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Cross-sectional study assessing the risk of needlestick injury from an insulin pen among nursing care providers

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Abstract

Objective: Needlestick injuries caused by insulin pen injection are a serious occupational hazard for health care workers in China. We evaluated the prevalence of stick injuries with insulin pen injection and identified associated risk factors.

Methods: This cross-sectional survey was conducted from 1 October to 30 November 2018 in two tier three hospitals in Chongqing, China. Self-administered questionnaires were developed by the Chinese Nursing Association Diabetes Care Special Committee. We analyzed associations between potential risk factors and injuries at different operational steps.

Results: A total 233 of 302 (77%) participants (mean age 28.5±5.3 years) reported a needlestick incident. Most respondents (49%) had 3 to 10 years' working experience and had received injection safety training. Most needlestick injuries occurred while recapping needles after injection. The risk of injury was significantly associated with department and job position. The injury rate increased with increased number of years worked. Respondents with ≥10 years working experience reported the highest needle-capping injury rate (88%): odds ratio 1.93, 95% confidence interval, 1.01 to 3.69.

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Conclusion: Recapping needles after injection showed the highest risk for stick injury with an insulin pen. Nurses in the surgery department and those with longer work histories were more likely to be injured.

Keywords
Needlestick injury, insulin pen, sharp injury, nursing, occupational hazard, worker safety

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Introduction

Needlestick injury is one of the main occupational health threats to health care workers. Numerous studies have shown that needlestick and sharp injuries are not only associated with an increased risk of infection with bloodborne pathogens such as the HIV and hepatitis virus, these injuries are also a primary source of mental distress for health care workers. Health care workers who experience a needlestick injury have been shown to have higher levels of anxiety and depression, which results in higher risk of recurring injury.[1,2] This type of injury creates an enormous financial burden to health care systems as well. The annual costs related to testing and treatment for needlestick injuries is between USD 118 million and USD 591 in the United States and approximately USD 300 million in Japan.[3] Owing to rapid growth in the population with diabetes over the past several decades, injuries owing to insulin pen injection have become a common form of needlestick injury. According to data from the International Safety Center's Exposure Prevention Information Network (EPINet®), about 20% of needlestick injuries are related to insulin injection.[4] Another study conducted in 14 European countries found that 32% of nurses reported experiencing an injury during insulin injection in the hospital.[5] These results confirm that injuries with a diabetes needle are one of the most frequent sharp injuries among health care workers. China has the largest population with diabetes in the world.[6] About 10 million diabetes patients in China require exogenous insulin. Therefore, the safety of insulin injection and the protection of health care workers from needlestick injury during insulin administration is an important health care topic. Many studies have confirmed that sharp injury among health care workers represents a serious health care burden in China.[7,8] In 2017, a multicenter survey reported a rate of 1032 incidents per 1000 health care workers in the country.[9] However, there is lack of studies in China specifically concerning injury from insulin needles. To evaluate the prevalence of insulin needle injury among nurses and to investigate the potential correlation between injury and risk factors, we conducted a survey from 1 October to 30 November 2018. Our aim was to provide data that can be useful in developing improved guidelines to protect clinical nurses against needlestick injury during administration of insulin injections.

Methods

Study design

This study comprised an institution-based cross-sectional survey. The study protocol

was approved by the China-Japan Friendship Hospital Clinical Research Ethics Committee (approval number: 2018-150-k107) and all participants provided written informed consent. Study participation was voluntary.

Study population and participants

No formal sample size estimation was conducted for this study. We used a convenience sample method to enroll clinical nurses from two tier three university-affiliated hospitals, Xinqiao Hospital and Southwest Hospital in Chongqing, China, between 1 October and 30 November 2018. Xinqiao Hospital has 45 departments with 2300 health care workers. Southwest Hospital has 47 departments with 2500 employees and admits 132,000 patients per year.

