Kaohsiung Journal of Medical Sciences (2014) 30, 477–483

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ORIGINAL ARTICLE

Incidence of ambulatory care visits after needlestick and sharps injuries among healthcare workers in Taiwan: A nationwide population-based study

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Received 27 September 2013; accepted 25 December 2013
Available online 21 June 2014

KEYWORDS
Ambulatory care visit;
Epidemiology;
Healthcare worker;
Incidence;
Needlestick and sharps injuries

Abstract Healthcare professionals have a high risk of needlestick and sharps injuries (NSIs), which have a high potential for disease transmission. Ambulatory care follow up is essential, but is usually overlooked. This study aimed to investigate the annual and cumulative (age-, sex-, and subtype-specific) incidences of ambulatory care visits after NSIs. This study was also designed to evaluate the incidences of blood-borne diseases associated with NSIs among Taiwanese health professionals in Taiwan between 2004 and 2010. Data were obtained from the National Health Insurance Research Database, which contains anonymized records representing approximately 99% of the Taiwan population. A total of 4443 nurse healthcare workers (NHCWs) and 3138 non-nurse healthcare workers (NNHCWs), including physicians, medical technologists, and other health professionals were included in this longitudinal study. Odds

Conflicts of interest: All authors declare no conflicts of interests.

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http://dx.doi.org/10.1016/j.kjms.2014.05.004

ratios (ORs) and 95% confidence intervals (CIs) were calculated. The Mantel-Haenszel method was used to adjust for sex, age, and type of affiliation. Results showed that the annual incidence of ambulatory care visits of NHCWs increased from 0.7% in 2004 to 1.9% in 2010; this incidence was significantly higher than that of NNHCWs (from 0.3% in 2004 to 0.5% in 2010) in any yearly comparison ($p < 0.05$). The sex-adjusted 7-year cumulative incidence rate was 3.23 (95% CI = 1.23—8.45) in males and 3.92 (95% CI = 2.70—5.69) in females ($p < 0.05$). The age-adjusted 7-year cumulative incidence rate was 2.74 (95% CI = 1.99—3.77) and 2.14 (95% CI = 1.49—3.07) in subjects ≤ 30 and ≥ 31 years old, respectively ($p < 0.0005$). The affiliation-adjusted 7-year cumulative incidence rate was 1.89 (95% CI = 1.21—2.94) in medical centers and 3.33 (95% CI = 2.51—4.41) in nonmedical centers ($p < 0.01$). In conclusion, NSIs increased steadily from 2004 to 2010 in Taiwan with NHCWs having higher NSIs incidences than NNHCWs. A routine ambulatory care visit after NSIs can prevent blood-borne transmission, especially for NHCWs. Educational programs may be helpful for reducing the incidence of NSIs and increasing ambulatory care visit ratios after NSIs.

Introduction

Needlestick and sharps injuries (NSIs) are the most common occupational injuries among healthcare workers. In addition to inappropriate design of reporting processes, behavioral factors, such as habits of recapping and discarding waste sharps and needles, affect the occurrence of NSIs [1]. NSIs often infect healthcare workers with blood-borne infectious diseases; approximately 6—37% of healthcare workers are infected with hepatitis B virus (HBV), 5—10% are infected with hepatitis C virus (HCV), and 0.3—2.5% are infected with human immunodeficiency virus (HIV) [2—7]. NSIs also incur economic costs to healthcare organizations. The average cost of one NSI accident is approximately $51,444 [8]; subsequent exposure to blood-borne pathogen (BBP) infections can increase costs to $1 million or more in the United States [9]. Nurse healthcare workers (NHCWs) use sharp objects such as syringes with needles and pill cutters, and perform blood extractions and administer subcutaneous, intramuscular, and intravenous injections. As a consequence, NHCWs are susceptible to NSIs, particularly at times when they may lack concentration or fail to perform relevant techniques proficiently [10,11]. In addition, numerous reports have indicated that NHCWs are at higher risk than non-nurse healthcare workers (NNHCWs) [10,12—16].

