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**Field Report**

# Characteristics of needlestick and sharps injuries of the hands in the operating room among orthopedic surgeons in Japan

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**Abstract: Among the reports on needlestick and sharps injuries (NSIs), many are orthopedic-related due to the frequent use of sharp devices such as pins and wires. This study aimed to identify high-risk instruments, the most common injury sites for each instrument, and the circumstances of NSIs of the hand during orthopedic surgeries in Japan. Incidents of exposure to blood or bodily fluids among physicians during orthopedic surgeries reported to the Japan-EPINet between 2000 and 2015 were included in this study. The four most common devices were identified and the associations among years of experience, equipment users, and injured sites were analyzed. We identified 666 cases of NSIs affecting orthopedic surgeons in the operating room. The instrument most frequently responsible for NSIs was suture needles, which were involved in 265 cases (39.7%). The second most common instrument was pins/wires, which was involved in 111 cases (16.6%). NSIs of the hands of orthopedic surgeons were frequently caused by suture needles used in all surgeries, but relatively often caused by orthopedic devices. Orthopedic surgeons must be aware that they are at risk of NSIs and must take appropriate measures and always be cautious when performing surgery, regardless of their years of experience.**

**Key words:** Human errors, Risk management, Occupational epidemiology, Needlestick injuries, Orthopedic surgeons

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## Introduction

Needlestick and sharps injuries (NSIs) during surgery may be associated with serious occupational infections caused by blood-borne pathogens. NSIs cause great mental distress, regardless of the presence or absence of contamination, and associations between NSIs and depressive symptoms[1)] and posttraumatic stress[2)] have been reported. Furthermore, the average cost for each NSI is approximately ¥63,711 for medical institutions[3)], and prevention is essential to reduce such costs.

Particularly, in orthopedic surgery, numerous sharp instruments, including pins and wires, are used. Therefore, the incidence of accidental NSIs in orthopedic operating rooms is high. The NSI risk for orthopedic surgeons is estimated to be 80%–90% over a period of 10 years[4)]. According to a report comparing departments, orthopedic residents have a 12 times higher risk of NSIs compared with emergency department residents[5)]. In terms of injury sites, the hand is the most common site for NSIs among orthopedic surgeons, accounting for 25%[6)], with the thumb of the right hand and the index finger of the left hand being particularly prone to NSIs[7)].

NSI prevention strategies can be developed by obtaining information such as the characteristics of the equipment causing the injury and the circumstance of the incident[8)]. A report from the Centers for Disease Control and Prevention has stated that 62%–88% of NSIs are preventable[9)], and meta-analysis studies have reported that training can significantly reduce the risk of NSIs[10)]. Hence, considering the characteristics of potential injury risks associated with each instrument is important when devising NSI prevention strategies in surgical settings. However, only a few studies have used a large-scale needlestick incision database to perform a detailed analysis of the injury sites and equipments associated with NSIs during surgery in the field of orthopedics[11)]. This study aimed to identify high-risk instruments, the most common injury sites for each instrument, and circumstances of NSIs of the hand during orthopedic surgeries in Japan.

## Methods

The Japanese version of the Exposure Prevention Information Network (EPINet®) is a surveillance system that records all cases of needlesticks, cuts, and blood and body fluid exposure in the standard format of Japan-EPINet as provided by the Research Group of Occupational Infection Control and Prevention in Japan. EPINet®, a tool for collecting standardized information for needle stick injuries and body fluid exposures[12, 13)], has been adopted as a nationwide surveillance tool in Canada[14)]. In this study, incidents of exposure to blood and bodily fluids in the operating room that were reported to the Japan-EPINet between 2000 and 2015 were included. Subsequently, the search was further narrowed to physicians (including residents) and the department of orthopedics.

