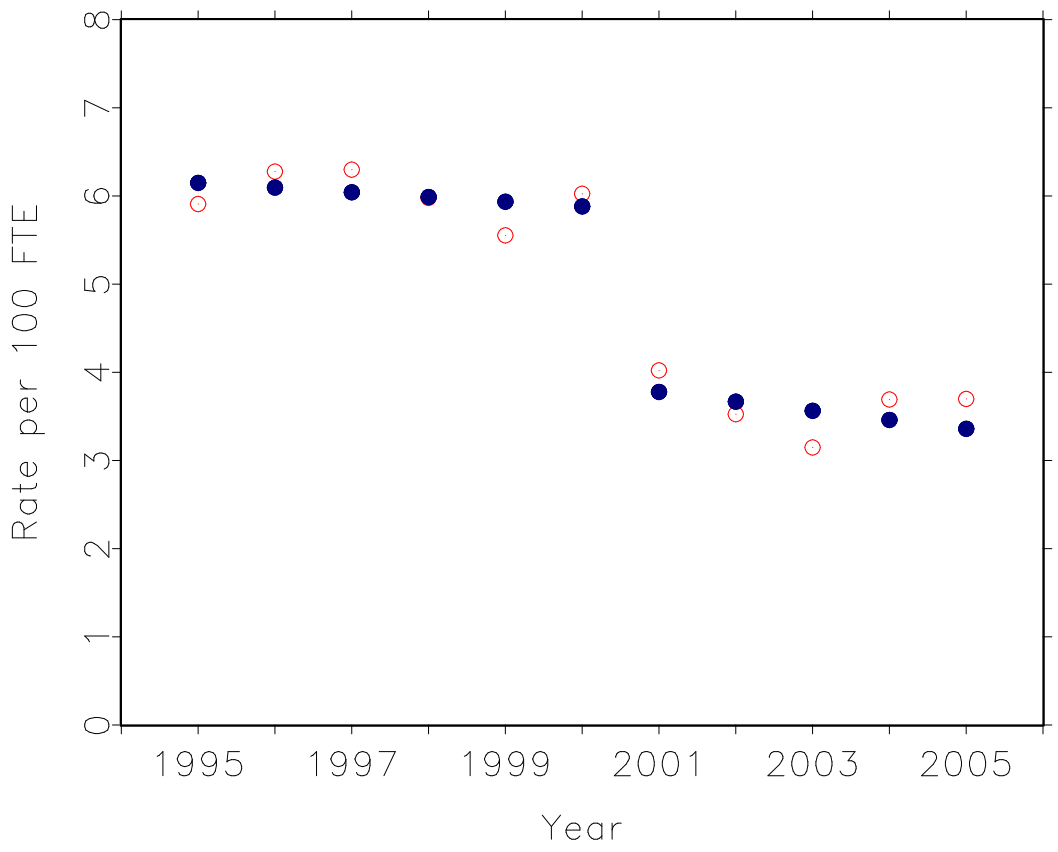


FIGURE 6

Black = Nurse proportion of injuries

Striped = Other workers