The National Health Insurance Research Database (NHIRD) of Taiwan is compiled by the Taiwan National Health Insurance (NHI) program and maintained by the Taiwan National Health Research Institutes (NHRI). The NHRI collects data from the NHI program and encodes these data into the NHIRD, which contains records for 99.7% of the Taiwan population. Therefore, the NHRID is one of the largest and most comprehensive nationwide population-based data sources currently available. More than 300 studies have been published in peer-reviewed journals based on the NHIRD. Using the NHIRD, we determined that NHCWs are at a high risk of NSIs in Taiwan. Studies have also been performed to determine the frequency of contaminated NSIs and the reasons that such injuries among NHCWs are underreported in other countries [17—20]. In a previous study, the reasons for underreporting are related to the personal judgment of NHCWs regarding the risks of BBP. For example, a previous study demonstrated that the majority of surgeons and NHCWs (41%) reported exposure injuries only if a contaminant is infected with HBV, HCV, or HIV, whereas only 22% of these staff members reported every NSIs [15]. Healthcare providers are at the highest risk of exposure to blood and body fluids (BBFs) because of NSIs. Infections with each of these pathogens are potentially life threatening but preventable. Therefore, we investigated the incidence of ambulatory care visits after NSIs among Taiwanese healthcare workers in the NHIRD of Taiwan.

Materials and methods

The Taiwanese Bureau of National Health Insurance (NHIB) provides electronic data containing information on the sex, birth date of patients, classification code of diagnosed diseases, health services received by patients, and clinic or hospital code. This study used data from 2004 to 2010 provided by the Taiwan NHIRD. Taiwan implemented the NHIB program in March 1995, in which mandatory enrollment is enforced in a government-run and single-payer insurance system; comprehensive benefits coverage is also provided for patients. These data files are de-identified by scrambling the identification codes of patients and medical facilities and sent to the NHIB for compilation in the NHIRD. Thus, the NHIRD is one of the largest and most comprehensive nationwide population-based data sources currently available.

This study used data from 2004 to 2010 provided by the NHIRD. The study population comprised 4443 NHCWs, 1466 physicians, 459 medical technologists, and 1213 other healthcare workers, such as radiologists and pharmacists, who reportedly suffered from occupational NSIs. Individuals with duplicate files or incomplete information were excluded from data analyses. Access to the NHIRD was approved by the NHIR Review Committee.

The cases of NSIs from 2004 to 2010 were identified in the NHIRD by using the ninth revision of the International Classification of Diseases, Clinical Modification (ICD-9-CM) for registered nurses and other healthcare workers. These NSIs are described in ICD-9-CM E920.5 listed in the ICD-9-CM coding books. The following conditions that occurred after NSIs were compared in this study: accidental punctures or lacerations sustained during a procedure (ICD-9-CM codes 998.2); accidental cuts, punctures, perforations, or hemorrhages (ICD-9-CM codes E870-870.9); and blood and blood fluid exposure diseases, including HBV (ICD-9-CM 070.30,070.31), HCV (ICD-9-CM 070.41,070.51), syphilis (ICD-9-CM 097.9), and HIV (ICD-9-CM 042 and V08).

Statistical analyses

The annual and cumulative incidence of ambulatory care visits after needlestick and sharps injuries, odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. Annual incidence was calculated by dividing the number of new cases during a period by the number of individuals in the population at risk at the beginning of the study. The 7-year cumulative incidence refers to the number of new cases divided by the size of the population at risk from 2004 to 2010. The incidences of blood-borne infections after NSIs in NHCWs and NNHCWs were also determined similarly. We used the Mantel-Haenszel (M-H) method to calculate ORs and 95% CIs adjusted for sex, age ($\leq$30 and $\geq$31 years), and type of affiliation (medical center or nonmedical center). The Student *t* test was used to compare the incidences of blood-borne infection between NHCWs and physicians. A value of $p < 0.05$ was considered statistically significant [21]. Fig. 1

Results

Demographic characteristics of the study cohorts

The patients were grouped into two cohorts: (1) 4443 NHCWs and (2) 3138 NNHCWs. Among these NHCWs, 46 (1%)

