ORIGINAL ARTICLE

Occupational sharps and needlestick injuries among physician residents at an academic health center

Alexei Krainev[1], Wali Jahangiri[1], Sofia Villaveces[1], Hannah Phipps[1], Victoria Wulsin[1], Kermit G. Davis[1], Gordon Lee Gillespie*[2,3]

[1] *Department of Environmental and Public Health Sciences, University of Cincinnati, Cincinnati, United States*
[2] *Department of Population Health, University of Cincinnati, Cincinnati, United States*
[3] *Programming Business Unit, National League for Nursing, District of Columbia, United States*

Received: March 9, 2025 **Accepted:** April 22, 2025 **Online Published:** May 12, 2025
DOI: 10.63564/jha.v14n1p34 **URL:** https://doi.org/10.63564/jha.v14n1p34

ABSTRACT

Objective: Occupational sharps and needlestick injuries (SNSI) are a significant and persistent challenge in the U.S. healthcare work environment. With the purpose of better delineating contributing factors for a ubiquitous occupational injury among healthcare workers, we undertook a two-component study of SNSIs among physician residents and nurses at an academic health center.

Methods: Retrospective injury data among nurses (N = 58) and medical residents (N = 63) were analyzed. A 35-item cross-sectional survey was used to evaluate the prevalence, non-reporting, and contributing factors among physician residents who sustained a SNSI (N = 76).

Results: Physician residents had a rate of injury that was 11.0 SNSIs/100 medical residents/year compared to nurses at 3.2 SNSIs/100 nurses/year; a rate three-fold higher. Physician residents in neurosurgery, otolaryngology, obstetrics and gynecology, and general surgery reported the highest rates of injury.

Conclusions: Our results underscore the need for a more comprehensive study to better identify injury drivers specific to the operating room environment.

Key Words: Needlestick injuries, Nursing, Physicians, Occupational injuries, Hospitals, Surveys and questionnaires

1. INTRODUCTION

Occupational sharps and needlestick injuries (SNSI) are a significant and persistent challenge in the U.S. healthcare work environment. A SNSI is defined as any percutaneous, or skin-penetrating, injury to the healthcare worker sustained from a blood-contaminated instrument during patient care. These instruments range from hypodermic needles, stylets, surgical suture needles, and orthopedic pins and rods.[1] Annually, there are approximately 385,000 SNSIs among the U.S. healthcare workforce, with nurses and physicians accounting for the greatest burden of injury.[1] Further, there are 20 known bloodborne pathogens, which have the potential for transmission through percutaneous inoculation from a SNSI, including HIV, hepatitis B, and hepatis C.[2]

Employee anxiety, absenteeism, lost productivity, occupational health evaluation, serologic testing and post-exposure HBV/HIV prophylaxis are among some of the direct and indirect costs associated with this ubiquitous occupational in-

*Correspondence: Gordon Lee Gillespie; Email: ggillespie@nln.org; Address: 2600 Virginia Ave, NW; National League for Nursing, District of Columbia 20037, United States.

jury. The median aggregate cost, including direct and indirect costs, associated with one SNSI is estimated at $747.[3] The total aggregate cost among the U.S. healthcare workforce is estimated to be a minimum of $118 million annually.[4]

U.S. Centers for Disease Control and Prevention surveillance data derived from the National Surveillance System for Healthcare Workers (NaSH) from 1995-2003 demonstrate that nurses accounted for most SNSIs (44%) followed by physicians 28%.[1] A total of 23,197 reports of bloodborne pathogen exposures were registered during this time period including SNSIs. Similarly, World Health Organization (WHO) reported trends indicate that nurses and physicians carry the greatest injury burden.[5] According to two multihospital SNSI reporting databases, EPINet Sharps Injury Surveillance Research Group (EPINet) and Massachusetts Sharps Injury Surveillance System (MSISS), needlestick injuries have been on the rise over the past decade.[6] Self-report of SNSIs is estimated to be at 23 to 103 needlestick injuries per 1,000 health care workers.[7] In all, SNSIs have a significant impact on healthcare workers.

