Epidemiol. Infect. (1999), **122**, 259–265. Printed in the United Kingdom

Needlestick and sharps injuries among health-care workers in Taiwan

Y. L. GUO[1,2], J. SHIAO[2,3,4], Y.-C. CHUANG[5] AND K.-Y. HUANG[6]*

[1] *Environmental and Occupational Health, National Cheng Kung University Medical College, Tainan, Taiwan*
[2] *Center for Occupational Health, National Cheng Kung University Medical College, Tainan, Taiwan*
[3] *Nursing Department, China Junior College of Medical Technology, Tainan, Taiwan*
[4] *School of Health Services Management, Faculty of Medicine, The University of New South Wales, Australia*
[5] *Internal Medicine, National Cheng Kung University Medical College, Tainan, Taiwan*
[6] *Microbiology and Immunology, National Cheng Kung University Medical College, 138, Sheng-Li Road, Tainan, Taiwan*

(*Accepted 14 October 1998*)

SUMMARY

Sharps injuries are a major cause of transmission of hepatitis B and C viruses and human immunodeficiency virus in health-care workers. To determine the yearly incidence and causes of sharps injuries in health-care workers in Taiwan, we conducted a questionnaire survey in a total of 8645 health care workers, including physicians, nurses, laboratory technicians, and cleaners, from teaching hospitals of various sizes. The reported incidence of needlestick and other sharps injuries was 1·30 and 1·21 per person in the past 12 months, respectively. Of most recent episodes of needlestick/sharps injury, 52·0% were caused by ordinary syringe needles, usually in the patient units. The most frequently reported circumstances of needlestick were recapping of needles, and those of sharps injuries were opening of ampoules/vials. Of needles which stuck the health-care workers, 54·8% had been used in patients, 8·2% of whom were known to have hepatitis B or C, syphilis, or human immunodeficiency virus infection. Sharps injuries in health-care workers in Taiwan occur more frequently than generally thought and risks of contracting blood-borne infectious diseases as a result are very high.

INTRODUCTION

Sharps injuries have become one of the most important occupational injuries and routes for contagion in health-care workers (HCWs) [1, 2]. Needlestick injuries have resulted in documented transmission of hepatitis B and C viruses (HBV, HCV) and human immunodeficiency virus (HIV) in HCWs [3, 4]. Centers for Disease Control of the United States has developed guidelines for the prevention of these injuries [5]. However, these serious and potentially fatal injuries have not received adequate attention in Taiwan.

* Author for correspondence.

Hepatitis B seroprevalence studies in Taiwan have shown HBsAg positivity rates of 15–21% [6, 7] and for hepatitis C, antibody positivity of approximately 2·5% in the general population [8]. Although the HIV epidemic occurred rather late in Taiwan, the number of patients with HIV antibody has been increasing steadily in the past few years. In June 1997, the Department of Health reported a total of 1491 people with documented HIV infection [9], a figure very likely under-estimating the true rate of infection.

The reported risk of hepatitis B seroconversion in HCWs sustaining HBsAg-positive needlestick injuries has ranged from 25 to 30% [2, 10]. The reported risk of contracting HCV infection after needlestick event

Table 1. *Job category, percent responders, gender, and age distribution of subjects to whom the needle and sharps stick questionnaire was given, Taiwan, 1996–7*

Job	No. respondent/No. questionnaire	Responded (%)	Male (%)	Average age (years)
Physicians (including physician assistants)	1389/2396	58·0	80·6	34·9 ± 0·24*
Nurses (including nursing assistants)	5269/5663	93·0	0·3	27·8 ± 0·11
Technicians	1291/1485	86·9	26·8	32·0 ± 0·22
Laundry workers/housekeepers/supportive personnel	676/862	78·4	23·0	43·8 ± 0·32
Other personnel	20/63	31·7	50·0	39·4 ± 2·7
Total	8645/10469	82·6	15·2	30·8 ± 0·11

* Mean ± standard error.