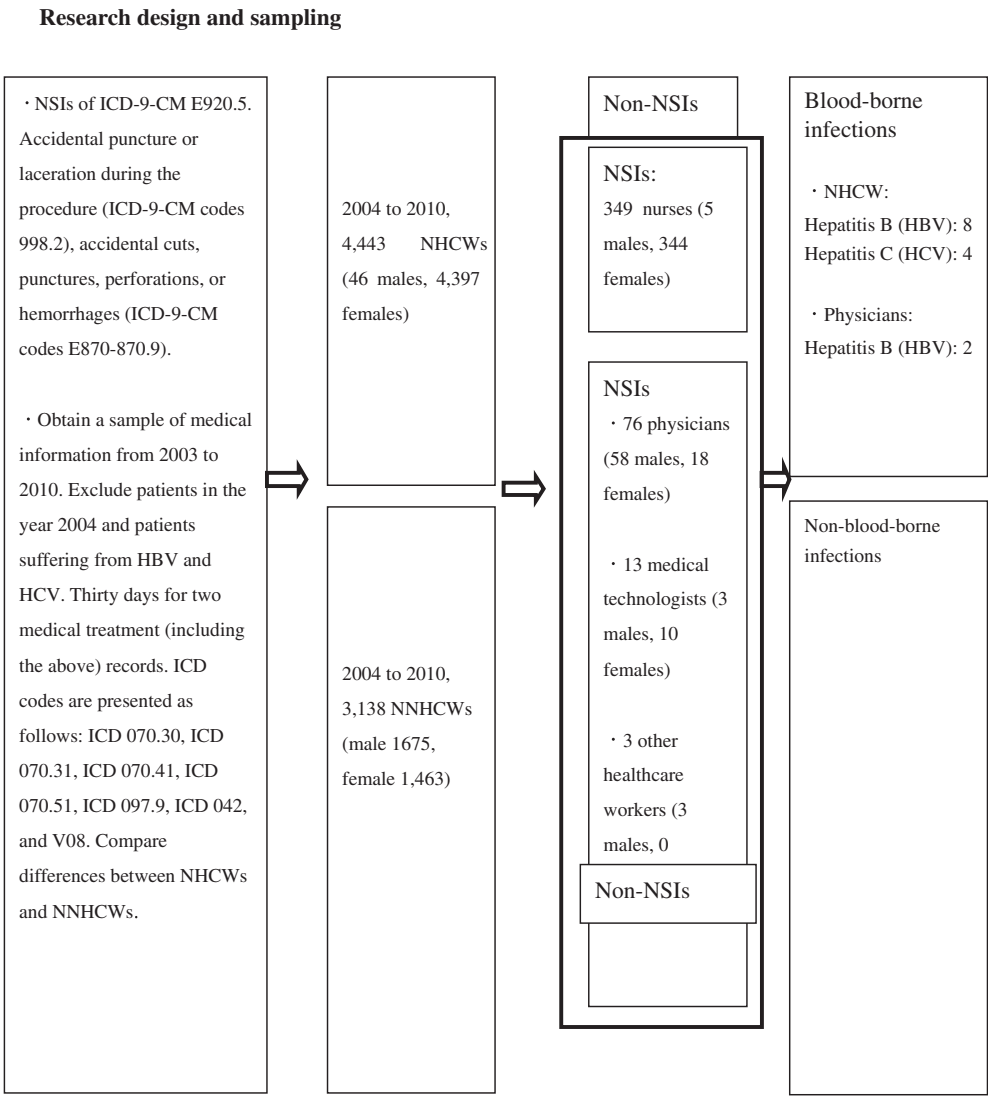

Figure 1. Case selection flow chart.

were male and the rest were female (99%). These NHCWs were randomly selected from the NHIRD (mean age, 33.65 ± 10.18 years). Among these NHCWs, 701 (15.8%) were affiliated with medical centers and 3742 (84.2%) were affiliated with nonmedical centers. The NNHCWs cohort was also randomly selected from one million people registered in the NHIRD between January 2004 and December 2010. The demographic characteristics of the patients are shown in Table 1.

Seven-year cumulative incidence of ambulatory care visits after NSIs in the study cohorts

In Table 2, the 7-year cumulative incidence rates of ambulatory care visits after NSIs for NHCWs, physicians, medical technologists, and other healthcare workers were 7.9% (n = 349), 5.2% (n = 76), 2.8% (n = 13), and 0.2% (n = 3), respectively.

Annual incidence rates of ambulatory care visits after NSIs among NHCWs and NNHCWs

The annual incidences of ambulatory care visits after NSIs for NHCWs during the period from 2004 (0.7) to 2010 (1.9) were significantly higher in NHCWs than in NNHCWs (all $p < 0.05$), in which the incidences of ambulatory care visits of NNHCWs after NSIs ranged from 0.3 in 2004 to 0.5 in 2010 (Table 3).

