RESEARCH ARTICLE

Prevalence, emotional and follow-up burden of insulin injection-related needle-stick injuries among clinical nurses in Shaanxi Province, west of China: A cross-sectional study

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Abstract

Aims and objectives: The aim of this study was to investigate the prevalence, emotional and follow-up burden of insulin injection-related needle-stick injuries among clinical nurses.

Background: needle-stick injures introduce statistically significant occupational hazards to healthcare workers. Although the large proportion of the needles injuries attributed to insulin injection, research evidence about the prevalence, emotional and follow-up burden of such injures is lacking.

Design: Cross-sectional study.

Methods: 5389 nurses were recruited from 45 hospitals in Shaanxi, China, from November 2018 to July 2019. Participants were administrated with a questionnaire specifically developed for this study. Descriptive statistics were used to present the findings.

Results: All 5,389 nurses responded to the survey, of which 396 (7.4%) participants experienced 620 insulin injection-related needle-stick injuries in the past year, representing an annual prevalence of 115.0 per 1000 nurses. The annual prevalence of infection caused by the injuries was 18.7 per 1000 nurses. The injuries occurred most frequently when nurses were recapping the needle (42.4%). In the majority (98.4%) of the injuries, the hurt nurses took proper immediate actions. However, only 30.3% of nurses reported the injuries to the administrative staff, and in 43.2% of the injuries, the nurses refused or discontinued the suggested follow-up. A large proportion (58.6%) of the hurt nurses experienced emotional changes. Multivariate logistic regression showed that department, removing and/or setting back needle caps with bare hands, frequency of insulin pen and syringes are associated with the incidence of insulin injection-related needle-stick injuries. This paper is reported following the STROBE recommendations.

Conclusions: This survey demonstrated a considerably high prevalence of insulin injection-related needle-stick injuries among clinical nurses. Even though the majority of the hurt nurses took proper immediate actions, a large quantity of them failed to

report the accidents to the administrative staff and complete the suggested follow-up. Nurses who suffered from insulin injection-related needle-stick injuries were subject to various negative emotional changes. It portends a statistically significant risk to occupational health management for nurses.

Relevance to clinical practice: Scientific preventive and management strategies are desirable in order to minimize the consequences of insulin injection-related needle-stick injuries.

KEYWORDS
insulin injection, needle-sticks injuries, nurse

1 | INTRODUCTION

needle-stick injures introduce a statistically significant occupational hazard and burden to the healthcare workers worldwide. The World Health Organization suggested that each healthcare worker experienced four needle-sticks and sharp injuries annually (Mantel, 2002). It is estimated that about 3.8 million sharp injuries occurred among healthcare workers in the hospital setting each year in China, of which 63.0% were caused by needles (Gao et al., 2017). Evidence suggests that nurses are at the highest risk of needle-stick injuries among healthcare professionals (Huang et al., 2017; Tarantola et al., 2003). According to a survey involving 4,707 nurses, about 48% of the informants had the experience of being injured by a needle of sharp that had been previously contaminated by a patient (Royal College of Nursing [RCN], 2009). Although the large proportion of the needles injuries attributed to insulin injection, little research evidence about the prevalence and burden of insulin injection-related needle-stick injures can be identified in the international and national literature body.

There has been longstanding advocacy that institutions should protect healthcare workers from various occupational hazards, including needle-stick injuries (Li et al., 2021; Ma et al., 2013). Many hospitals in China have carefully addressed such advocacy by providing professional training, improving the working environment, using safety-engineered equipment/devices and establishing contingency protocols. In general, a four-step contingency protocol is employed in hospitals. Firstly, once a needle-stick injury occurred, the healthcare worker should immediately take actions such as flushing the hurt location with water, squeezing blood out of the wound from the proximal end to the distal end and disinfection Secondly, the healthcare worker should seek professional help from the infection departments, where they would receive etiological assessments and treatments. Thirdly, the healthcare worker should register the accident via an online system. Finally, if the healthcare worker is confirmed with an infection of infectious diseases, the infection control department of the institution should report the case to the local centres for disease control and prevention.

What does this paper contribute to the wider global clinical community?

- The prevalence of insulin injection-related needle-stick injuries among clinical nurses is considerably high.
- Insulin injection-related needle-stick injuries occurred most frequently when nurses were recapping the needles. Thus, using safety-engineered devices could be beneficial.
- The emotional harms caused by insulin injection-related needle-stick injuries should be properly addressed.
- The regular monitoring and follow-up visit post insulin injection-related needle-stick injuries should be emphasized by medical institutions.

