ORIGINAL ARTICLE

Needlestick Injuries among Surgeons in Training

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ABSTRACT

BACKGROUND

Surgeons in training are at high risk for needlestick injuries. The reporting of such injuries is a critical step in initiating early prophylaxis or treatment.

METHODS

We surveyed surgeons in training at 17 medical centers about previous needlestick injuries. Survey items inquired about whether the most recent injury was reported to an employee health service or involved a "high-risk" patient (i.e., one with a history of infection with human immunodeficiency virus, hepatitis B or hepatitis C, or injection-drug use); we also asked about the perceived cause of the injury and the surrounding circumstances.

RESULTS

The overall response rate was 95%. Of 699 respondents, 582 (83%) had had a needlestick injury during training; the mean number of needlestick injuries during residency increased according to the postgraduate year (PGY): PGY-1, 1.5 injuries; PGY-2, 3.7; PGY-3, 4.1; PGY-4, 5.3; and PGY-5, 7.7. By their final year of training, 99% of residents had had a needlestick injury; for 53%, the injury had involved a high-risk patient. Of the most recent injuries, 297 of 578 (51%) were not reported to an employee health service, and 15 of 91 of those involving high-risk patients (16%) were not reported. Lack of time was the most common reason given for not reporting such injuries among 126 of 297 respondents (42%). If someone other than the respondent knew about an unreported injury, that person was most frequently the attending physician (51%) and least frequently a "significant other" (13%).

CONCLUSIONS

Needlestick injuries are common among surgeons in training and are often not reported. Improved prevention and reporting strategies are needed to increase occupational safety for surgical providers.

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An estimated 600,000 to 800,000 needlestick and other percutaneous injuries are reported annually among U.S. health care workers.[1] These injuries can result in substantial health consequences and psychological stress for providers and their loved ones.[2-4] All health care providers who perform invasive procedures with sharp instruments are at risk for injury[5]; however, the operating-room setting presents the greatest risk.[6-8] Surgeons in training have the greatest risk of exposure to blood-borne pathogens, given their numerous encounters involving the use of sharp instruments on patients and the increased propensity for injury while learning new technical skill sets.[6] The hazard of injury is further compounded by the high prevalence of human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) among hospitalized surgical patients.[9] In a recent study of a general surgical service in an urban academic hospital, 20 to 38% of all procedures involved exposure to HIV, HBV, or HCV.[10]

Timely reporting of occupational exposures to an employee health service is required to ensure appropriate counseling, facilitate prophylaxis or early treatment, and establish legal prerequisites for workers' compensation.[1,11] Failure to report exposures precludes interventions that could benefit the injured party, placing health care workers at unnecessary risk.

Information is limited regarding the prevalence of needlestick injuries, the circumstances surrounding them, and the barriers to reporting them. We conducted this study to investigate the prevalence and context of needlestick injuries and behavior associated with the reporting of injuries among a large number of surgeons in training.

METHODS

STUDY DESIGN AND POPULATION

Respondents were surgeons in training at residency programs in general surgery certified by the Accreditation Council for Graduate Medical Education in the United States. Nineteen training programs involving 741 surgeons in training were invited to participate in the study; of those programs, 3 were chosen because of a working relationship with the authors, and 16 were randomly selected through a national sampling process. Seventeen programs involving 702 surgeons in training agreed to participate in the study.

First-year and second-year residents included trainees in subspecialties (orthopedics, otolaryngology, urology, and plastic surgery) who regularly rotate through general surgery as a part of their training. Study participants were surveyed after completing the January 2003 American Board of Surgery In-Service Training Examination, a standardized nationwide exam administered to all general-surgery residents. Surveys were administered with a pencil and a blank, sealable envelope for confidentiality. Participation was voluntary, and no unique demographic information that could potentially identify a participant was collected. Completion of the survey was considered implied consent for study participation. We obtained approval for the study from the institutional review board at Johns Hopkins University.

SURVEY INSTRUMENT

The survey instrument was developed in 2002 by a multidisciplinary panel of surgical residents and faculty, with specialists in infectious disease and occupational safety. Survey design and refinement involved literature review, item generation, small focus group discussions, and large group discussions during general residency meetings. The survey was pilot-tested in a group of 20 surgical residents at a single institution during a 3-month period, for face validity, content validity, and feasibility. Feedback from the focus group and general residency meetings was integrated into the final survey.

The survey asked about the postgraduate year of clinical training, the sex of the respondent, the number of past needlestick injuries during training, needlestick injuries involving a high-risk patient, and an expanded set of questions about the most recent needlestick event. A high-risk patient was defined as one with a history of infection with HIV, hepatitis B, or hepatitis C or injection-drug use. Respondents were also asked which blood-borne pathogen they feared the most. The expanded questions about the most recent needlestick injury included whether it involved a high-risk patient, the perceived causes and circumstances of injury, whether it was reported, reasons for not reporting it if applicable, and whether anyone else knew of the injury. For responses regarding the cause of injury, behavior associated with the reporting of injuries, and the identity of another person who knew about the event, participants were instructed to select all the responses

that applied. (The survey questions are listed in the Supplementary Appendix, which is available with the full text of this article at www.nejm.org.)

