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CONCISE COMMUNICATION

Use of the Haddon Matrix as a Tool for Assessing Risk Factors for Sharps Injury in Emergency Departments in the United Arab Emirates

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We investigated the epidemiology and prevention of sharps injuries in the United Arab Emirates. Among 82 emergency nurses and 38 doctors who responded to our questionnaire, risk factors for sharp device injuries identified using the Haddon matrix included personal factors (for the pre-event phase, a lack of infection control training, a lack of immunization, and recapping needles, and for the postevent phase, underreporting of sharps injuries) and equipment-related factors (for the pre-event phase, failure to use safe devices; for the event phase, failure to use gloves in all appropriate situations). Nearly all injuries to doctors were caused by suture needles, and among nurses more than 50% of injuries were caused by hollow-bore needles.

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Injuries caused by sharp devices (hereafter, sharps injuries) are a major occupational hazard for healthcare workers (HCWs) because of the risk of transmission of bloodborne infections. Over 20 diseases can be transmitted by contaminated sharps.[1,2] In 2002, the World Health Organization reported that of 35 million HCWs, 2 million experienced percutaneous exposure to infectious diseases each year and that 40% of hepatitis B virus (HBV) infections, 40% of hepatitis C virus (HCV) infections and 2.5% of human immunodeficiency virus (HIV) infections in HCWs are the result of needlestick injuries.[2]

Depending on the device and procedure being performed, 62%-88% of sharps injuries could be prevented by use of safer medical devices,[2] which are not provided by all healthcare facilities. In many hospitals, compliance with standard precautions, including the use of protective equipment and the correct use and disposal of sharps, is alarmingly low, so injuries continue to occur.[2,3] For the 40%-80% of injuries that go unreported, the opportunity for postexposure prophylaxis is lost.[2-4]

Sharps injuries result from exposures to specific hazards and affect certain high-risk groups more than others. Emergency department personnel are at high risk for occupational infections due to exposure to sharps and blood. Emergency department patients tend to have higher seroprevalence for HIV, HBV and HCV than patients in other settings.[5] In the United Arab Emirates (UAE), 80% of the population are from other countries; these individuals undergo periodic HIV testing, followed by deportation if the test results are positive, so HIV exposure for HCWs in the UAE would be less than it is for HCWs in emergency departments in many other countries. On the other hand, hepatitis B and C are prevalent in the home countries of low-income construction and agricultural workers, who are a major risk group for trauma and are frequently treated in emergency departments.

There are many studies on the epidemiology of sharps injuries among HCWs, but few utilize the comprehensive approach of modern injury prevention. To our knowledge, there has been no research on sharps injuries in the UAE. HCWs in the UAE are of many different nationalities, with different training, skills, and knowledge of occupational safety practices and policies, which poses challenges for the implementation of standard precautions for preventing and managing sharps injuries.

The goal of this study was to improve the sharps safety of emergency department doctors and nurses and to verify the utility of the Haddon matrix for comprehensive management of the risk of sharps injuries. The main objectives were to assess sharps injury determinants during 3 phases (the pre-event phase [ie, before an injury occurs], the event phase [ie, while an injury is occurring], and the postevent phase [ie, after an injury occurs]), and to identify personal, equipment-related, and environmental risk factors pertinent to prevention for each phase using a 9-cell Haddon matrix.[6-8]

Whereas most safety devices, training, and safe work practices are intended to prevent sharps injuries in the pre-event phase, other equipment, such as latex gloves, reduces the volume of the inoculum during a sharps injury event. Pre-exposure immunization of all staff members in the pre-event phase and postevent prophylaxis, such as antiretroviral therapy, both reduce the risk of acquiring bloodborne infection from sharps injuries.

Although the Haddon matrix has been widely used for injury prevention in the community, it is seldom used in the context of hospital and patient safety.[9] Other key concepts of modern injury control and occupational safety include a preference for interventions that provide passive or automatic protection wherever feasible, reducing the need for personal protective equipment and for constant active protection (ie, vigilance), which inevitably fails in the presence of unanticipated hazards. Such interventions include appropriate integral safety devices, and other aspects of the hierarchy of controls and Haddon's 10 basic strategies, such as elimination and substitution. Our research was designed to bridge the gap between the fields of injury prevention, infection control, patient safety, and occupational safety.