Although instruments were subdivided into minor categories in EPINet®, in a broader fashion, we classified disposable syringe needles and lumbar puncture needles as "disposable needles", disposable surgical scalpels, and reusable surgical scalpels as "scalpels", and wires and pins as "pins/wires". Because "suture needles", "bone fragments", and "skin hooks" could not be included in the above-mentioned broader categories, they were categorized as they were. Among the reported cases, four instruments that were most frequently responsible for NSIs (i.e. suture needles, pins/wires, scalpels, and disposable needles) were extracted. The number of years of post-graduate experience was classified into five categories: 0–4 years, 5–9 years, 10–14 years, 15–19 years, and ≥20 years. Table 1 shows NSIs for each instrument in relation to the years of experience of the injured person.

The person holding the equipment at the time the NSIs occurred was classified as "self" or "others". Table 2 reports the proportion of NSIs in relation to the years of experience of the injured person and the person holding the instrument at the time of injury.

The injury site was limited to the hand and categorized using the classification in EPINet®: locations 1–7 as the dorsum of the right hand, locations 8–14 as the palm of the right hand, locations 15–21 as the palm of the left hand, and locations 22–28 as the dorsum of the left hand. Fig.1-a–d shows the hazard map for each instrument. Table 3 reports the results by the injury site and the person holding the instrument during the time of injury.

*Statistical analysis*

Descriptive statistic is used to report the study results. Data were analyzed using Microsoft Excel 2010 and the results are presented as frequency and percentage.

*Ethics statement*

This was a retrospective study and was approved by the Ethics Review Committee of the International University of Health and Welfare (approval number: 19-Im-004).

**Table 1. Number of years of experience by sharp equipment in orthopedic surgery**

| Years of experience | Suture needle n=265 | | Pin/wire n=111 | | Scalpel n=64 | | Disposable needle n=43 | |
|---|---|---|---|---|---|---|---|---|
| | n | (%) | n | (%) | n | (%) | n | (%) |
| **0–4** | 87 | (32.8) | 20 | (18.0) | 13 | (20.3) | 12 | (27.9) |
| **5–9** | 42 | (15.8) | 23 | (20.7) | 11 | (17.2) | 7 | (16.3) |
| **10–14** | 33 | (12.5) | 19 | (17.1) | 9 | (14.1) | 7 | (16.3) |
| **15–19** | 33 | (12.5) | 12 | (10.8) | 12 | (18.8) | 5 | (11.6) |
| **≥20** | 36 | (13.6) | 15 | (13.5) | 11 | (17.2) | 5 | (11.6) |
| **Unknown** | 34 | (12.8) | 22 | (19.8) | 8 | (12.5) | 7 | (16.3) |

**Table 2. Number of years of experience by sharp equipment in orthopedic surgery and classification of users**

| Years of experience | Suture needle n=206 | | | | Pin/wire n=85 | | | | Scalpel n=51 | | | | Disposable needle n=37 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Myself | | Others | | Myself | | Others | | Myself | | Others | | Myself | | Others | |
| | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) |
| **0–4** | 33 | (53.3) | 29 | (46.8) | 9 | (69.3) | 4 | (30.8) | 2 | (18.3) | 9 | (81.8) | 8 | (72.8) | 3 | (27.3) |
| **5–9** | 19 | (61.4) | 12 | (38.7) | 16 | (76.3) | 5 | (23.8) | 2 | (22.3) | 7 | (77.8) | 6 | (85.7) | 1 | (14.3) |
| **10–14** | 20 | (76.1) | 6 | (23.1) | 4 | (28.7) | 10 | (71.4) | 3 | (42.1) | 4 | (57.1) | 6 | (85.7) | 1 | (14.3) |
| **15–19** | 18 | (56.4) | 14 | (43.8) | 9 | (100.0) | 0 | 0.0 | 2 | (25.1) | 6 | (75.0) | 2 | (50.1) | 2 | (50.0) |
| **≥20** | 26 | (78.9) | 7 | (21.2) | 10 | (71.4) | 4 | (28.6) | 4 | (40.1) | 6 | (60.0) | 2 | (40.1) | 3 | (60.0) |
| **Unknown** | 12 | (54.6) | 10 | (45.5) | 10 | (71.4) | 4 | (28.6) | 4 | (66.8) | 2 | (33.3) | 1 | (33.4) | 2 | (66.7) |
| **Total** | 128 | (62.2) | 78 | (37.9) | 58 | (68.3) | 27 | (31.8) | 17 | (33.4) | 34 | (66.7) | 25 | (67.7) | 12 | (32.4) |