To better understand SNSIs, a determination of where they occur is necessary. The operating room has been identified as the department with the greatest number of SNSIs.[6] Of note, these types of injuries are of particular relevance to physician residents. As many as 99 of all surgical medical residents are reported to have sustained an SNSI during their medical careers.[8] Moreover, 51% of SNSIs occurring during surgical residency are believed to be unreported.[8]

With the purpose of better delineating contributing factors for a ubiquitous occupational injury among healthcare workers, we undertook a two-component study of SNSIs among physician residents and nurses at an academic health center.

2. METHODS

The study was divided into 2 components: (1) retrospective phase and (2) cross-sectional survey phase. The retrospective phase reviewed data from an electronic employee injury reporting system from 10/2020 to 11/2021 to evaluate prevalence of institutional OSHA-recordable SNSIs. The cross-sectional survey phase consisted of an anonymous 35-item paper survey distributed to nurses and physician residents.

2.1 Retrospective phase

The retrospective SNSI data consisted of SNSI events among nurses and physician residents that were recorded in an electronic employee health database known as Readyset from 10/2020 to 11/2021 and de-identified to protect employee anonymity. Readyset is an electronic health database through which employees, including nurses and physician residents, report all institutional workplace injuries. The database logs variables including date and time of injury, location of injury, department or division, job title, hire date, needle type, and activity upon occurrence.

Crude injury rates were calculated using Readyset numerator data and denominator data from the institutional human resources department. The following denominator data were obtained from the human resources department: total number of nurse and physician resident hours worked and number of nurses and physician residents at risk. Physician residents were divided into either surgical or non-surgical categories. Non-parametric statistical tests then were performed using the program R.

2.2 Cross-sectional survey phase

2.2.1 *Instrumentation*

An anonymous 35-item 2-page paper survey was generated to assess contributing factors related to SNSI, lifetime injury prevalence, and injury non-reporting among physician residents and nurses. In addition to a comprehensive literature review, a five-member expert panel helped to generate the survey content. This panel consisted of one industrial hygienist, one doctorally prepared occupational health nurse, and three physicians. Members of the panel were experts in the fields of industrial hygiene, ergonomics, occupational health nursing, and medicine and helped with the literature review.

The cross-sectional survey addressed the background of each nurse or physician resident respondent regarding: gender, race, position, level of training, and specialty. The survey then asked whether the respondent experienced a SNSI in the last 12 months, how many, and if they had reported it. Among the examined factors were division of SNSI by type of needle, contributing factors to the injury, shift length during most recent injury, intended task, and if applicable, reasons for non-reporting of the injury. Likewise, needle recapping also was addressed in the survey as it is a known risk factor for SNSI.[9]

2.2.2 *Procedures*

Surveys were solicited through the Graduate Medical Education Office at monthly physician resident lunches and annual physician resident in-service exams. The respondents placed the completed paper surveys into opaque envelopes and then deposited them into locked boxes placed in each department's mailroom. Respondents were asked to submit the survey regardless of survey completion.

2.3 Data analysis

Physician residents were divided by surgical and non-surgical specialty. OSHA-recordable SNSI injury data were queried

on ReadySet and then imported into Microsoft Excel. Individual employee identifiers were removed, Crude rates were calculated by obtaining human resources department data for the corresponding 2020-21 fiscal year. Crude rates were calculated for SNSIs among nurses and physician residents.

2.4 Ethical considerations

Review of de-identified OSHA-recordable employee injury records and solicitation of an anonymous paper survey were conducted following approval by the Institutional Review Board under University of Cincinnati IRB #2022-0364. Waiver of signed consent document was approved.