2 | BACKGROUND

Diabetes has become one of the chronic diseases that seriously threaten the well-being of human beings. The current prevalence of diabetes among adults is estimated to be 9.3% worldwide (International Diabetes Federation [IDF], 2019) with the number of 10.9% in China (Wang et al., 2017), and with the development of the disease, the majority of the individuals with diabetes need to use insulin for optimal glycaemic control. Subcutaneous injection is the common delivery route of insulin therapy. In the hospital setting, nurses take the main responsibility about subcutaneous insulin injections for individuals with diabetes. As a result, nurses are susceptible to insulin injection-related needle-stick injuries.

needle-stick injuries pose a statistically significant risk of blood-borne infections transmission and constitute a major health hazard for nurses (Tarantola et al., 2006). It has been confirmed that more than 20 life-threatening blood-borne bacteria and viruses can be transmitted via needle-stick injuries, such as hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency viruses (HIV) and Syphilis(Pruss-Ustun et al., 2005; White, 2007). As a result, nurses are susceptible to multiple blood-borne

diseases. Apart from the risk of chronic and life-threatening diseases, needle-stick injuries might also cause psychosocial problems, such as inability to concentrate on work, anxiety, fear, crying and being willing to quit the job. In addition, needle-stick injuries could increase medical costs.

Even though needle-stick injuries have drawn the attention of many scholars, research data about the prevalence and associated factors of insulin injection-related needle-stick injuries are lacking. Because of the increasing prevalence of diabetes mellitus (International Diabetes Federation [IDF], 2019; Wang et al., 2017), an increasing number of patients were being treated with insulin. Nurses have injected insulin on an increasing number of occasions. An increase in the frequency of injection may contribute to the risk of needle-stick injuries. In addition, nurses can dispose of a used syringe using a safety-engineered sharps container; however, they usually set back needle caps on the insulin pen or syringe after a single injection (Mengistu & Tolera, 2020). However, due to the limited development of nursing occupational protection in China, and Shaanxi province is located in the west of China the economy and technology are under development, a standard procedure following insulin injection-related needle-stick injuries is poor execution. After insulin injection-related needle-stick injuries occurred, some nurses do not report the accidents to the administrators and failed to take preventive actions. Some other nurses may discontinue the suggested follow-up because they need to pay for the medical expenses by themselves. Previous studies have focused on intravascular injection commonly practised during routine nursing care. Few have focused on insulin injection needle-stick injuries. Based on this background, the current study was conducted in order to investigate the prevalence, emotional and follow-up burden of insulin injection-related needle-stick injuries among clinical nurses in Shaanxi Provence, West of China.

3 | METHODS

3.1 | Design

This was a cross-sectional study.

3.2 | Participants

A random cluster sampling was employed to recruit the participants. We randomly selected 15 tertiary hospitals, 15 secondary hospitals and 15 primary hospitals in Shaanxi province. We chose responsible nurses separately in 45 hospitals and trained them. The electronic questionnaire was sent to the responsible nurse, who then invited the nurses from the hospital who met the inclusion criteria to participate in the survey. The responsible nurse is the leader of the diabetes care professional group at the hospital. The inclusion criteria were as follows: (1) Registered nurses with a working experience of at least one year, (2) nurses working in clinical departments which provide insulin therapy for individuals with diabetes and (3)

volunteered to participate in this study. The exclusion criteria were as follows administrative nurses who are not engaged in clinical nursing were excluded from the study. A total of 5389 eligible participants completed the questionnaire.

3.3 | Data collection

Data were collected through an online questionnaire from November 2018 to July 2019. Before the beginning of the survey, the researcher organized the training meeting. Responsible persons from all hospitals of Shaanxi Province have participated in the training, introducing to research in detail, including the contents of the questionnaire, the rules for filling in the questionnaire and the matters needing attention. The person in charge of each hospital was required to organize nurses to complete the questionnaire survey with high quality. After getting consent forms from the participants, a research staff instructed the participants to complete the questionnaire. The participants were encouraged to consult the research staff once they have inquiries about interpreting or completing the survey.