The participants were classified into three groups according to professional rank categories in hospitals of China. These categories include junior nursing professionals, who have received a 2-year associate's degree. Nurse practitioners are professionals have received an advanced degree in nursing. Nurse supervisors are professionals who are in charge of a nursing care unit.

Survey

We administered a questionnaire developed and provided by the Chinese Nursing Association Diabetes Care Special Committee. The survey included questions on demographics, insulin injection-related needlestick injury, and protective measures. The English version of the part of survey related to this study is provided in the appendix.

Data collection and quality control

Data were collected using anonymous, self-administered questionnaires. Research personnel were trained according to the survey protocol before conducting the study. All self-reported injury cases were verified in a comparison with the medical records from the department of infectious diseases of the same hospital where participants were employed. Data were entered into Epidata using a double-entry method.

Statistical analysis

Frequency and percentage were used to summarize the data. Group comparisons were conducted using the chi-square test to identify univariate associations of potential risk factors. Further post-hoc pairwise comparisons were performed. A multivariate logistic regression analysis was conducted to identify associations between predictors and outcomes. Statistical significance was set to $P<0.05$ (two-sided). Multiple comparisons were corrected using the Bonferroni method, with two-sided $P<0.017$ as the cutoff for statistical significance. All analyses were performed using IBM SPSS 23.0 (IBM Corp, Armonk, NY, USA).

Results

In total, 310 participants returned the survey. Eight returned surveys were invalid because of missing information, resulting a 97.4% effective response rate. The average age of the remaining 302 participants was 28.5 ± 5.3 years (mean $\pm$ standard deviation). Among them, 68 (22.5%) participants worked in the department of endocrinology. Ninety participants (29.8%) had less than 2 years' working experience, 148 (49%) had 3 to 10 years' experience, and 64 (21.2%) had worked for more than 10 years. The cohort included 144 (47.7%) nurses, 107 (35.4%) nurse practitioners, and 51 (16.9%) nurse supervisors. Most respondents (257, 85.1%) had received safety training for injection injury.

We surveyed all 10 procedures in which an injection injury with an insulin pen could occur: opening a single-use needle package, attaching a fresh pen needle to the injection pen, removing the outer cap, removing the inner cap, cleaning the skin while holding an uncapped injection pen, pinching the skin and performing subcutaneous injection, retrieving the needle, replacing the cap, disposing of an uncapped needle, and collecting used needles. The results showed that 77.2% (233/302) of injuries happened while replacing the cap on the needle after injection, 61.6% (186/302) when disposing of uncapped needles, 56.0% (169/302) when removing the inner cap, and 52.3% occurred when collecting used needles. The lowest frequency of injury occurred during subcutaneous injection (16.6% or 50/302).

As shown in Table 1, the risk of insulin pen injury occurred while replacing the needle cap was significantly associated with the department in which the nurses worked and their job position. Further pairwise comparisons were performed. Endocrinology nurses reported significantly fewer injuries than nurses in internal medicine departments (65% vs. 79%, respectively; P=0.006; unadjusted odds ratio (OR): 0.49, 95% confidence interval [CI]: 0.25–0.95). As for job position, the difference in injuries between nurses and nurse practitioners was statistically significant (70% vs. 84%, respectively; P=0.010; OR: 0.44, 95% CI: 0.23–0.83). All the other pairwise comparisons did not reach statistical significance. Of note, although the P value of the chi-square test for work experience was only marginally significant, the Armitage trend test revealed a significant linear trend in the rate of injury (P=0.025). With increased number of working years, the rate of injury was increased. Respondents with 10 years or more of working experience reported the highest rate of injury (88%). In the multivariate model, both the effects of department and job position remained significant. The adjusted OR of endocrinology nurses versus other internal medicine nurses was 0.45 (95% CI: 0.22–0.93). The adjusted OR of junior nurses to nurse practitioners was 0.52 (95% CI: 0.27–0.99).