3. Results

3.1 Retrospective phase

Nurses and physician residents made up 33% and 54% of all 138 reported institutional SNSIs, respectively. The crude SNSI rate for nurses was 3.2 SNSIs/100 nurses/year and for physician residents was 11 SNSIs/100 physician residents/year (see Table 1). When adjusted per hours worked, nurses had a rate of 2 SNSIs/100,000 hours whereas residents had a rate of 4 SNSIs/100,000 hours.

Table 1. Crude institutional SNSI rates for nurses and resident physicians

Variable	Nurses	Physician Residents
Total number	1,801	579
Total hours worked	2,943,784	1 437,081
Recorded SNSI events	58	64
Number SNSI per 100,000 hours worked	2	4
Number SNSI per 100 persons	3.2	11

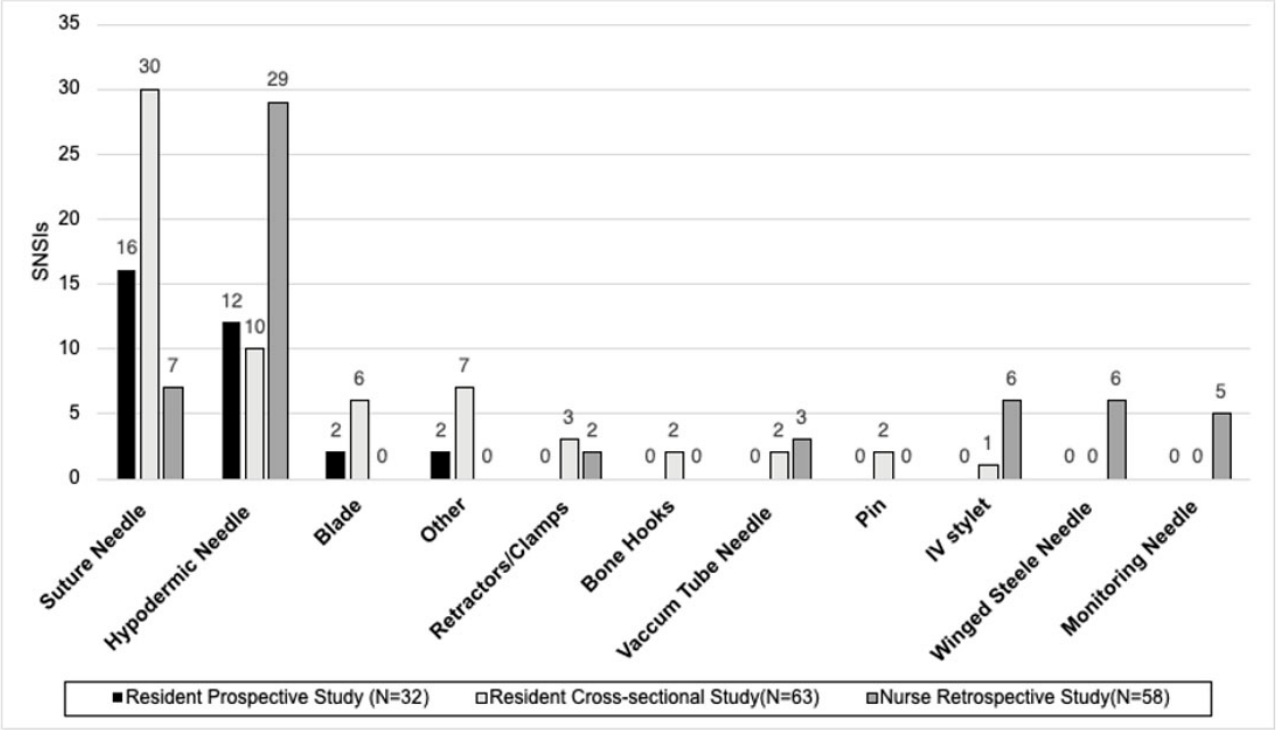

Figure 1. Instrument use and SNSI among physician residents and nurses figNoteThe greatest number of SNSIs among physician residents occurred due to suture needles. Most SNSIs among nurses were associated with use of hypodermic needles followed by suture needles