3.4 | Instruments

The research team developed a questionnaire for this study to collect information on insulin injection needle-stick injuries. The preliminary questionnaire was outlined based on a literature review (Bagnasco et al., 2020; Costigliola et al., 2012; Deng & Liu, 2018; He et al., 2017; Lee et al., 2005; Zhou et al., 2015). The preliminary questionnaire was evaluated by an expert panel to decide its content validity. The expert panel consisted of two Registered nurses, two nursing managers and one nursing academic in the field of diabetes management. The panel members rated the relevance of each item on a 4-point Likert scale (from 1 = "not relevant" to 4 = "highly relevant"). For items that were rated 1 or 2, reasons and suggestions for revisions were required. Revisions were made accordingly until the expert panel suggested the questionnaire was feasible for the survey. Afterwards, we conducted pilot testing (*n* = 50) at a tertiary teaching hospital and secondary hospitals and refined the questionnaire based on the pilot testing. The final version of the questionnaire included 41 items, among which 10 items were on the general information of the informant while the other 31 items collected information about insulin injection-related needle-stick injuries. General information includes nurses' age, educational background, professional ranks and title, working years, etc. Data of insulin injection related-needle-stick injuries: including the removal method of the needle, whether to participate in the training of the protection on needle-stick injuries, weekly frequency of insulin injection, whether the injection needle has contacted the patient, whether the patient has blood-borne infectious diseases such as HIV, HBV, HCV, syphilis, etc., mastery of occupation protection measures on needle-stick injuries, report of needle-stick injuries, disposal of sharps in daily routine.

3.5 | Data analysis

Data analysis was performed using the Statistical Package for Social Science (SPSS Inc., Chicago, IL, USA) version18.0. The general information and data on insulin injection-related needle-stick injuries of the participants were categorical data, and thus were described using count and/or percentage. Risk factors for insulin needle-stick injury were explored using multivariate logistic regression analysis. The independent variables were those that were statistically significant in univariate analysis ($p < .05$) and those deemed significant based on clinical expertise, while the dependent variable was whether an insulin-related needle-stick injury occurred (treated as a binary variable). Thresholds for inclusion or exclusion of variables were p values of .05 or .10, respectively. Factors influencing insulin needle-stick injuries were adjudicated based on odds ratios (ORs) and outcomes were reported in terms of odds ratios (ORs) and 95% confidence intervals (CIs).

4 | RESULTS

4.1 | General information of the participants

A total of 5,389 Registered nurses responded to the survey; all questionnaires were valid and included in the analysis. The majority of the participants were aged between 26 and 35 years. Around two-thirds of the participants were working in tertiary hospitals. Most of the participants were junior or senior clinical Registered nurses and had a working experience of 3 ~ 10 years. Bachelor's degree (55.0%) was the most reported educational background, followed by a college degree (43.4%). About 70% of the participants ever received safety training on insulin injection with a syringe and/or pen. The detailed general information of the participants is presented in Table 1.

4.2 | Prevalence of insulin injection-related needle-stick injuries and needle contamination outcomes

A total of 396 (7.4%) participants experienced insulin injection-related needle-stick injuries in the past year. The total number of insulin injection-related needle-stick injuries in the past year was 620, representing a prevalence rate of 115.0 per 1000 nurses per year (Table 1). The prevalence rate of insulin injection-related needle-stick injuries in the department of Endocrinology was much higher than that in other departments: About 19.0% (77/406) of the participants from the Department of Endocrinology experienced the accident in the past year while 300.5insulin injection-related needle-stick injuries occurred among 1,000 nurses per year (Table 1). Among all the accidents, needle-stick injuries caused by insulin pens were predominant, accounting for 75.0% (465/620) of all the cases, while the injuries caused by syringes accounted for 25.0% (155/620).

Of all the 620 insulin injection-related needle-stick injuries, 387 (62.4%) occurred after the instruments have been used by the patients, among which 57(14.7%) cases were confirmed as HBV infected, 4 (1.0%) cases as HCV infected, 8 (2.1%) cases as Syphilis infected, 4 (1.0%) cases as HIV infected, 15 (3.9%) cases as other virus infected, 13 (3.4%) cases as multiple virus infected and 157 (40.6%) cases as non-infected according to the results of medical tests. In the other 129 (33.3%) cases, the participants were unclear about the infection condition (Table 2).

4.3 | Factors associated with insulin injection-related needle-stick injuries

Multivariate logistic regression showed that department, removing and/or setting back needle caps with bare hands, frequency of insulin pen and syringes are associated with the incidence of insulin injection-related needle-stick injuries. To be specific, working in the Department of Endocrinology, removing or setting back needle caps with bare hands, and higher frequency of insulin pen and syringes introduce a higher risk of insulin injection-related needle-stick injuries (Table 3).