STATISTICAL ANALYSIS

We performed descriptive analyses with the use of percentages, means, and medians. Differences in proportions according to postgraduate year were analyzed with the use of the Mantel–Haenszel chi-square test; nonparametric tests (Kruskal–Wallis) were used to compare numbers of needlestick injuries according to the postgraduate year. Logistic regression was performed to assess the relationship between reporting behavior and variables associated with the most recent needlestick injury. Univariate analysis identified factors associated with not reporting the most recent needlestick injury; factors that were significant at $P<0.05$ were then included in a stepwise multivariate model. All reported P values were two-sided. All analyses were performed with the use of SAS software, version 8.0 (SAS Institute).

RESULTS

RESPONDENTS

Of 741 surgical residents invited to participate, 702 (95%) returned completed survey forms; of those, 215 (31%) were women. One respondent was excluded from the analysis as an outlier for reporting a range of more than 100 injuries, and two did not report the number of needlestick injuries. Of 699 respondents, 582 (83%) had a needlestick injury during training (Table 1). The mean total number of needlestick injuries during all years of residency was 3.8, and the mean total number sustained by 78 respondents who were in the fifth postgraduate year (PGY-5) was 7.7, averaging 1.7 per year (7.7 injuries divided by 4.5 years). The mean total number of needlestick injuries increased according to the postgraduate year of training. Similarly, the percentage of residents who had a needlestick injury involving a high-risk patient increased according to the year of training. By PGY-5, 99% had had a needlestick injury, and for 53% of respondents, that injury had involved a high-risk patient (Fig. 1).

Details of the most recent needlestick injury were provided by 576 of 580 surgical residents, with the number varying according to the category. Of these injuries, 384 of 577 respondents (67%) reported that the injury was self-inflicted, 467 of 576 (81%) reported injury by a solid needle, 415 of 578 (72%) reported that the injury occurred in the operating room, and 301 of 578 (52%) reported that it occurred during suturing (Table 2). A feeling of being "rushed" was identified by 327 respondents (57%) as the cause of the injury, whereas 114 (20%) believed that the injury was not preventable. Ninety percent of respondents identified a single cause for the injury.

A total of 297 respondents (51%) did not report the injury to an employee health service (Table 3). Of 91 recent needlestick injuries involving high-risk patients, 15 (16%) were not reported. Of 297 respondents, 126 (42%) chose "It takes too much time" and 84 (28%) chose "No utility in reporting" as the reason for not reporting the injury. Of the most recent needlestick injuries that were not reported, 155 were known to others: the attending physician was aware in 79 of these events (51%), whereas a spouse or "significant other" was aware in only 20 events (13%). When 661 respondents were asked which blood-borne pathogen they feared most, 355 (54%) identified HCV, 284 (43%) identified HIV, and 22 (3%) identified HBV.

UNIVARIATE AND MULTIVARIATE ANALYSES

In univariate analysis, factors that were significantly associated with not reporting the most recent needlestick injury to an employee health service included male sex, the lack of involvement of a patient known to be at high risk, the use of a solid needle, occurrence in the operating room, the lack of knowledge of the injury by another person, and the total number of needle-

Table 1. Needlestick Injuries, According to Postgraduate Year.*

Year of Training	No. of Residents	Residents with Needlestick Injury	Mean No. of Needlestick Injuries per Resident†
		no. (%)	
All years	699‡	582 (83)	3.8
PGY-1	221	141 (64)	1.5
PGY-2	141	125 (89)	3.7
PGY-3	156	146 (94)	4.1
PGY-4	102	93 (91)	5.3
PGY-5	78	77 (99)	7.7

* PGY denotes postgraduate year.
† The mean numbers of total needlestick injuries among all residents include those without a previous needlestick injury.
‡ One survey respondent did not report his or her year of training.

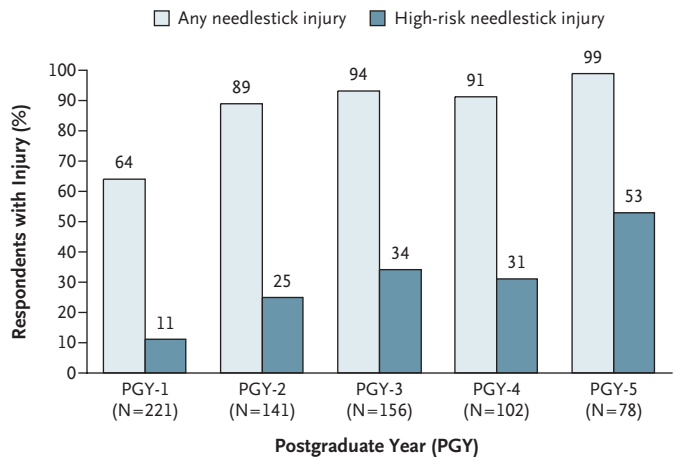

Figure 1. Percentage of Respondents Who Ever Had Any Needlestick Injury or a High-Risk Injury, According to Postgraduate Year.