proportion of injuries

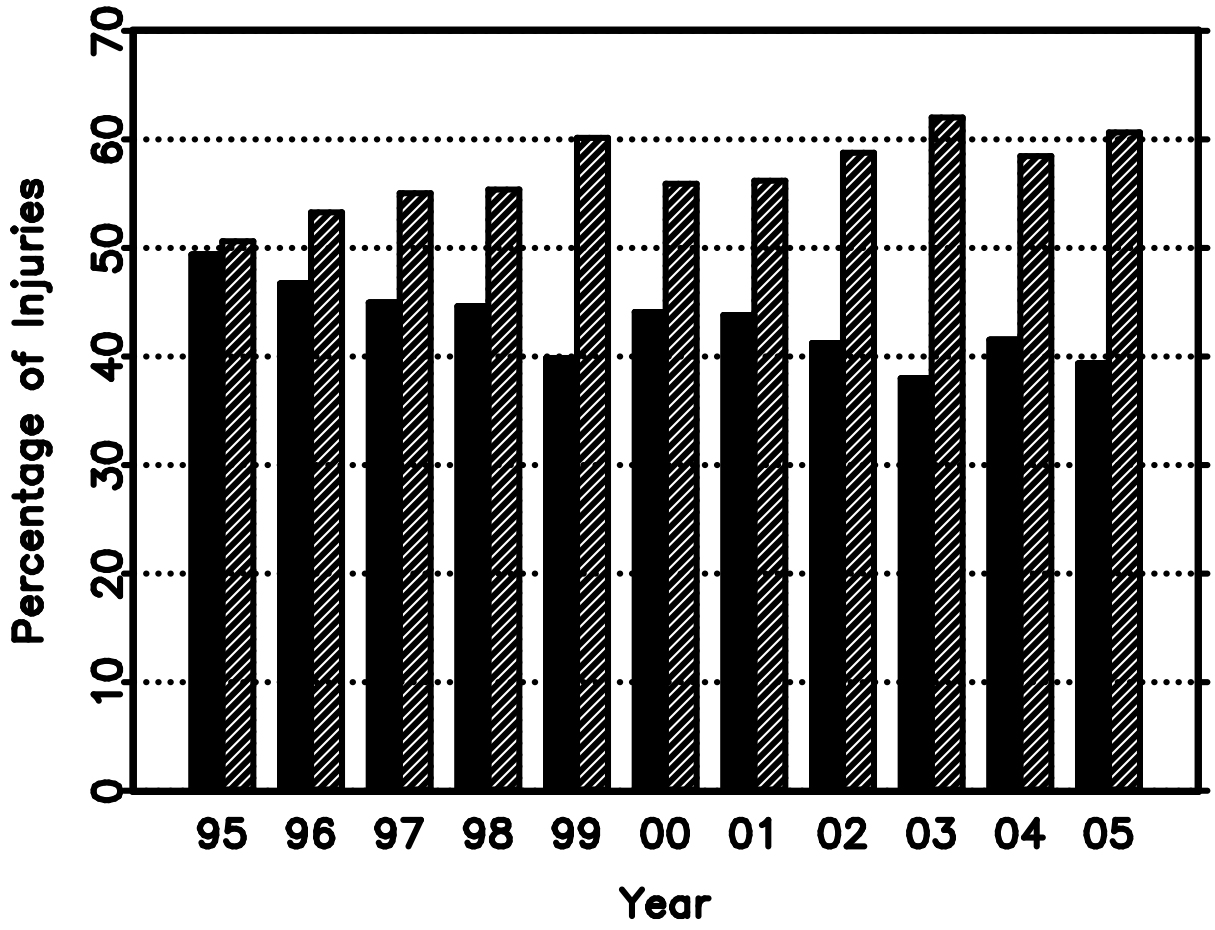
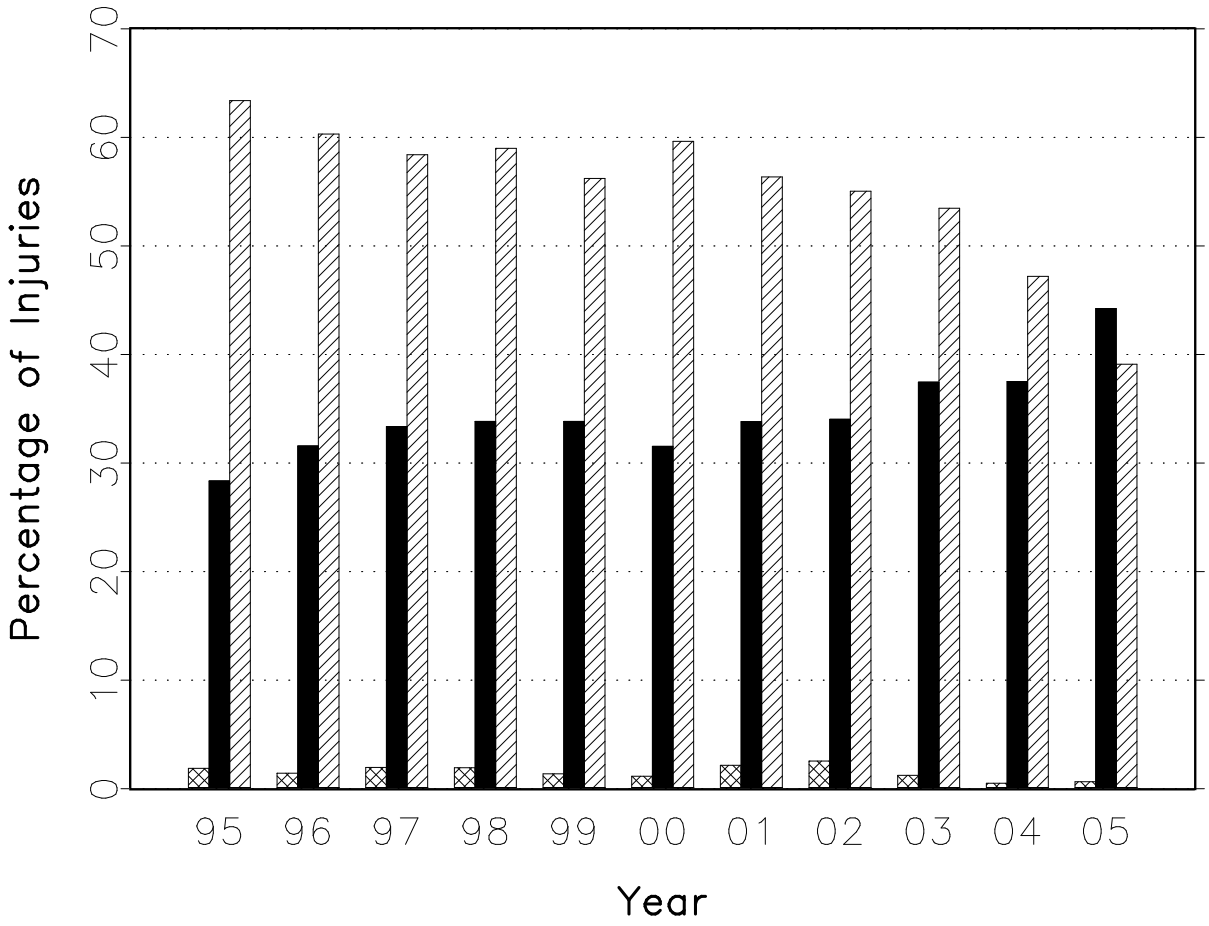