METHODS

Study population. The study group comprised doctors and nurses at 4 emergency departments, 1 in each of the 2 largest government hospitals in Abu Dhabi (Sheikh Khalifa and Al

Mafraq Hospitals) and 1 in each of the 2 largest government hospitals in Al Ain (Al Ain and Tawam Hospitals). Abu Dhabi and Al Ain are 2 of the 4 largest cities in the UAE. This group was studied during January-February 2005. Sampling included a census of all 56 emergency department doctors and a random sample of 30 nurses from each emergency department.

Study design and instrument. A cross-sectional survey was done with an anonymous, self-administered questionnaire in English. The questionnaire was pilot tested among faculty surgeons, then distributed by emergency department head nurses (in 3 hospitals) and by the authors (in 1 hospital) (the instrument is reprinted in the Appendix [online only]). Twenty-seven questions collected information on 3 topics. The first was activities involving sharps and frequency of exposures. The second was the number and type of sharps injuries the individual had experienced during the preceding year, and whether an injury could have been prevented if the sharp had had a safety feature. The third topic was risk factors, which were divided into 3 categories: personal, equipment-related, and environmental. The questionnaire included questions about nonmodifiable personal factors, such as age, sex, nationality, and job category, as well as modifiable personal factors, such as training in infection control and safety, safe work practices, HBV immunization, reporting of sharps injuries, and belief in the preventability of such injuries. It also included questions about equipment-related risk factors, including devices used and the availability and use of safety features, disposal units, and gloves. Questions about environmental risk factors addressed the institutional safety climate (ie, communication of policy to employees).

Definitions. Percutaneous injury was defined as a puncture or laceration of skin by a needle or other pointed instrument.[10] An invasive procedure was defined as a procedure that invades (enters) the body, usually by cutting or puncturing skin or by inserting instruments.[11]

Data analysis. Data analysis was performed with SPSS software (SPSS). Significance was assessed by the χ^2 test, Fisher exact test, or Student *t* test, and presumed when *P* was less than .05.

RESULTS

Response rates for doctors (38 of 56) and nurses (82 of 120) were both 68%. Over two-thirds of respondents (82 [68%]) were nurses. Most (32 [84%]) of the doctors who responded were male and most (63 [77%]) of the nurses who responded were female. The age of respondents ranged from 24 to 60 years (median, 29 years); 61 (51%) of the respondents were 24-34 years old, 33 (27%) were 35-44 years old, and 26 (22%) were 45 or older. The mean number of years in practice was 3.7, and the mean number of hours worked per month was 171. Only 3 (3%) of the respondents were Emiratis; 58 (49%) came from other Middle Eastern countries or East African countries, 39 (33%) came from Asia, and 18 (15%) came from Europe, North America, or Australia. (Some North African countries are counted with Middle Eastern countries.)

Exposures. For doctors, the most common activities involving sharps exposure were suturing (mean weekly frequency, 32 times [range, 0-200 times]) and using a scalpel (mean weekly frequency, 12 times [range, 0-98 times]). For nurses, the most common activities involving sharps exposure were injecting drugs (mean weekly frequency, 78 times [range, 0-700 times]), inserting intravenous cannulas (mean weekly frequency, 75 times [range, 0-300 times]), and drawing blood (mean weekly frequency, 57 times [range, 0-300 times]).

Injuries. During the preceding 12 months, 23 (19%) of 119 of respondents (11 [29%] of the doctors and 12 [15%] of the nurses) had sustained a sharps injury ($P > .06$). All of the doctors had been injured by a solid needle while suturing and several had sustained additional sharps injuries, including 2 (18%) who were injured while giving an injection and 1 (9%) injured while using a scalpel. For nurses, 7 (59%) had been injured by a hollow bore needle (3 [25%] while drawing blood, 2 [17%] while giving an injection, and 2 [17%] while inserting a cannula), 1 (8%) by a needle while suturing, and 4 (33%) during disposal of a needle and/or sharp. All injuries occurred on the fingers, thumb, or palm of the hand. HCWs were asked whether they believed their injury would have been prevented if the sharp had had a safety feature; 3 (37%) of 8 doctors who answered this question said yes, as did 8 (73%) of 11 nurses.