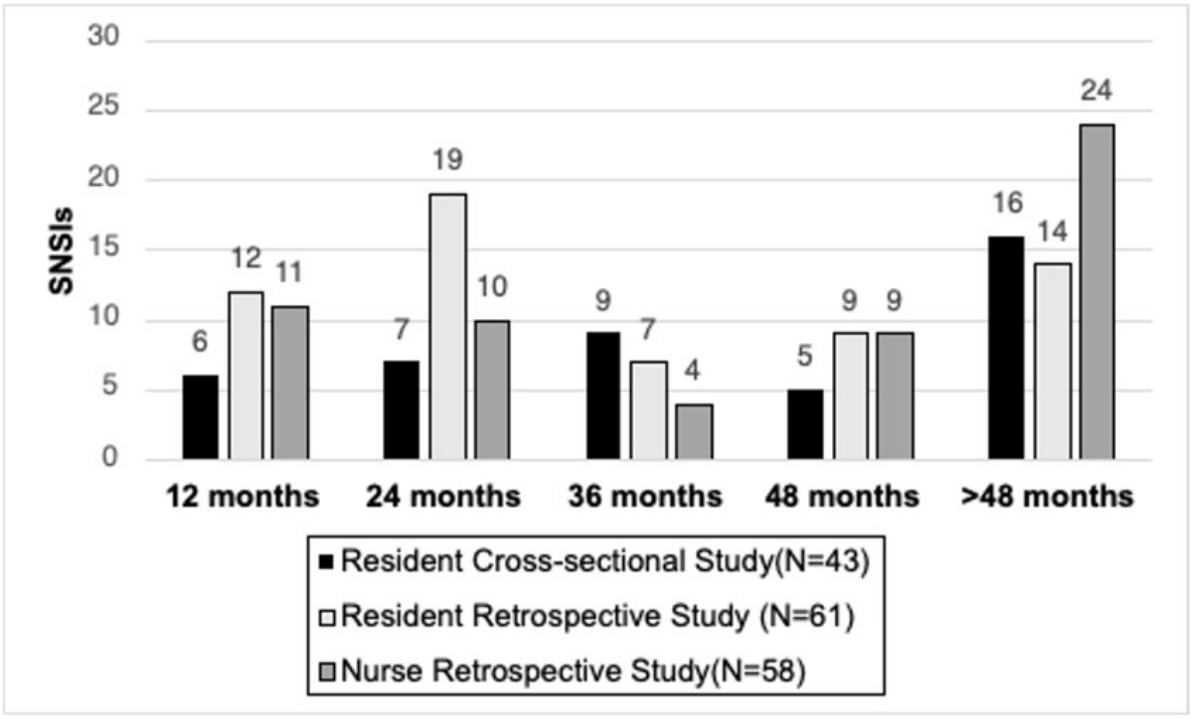

Figure 2. SNSIs among physician residents and nurses compared by date of employment initiation figNoteSNSIs among physician residents peaked at 24 months and 48+ months following the date of employment. Among nurses, SNSIs peaked at 48+ months

Table 2. Retrospective phase: SNSI rate by physician resident specialty

Specialty	Rate	95% CI	*p*-value
Aggregate resident rate	0.11	-	-
Otolaryngology	0.58	0.330-0.800	< .0001
Neurosurgery	0.38	0.140-0.680	.01
OB/GYN	0.30	0.160-0.470	.002
Ophthalmology	0.21	0.050-0.510	.20
General Surgery	0.20	0.110-0.310	.02
Orthopedics	0.20	0.08-0.390	.13
Podiatry	0.14	0.004-0.580	.56
Emergency Medicine	0.10	0.040-0.210	1.00
Urology	0.10	0.002-0.450	1.00
Dermatology	0.09	0.002-0.410	1.00
Pathology	0.07	0.002-0.340	1.00
Radiology	0.03	0.001-0.140	.18
Anesthesia	0.03	0.001-0.140	.12
Internal Medicine	0.004	0.0001-0.030	< .0001