In terms of injury when disposing of uncapped needles, there was no significant association between department or job position and the risk of injury (Table 2).

Table 1. Risk factors associated with needlestick injury on replacing needle cap after insulin injection.

Risk factors	Injury N=233	No injury N=69	P value
Department			0.016
Endocrinology	44 (65%)	24 (35%)	
Internal medicine (excluding endocrinology)	92 (83%)	19 (17%)	
Surgery and others	97 (79%)	26 (21%)	
Job position			0.021
Nurse	101 (70%)	43 (30%)	
Nurse practitioner	90 (84%)	17 (16%)	
Nurse supervisor	42 (82%)	9 (18%)	
Working experience			0.07*
Intern or <2 years	65 (72%)	25 (28%)	
3–10 years	112 (76%)	36 (24%)	
>10 years	56 (88%)	8 (13%)	

*P value of Cochran–Armitage trend test was 0.025.

Data are presented as frequency and percentage.

Table 2. Risk factors associated with stick injury when disposing of uncapped needles.

Risk factors	Injury N=158	No injury N=144	P value
Department			0.231
Endocrinology	39 (57%)	29 (43%)	
Internal medicine (excluding endocrinology)	51 (46%)	60 (54%)	
Surgery and others	68 (55%)	55 (45%)	
Job position			0.153
Nurse	69 (55%)	75 (52%)	
Nurse practitioner	64 (60%)	43 (40%)	
Nurse supervisor	25 (49%)	26 (51%)	
Working experience			0.016
Intern or <2 years	37 (41%)	53 (59%)	
3–10 years	89 (60%)	59 (40%)	
>10 years	32 (50%)	32 (50%)	

Data are presented as frequency and percentage.

However, the effect of working experience was significant (P=0.016). The pairwise comparison showed that interns or those with fewer than 2 years' working experience had significantly less frequent stick injuries than nurses with 3 to 10 years' experience (41% vs. 60%, respectively). Multivariate logistic regression analysis showed that the odds of injury among nurses with 3 to 10 years' experience was 2.2 times that of nurses with <2 years' experience (OR 2.2, 95% CI: 1.27–3.68) after controlling for other risk factors.

There was no significant difference in the frequency of injury for the other eight steps during insulin injection using an insulin pen according to department, job position, or working experience. As the highest risk to injection injury was during the process of replacing the cap and collecting and disposing of used needles, we carried out an additional survey to investigate how most injuries occurred when removing a pen needle from an insulin pen after insulin administration. The results showed that the highest injury rate was 60.0% (181/302), which occurred when replacing the cap on the needle and unscrewing the needle itself from the insulin pen. The rates of injury for other methods were as follows: 49.3% occurred when removing a needle with ungloved hands, 36.4% when using the lid of a sharps container to remove the needle, 20.2% when using clippers or forceps to remove the needle, 17.6% when having patients recap and remove the needle themselves, and 14.2% when using other tools to remove the needle from an insulin pen. Surprisingly, the lowest rate of stick injury (12.3%) was when patients themselves unscrewed the needle directly with their bare hands and without recapping.

Nurses in internal medicine (excluding endocrinology) reported the lowest occurrence of stick injury when unscrewing the needle with clippers or forceps (Table 3), which was significantly lower than the rates among nurses in the surgery and other departments (11% vs. 28%, P=0.001). Job position was also significantly associated with stick injury caused by unscrewing the needle with clippers or forceps (P=0.007), with nurses reporting more injuries than nurse practitioners (28% vs. 13%, P=0.005). Work experience according to years was not relevant statistically. However, inexperienced health care

Table 3. Risk factors associated with stick injury when unscrewing a needle with clippers or forceps.