FIGURE 7

Cross-hatch = injuries before use

Black = injuries during use

Striped = injuries after use



Publications and Presentations

Below are a list of publications and presentations completed over the course of the grant. First listed are publications and presentations that come directly from the funded research and that specifically address the aims of the study. Following those are publications and presentations that occurred during the time of the grant and include topics related to the aims of the grant.

Publications

Phillips EK, Conaway M, Parker G, Perry J, Jagger JC. Issues in sharps injuries and H.R. 5178 (the Needlestick Safety & Prevention Act). Journal of Safety Research. (solicited article, revisions under review)

This manuscript was solicited following a presentation at the National Occupational Injury Research Symposium. (Revisions have been submitted for approval.) It includes comparison of rate changes using different denominators (beds, admissions and FTEs) and examination of the influence of safety-engineered devices on rates. The pattern of changes was virtually identical for all three denominators. The diffusion of safety-engineered devices was concurrent with a decrease in overall PI rates and an increase in the proportion of all injuries attributed to safety-engineered devices. In addition, we estimated the national number of PIs prevented since the legislation and the related cost savings from the decrease. The estimated annual savings for each year since the legislation range from $69-$415 million.

Phillips EK, Conaway M, Jagger J. Percutaneous injuries before and after the Needlestick Safety and Prevention Act. New England Journal of Medicine. 2012: 366(7):670-1.

This article summarizes the results of the primary hypothesis. We found a trend toward increasing rates of injuries before the legislation was enacted, followed by a drop of about 38% in 2001 when the NSPA took effect. Subsequent injury rates, through 2005, remained well below pre-NSPA rates. Our findings provide evidence that the NSPA contributed to the decline in percutaneous injuries among U.S. hospital workers. They also support the concept that well-crafted legislation bolstered by effective enforcement can be a motivating factor in the transition

to injury-control practices and technologies, resulting in a safer work environment and workforce.

Presentations

Phillips EK and Wilburn S (April 2012) Protecting healthcare workers (including OURSELVES) from bloodborne pathogens. Webinar sponsored by American Association of Occupational Health Nurses.

Phillips EK (March 2012) Needlestick safety legislation: Mandated occupational prevention. Association of Occupation Health Professionals (Virginia), Staunton, VA

Phillips, EK, Dawson J (December, 2011) Nursing and sharp injuries: NSPA impact and emerging areas of concern. Safe Needles Save Lives: National Center for Nursing Quality Teleforum. American Nurses Association.