Among physician residents, those in a surgical specialty had a significantly higher number of recorded SNSIs. A surgical physician resident specialty was defined to include: general surgery, orthopedics, otolaryngology (ENT), obstetrics and gynecology (OB/GYN), podiatry, ophthalmology, urology or neurosurgery. Physician residents were most likely to be injured by a suture needle or hypodermic needle during work (see Figure 1). Suture needles made up 47% of all recorded injuries in the retrospective study. Among residents in a surgical specialty, those in general surgery, otolaryngology (ENT), OB/GYN and neurosurgery carried the greatest burden of SNSI. Physician residents' SNSIs peaked at 24 months following the start of employment and then again at greater than 48 months after the start of employment (see Figure 2). Otolaryngology or ENT recorded the highest rate of SNSI at 58 SNSIs/100 physician residents/year when rate of injury was evaluated for each individual specialty (see Table 2). Neurosurgery, OB/GYN, and general surgery likewise had rates significantly higher than the aggregate resident rate (0.11).

Among nurses, hypodermic needles accounted for 50% of all SNSIs followed by suture needles and IV stylets. Most SNSIs occurred during two shift blocks: 6 am to noon and noon to 6 pm. Medical and surgical wards (31%), followed by the operating room (20%) and intensive care unit (17%) accounted for the greatest number of SNSIs (see Figure 3). Nurses who were more than 48 months from the date of hire carried the greatest burden of SNSI.

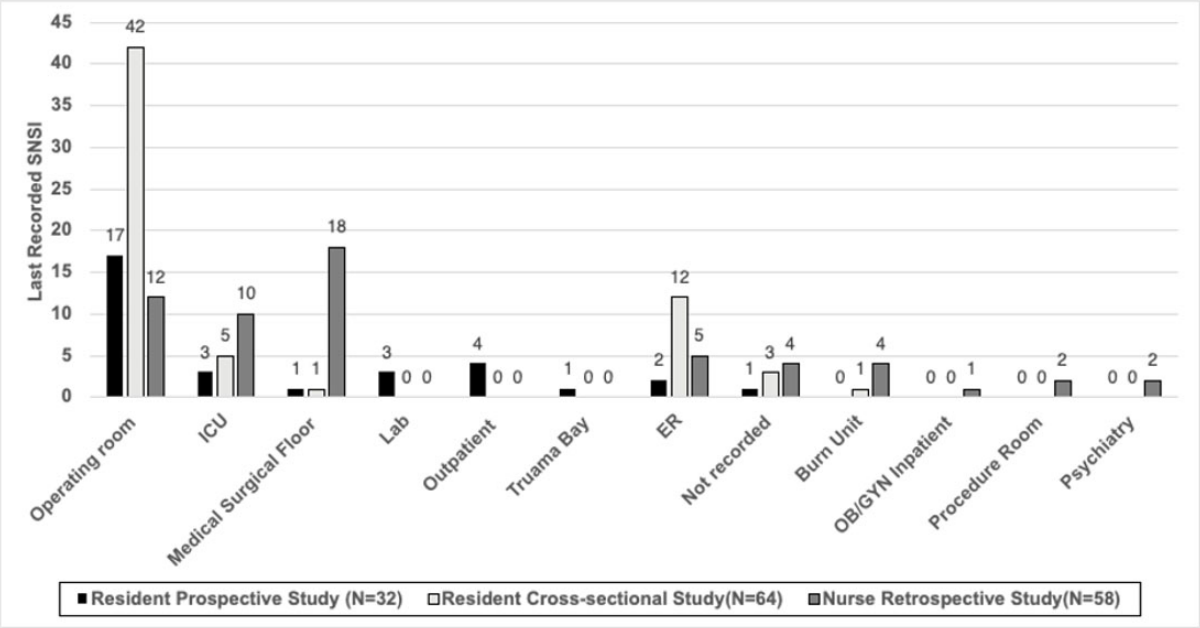

Figure 3. Most SNSIs among resident physicians occurred in the operating room according to the cross-sectional survey followed by the outpatient setting figNoteAmong nurses, most SNSIs occurred in the medical surgical ward (31%) followed by the operating room (21%)