Association of ambulatory care visits after NSIs with sex, age, and affiliation among NHCWs and NNHCWs

Table 4 shows the demographic data regarding sex, age, and type of affiliation, which were stratified using the M-H method. Our results indicated that the cumulative incidence rate of ambulatory care visits after NSIs was higher in NHCWs than in NNHCWs after adjustment for sex (OR = 3.23; 95% CI = 1.23–8.45, $p < 0.030$ for males and OR = 3.92; 95% CI = 2.70–5.69, $p < 0.0005$ for females). Similar results were obtained after cumulative incidence rate was adjusted for age (OR, 2.74; 95% CI = 1.99–3.77, $p < 0.000$ for ≤30 years old and OR = 2.14; 95% CI = 1.49–3.07, $p < 0.0005$ for ≥31 years old) and for the type of affiliation (OR = 1.89; 95% CI = 1.21–2.94, $p < 0.006$ for medical centers and OR = 3.33; 95% CI = 2.51–4.41, $p < 0.0005$ for nonmedical centers).

The incidence of ambulatory care visits after NSIs was higher in male NHCWs than in male NNHCWs (OR = 3.23; 95% CI = 1.23–8.45, $p < 0.030$). The incidences of ambulatory care visits after NSIs was significantly higher in female NHCWs than in female NNHCWs (OR = 3.92; 95% CI = 2.70–5.69, $p < 0.0005$). The incidence of ambulatory care visits after NSIs was higher in the ≤30-year-olds NHCWs than in the ≤30-year-old NNHCWs (OR = 2.74; 95% CI = 1.99–3.77, $p < 0.0005$). The incidences of ambulatory care visits after NSIs was significantly higher in the ≥31-year-old NHCWs than in the ≥31-year-old NNHCWs (OR = 2.14; 95% CI = 1.49–3.07, $p < 0.0005$). The incidence of ambulatory care visits after NSIs was higher in NHCWs affiliated in medical centers than in NNHCWs affiliated in medical centers (OR = 1.89; 95% CI = 1.21–2.94, $p < 0.006$). The incidences of ambulatory care visits after NSIs was significantly higher in NHCWs affiliated in nonmedical centers than in NNHCWs in nonmedical centers (OR = 3.33; 95% CI = 2.51–4.41, $p < 0.0005$). Significant differences were found between NHCWs and NNHCWs. The Mantel-Haenszel (M-H) method was used and a significant statistical relationship of sex, age, and type of affiliation with the incidence of ambulatory care visits after NSIs was observed between NHCWs and NNHCWs (Table 4).

Risk of blood-borne infectious diseases is associated with ambulatory care visits after NSIs

The number of NHCWs after NSIs and infected with HBV were 8 and 2 in NHCWs and physicians, respectively. The number of NHCW after NSIs and infected with HCV were 4 and 0 in NHCWs and physicians, respectively (Table 5). The incidence rate of HBV infection after NSIs was the same between NHCW (2.29) and physicians (2.17) (OR, 0.87; 95% CI, 0.20–3.86, p = 0.56). The incidence rate of NSIs-associated HCV infection was 1.15 in NHCWs and 0.00 in physicians (OR, 1.99; 95% CI, 0.14–27.51, p = 0.45).

Table 1 Demographic data in NHCWs and NNHCWs in 2004–2010.

Variable	NHCWs (N = 4443) n (%)	NNHCWs (N = 3138)			
		Physicians, n (%)	Medical technologists, n (%)	Other healthcare workers, n (%)	Total NNHCWs, n (%)
Sex					
Male	46 (1.0)	1123 (76.6)	165 (35.9)	387 (31.9)	1675 (53.4)
Female	4397 (99.0)	343 (23.4)	294 (64.1)	826 (68.1)	1463 (46.6)
Age (y)					
≤30	2527 (56.9)	477 (32.5)	217 (47.3)	490 (40.4)	1184 (37.7)
≥31	1916 (43.1)	989 (67.5)	242 (52.7)	723 (59.6)	1954 (62.3)
Type of affiliation					
Medical center	701 (15.8)	393 (26.8)	95 (20.7)	116 (9.6)	604 (19.2)
Nonmedical center[a]	3742 (84.2)	1073 (73.2)	364 (79.3)	1097 (90.4)	2534 (80.8)

[a] Nonmedical centers include regional hospitals, local hospitals, clinics, contracted pharmacies, home care settings, community rehabilitation centers, and midwifery settings.

Table 2 Seven-year cumulative incidences of ambulatory care visits after needlestick and sharps injuries (NSIs) in NHCWs and NNHCWs.