Table 2. *Source of health-care worker's most recent needlestick/sharp object injury at work*

Type of needle/sharp	No.	%	% known to have been used in patient†
Syringe needle*	3924	52·0	59·4
Glass item	705	9·3	8·8
Suture needle	544	7·2	85·3
Intravenous catheter stylet*	344	4·6	88·4
Insulin needle/hyperdemic needle*	201	2·7	74·1
Air-induction needle/needles of the IV kit	180	2·4	NA‡
Phlebotomy needle*	162	2·1	85·2
Scalpel blade	160	2·1	72·5
Butterfly needle*	149	2·0	86·6
Blood glucose lancet	131	1·7	81·7
Tapping needle*	72	1·0	94·4
CVP introducer needle*	34	0·5	82·4
Other	944	12·5	22·0
Total	7550	100	

* Hollow-bored needle-related injuries (64·9%)
† Information on whether the item had been used in a patient was obtained from the health-care worker's recall.
‡ NA, Non-applicable because the air-induction needle was not used directly on a patient.

with HCV-RNA-positive blood-contaminated needles has ranged from 4 to 10% [2, 7]. The risk of HIV seroconversion in HCWs following HIV-positive percutaneous injury ranged from 0·1 to 0·3% [8, 11]. With high prevalences of HBV and HCV among the general population of Taiwan, Taiwanese HCWs may be expected to run a significant risk of occupational infection with hepatitis B and C viruses, and HIV.

Multicentre studies on the incidence, items, settings, and risk factors of needlestick injuries similar to those conducted in other countries are lacking in Taiwan. We conducted an investigation to better define these risks.

METHODS

There are 132 teaching hospitals in Taiwan. Sixteen of these were randomly selected, including four hospitals each with more than 1000, 500–999, 200–499, or less

https://doi.org/10.1017/S0950268899002186 Published online by Cambridge University Press

Table 3. *Answers to the question: 'In what circumstances did your most recent needlestick or sharps injury occur at work?'*

Circumstance/factor	No.	%	% known to be used in patient
Needle-related	5431	(71·9)	
Recapping	1809	24·0	74·2
Needle penetrating cap	612	8·1	65·2
Drawing blood or pushing medication through venous route	478	6·3	75·1
Opening the needle cap	462	6·1	13·9
After drawing blood or pushing medication through venous route	338	4·5	91·7
Withdrawing medication	329	4·4	0·0
Accidental uncapping of needle already recapped	218	2·9	71·6
Stuck accidentally by needle held by colleague	146	1·9	82·2
Disassembling needle and syringe after use	139	1·8	60·4
By needle after use, before disposal	124	1·6	82·3
While introducing the needle into a disposal box	112	1·5	83·9
Stuck by needle protruding from disposal box	72	1·0	73·6
Stuck by improperly disposed needle in patient unit	58	0·8	70·7
Cleaning of 'infectious waste'	52	0·7	75·0
Collecting sharps collector	50	0·7	82·0
Fumbling with items	27	0·4	40·7
Attempting to bend or break the needle	24	0·3	54·2
Cleaning of 'non-infectious waste'	23	0·3	78·3
Transferring drawn blood into test tube	23	0·3	100
Other needles	335	4·4	54·9
Sharps-related	2119	(28·1)	
Opening of ampoule or vial	547	7·2	0·0
By myself during procedure	343	4·5	80·2
Cleaning up medical instrument	148	2·0	76·4
Assembling/disassembling of device	126	1·7	73·8
By colleagues	92	1·2	88·0
Using medical instrument	56	0·7	50·0
Fumbling with item	31	0·4	25·8
Broken ampoule or vial	23	0·3	0·0
Cleaning of 'non-infectious waste'	21	0·3	57·1
Item penetrating from sharps collector	20	0·3	75·0
Cleaning of 'infectious waste'	20	0·3	75·0
Collecting sharps collector	18	0·2	83·3
Other or unknown	674	8·9	4·8

than 200 employees. All the medical staff, nurses, laboratory technicians, and supporting staff of these hospitals were recruited into this investigation.