## Results

From April 2000 to March 2015, the number of NSIs registered in the Japanese version of EPINet® was 65,032. Among those, 666 were cases affecting orthopedic surgeons that occurred in operating rooms. The instrument most frequently responsible for NSIs was suture needles, which was involved in 265 cases, accounting for approximately 39.7% of the total cases. The second most common instrument was pins/wires, which was involved in 111 cases (16.6%), followed by scalpels in 64 cases (9.6%), and disposable needles in 43 cases (6.4%).

*Years of experience*

Table 1 reports the cases of injuries that were analyzed for each instrument in relation to the years of experience of the injured person. Injuries caused by suture needles were the most common among physicians with <5 years of experience, totaling 87 cases (32.8%). Among suture needle injuries, 48.6% occurred in those with <10 years of experience. Injuries caused by pins/wires were the most common among physicians with 5–9 years of experience, totaling 23 cases (20.7%). Injuries caused by scalpels were the most common among physicians with <5 years of experience, totaling 13 cases (20.3%). Similarly, injuries caused by disposable needles were the most common among physicians with <5 years of experience, totaling 12 cases (27.9%).

*Person holding the instrument*

Table 2 shows injuries in relation to the years of experience of the injured person and the person holding the instrument at the time of injury. When the years of experience were unspecified, they were categorized as "unknown". As the cases in which no checkmark had been placed in the box pertaining to the user were not counted, the total number of injuries was smaller when considered according to the injured person and the user holding the instrument (Table 2) than when considered according to the injured person only (Table 1). Suture needle injuries (128/206; 62.2%) and scalpel injuries (34/51; 66.7%) were often self-inflicted in all age groups. Similarly, pin/wire injuries (58/85; 68.3%) and disposable needle injuries (25/37; 67.7%) were also often self-inflicted.

*Injury site*

Furthermore, the injury site was classified according to the person holding the device responsible for the NSIs (Table 3) and was mapped for each device to create a hazard map (Fig.1-a–d). Self-inflicted injuries were mapped using an oblique line, whereas those inflicted by others were mapped using dots. Suture needle and pin/wire injuries were mapped as the top two, whereas scalpel and disposable syringe injuries were mapped as the third and fourth