4.4 | needle-stick injuries' indifferent stage of the subcutaneous insulin injection

The needle-stick injuries occurred most frequently (263/620, 42.4%) when nurses were setting back the needle cap after injection. The detailed information on insulin injection-related needle-stick injuries that occurred in the different links is presented in Table 4.

4.5 | Reporting condition of insulin injection-related needle-sticks injuries

Of the 396 participants who experienced insulin injection-related needle-stick injuries in the past year, only 120 participants (30.3%) reported the accidents to the administrative staff. The most frequent reason for not reporting the accidents was "fear of troubles" (201, 72.8%). Other reasons for not reporting the accidents are presented in Table 5.

4.6 | Actions immediately taken after insulin injection-related needle-stick injuries

In the majority (610, 98.4%) of the 620 insulin injection-related needle-stick injuries, the hurt nurses took proper immediate actions after the accidents. The most reported action was squeezing blood out of the wound from the proximal end to the distal end (Table 6).

TABLE 1 General information and data on insulin injection-related needle-stick injuries of the participants (n = 5389)

Items	Contents	Number of people (%)	Number of people experienced needle-stick injuries in the past year (%)	Number of needle-stick injuries in the past year (per 1000 nurses per year)
Hospital category	Primary hospital	91 (1.7)	7 (1.8)	7(76.9)
	Secondary hospital	1,886 (35.0)	109 (27.5)	165(87.5)
	Tertiary hospital	3412 (63.3)	280 (70.7)	448(131.3)
Age(year)	≤25	380 (7.1)	29 (7.3)	43(113.2)
	26 ~ 30	2,070 (38.4)	152 (38.4)	233(112.6)
	31 ~ 35	1,883 (34.9)	128 (32.3)	186(98.8)
	≥36	1,056 (19.6)	87 (22.0)	158(149.6)
Units	Department of endocrinology	406 (7.5)	77 (19.4)	122 (300.5)
	Department of internal medicine	1653 (30.7)	102 (25.8)	163 (98.6)
	Department of surgery	1085 (20.1)	74 (18.7)	110 (101.4)
	Department of emergency	281 (5.2)	13 (3.3)	24 (85.4)
	Intensive care unit	250 (4.6)	13 (3.3)	28 (112)
	Department of pediatrics	227 (4.2)	6 (1.5)	6 (26.4)
	Department of gynecology	132 (2.4)	8 (2.0)	12 (90.9)
	Department of obstetrics	222 (4.1)	5 (1.3)	9 (40.5)
	Department of oncology	268 (5.0)	14 (3.5)	21 (78.4)
	Other departments	865 (16.2)	84 (21.2)	125 (144.5)
Professional title	Junior nurse	2,160 (40.1)	155 (39.1)	236(109.3)
	Senior nurse	2,487 (46.2)	195 (49.2)	309(124.2)
	Supervisory nurse	668 (12.4)	44 (11.1)	73(109.3)
	Associate chief nursing or above	74 (1.4)	2 (0.5)	2(27.0)
Years of working experience	≤2	899 (16.7)	73 (18.4)	104 (115.7)
	3 ~ 5	1,581 (29.3)	111 (28.0)	172 (108.8)
	6 ~ 10	1,660 (30.8)	127(32.1)	218 (131.3)
	11 ~ 19	934 (17.3)	67 (16.9)	102 (109.2)
	≥20	315 (5.9)	18 (4.5)	24 (76.2)
Educational background	Technical secondary school	66 (1.2)	6 (1.5)	17 (257.6)
	Junior college	2,336 (43.4)	160 (40.4)	252 (107.9)
	Bachelor degree	2,966 (55.0)	229 (57.8)	348 (117.3)
	Master's degree or above	21 (0.4)	1 (0.3)	3 (142.9)
Safety training received	Both insulin syringe and insulin pen	2,728 (50.6)	217 (54.8)	345 (126.5)
	Only insulin injection with a syringe	634 (11.8)	43 (10.9)	71 (112.0)
	Only insulin injection with a pen	355 (6.6)	35 (8.8)	50 (140.8)
	Neither	1,672 (31.0)	101 (25.5)	154 (92.1)
Total		5,389	396 (7.4)	620 (115.0)

4.7 | Follow-up visit condition

In 337 (54.4%) of the 620 insulin injection-related needle-stick injuries, the injured nurses had completed the suggested follow-up visit. In 15 (2.4%) cases, the injured nurses were in the process of suggested follow-up while in the other 268 (43.2%) cases the injured nurses had refused or discontinued the suggested follow-up (Table 7).