The selected hospitals were notified and visited to offer administrative assistance before the questionnaire was given to the HCWs. Names of the medical staff, nurses, laboratory technicians, and supporting staff were obtained from the employment records of the hospital. Subjects were contacted by the investigators and invited to participate in the study. They were told that participation in the investigation was strictly voluntary and that refusal would not affect their employment status or medical benefit. After recruitment, participants were asked to fill out a structured questionnaire. Detailed information about the causal item, location, and situation of the most recent episode of needle or sharps stick injury, whilst the memory of the circumstances was still fresh, was collected carefully. Programmes of education and training for injury prevention in the hospital were documented. If participants had been stuck by a needle or sharp object at work, the status of the sharp item, whether previously used in a patient, and the status of the sharp stick episode, whether reported to the hospital administration, and the nature of the response of the hospital authority were sought. Participants were also asked to recall the frequency of needle and sharps stick injuries in the past 12 months.

RESULTS

There was a total of 10469 eligible HCWs in the 16 hospitals. Of these, 8645 (82·6%) completed the questionnaire satisfactorily (Table 1). Nurses constituted the largest group of HCWs, followed in order by physicians, technicians, and other supporting personnel. The response rate was best in nurses, followed by technicians and then supporting personnel. Physicians did not participate as well as other HCWs.

Answers to the question: 'Where at work did your most recent needlestick/sharps injury occur?' are summarized as follows. Less than one seventh of the subjects (1095, 12·7%) reported 'never'. The places where injuries occurred most frequently were the patient rooms (3329, 38·5%), followed next by operating rooms (1030, 11·9%), intensive care units (869, 10·1%), emergency rooms (466, 5·4%), outpatient departments (434, 5·0%), laboratories (245, 2·8%), haemodialysis units (141, 1·6%), and others (1036, 12·0%). The answers to the question: 'What item caused your most recent needlestick/sharps injury at work?' are summarized in Table 2. Syringe needles were by far the most important items causing injuries, constituting 52% of cases, followed by glass products, suture needles, and intravenous catheters, each responsible for less than 10% of the incidents. When suture needle, intravenous catheter stylet, insulin needle/hyperdemic needle, phlebotomy needle, scalpel blade, butterfly needle, blood glucose lancet, tapping needle, or CVP introducer needle were the items involved in sharps injury incidents, 70% or more of them were items already used in a patient. Table 3 summarizes the answers to the question: 'In what circumstances did your most recent needlestick or other sharps injury occur at work?' In most of the circumstances associated with sharps injuries, the sharps had already been used in a patient.

The answers to the question: 'To the best of your knowledge, had the item which stuck you been used on any patient with any of the following infectious diseases?' are summarized in Table 4. Approximately 8% of the needle/sharps injuries were caused by items used on a patient with hepatitis B, hepatitis C, syphilis, or HIV infection. However, almost 30% of injury events were caused by items used on patients whose infectious status was unknown. Only 18·2% of the HCWs stated they had reported the event (data not shown).

Details on procedures for recapping needles and the nature of disposal containers after needles had been used were also sought. Of those HCWs whose jobs involved using needles, 73% reported recapping the needle, and 35% did not use commercially available needle disposal boxes.

HCWs were asked how many times they had been injured by a needle and by other sharp object in the past 12 months. They reported an average of 1·30 needlestick injuries in the past 12 months, and 1·21 injuries due to other sharps (Fig. 1). The HCWs were also asked how many times their broken skin, eye, nasal mucosa or buccal mucosa had come in contact with patient's body fluid. The average was of 0·84, 0·41, 0·16 and 0·21 times, respectively (Figs 2, 3).

Table 4. *Answers to the question: 'To the best of your knowledge, had the item which stuck you been used on any patient with any of the following infectious diseases?'*

	No.	%
Unused	2518	33·4
Used		
Patient had hepatitis B	377	5·0
Patient had hepatitis C	107	1·4
Patient had hepatitis B and C	82	1·1
Patient had syphilis	46	0·6
Patient had HIV	5	0·1
Patient had none of the above diseases	1281	16·9
Do not know whether the patient had any of the above diseases	2243	29·7
Unsure whether used	891	11·8