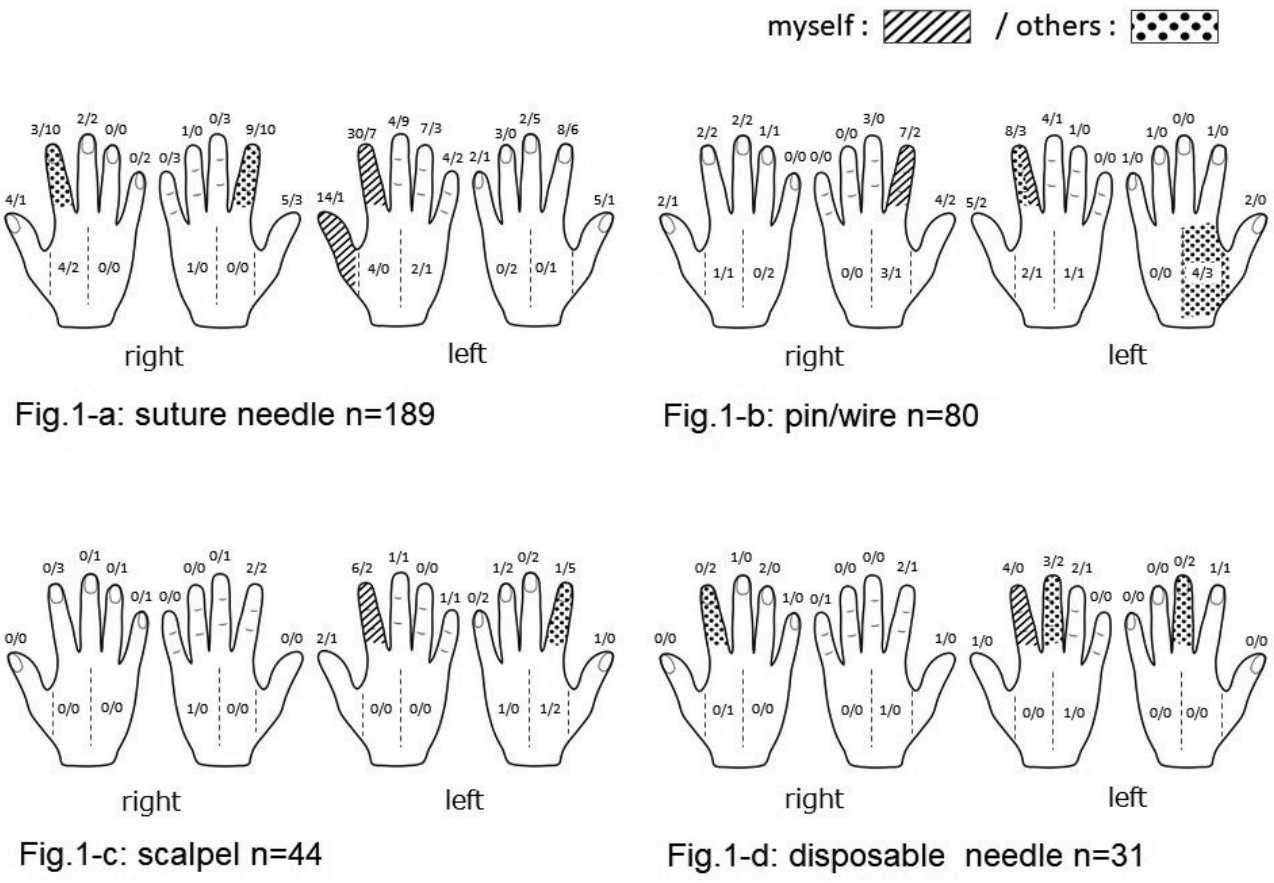


**Fig. 1. Hazard map for each instrument.**

most common equipment responsible for NSIs. Seventy cases (58.8%) of the suture needle injuries involved stabbing one's own left hand on the palm side (Fig.1-a). Pin/wire injuries often involved stabbing one's palm, of which injuries to the right palm side totaled 17 cases (30.9%) and injuries to the left palm side totaled 21 cases (38.2%). In particular, the palm side of both index fingers was often involved, with 9 cases of the right index finger injury and 11 cases of the left index finger injury (Fig.1-b). Scalpel injuries totaled 13 cases (46.4%) and often involved being stabbed on the back of the left hand by others. The most frequently self-injured site was the left index finger on the palm side, but many cases involved the entire backside of the right hand being stabbed by others (Fig.1-c). Disposable needle injuries totaled 11 cases (55.0%) and often involved stabbing one's own left palm; the left middle finger on the palm side was the most common site of injury, accounting for 5 cases (Fig.1-d).

## Discussion

NSIs caused by suture needles were the most common, followed by those caused by pins/wires, scalpels, and disposable needles. In a survey of orthopedic surgeons[15], suture needles were the most common instruments, followed by pins/wires, which is consistent with the findings of the present study.