4.8 | Emotional changes after insulin injection-related needle-stick injuries

Of the 396 participants who experienced insulin injection-related needle-stick injuries in the past year, a large proportion (232, 58.6%) reported emotional changes. The emotional changes are presented in Table 8.

TABLE 2 Infection condition of the insulin injection-related needle-stick injuries by a contaminated instrument (*n* = 387)

Infection condition	Number of cases (%)
HBV infected	57 (14.7)
HCV infected	4 (1.0)
Syphilis infected	8 (2.1)
HIV infected	4 (1.0)
Other virus infected	15 (3.9)
Infected with two kinds of virus or above	13 (3.4)
Not infected	157 (40.6)
Unclear about infection condition	129 (33.3)
Total	387(100)

5 | DISCUSSIONS

5.1 | Prevalence of insulin injection-related needle-stick injuries

Research data about the prevalence of insulin injection-related needle-stick injuries among healthcare providers in the hospital setting are limited. This large-scale cross-sectional study investigated the prevalence and comprehensive burdens of insulin injection-related needle-stick injuries. The result of this study showed that 7.4% of clinical nurses experienced at least one insulin injection-related needle-stick injury in the past year. Such a result was in concordance with similar studies. A 2012 survey involving 14 European countries showed that about 32% of nurses suffered from insulin injection-related needle-stick injuries in hospitals, suggesting a much higher proportion of nurses experienced the accidents compared with the current study (Costigliola et al., 2012). However, the statistically significant difference could be explained by the fact that the current study investigated the prevalence of insulin injection-related needle-stick injuries in the past year while the previous study considered the accidents that occurred at any time point in the past. In a study originating from the United States, the investigators stated that 8.25% of nurses experienced insulin injection-related needle-stick injuries in the past 12 months, which is similar to the findings of the current study (Lee et al., 2005). In a recent survey conducted in China, Zhao and colleagues concluded that 39.1% of nurses reported experiencing at least one insulin injection-related needle-stick injury at some point in the past (Zhao et al., 2019). The investigators also proposed an annual insulin injection-related needle-stick injuries' prevalence rate of 139.5 per 1000 nurses, which was slightly higher than the annual prevalence rate in the current study (115.0 per 1000 nurses). The slight difference in the prevalence rate of the accidents could be attributed to the difference in the participant composition of the two studies: Zhao's study recruited a higher proportion of nurses from the department of Endocrinology than the current study (32.4% vs. 7.5%). As the prevalence rate of insulin injection-related needle-stick injuries was much higher in

the department of Endocrinology (300.5 per 1000 nurses annually) than that in other departments, a higher proportion of nurses from the department of Endocrinology would inflate the overall prevalence rate. In this study, two methods were used to calculate the prevalence of insulin injection-related needle-stick injuries: calculation based on the number of participants who suffered the accident (7.4%) and the number of insulin injection-related needle-stick injuries (115.0 per 1000 nurses). It should be noted the former method may underestimate the risk of the accident as in this case those participants who suffered multiple injuries were only counted for once. Especially in the endocrinology department, there may have been one nurse with multiple needle-stick injuries related to insulin injection due to the high frequency of insulin injection. The study stated that 19.4% of nurses experienced insulin injection-related needle-stick injuries in the past 12 months, the prevalence rate of 300.5 per 1000 nurses, which was much higher than the other department.

5.2 | Factors associated with insulin injection-related needle-stick injuries

This study demonstrated that department, removing and/or setting back needle caps with bare hands, frequency of insulin pen and syringes are associated with the incidence of insulin injection-related needle-stick injuries. Individuals working in the Department of Endocrinology are at significantly higher risk of the accident, and this could be explained by the fact that healthcare workers working in the department are more frequently administrating insulin injections for the patients (with diabetes) compared with their counterparts from other departments (Mengistu & Tolera, 2020). Individuals who remove and/or set back needle caps with bare hands experienced more insulin injection-related needle-stick injuries. Using safety-engineered devices might be effective to reduce such injuries (Reddy et al., 2017). This study also showed that a higher frequency of insulin pen and syringes use is a risk factor for insulin injection-related needle-stick injuries (Mengistu & Tolera, 2020). Because of these nurses had more exposure to the needle-sticks. Out of the expectation, the working experience was not identified to be associated with the prevalence of needle-stick injuries, the constitution of the research sample could be the reason. The majority of the participants in the current study had a working experience of more than three years, and as a result, the statistical analysis could not detect the difference.