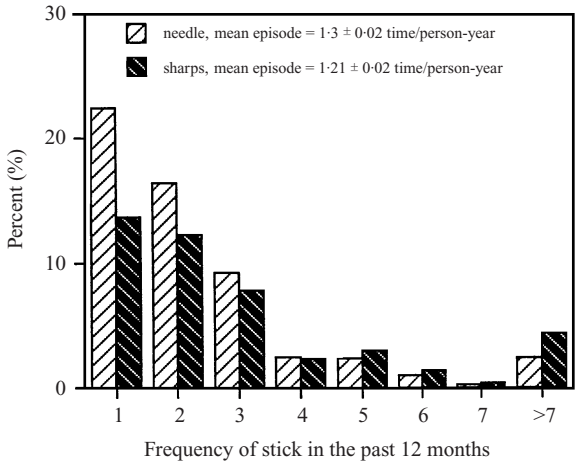

Fig. 1. Reported frequency of needle or sharps stick in the past 12 months in Taiwanese HCWs. *Those with work duration of less than 12 months were excluded from this analysis.

https://doi.org/10.1017/S0950268899002186 Published online by Cambridge University Press

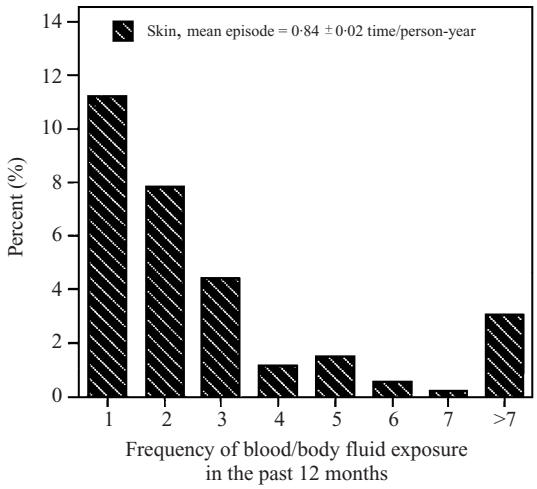

Fig. 2. Reported frequency of blood/body fluid exposure to the broken skin in the past 12 months. * Those with work duration of less than 12 months were excluded from this analysis.

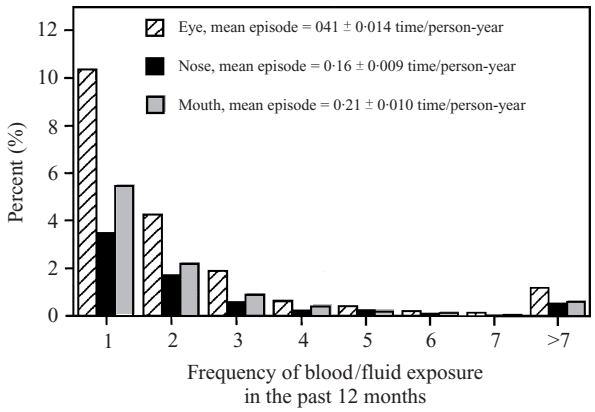

Fig. 3. Reported frequency of eye, nose, and/or mouth exposure to blood/body fluids in the past 12 months. * Those with work duration of less than 12 months were excluded from this analysis.

DISCUSSION

This is the first population-based survey of needlestick and other sharps injuries in HCWs in Taiwan. We found high incidence rates of needlestick and other sharps injuries in the sampled hospitals. Needlestick injuries caused by recapping were the single most important cause of sharps injuries in HCWs.

Approximately two-thirds of the most recent sharps injury events occurred either in patient rooms (38%), operation rooms (12%), intensive care units (10%), or emergency rooms (5%). These findings were consistent with the investigations reported by the US EPINet group [12]. Hollow-bore needles accounted for approximately two-thirds of the most recent sharp injuries in this group of HCWs. This was also similar to the data presented by US EPINet, in which hollow-bore needles accounted for 68·5% of percutaneous injuries. In the hollow-bore needle injuries, two-thirds of the needles had been used on a patient. Approximately three-quarters of the most recent injuries were caused by only four device categories, namely syringe needles, glass items, suture needles, and intravenous catheter stylets. In our HCWs, injuries due to glass items (9·9%) were more frequent than those reported by the US EPINet or the Italian SIROH EPINet.

Needle recapping or circumstances related to recapping accounted for the most needlestick injuries reported, namely, recapping, needle penetrating cap, accidental uncapping of needle already recapped, disassembling needle and syringe after use. A total of 36·8% of all needle/sharps injuries, and approximately one half of needle injuries were related to recapping. Although some educational programmes for the prevention of needlestick and sharps injuries have been given to hospital personnel, approximately three-quarters of our HCWs reported still recapping their needles after use. This contributed, at least partly, to the high incidence of needlestick injuries.