In this survey, a high-risk needlestick injury involved a patient with a history of infection with human immunodeficiency virus, hepatitis B, or hepatitis C or the use of injection drugs. Postgraduate training was considered to begin with internship in postgraduate year 1 (PGY-1).

stick injuries during training (Table 4). Stepwise multivariate analysis that included these six factors resulted in a model that included five of the six factors: male sex ($P=0.03$), the lack of involvement of a high-risk patient ($P<0.001$), occurrence in the operating room ($P=0.008$), the lack of knowledge of the injury by another person ($P<0.001$), and the total number of needlestick injuries during training ($P=0.002$) (Table 4). There was no significant difference in behavior associated with the reporting of an injury according to the year of training, with 44% reporting in PGY-1, 54% in PGY-2, 51% in PGY-3, 46% in PGY-4, and 48% in PGY-5 ($P=0.77$ as calculated by the chi-square test).

DISCUSSION

Needlestick injuries pose a significant occupational risk for surgical trainees. We found that virtually all surgical residents (99%) had had a needlestick injury by their final year of training. Furthermore, many injuries (51% of those assessed overall, including 16% of those involving high-risk patients) were not reported to an employee health service.

Our study extends earlier observations indicating that needlestick injuries are common in surgical trainees.[12-14] A 1990 survey of all 221 medical and surgical house staff at one hospital reported that 74% had had at least one needlestick injury; the frequency of injury was higher among surgical trainees than among medical trainees by a factor of 6.[13] Another study involving 550 medical students and residents during the 1989–1990 training year likewise reported a high prevalence of needlestick injuries (71%), and a higher frequency of injury (by a factor of 6) among surgical residents than among medical residents.[14] In these two studies, rates of reporting needlestick injuries ranged from 9 to 19%, and a more recent survey of all types of providers from an Iowa medical organization found that 34% had reported their exposure to an employee health service.[15] Our finding that only 49% of surgical residents report such injuries extends previous observations that underreporting may result in a substantial underestimation of the magnitude of the problem.[1,16,17]

The risks of underreporting and thus delaying or forgoing treatment are significant. HIV, HBV, and HCV infections have implications for personal relationships, future employment, and insurance coverage.[18] Reporting the injury to an employee health service enables counseling regarding the risk of exposure and prevention of secondary transmission, including possible transmission to patients,[6,18,19] and may alleviate associated anxiety.[2,19,20] It also allows medical evaluation, including testing and, if warranted, antiretroviral therapy or administration of the HBV vaccine containing hepatitis B immune globulin. Antiretroviral therapy administered within 24 to 36 hours after exposure has been associated with an 81% reduction in HIV infection.[21,22] Although no postexposure prophylaxis is available for HCV, testing with HCV RNA can identify HCV infection at an early stage, during which treatment is highly effective in preventing chronicity.[23,24] Furthermore, reporting of needlestick injuries may be required to establish the causal relationship of the exposure and subsequent complications (e.g., chronic infection or inability to practice medicine[25]). Although legal requirements vary, failure to report an occupational exposure may lead to the denial of subsequent claims.[26]

We identified several risk factors for nonreporting of needlestick injuries that warrant attention. A history of a greater number of injuries was associated with a lower likelihood of reporting the injury. It is possible that trainees become de-

sensitized with each event or may be embarrassed to report it. The fact that another person knew about the injury at the time was the strongest predictor for reporting, and attending physicians were the persons who most often knew of trainees' injuries. We do not have data to inform whether attending physicians motivated the reporting of injury, but this conclusion is likely, given their supervisory roles. Needlestick injuries involving patients not considered to be at high risk were less likely to be reported. Other studies have observed that most surgeons substantially underestimate seroconversion rates with HIV, HBV, and HCV exposures,[27] suggesting that more education on the subject in surgical training might improve rates of reporting and seeking appropriate care.