5.3 | Failure to follow procedures may increase needle-stick injuries' occurrence and associated infections

This study identified 101 infections caused by insulin injection-related needle-stick injuries, indicating that 16.5% (101/620) of the accident would result in an infection and the annual prevalence

TABLE 3 Multivariate logistic regression of factors related to insulin injection-related needle-stick injuries (n = 5389)

Variables	Univariate analysis		Multivariate analysis	
	OR	95% CI	OR	95% CI
Hospital category				
Primary hospital	1	reference	1	reference
Secondary hospital	0.720	(0.413, 1.255)	0.718	(0.402, 1.284)
Tertiary hospital	1.089	(0.630, 1.880)	0.785	(0.444, 1.388)
Local department				
Endocrinology department	1	reference	1	reference
Other department	0.234*	(0.189, 0.289)	0.373*	(0.295, 0.472)
Age(years)				
≤25	1	reference	1	reference
26 ~ 30	1.326	(0.950, 1.851)	1.053	(0.724, 1.530)
31 ~ 35	1.760*	(1.263,2.452)	1.309	(0.857,2.000)
≥36	1.654*	(1.168, 2.344)	1.503	(0.906, 2.492)
Professional title				
Junior nurse	1	reference	1	reference
Senior nurse	1.504*	(1.285, 1.759)	1.234	(0.989, 1.540)
Supervisory nurse	1.218	(0.960, 1.545)	0.978	(0.676, 1.415)
Associate chief nursing or above	1.195	(0.637, 2.244)	1.215	(0.547, 2.701)
Years of working experience				
≤2	1	reference	1	reference
3 ~ 5	1.337*	(1.054, 1.695)	1.106	(0.837, 1.461)
6 ~ 10	1.600*	(1.269, 2.017)	0.968	(0.685, 1.368)
11 ~ 19	1.633*	(1.265, 2.107)	0.949	(0.615, 1.464)
≥20	1.208	(0.837, 1.743)	0.855	(0.469, 1.557)
Educational background				
Technical secondary school	1	reference	1	reference
Junior college	1.005	(0.493, 2.051)	0.953	(0.446, 2.036)
Bachelor degree	1.526	(0.751, 3.101)	1.196	(0.558, 2.562)
Master's degree or above	1.979	(0.581, 6.743)	1.234	(0.333, 4.572)
Safety training received				
Both insulin syringe and insulin pen	1	reference	1	reference
Neither	0.765*	(0.647, 0.905)	1.082	(0.903, 1.297)
Only insulin injection with a syringe	0.764*	(0.600, 0.972)	0.998	(0.774, 1.285)
Only insulin injection with a pen	1.288	(0.985, 1.685)	1.478	(1.110, 1.967)
Set-back needle cap or unshackle cap with bare hands				
no	1	reference	1	reference
yes	1.905*	(1.519, 2.390)	1.428*	(1.127, 1.810)
Frequency of weekly use of syringes				
>10	1	reference	1	reference
5 ~ 10	0.851	(0.686, 1.055)	1.226	(0.962, 1.563)
1 ~ 4	0.515*	(0.430, 0.617)	1.026	(0.822, 1.280)
0次	0.315*	(0.251, 0.396)	0.663*	(0.505, 0.870)
Patients injected themselves	0.317*	(0.207, 0.485)	1.189	(0.701, 2.017)
Frequency of weekly use of insulin pens				
>10	1	reference	1	reference

TABLE 3 (Continued)

Variables	Univariate analysis		Multivariate analysis	
	OR	95% CI	OR	95% CI
5 ~ 10	0.629[*]	(0.515, 0.769)	0.710[*]	(0.565, 0.893)
1 ~ 4	0.258[*]	0.218, 0.305)	0.365[*]	(0.293, 0.455)
Patients injected themselves	0.181[*]	(0.125, 0.262)	0.233[*]	(0.147, 0.370)

rate of infection caused by the accident was 18.7 per 1000 nurses. Considering that in 129 accidents with a contaminated instrument, the hurt nurses stated that they were not clear about the infection condition, and the actual prevalence of such infection could be larger. Among the infections, HBV was the most common pathogen (10.6 per 1000 nurses annually), which was consistent with the findings of previous studies (Elmi et al., 2018; Wang et al., 2008; Zhao et al., 2019).