Table 4 shows that approximately 8% of needle/sharps injuries were caused by items used on patients known to have hepatitis B or C, syphilis, or HIV. A total of 1898 items had been used on patients whose infectious status was known. Among known infected patients, 459 (24·2%) had hepatitis B and 189 (10·0%) hepatitis C infection markers. These figures were higher than the background carrier rates of hepatitis B and hepatitis C in the community. It was possible that hospitalized patients had higher rates of hepatitis carrier status than the general population [13]. Since the seroprevalence of hepatitis B and C in hospital patients has not been studied in Taiwan, further investigation to elucidate these seroprevalences is warranted. It was striking that a large proportion of sharps injuries (29·7%) occurred with items used in patients whose infection status was not known. Determination of hepatitis B, C or HIV status is not routine in most of the hospitals in Taiwan, and therefore, unless the incident is reported, the infection status of the patient will remain unknown. Thus, the large proportion of used items with unknown infection status might have been caused by the high percentage of non-reporting (81·8%). HCWs, especially physicians were known to under-report their sharps injuries at work [14, 15]. Under-reporting of injuries was confirmed in this investigation with only 18·2%

https://doi.org/10.1017/S0950268899002186 Published online by Cambridge University Press

of our HCWs reporting their most recent sharps injury to the hospital administration.

The risk of seroconversion to hepatitis B and C infection can be estimated roughly using the data derived from this investigation and from previous studies. The reported yearly incidence of needlestick was 1·30 per person in this survey, and 65% of the needles were hollow-bored; two thirds of them had been used in a patient, and therefore contaminated. Taking the reported hepatitis B carrier rate of approximately 20%, the incidence rate of percutaneous exposure to hepatitis B seropositive blood was calculated to be 0·11 per person-year. Since the risk of infection following percutaneous exposure to HBsAg-positive blood has been estimated as 6% [16] to 13% [12], the risk of seroconversion in our HCWs due to needlestick can be calculated as $0{\cdot}11 \text{ per person-year} \times (6 \sim 13\%) = 0{\cdot}0068 \sim 0{\cdot}0146$ per person-year. With a current work force of approximately 110000 HCWs in Taiwan, and assuming that 20% of them are HBsAg- and HBsAb-negative [17], the risk of contracting hepatitis B can be estimated at $110000 \times 20\% \times 0{\cdot}0068 \sim 0{\cdot}0146 = 150 \sim 322$ persons per year. For hepatitis C, taking the reported carrier rate of approximately 10%, the incidence rate of percutaneous exposure to HCV antibody (+) blood was 0·056 per person-year. Assuming two-thirds of the HCV antibody (+) patients were HCV-RNA positive, and $4 \sim 10\%$ of percutaneous exposure to HCV-RNA (+) blood became infected, the risk of seroconversion in our HCWs due to needlestick can be calculated as $0{\cdot}056 \text{ person/year} \times \frac{2}{3} \times (4 \sim 10\%) = 0{\cdot}0015 \sim 0{\cdot}0038$ person/year. With a total of 110000 HCWs, of whom 90% are anti-HCV negative, the risk of contracting hepatitis C can be estimated at $110000 \times 90\% \times 0{\cdot}0015 \sim 0{\cdot}0038 = 149 \sim 376$ persons per year. The hazard of occupational exposure to infectious agents in HCWs in this population is real and not theoretical.

To ensure better cooperation from hospital administrations and from HCWs, subjects were sampled from the teaching hospitals around Taiwan. HCWs from teaching hospitals might have been more cautious and better educated in terms of occupational health and safety than those from private hospitals. In addition, those HCWs who were willing to participate in this survey probably had greater awareness of occupational safety than those who were not. Therefore, our estimates of needle and sharps sticks incidence might prove to have fallen short of the true risk.