NSIs caused by pins/wires, which are devices specific to orthopedics, totaled 111 cases (16.6%), which was the second highest injury following injuries caused by suture needles. Although only a few studies have reported on NSIs caused by pins/wires, the risk of NSIs is high among orthopedic surgeons, which suggests that these devices require careful handling and attention. Studies in the USA and Canada shows a high risk of needlestick injuries among orthopedic surgeons[5, 16]. As orthopedic surgeons are greatly exposed to sharp operating tools, suture needles, and fatigue due to long operating hours, they are likely to be at risk of the injuries involving needlestick. A study reported that surgeons are more likely to report needlestick injuries compared to non-surgeons[5]. In addition to orthopedic surgeons, dentists, obstetrics and gynecologists, plastic surgeons and urologists were more likely to incur injuries compared to physicians in internal medicine and emergen-

**Table 3. Number of users and injured parts by sharp instruments in orthopedic surgery**

| Injured part / instrument | Right hand back | | Right hand palm | | Left hand back | | Left hand palm | |
|---|---|---|---|---|---|---|---|---|
| | n | (%) | n | (%) | n | (%) | n | (%) |
| **Suture needle** | | | | | | | | |
| **Myself** | 13 | (10.9) | 16 | (13.4) | 20 | (16.8) | 70 | (58.8) |
| **Others** | 17 | (24.3) | 19 | (27.1) | 16 | (22.9) | 18 | (25.7) |
| **Pin/wire** | | | | | | | | |
| **Myself** | 8 | (14.5) | 17 | (30.9) | 9 | (16.4) | 21 | (38.2) |
| **Others** | 9 | (36.0) | 5 | (20.0) | 3 | (12.0) | 8 | (32.0) |
| **Scalpel** | | | | | | | | |
| **Myself** | 0 | | 2 | (12.5) | 5 | (31.3) | 9 | (56.3) |
| **Others** | 6 | (21.4) | 4 | (14.3) | 13 | (46.4) | 5 | (17.9) |
| **Disposable needle** | | | | | | | | |
| **Myself** | 4 | (20.0) | 4 | (20.0) | 1 | (5.0) | 11 | (55.0) |
| **Others** | 3 | (27.3) | 2 | (18.2) | 3 | (27.3) | 3 | (27.3) |

cy medicine[5, 16, 17]. In an obstetrics and gynecology survey[18], 57.1% (315/552) experienced the most recent NSI during cesarean section, which was mainly inflicted by someone else (72.4%; 228/315). 42.9% (237/552) of NSIs were during perineal sutures, and 84% (199/237) of them were self-inflicted.

Regarding the number of years of experience, the injury rate among those with 5–9 years of experience was the highest at 20.7% (27 cases), but that among those with ≥20 years of experience was also high at 13.5% (15 cases). The risk decreased with experience but was not entirely eliminated. With regard to the injury site, many cases involved injuring one's own hands on the palm side, especially the palm side of both index fingers. The injury occurred while handing over equipment or during temporary fixing when the tip of the wire inserted into the bone went unnoticed, which resulted in a cut on the fingertip. The results suggest that regardless of the years of experience, surgeons should remain vigilant about preventing NSIs and be careful not to cut their fingers when grasping a pin/wire. In addition, prevention measures, such as covering the sharp part of the inserted pin[19] should be practiced to reduce the risk of injuries.