Risk factors	Injury N=61	No injury N=241	P value
Departments			0.005
Endocrinology	15 (22%)	53 (78%)	
Internal medicine (excluding endocrinology)	12 (11%)	99 (89%)	
Surgery and others	34 (28%)	89 (72%)	
Job position			0.007
Nurse	40 (28%)	104 (72%)	
Nurse practitioner	14 (13%)	93 (87%)	
Nurse supervisor	7 (14%)	44 (86%)	
Working experience			0.102
Intern or <2 years	25 (28%)	65 (72%)	
3–10 years	25 (17%)	123 (83%)	
>10 years	11 (17%)	53 (83%)	

Data are presented as frequency and percentage.

workers had more injuries (28% vs. 17%) than other survey respondents. In multivariate logistic regression analysis, the effects of both department and job position remained statistically significant, indicating that these are independent risk factors for stick injury. The OR for nurses in the surgery department versus internal medicine was 2.87 (95% CI: 1.39–5.95), and the OR of nurse practitioners versus junior nurses was 2.38 (95% CI: 1.19–4.74).

Discussion

Needlestick injury is a consequence of careless mistakes, a lack of training, and unawareness about the risk of such injuries. Poor work habits and protocols are also contributing risk factors.[1,2] Because needlestick injuries may result in the transmission of bloodborne pathogens, it is important to identify the high-risk steps in handling and using an insulin pen as well as to improve awareness about this issue among health care workers. This study showed that the most frequent injury owing to insulin pen injection occurred during the processes of recapping and disposing of needles. These results are consistent with those reported by other researchers.[10,11]

In our study, endocrinology nurses reported fewer injuries caused by recapping an insulin pen after injection, in comparison with internal medicine nurses. Because an insulin pen is used more often in endocrinology, nurses working in this department usually receive more specific training in how to use the pen safely. These nurses are also more skilled in insulin pen injection, which is performed more intensively in the endocrinology department. Nurses in other departments receive general training in how to prevent needle injury owing to the most frequently performed procedures in their department, such as blood withdrawal and venipuncture; however, nurses in these other department may lack experience in the proper use of an insulin pen. Surprisingly, nurses reported fewer injuries during recapping than nurse practitioners and supervisors. Similarly, fewer years of work experience was associated with fewer reported injuries. These findings seem contradictory to higher-level professionals and nurses with a longer working history being considered more skilled. A possible reason for this contradiction could be that

lower-ranked nurses and trainees are more careful during injection because they are new to these procedures. Another explanation is that the nurse practitioners, supervisors, and nurses with longer working histories have performed a greater number of insulin injections and are therefore likely to have experienced more injuries because the recapping procedure is the riskiest step for stick injury.

Similar to these results, 3 to 10 years of working experience was associated a higher frequency of stick injury during collection and disposal of used needles, in comparison with interns or nurses with fewer than 2 years' working experience. In the hospital, the main nursing workforce comprises those with 3 to 10 years' experience. Owing to the high volume of patients in China, the workload of nurses is usually quite heavy. To provide timely nursing care, nurses may increase their risk of a stick injury. Other studies of needlestick injuries also report that busy schedules and long working hours are significantly associated with injuries.[12,13]

Table 3 demonstrates how department, job position, and years of working experience may impact the frequency of injury in a critical step of insulin pen use, i.e., removing the needle. Compared with nurses in the surgery department, nurses in internal medicine were less likely to use clippers or forceps to remove a needle. Therefore, these nurses reported a lower frequency of stick injuries when unscrewing needles using these tools. This result is consistent with the finding of a French study reporting that 89.6% of injuries occurred in the operating room or geriatric and surgical wards.[14] Higher-level professionals also reported fewer injuries, indicating that they are more skillful in using these tools.