Personal risk factors. Personal risk factors in the pre-event phase that we evaluated were training in infection control, safe work practices, immunization status for hepatitis B, and attitude toward sharps injury prevention. Only 6 (16%) of 38 doctors and 44 (54%) of 81 nurses ($P = .0001$) had attended training in infection control. Rates of avoiding recapping varied by occupation; compliance was lower among doctors, with 29 (78%) of 37 reporting never recapping needles, than among nurses, with 80 (99%) of 81 reporting never recapping ($P = .001$). Attendance at training was negatively associated with recapping; 12% of those who had not attended any training recapped, compared with 2% among the trained ($P = .045$). Among doctors, 4 (11%) of 38 were not immunized against HBV, compared with 3 (4%) of 82 nurses ($P = .2$). Sharps injuries were felt to be nearly or mostly preventable by 98 (82%) of all respondents at the beginning of the questionnaire and by 101 (84%) at the end.

For the postevent phase, we evaluated reporting of exposure. Among 11 doctors who had sustained an occupational sharps injury during the preceding year, 5 (45%) had not reported their most recent injury, compared with 2 (17%) of 12 nurses ($P = .3$). There was an association between underreporting and training in infection control; among injured HCWs, 44% of those who did not report their injury also lacked training, whereas 0% of those with training let their injury go unreported ($P = .05$). Reasons for not reporting an injury included already being immunized (selected by 30% of respondents), followed by certainty that patient did not

TABLE A 9-Cell Haddon Matrix With Examples of Modifiable Risk Factors for Sharp Device Injuries in the Pre-event, Event, and Postevent Phases of Injury

Time phase	Risk Factor		
	Personal	Equipment-related	Environmental
Pre-event	Training in infection control, sharps safety, and/or safe suturing techniques; use of safe work practices; HBV immunization status; attitude toward preventability of injuries	Use of sharps with retractable, self-sheathing, or self-blunting safety features (needles, lancets, and scalpels); needle-free intravenous connectors; sharps disposal containers; impenetrable gloves (eg, made of Kevlar); and/or sterile adhesive strips to replace cutaneous suturing, where possible	Organizational factors, institutional safety climate, implementation of surveillance and prevention of sharps injuries using Haddon matrix or other epidemiologic approach
Event	…	Use of latex gloves, blunt-tipped scalpels, and/or blunt needles (for subcutaneous suturing)	…
Postevent	Exposure control plans and reporting of exposures	Written reporting protocols; access to HAART, HBV immunoglobulin, and/or HBV vaccine	Presence of reporting center; use by the reporting center of prompt recording, evaluation, treatment, and follow-up; and the availability of specialist in postexposure prophylaxis

NOTE. HAART, highly active antiretroviral therapy; HBV, hepatitis B virus.

have a bloodborne infection (14%), time constraints (14%), lack of familiarity with reporting procedures (14%), belief that reporting would not prevent infection (14%), and other (14%).

Equipment-related risk factors. For the pre-event phase, we evaluated use of safe devices and safe disposal of sharps. No respondent used safe devices that provided protection during the pre-event phase, such as self-sheathing, retractable, hollow bore needles; blunted suture needles; or retractable scalpels. Syringes with needles were disposed of directly into sharps disposal containers without recapping by 29 (78%) of 37 doctors and 80 (99%) of 81 nurses. No one cut off needles.

For the event phase, we evaluated use of gloves in all appropriate situations. Among doctors, 35 (97%) of 36 always wore gloves when suturing or using a scalpel; among nurses, 74 (92%) of 80 always wore gloves while drawing blood, 72 (90%) of 80 always wore them while inserting cannulas, and 49 (62%) of 79 always wore them while giving injections.