Phillips EK (November, 2011) Legislative mandates in injury prevention: Impact of the Needlestick Safety and Prevention Act. Johns Hopkins University, School of Public Health, Seminar in Injury Research and Policy, Baltimore, MD

Phillips EK, Conaway M, Parker G, Perry J, Jagger J (November, 2011) Impact of needlestick safety legislation on nurses' injuries. American Public Health Association, Washington, DC

Phillips EK, Conaway M, Parker G, Perry J, Jagger J (October, 2011) Changes in sharps injuries among healthcare workers: the effect of HR 5178 (National Needlestick Safety and Prevention Act). National Occupational Injury Research Symposium (CDC/NIOSH), Morgantown, WV

Phillips, EK, Ogg M (AORN), Hughes N (ANA) (June, 2011) A view of sharps injuries. Webinar. American Nurses Association.

Phillips EK, Conaway M, Parker G, Perry J, Jagger J (November, 2010) Needlestick legislation makes an impact on hospital injury rates. American Public Health Association, Denver, CO

Phillips EK , Yassi A, Gomaa A, Wilburn S, Lavoie MC (November 2010) Occupational health surveillance in healthcare settings. International Conference on Occupational Health for Health Care Workers, Casablanca, Morocco (two-day workshop)

Phillips EK (November 2010) Healthcare worker injury risk and the impact of the Needlestick Safety and Prevention Act. 10th Anniversary of the Needlestick Safety and Prevention Act: Mapping Progress, Charting a Future Path, Charlottesville, VA

Phillips EK (September 2010) Safety & Prevention: Impact of NSPA on hospital worker injuries. University of Virginia School of Nursing, Center for Nursing Research Forum, Charlottesville, VA

Also:

Publications

Phillips EK, Dawson J. Sharps safety is as important as ever. American Nurse Today. 2012: 7(3):34.

This article does not specifically address the aims of the study, but is related to them. It summarizes the NSPA and the nurse's role in sharps safety. It was written in collaboration with ANA's occupational health staff specifically for the nursing audience.

Perry J, Jagger J, Parker G, Phillips EK, Gomaa A. Disposal of sharps medical waste in the United States: impact of recommendations and regulations, 1987-2007. American Journal of Infection Control. 2012: 40(4):354-8.

This article parallels the aims, but focuses on injuries related to disposal of sharp medical devices. It compares injuries from 1993-94 to those occurring in 2006-07. This simple before-and-after comparison showed a 53% decline in disposal-related injuries . Possible explanations for the decline are discussed.

Jagger J, Berguer R, Phillips EK, Parker G, Gomaa AE. Increase in sharps injuries in surgical settings versus nonsurgical settings after passage of national needlestick legislation. Journal of the American College of Surgeons 2010:210(4):496-502.

This article compares injury rates (per 100 beds) in the surgery (OR) areas to other areas of the hospital, combining injuries for the pre-NSPA period (1993-2000) and the post-NSPA

period (2001-2006). Outside the OR, rates decreased 31.6%, from 24.1 injuries to 16.5 injuries. Within the OR, rates increased 7%, from 6.3 to 6.8. Suture needles continue to account for the large majority of OR injuries, and OR practices have been slow to adopt blunt suture needles. Also, safer practices, such as neutral zone passing, could further reduce OR injuries.

Jagger J, Perry J, Gomaa A, Phillips EK. : The impact of U.S. policies to protect healthcare workers from bloodborne pathogens: the critical role of safety-engineered devices. Journal of Infection and Public Health. 2008;1:62-71.

This article was a precursor to the funded study, combining all data that had been collected in EPINet from 1993-2004, calculating injuries per 100 beds. It was completed after the funded study began, but before the analysis took place. It provided a history of sharps injury prevention and a description of the NSPA. It tracked injury rates and the U.S. market share of safety-engineered devices. Collapsing all "before" years and "after" years, it examined device-specific injury rates.

Presentations

Phillips EK and Wilburn S (April 2012) Protecting healthcare workers (including OURSELVES) from bloodborne pathogens. Webinar sponsored by American Association of Occupational Health Nurses.

Phillips EK (July, 2010) Healthcare workers and sharps injuries: Understanding the risks, requirements and recommendations. (Webinar 740 registrants) Advanceweb/nurses.

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