Although vaccination for hepatitis B is highly recommended for HCWs at their entry into this occupation, it is not mandatory in Taiwan. However, the health policy and management authority of Taiwan, the Ministry of Health, has recently adopted employees' hepatitis B vaccination coverage as an evaluation measure of hospital accreditation. This may be an important incentive to hospitals to provide vaccination to their HCWs. Other efforts of the Ministry of Health for reducing sharps injuries have included publishing an instructional booklet for hospital administrators which describes non-recapping policy, educational needs, and reporting and response policies after injuries. The effects of such efforts, however, might have been significantly reduced by the heavy work load and generally busy schedule of the HCWs, relative ignorance of potential occupational hazards in these workers, and lack of financial incentives of some individual hospitals for the prevention of sharps injuries.

The lifetime and one-year incidence of needle/sharps injuries in Taiwanese HCWs were both higher than we expected. The most important circumstances associated with needlestick injuries were still related to recapping of the needles after use. With a high background carrier rate of hepatitis B and C, needle/sharps injuries can be a significant source of occupational hazards in HCWs. Further investigations including seroprevalence studies of hepatitis B, hepatitis C and HIV in hospital patients are warranted to determine the risk of contracting these potentially serious infections in HCWs.

ACKNOWLEDGEMENTS

The authors are grateful to the participants and administrators of the 16 selected hospitals in Taiwan. This project was supported by Centre for Occupational Health, jointly sponsored by National Cheng Kung University Medical College and the Ministry of Health, Taiwan, Republic of China.

REFERENCES

1. Gestal JJ. Occupational hazards in hospitals: risk of infection. Br J Ind Med 1987; **44**: 435–42.
2. Sepkowitz KA. Occupationally acquired infections in health care workers. An Intern Med 1996; **125**: 917–28.
3. Mitsui T, Iwano K, Masuko K, et al. Hepatitis C virus infection in medical personnel after needlestick accident. Hepatology 1992; **16**: 1109–14.

4. Ippolito G, Puro V, DeCarli G. The risk of occupational human immunodeficiency virus infection in health care workers. Arch Intern Med 1993; **153**: 1451–8.
5. Centers for Disease Control. Guideline for prevention of transmission of human immunodeficiency virus and hepatitis B virus to health care and public safety workers. MMWR 1989; **38**: 1–38.
6. Chen DS, Sung JL, Lai MY. A seroepidemiologic study of hepatitis B virus infection in Taiwan. J Formosan Med Assoc 1978; **77**: 908–18.
7. Chen HL, Chang MH, Ni Yh, et al. Seroepidemiology of hepatitis B virus infection in children: The ten years of mass vaccination in Taiwan. JAMA 1996; **276**: 906–8.
8. Sheu JC, Wang JT, Wang TH, et al. Prevalence of hepatitis C viral infection in a community in Taiwan. J Hepatol 1993; **17**: 192–8.
9. Department of Health Republic of China. Epidemiol Bull 1997; **13**: 164.
10. Udasin ID, Gochfeld M. Implications of the occupational safety and health administration's bloodborne pathogen standard for the occupational health professional. J Occup Med 1994; **5**: 548–55.
11. Cardo DM, Culver DH, Ciesielski CA, et al. A case-control study of HIV seroconversion in health care workers after percutaneous exposure. N Engl J Med 1997; **337**: 1485–90.
12. Ippolito G, Puro V, Petrosillo N, et al. Prevention, management and chemoprophylaxis of occupational exposure to HIV. University of Virginia: International Health Care Worker Safety Center, 1997: 1–25.
13. Nelsing S, Wantin P, Skøt J, et al. The seroprevalence of hepatitis B and C in hospitalized Danish patients. Scand J Infect Dis 1995; **27**: 445–8.
14. Harmory BH. Underreporting of needlestick injuries in a university hospital. Am J Infect Control 1983; **11**: 174–7.
15. Albertoni F, Ippolito G, Petrosillo N, et al. Needlestick injury in hospital personnel: a multicenter survey from central Italy. Infect Control Hosp Epidemiol 1992; **13**: 540–4.
16. Centers for Disease Control. Recommendations for protection against viral hepatitis. 1985; **34**: 313–24, 329–35.
17. Chen DS. Hepatitis B virus infection, its sequelae, and prevention in Taiwan. In: Okuda K, Ishak KG, eds. Neoplasms of the liver. Tokyo: Springer-Verlag, 1987: 71–80.