Environmental risk factors. We evaluated knowledge of hospital policy as an environmental risk factor for the postevent phase. Lack of knowledge regarding institutional policy for management of sharps injuries was reported by 3 (9%) of 35 doctors and 0% of the nurses ($P = .049$).

DISCUSSION

Use of a structured questionnaire developed on the basis of common activities, exposures, and injuries involving sharps by major job category, together with the typical Haddon matrix, facilitated rapid identification of hazardous exposures and opportunities for prevention, examples of which are shown in the Table. Although nearly all HCWs in UAE emergency departments were from other countries and had differing backgrounds, we found strong compliance with safe work practices for use of sharps and a low frequency of injury, compared with other reports.[2-4,12,13]

There are several possible causal factors that might explain our positive findings. It could be that training programs and safety equipment are better funded in the UAE than in some other countries; however, we are not aware of such differences and we did not find that hospitals were equipped with the full range of sharps safety devices that provide automatic or so-called passive protection, such as retractable needles. Other possibilities could include the fact that foreign HCWs in the UAE may either underreport injury or take more precautions because they feel personally threatened by the risk and potential outcomes of injuries that could cause bloodborne infection. For HIV, these potential outcomes include loss of employment and deportation. National policies do not provide adequate compensation for occupational bloodborne infections. HCWs are not provided with data on HIV seroprevalence in the general population or among emergency department users to assess their personal risk, as such data are confidential. Further research is needed to verify whether fear of losing a relatively attractive and well-paid job as a result of an occupational bloodborne infection helps to maintain safe work practices or simply biases self-reporting.

The evident risk factors for occupational bloodborne infection for emergency department doctors are skin injuries from suture needles, as well as recapping needles, incomplete immunization coverage, and high underreporting of sharps

injuries. Thus, pre-event phase interventions designed to increase the safety of handling solid needles, such as training in basic surgical techniques with instruments to avoid touching needles with the fingers, should decrease injuries among doctors.[2] Another intervention, based on the hierarchy of controls for occupational safety,[2,6-8] such as elimination or substitution, would be to encourage the use of sterile wound-closing adhesive strips for skin closure, wherever feasible, as a preferred alternative to suturing, and suturing underlying tissues with blunt-tipped suture needles. Appropriate disposal of sharps to avoid recapping also needs to be encouraged.[2,3,12] Furthermore, administrative controls are necessary to facilitate surveillance of sharps injuries and of immunization coverage, and to encourage complete reporting of injuries and universal coverage by HBV immunization.[2-4,12]

Our findings, and those of other studies,[2-4,12] confirm that sharps injuries among nurses are caused mainly by hollow-bore needles. Policies to reduce the number and consequences of needlestick injuries for nurses should focus on passive protection in the pre-event phase by introducing safety devices for needles and on event-phase protection by encouraging glove use.[2,3] As appropriate sharps injury prevention programs positively influence attitudes towards safe work practices and reporting, training that emphasizes methods to minimize the risk of occupationally acquired bloodborne infection should be mandatory for both doctors and nurses and should be evaluated periodically to ensure that it is effective. As risk factors for acquiring bloodborne infection differ by job category, educational interventions need to be tailored to job categories, even in specific settings, such as emergency departments.[3]

Potential limitations of this study include the fact that its study group was confined to HCWs in government hospitals, and it may not be generalizable to all institutions. Participation, response, and/or recall bias are also possible. An English-language questionnaire was used, although English is not the first language of many HCWs. We relied on self-reports of compliance, and although widely used elsewhere, these could differ from observed behavior.[3] Self-administered questionnaires could have compromised the independence of responses; however, results were similar for another small survey in another emergency department that was done by interviewing nurses individually.

Prevention of sharps injuries is an integral component of occupational safety and health for HCWs. Rapid surveillance using a standardized questionnaire facilitates development of appropriate interventions for different activities and occupations according to risk factors and time phases of frequent exposures and injury incidents.[6-9] Although it is essential to monitor sharps injuries at each workplace, standardized national and international surveillance and prevention of these and other healthcare-related injuries should also be considered.

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