NSIs caused by suture needles were the highest with 265 cases, accounting for approximately 39.7% of the total number of cases. According to previous reports[20], suture needles often result in a high frequency of needle sticks, accounting for 54.9% of all NSIs among physicians in the operating room[21]. This study was conducted exclusively on orthopedic surgeons, and although the proportion of suture needle related NSIs decreased due to the use of other high-risk equipment, suture needles remained one of the instruments with the highest risk of causing NSIs. Regarding the number of years of experience, 48.6% had <10 years of experience, suggesting a high number of younger physicians at increased risk. A feeling of being 'rushed', followed by 'fatigue' is recognized as one of the major reasons for NSIs among young surgeons[22]. However, the number of cases did not decrease with age, and those with 10–14 years, 15–19 years, and ≥20 years of experience comprised 12.5%, 12.5%, and 13.6%, respectively, of all cases of injuries. This is consistent with the findings of previous studies that have reported that NSIs with suture needles did not decrease among skilled physicians[21]. The increased cumulative exposure to handling of needles over the years could possibly have led to the constant prevalence of injuries even among experienced individuals. Stress and burnout during hours long surgeries could also lead to such injuries. Similarly, other factors such as complacency and negligence may lead to higher incidence of NSI among experienced physicians. The most common injury site was the left palm side of the hand, inflicted by self. Several NSIs caused by suture needles often occur while suturing muscles and fascia, especially while grasping the needle with fingers and changing direction; the nondominant hand is reported to be the most injury-prone site[23, 24]. Given that several surgeons are right-handed, the results of this study are consistent with those of previous studies. Using a blunt needle as a preventive method is recommended by the Cochrane Review[25] and can be used when suturing fascia in orthopedic surgery.

The number of NSIs caused by scalpels was 64 (9.6%), which was the third highest, and the stab was often inflicted by others in all age groups. According to a study by Wada *et al.*[21], scalpels are a high-risk source of stab injuries inflicted by others. In these injuries, the most common injury

site was the back of the left hand. Since the physical distance between the right hand of a right-handed surgeon holding the scalpel and the left hand of the assistant on the opposite side (or next to) is close, it is believed that the back of the assistant's left hand is often inadvertently stabbed by the surgeon or the assistant.

NSIs caused by injection needles were relatively few in number, totaling 43 cases (6.4%). In surveys involving hospital rooms and nurses, NSIs caused by injection needles are the most common[26, 27], but the frequency of the use of injection needles during orthopedic surgeries is low and limited to local and intravenous anesthesia, arthroscopic surgery, and spinal surgery marking. However, it should be recognized that NSIs still occur even if these devices are used infrequently.

*Strengths and limitations*

This study used a large-scale needlestick incision database and analyzed the injury sites and equipment associated with NSIs during surgery among orthopedic surgeons in the operating rooms. There are, however, some limitations of this study. Under-reporting of NSIs is noted in various studies[26, 28, 29]. The reason for under-reporting was a chronic lack of time due to excessive paperwork, surgeries, and inadequate support for overtime[30]. A literature review of 24 publications on NSIs conducted in 2006 reported that under-reporting was frequent and that the actual number of reports is 10 times that of the reports made[31]. In the future, it is essential to conducting further investigation to analyze the frequency and the risk of NSIs. In addition, some studies have reported injuries caused by bone spikes in orthopedic surgery[32], but because the number of such cases was small (7 of 666), they were not included in the present study. In the future, more accurate analysis of NSIs among orthopedic surgeons needs to be done by increasing the sample size. It is essential to encourage hospitals to comply with reporting for appropriate evaluation and management of needlestick injuries. Since the database used in this study did not use an orthopedic-specific question, it is unclear what surgical procedure was being conducted during the injury. It is necessary to carry out an NSI investigation to obtain detailed information of orthopedic surgical procedures.

## Conclusion

The present study found that NSIs of the hands of orthopedic surgeons in operating rooms were frequently caused by suture needles used in all surgeries, but relatively often caused by orthopedic devices. In orthopedic surgery, the risk of NSIs caused by devices other than those reported in this study (bones, skin hooks, drain tips, etc.) was high. The use of equipment with safety devices[4] and double gloving[7] have been reported as preventive measures in orthopedic studies. Orthopedic surgeons must be aware that they are at risk of NSIs and must take appropriate measures and always be cautious when performing surgery, regardless of their years of experience.

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## Conflicts of Interest

The authors declare that there are no conflicts of interest.

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