Systems-based strategies such as the use of "sharpless" methods for handoff and passing of instruments and needles, a safe zone in the operative field, and innovative surgical techniques such as "sharpless surgery" (using nonsharp alternatives whenever possible) and the use of blunt-tip needles are associated with a reduced risk of injury.[28-31] Double-gloving can reduce the risk of blood contamination by a factor of 7 to 8,[32,33] yet in one study of the members of two surgical societies, only about 12% of surgeons engaged in this practice.[28,34] We did not collect data on the use of these techniques. However, the circumstances of injury we observed are similar to the findings from a study of 98 reports of percutaneous injury filed by providers at a Veterans Affairs medical center, in which most injuries occurred in the operating room with suture needles and were accidentally self-inflicted; in such cases, residents were most often involved.[35]

In our study, respondents indicated that being in a hurry was the leading cause of their injury, consistent with our finding that the majority of injuries were accidentally self-inflicted. We found that a lack of time was a leading reason given for the failure to report injuries. On the basis of these findings, surgical training programs should provide for coverage systems to facilitate prompt reporting and curricula that include specific instruction and credentialing on safe techniques. Other system-level changes that may increase reporting of needlestick injuries include timely reporting mechanisms (e.g., needlestick hotlines[11]), routine prompts (e.g., postoperative checklists that include a question about

Table 2. Characteristics of the Most Recent Needlestick Injury.*

Characteristic	No. of Residents Surveyed	Frequency
		no. (%)
Source of injury	577	
Self-inflicted (accidental)		384 (67)
Someone else		193 (33)
Needle type	576	
Solid-bore		467 (81)
Hollow-bore		109 (19)
Location of injury	578	
In the operating room		415 (72)
At the bedside		118 (20)
Other		45 (8)
Task performed during injury	578	
Suturing		301 (52)
Loading needle		65 (11)
Passing needle		77 (13)
Recapping needle		19 (3)
Cleaning up		20 (3)
Other		96 (17)
Perceived cause of injury†		
Rushed	578	327 (57)
Fatigued	579	84 (15)
Lack of skills	580	67 (12)
Lack of assistance	578	54 (9)
Not preventable	578	114 (20)

* Percentages may not sum to 100 because of rounding.
† Respondents could select more than one response.

Table 3. Behavior Associated with Nonreporting of the Most Recent Needlestick Injury.*

Characteristic	No. of Residents Surveyed	Frequency
		no. (%)
Reason for not reporting needlestick	297	
"It takes too much time"		126 (42)
"No utility in reporting"		84 (28)
"Did not want to know results"		19 (6)
"Stigma of having had a needlestick"		14 (5)
Other or no response		67 (23)
Other person aware of unreported needlestick	155	
Attending physician		79 (51)
Resident		58 (37)
Nurse		53 (34)
Medical student		7 (5)
Significant other		20 (13)
Other		7 (5)

* Respondents could give more than one response.

Table 4. Variables Associated with Nonreporting of the Most Recent Needlestick Injury.*

Variable	Residents Surveyed		Odds Ratio (95% CI)	
	Did Not Report Injury	Reported Injury	Univariate Analysis	Multivariate Analysis
	no./total no. (%)			
Male sex	220/403 (55)	183/403 (45)	1.52 (1.06–2.18)	1.63 (1.04–2.56)
No involvement of a high-risk patient	282/487 (58)	205/487 (42)	6.97 (3.89–12.47)	6.06 (3.03–12.14)
Use of solid-bore needle	253/465 (54)	212/465 (46)	1.90 (1.24–2.92)	NA
Occurrence in operating room	236/413 (57)	177/413 (43)	2.24 (1.54–3.26)	1.87 (1.17–2.99)
No knowledge of injury by another person	142/154 (92)	12/154 (8)	20.46 (10.99–38.09)	19.29 (10.09–36.88)
Total no. of needlesticks during training	NA	NA	1.09 (1.04–1.13)	1.08 (1.03–1.13)

* Only variables that were significant at $P<0.05$ in the univariate model are listed. Other variables that were assessed in univariate analyses but were not significantly associated with the nonreporting of an injury included the year of postgraduate study, having a self-inflicted injury, the task being performed when the injury occurred, and the perceived reasons for the injury. CI denotes confidence interval, and NA not applicable.

whether an injury occurred[36]), and peer education to create a culture that encourages speaking up.[37]

Limitations of our study should be noted. We assessed only surgeons in training because they are at the highest risk for needlestick injury; previous studies have indicated that they have more injuries than do attending surgeons, scrub nurses, anesthesiologists, and other operating room personnel.[6,35] Because all information was self-reported, misclassification is possible, although the anonymous nature of the survey would be expected to facilitate accurate reporting. We lack data on outcomes, including results of serologic testing for HIV or hepatitis infection among trainees who sought care for their injuries. Needlestick injuries are the most common type of exposure, but other percutaneous and splash exposures represent additional hazards to the surgeon-in-training; we did not collect data on these exposures.

In summary, needlestick injuries among surgeons in training are common and often not reported to an employee health service. These findings underscore the need for ongoing attention to strategies to reduce such injuries in a systematic way and to improve reporting systems so that appropriate medical care can be delivered.

No potential conflict of interest relevant to this article was reported.

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