Variable	NHCWs		NNHCWs			NNHCWs
			Physicians	Medical technologists	Other healthcare workers	
Seven-year cumulative incidence of NSIs[a]	Male	5	58	3	3	64
	Female	344	18	10	0	28
	Incidence (%)	349/4443	76/1466	13/459	3/1213	92/3138
		7.9	5.2	2.8	0.2	2.9

[a] The 7-year cumulative incidence is the number of new cases of NSIs divided by the size of the population at risk from 2004 to 2010.

Discussion

In the present study, the 7-year cumulative incidence ambulatory care visits after NSIs among NHCWs derived from the NHIRD were 7.9%. The annual incidence rates of NSIs for NHCWs in 2004—2010 ranged from 0.7% to 1.9%. The annual incidence ambulatory care visits after NSIs rates were lower than the 7-year cumulative incidence ambulatory care visits. In a previous study, the incidence rates of NSIs among nurses reached possibly as high as 61.2% in Taiwan, 65.1% in Japan, 45.7% in Korea, 40.6% in the United States, and 41.2% in the United Kingdom [22]. However, a lower incidence rate of NSIs (28.0%) was reported in Poland [23]. The reliability of sharps injury data is disputable because of underreporting [23]. The 1983 global reports confirmed that a maximum of 40% of sharps injuries in healthcare workers were not reported [3,10]. The rate of underreported NSIs cases determined in the published literature has ranged from 18.0% to 91.0% [10,17,19,20,24—29]. The prevention of NSIs by various agencies is often based on notifications regarding NSIs, but underreporting is extremely common in workplaces. Consequently, this method cannot accurately reflect the number of NSIs events. Therefore, using an anonymous self-reporting method of investigation is becoming more common for understanding the incidences of NSIs occurring in hospitals [10]. Underreporting results in a much lower incidence rate of ambulatory care visits made by NHCWs due to NSIs according to the NHIRD medical records data.

A similar finding regarding in Taiwanese healthcare workers was reported in a previous study [30]. Healthcare workers might not report NSIs because they perceive a low risk to NHCWs. NHCWs who have received an HBV antibody may not be infected with the corresponding disease but are busy at work and may feel embarrassed about the incident; NHCWs may find reporting this incident a nuisance; in other cases, NHCWs may be unfamiliar with the reporting process [17,31]. In addition, NHCWs may not be aware of the importance of this information regarding potential risk. Therefore, NHCWs should be discouraged against subjectively evaluating patients for potential risk; instead, NHCWs should be educated regarding the importance of reporting exposure injuries. The number of exposure injuries may also be underestimated because underreported cases may cause inaccurate information regarding the overall risk of BBP exposure [15]. Reports have revealed that the most critical cause of unreported NSIs involves NHCWs are not adequately trained or unaware of the associated potential hazards of NSI events. Experienced nurses can identify potential hazards, such as NSIs and problems related to infectious diseases. NHCWs who lack knowledge of their institution's policies or occupational health protocols might not report or delay the reporting of NSIs [32—34].

Exposure to BBPs via needlestick injuries is a potential risk for healthcare workers, including NHCWs. Needlestick injuries sustained by healthcare workers are a critical occupational hazard that causes BBP infections, including HBV and HCV [32—34]. Training programs on NSI prevention

Table 3 Annual incidences of ambulatory care visits after needlestick and sharps injuries (NSIs) for NHCWs and NNHCWs, 2004—2010.

Year	Annual incidences[a] (%)				
	NHCWs	NNHCWs	Odds ratios (ORs)	95% confidence intervals (CIs)	*p*
2004	31 (0.7)	8 (0.3)	2.8	1.3—5.9	<0.01
2005	39 (0.9)	5 (0.2)	5.6	2.2—13.9	<0.0005
2006	36 (0.8)	9 (0.3)	2.8	1.4—5.9	<0.01
2007	54 (1.2)	15 (0.5)	2.6	1.5—4.5	<0.01
2008	52 (1.2)	18 (0.6)	2.1	1.2—3.5	<0.01
2009	51 (1.1)	20 (0.6)	1.8	1.1—3.0	<0.05
2010	86 (1.9)	17 (0.5)	3.6	2.2—6.1	<0.0005

Note: data are presented as the number (incidence) and the rate is given in parentheses. NNHCWs include physicians, medical technologists, and other healthcare workers.

[a] Annual incidence is the number of new cases of NSIs divided by the size of the population at risk in each year.

Table 4 Demographic data regarding 7-year cumulative incidences of ambulatory care visits after needlestick and sharps injuries (NSIs) by NHCWs and NNHCWs, 2004–2010.