It was found in this study that insulin injection-related needle-stick injuries occurred most frequently when nurses were setting back the needle cap after insulin injection, accounting for more than two fifths. Despite the difference in the percentage data, recapping a used needle was consistently identified as the most common stage in which needle-stick injuries occurred in relevant studies (Akyol & Kargin, 2016; Costigliola et al., 2012; Motaarefi et al., 2016).

5.4 | Regular follow-up and active reporting should be valued

Among the 396 participants who experienced insulin injection-related needle-stick injuries, only 30.3% reported the accidents to the administrative staff. Even though the literature on the reporting fact of insulin injection-related needle-stick injuries is lacking, the percentage of nurses who reported the accident after suffering from needle-stick injuries ranged significantly. In a cross-sectional study, Huang and colleagues suggested only 4.6% of healthcare workers reported the experience of needle-stick injuries to their hospitals (Huang et al., 2017). However, it was stated in another study that 51% of the hurt healthcare workers reported needle-stick injuries to the hospitals (Elmiyeh et al., 2004). The most common reason for not reporting the accidents was "fear of trouble," followed by "considering the instrument is not contaminated or that the patient has no infectious disease." It was encouraging that in the majority (98.4%) of the insulin injection-related needle-stick injuries, the hurt nurses took proper immediate actions after the accidents. The most reported actions included "squeezing blood out of the wound from the proximal end to the distal end," "water flushing" and "skin disinfection." However, the alarming fact was that in 43.2% of the insulin injection-related needle-stick injuries, the hurt nurses refused or discontinued the suggested follow-up, which is much higher than the proportion of healthcare workers who simply ignored the accidents in studies about needle-stick injuries (Thomas & Murray, 2009). Insulin injection-related needle-stick injuries is a form of blood-borne occupation exposure that may cause haematogenous infectious diseases. The healthcare givers who have experienced needle-stick injuries should undergo regular follow-up monitoring and documentation of haematogenous and symptomatic origin (Rezaei et al., 2017).

5.5 | The emotional burden after needle-stick injuries should be valued

needle-stick injuries do not only harm nurses' health, but also cause great psychological stress for nurses. In a study of 313 Health Care Workers post-NSI, 41.8% felt anxious, depressed or stressed (Lee et al., 2005). In another study, anxiety was reported by 80.2% of Health Care Works post-NSI with 66.4% having mild/moderate anxiety, and 13.8% with persistent anxiety (Cooke & Stephens, 2017). In this study, 46.5% of the nurses were unable to concentrate while working, 30.8% suffered from anxiety, fear and crying, 12.6% of the nurses wanted to quit the job, 3.5% of the nurses wanted to change the job, and 1.8% of the nurses also caused stress to the family. The result demonstrated that a large proportion of the hurt nurses experienced emotional changes after an insulin injection-related needle-stick injury occurred. The nursing human resource is inadequate, and timely and appropriately deal with the psychological stress caused by insulin injection-related needle-stick injuries of nurses is statistically significant to ensure the quality of clinical nursing care and solid nursing human resources.

5.6 | Implications for nursing practice

Considering the high prevalence and the tremendous multidimensional burdens of insulin injection-related needle-stick injuries, strategies should be made to prevent the accident and establish a standard management procedure. Evidence suggested that education and training on needle-stick injuries prevention and infection control precautions are effective approaches (Akyol & Kargin, 2016; Ersin et al., 2016). In a systematic review of 17 studies about the effectiveness of different preventive interventions for needle-stick injuries, the reviewers concluded that the combination of safety training with safety-engineered devices could produce extra effectiveness (Tarigan et al., 2015). The administrative staff of hospitals and departments should pay attention to the possible emotional changes following insulin injection-related needle-stick injuries and provide appropriate support to the hurt health care workers when necessary.

needle-stick injuries link	Number of cases (%)
When setting back the needle cap after injection	263 (42.4)
When removing the needle cap	89 (14.4)
When holding a syringe or insulin pen with the needle cap removed while sterilizing the skin at the same time	57 (9.2)
When a syringe is used to extract drug solution	52 (8.4)
When separating the needle and the injection instrument after injection	45 (7.3)
When the destroying the contaminated needle	34 (5.5)
When pulling out the needle after injection	23 (3.7)
When the needle dropped out from the sharp box	22 (3.5)
When passing a needle	15 (2.4)
When injecting the medicine	11 (1.8)
Others	9 (1.4)
Total	620 (100)