An insulin pen is very small, short, and difficult to handle. It is essential to require that all operations be conducted according to standard protocols. The clinically recommended method of unscrewing used needles from an insulin pen is to recap the needle with the outer cap because the diameter of this cap is five times larger than that of the inner cap. Our study findings suggested that unscrewing needles with clippers or forceps was also a reliable method. It is important to reinforce safety training among providers of nursing care who perform insulin pen injection in daily clinical practice. Technological advancements that provide safer methods of injection will also be helpful in reducing the risk of stick injury.[15]

Our study had a fairly large sample size and good survey response rate, which ensures the validity of the collected data. There also some study limitations. First, this survey was carried out in only two tier three hospitals in one area of China. The results should be interpreted together with those of other studies in China. Second, the survey did not include components such as time window of injuries, injury counts, and knowledge about stick injury and prevention, among others. However, our results provide useful information about risk factors and critical steps during which stick injuries frequently occur. Further study using a revised survey and more generalizable sample population is warranted.

Conclusion

This study confirmed that recapping a needle after administering an insulin injection with an insulin pen was the highest-risk step for needlestick injury. Nurses in the surgery department and those with a longer work history were at higher risk of these injuries.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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References

1. Sohn JW, Kim BG, Kim SH, et al. Mental health of healthcare workers who experience needlestick and sharps injuries. *J Occup Health* 2006; 48: 474–479.
2. Motaarefi H, Mahmoudi H, Mohammadi E, et al. Factors Associated with Needlestick Injuries in Health Care Occupations: A Systematic Review. *J Clin Diagn Res* 2016; 10: IE01–IE04.
3. Kunishima H, Yoshida E, Caputo J, et al. Estimating the national cost burden of in-hospital needlestick injuries among healthcare workers in Japan. *PLoS One* 2019; 14: e0224142.
4. Mitchell AH and Parker GB. Building programs to reduce sharps injuries from insulin injection.https://www.americannursetoday.com/reduce-sharps-injuries-insulin-injection/.
5. Costigliola V, Frid A, Letondeur C, et al. Needlestick injuries in European nurses in diabetes. *Diabetes Metab* 2012; 38: S9–S14.
6. Hu C and Jia W. Diabetes in China: Epidemiology and Genetic Risk Factors and Their Clinical Utility in Personalized Medication. *Diabetes* 2018; 67: 3–11.
7. Wang C, Huang L, Li J, et al. Relationship between psychosocial working conditions, stress perception, and needle-stick injury among healthcare workers in Shanghai. *BMC Public Health* 2019; 19: 874.
8. Zhang L, Ai Y, Liu J, et al. Economic burden of needlestick injuries among healthcare workers in China. *J Med Econ* 2020; 23: 683–689.
9. Gao X, Hu B, Suo Y, et al. A large-scale survey on sharp injuries among hospital-based healthcare workers in China. *Sci Rep* 2017; 7: 42620.
10. Bekele T, Gebremariam A, Kaso M, et al. Factors Associated with Occupational Needle Stick and Sharps Injuries among Hospital Healthcare Workers in Bale Zone, Southeast Ethiopia. *PLoS One* 2015; 10: e0140382.
11. Stefanati A, Boschetto P, Previato S, et al. [A survey on injuries among nurses and nursing students: a descriptive epidemiologic analysis between 2002 and 2012 at a University Hospital]. *Med Lav* 2015; 106: 216–229.
12. Trinkoff AM, Le R, Geiger-Brown J, et al. Work schedule, needle use, and needlestick injuries among registered nurses. *Infect Control Hosp Epidemiol* 2007; 28: 156–164.
13. Lo WY, Chiou ST, Huang N, et al. Long work hours and chronic insomnia are associated with needlestick and sharps injuries among hospital nurses in Taiwan: A national survey. *Int J Nurs Stud* 2016; 64: 130–136.
14. Pellissier G, Migueres B, Tarantola A, et al. Risk of needlestick injuries by injection pens. *J Hosp Infect* 2006; 63: 60–64.
15. Yakushiji F, Funaki Y, Yamakawa K, et al. The AutoShield Pen Needle is useful for preventing accidental puncture while administering insulin to others by injection. *J Diabetes Sci Technol* 2012; 6: 723–724.