Variable	NHCWs[a]	NNHCWs[a]	M-H odds ratios (ORs)[b]	95% confidence intervals (CIs)	*p*
Sex					
Male	5 (10.9)	61 (3.7)	3.23	1.23–8.45	0.030
Female	344 (7.8)	31 (2.1)	3.92	2.70–5.69	<0.0005
Age					
≤30	257 (10.2)	47 (4.0)	2.74	1.99–3.77	<0.0005
≥31	92 (4.8)	45 (2.4)	2.14	1.49–3.07	<0.0005
Type of affiliation					
Medical center	65 (9.3)	31 (5.1)	1.89	1.21–2.94	0.006
Nonmedical center	284 (7.6)	61 (2.4)	3.33	2.51–4.41	<0.0005

[a] Data are presented as the number (incidence) and the rate is given in parentheses.
[b] The Mantel-Haenszel (M-H) method was used to calculate odds ratios adjusted for confounders (sex, age, and type of affiliation).

Table 5 Blood-borne infection incidences following needlestick and sharps injuries (NSIs) in NHCWs and physicians, 2004–2010.

ICD-9 code		NHCWs[a]	Physicians[a]	Odds ratios (ORs)	95% confidence intervals (CIs)	*p*
070.30 070.31	Hepatitis B (HBV)	8 (2.29)	2 (2.17)	0.87	0.20–3.86	0.56
070.41 070.51	Hepatitis C (HCV)	4 (1.15)	0 (0.00)	1.99	0.14–27.51	0.45

Note: ICD-9-CM, 9th revision of the International Classification of Diseases, Clinical Modification; there were no cases of syphilis (097.9) and HIV (042; V08).
[a] The data are presented as the number (incidence) and the rates are given in parentheses.

or coping strategies for NSIs may help reduce the incidence of NSIs. In addition, educational reminders concerning the risk of blood-borne infections, transmission of these infections, and methods of reducing the risk of transmission in the workplace should be implemented to urge employees to comply with standard precautions. The incidences of infection with NSIs are approximately 2.29 for HBV and 1.15 for HCV in Taiwanese NHCWs. NHCWs are also at a high risk of BBF exposure because NSI injuries are mainly caused by re-capping needles, which are the most frequently determined risk factor of NSIs [22]. The major infections caused by BBF exposure were HBV and HCV, but not syphilis and HIV. This result may be due to the relatively higher incidence of these types of hepatitis in Taiwan.

Our results indicated that sex, age, and type of affiliation of the cumulative incidence rate of ambulatory care visits after NSIs were higher in NHCWs than in NNHCWs. NHCWs with a higher chance of sustaining NSIs may have partially caused the increase in the incidence of infectious diseases among NHCWs in Taiwan. However, a high proportion of NHCWs in our study were aware of the hazard; the associated hospitals lack training policies involving NSIs, suggesting insufficient workplace training [3,35–37].

This study demonstrated that Taiwanese NHCWs are at a higher risk of sustaining NSIs than NNHCWs. Although educational programs covering the standard precautions applied to reduce occupational exposure risks are currently available to NHCWs in Taiwan, a large gap is observed between the knowledge of NHCWs and their attitudes toward reporting diseases and malpractice. Therefore, educational approaches that can effectively change the practice of personnel should be applied to promote the early administration of postexposure prophylaxis after NSI accidents.

These findings indicate that the incidences of ambulatory care visits after NSIs in terms of sex, age, and type of affiliation were higher in NHCWs than in NNHCWs. This high incidence may be reduced by implementing on-the-job training for NHCWs. In summary, efforts to prevent NSIs should focus on training programs and preventive measures against NSIs; such initiatives should be applied to reduce occupational exposure risks and promote routine ambulatory care visits after NSIs to prevent blood-borne transmission.

This study exhibits inherent limitations. The 2000 Longitudinal Health Insurance Database sociodemographic variables, except sex, age, and type of affiliation, were not examined because of the lack of patient information, such as educational level and lifestyle of healthcare workers. We did not also have complete information on the history of employment of the study patients; as such, the causal inference between profession and incidence of NSIs is limited.

Acknowledgments

This study was supported by the Central Taiwan University of Science and Technology (CTU100-2). This study was conducted partly using data from the National Health Insurance Research Database provided by the Bureau of National Health Insurance, Department of Health and managed by the National Health Research Institute. The interpretation and conclusions contained herein do not represent the opinions of the Bureau of National Health

Insurance, the Department of Health, or the National Health Research Institute.

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