TABLE 4 needle-stick injuries in different stages of the subcutaneous insulin injection (n = 620)

Reason for not reporting the accidence	Number of people (%)
Fear of trouble	201 (72.8)
Considered that the instrument is not contaminated or that the patient has no infectious disease	151 (54.7)
Too busy, no time to report it	112 (40.6)
Reporting process is too tedious	110 (39.9)
It was my own mistake, I thought I was unlucky	65 (23.6)
There is no control after the report	45 (16.3)
Leaders link to personal responsibility	24 (8.7)
Reporting procedure is not known	23 (8.3)
Afraid of affecting your career and reputation	15 (5.4)
There is no reporting department in the hospital	14 (5.1)
Others	10 (3.6)

TABLE 5 Reasons for not reporting the insulin injection-related needle-stick injuries (n = 276)

Actions	Number of cases (%)
Squeezing blood out from the proximal end to the distal end	568 (91.6)
Water flushing	524 (84.5)
Skin disinfection	496 (80)
No action	10 (1.6)

TABLE 6 Actions immediately taken after insulin injection-related needle-stick injuries (n = 620)

TABLE 7 Follow-up condition (n = 620)

Characteristic	Number of people (%)
Suggested follow-up completed	337 (54.4)
Suggested follow-up in process	15 (2.4)
Refused or discontinued suggested follow-up	268 (43.2)
Total	620 (100)

5.7 | Limitations of this study

The findings of this study should be interpreted with consideration of its limitations. The participants were invited to participate in the study on a voluntary basis, so it was possible that individuals with prior experience of the injuries were more probably to join the study, which could introduce selection bias to the study (Heckman, 1990). Despite its large sample size, the study was conducted in Shaanxi province,

TABLE 8 Emotional changes after insulin injection-related needle-stick injuries (*n* = 396)

Emotional changes	Number of people (%)
Inability to concentrate on work	184 (46.5)
Anxiety, fear or crying	122 (30.8)
Willing to quit the job	50 (12.6)
Job transfer	14 (3.5)
Family tension	7 (1.8)
Others	4 (1.0)
No emotional changes	164 (41.4)

which could compromise the generalizability of the findings. The research data were collected in a retrospective approach by asking the participants to recall their experience related to insulin injection-related needle-stick injuries in the past year. As a result, the results of the study could be influenced by recall bias (Coughlin, 1990).

6 | CONCLUSION

In summary, this study demonstrated a considerably high prevalence of insulin injection-related needle-stick injuries among clinical nurses, with the largest proportion of the accidents, occurring when recapping the needle. While nurses could be at risk of various infectious diseases, HBV was the most common pathogen. Even though the majority of the hurt nurses took proper actions immediately after insulin injection-related needle-stick injuries, a large quantity of them failed to report the accidents to the administrative staff and complete the suggested follow-up. It portends a statistically significant risk to occupational health management for nurses. Nurses who suffered from insulin injection-related needle-stick injuries were subject to various negative emotional changes.

7 | RELEVANCE TO CLINICAL PRACTICE

This study explored the prevalence and burden of insulin injection-related needle-stick injuries among clinical nurses. The findings showed a considerably high prevalence of and tremendous multi-dimensional burdens of the injuries, which could provide important evidence for administrative staff of hospitals/departments to make scientific preventive and management strategies in order to minimize the consequences of the injuries. Nursing managers should pay attention to the reporting, monitoring and follow-up of needle-stick injuries.

AUTHOR CONTRIBUTIONS

Meng Li, Lanting Huo, Fenjing Du, Wuping Li, Huali Zhang and Bingyin Shi made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Meng Li and Lanting Huo involved in drafting the manuscript or revising it critically for important intellectual content. Meng Li, Lanting Huo, Fenjing Du, Wuping Li, Huali Zhang, Bingyin Shi gave final approval of the version to be published. Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content.

ETHICAL APPROVAL

Ethics approval was obtained from the Ethics Committee of the principal investigator's hospital, and written permissions were obtained from the participating institutions. The reporting of this paper is in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations (Supplementary Data S1) (von Elm et al., 2007).

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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SUPPORTING INFORMATION

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