Table 3. Descriptive findings from cross-sectional survey phase with physician residents (N = 76)

Variable	Frequency	Percentage
Biological sex*		
Male	21	61.8
Female	13	38.2
Current postgraduate year training level**		
1	6	14
2	7	16.3
3	9	20.9
4	5	11.6
5	4	9.3
6	7	16.3
7	4	9.3
8	1	2.3
Specialty***		
General surgery	22	46.8
Internal medicine	8	17
Anesthesia	5	10.6
Neurology	3	6.4
Pathology	3	6.4
ENT	2	4.3
Psychiatry	2	4.3
Radiation oncology	1	2.1
Radiology	1	2.1
Total career sharp/needlestick injury	73	96.1
Instrument/device (n = 32)		
Suture needle	16	50
Hollow-bore needle	12	37.5
Blade	2	6.3
Glass shard	1	3.1
Not recorded	1	3.1

Note. * Missing data for 42 participants; ** missing data for 33 participants; *** missing data for 29 participants

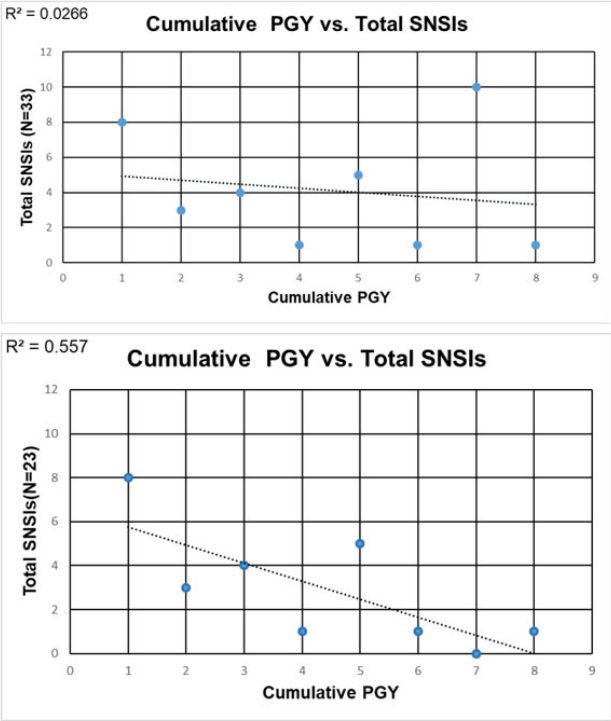

Figure 4. Cumulative postgraduate training year and total recorded SNSIs among physician residents. (4a) There is a weak negative association between cumulative postgraduate year and number of SNSIs (R^2 = 0.027). (4b) When a single physician resident with 10 SNSIs is removed, it increases (R^2 = 0.48)

3.2 Cross-sectional phase

In the cross-sectional survey (N = 76), 96.1% (N = 73) of physician resident respondents reported a history of a SNSI during their career (see Table 3). Among those with a prior history of injury, general surgery physician residents accounted for the highest number of SNSIs, followed by anesthesia and internal medicine. When plotting cumulative postgraduate resident training as the independent variable and SNSIs as the dependent variable; there is a weak negative association (see Figures 4a & 4b). As cumulative postgraduate training increases, the number of recorded SNSIs decreases. Among physician residents, 38% reported having recapped a hollow-bore hypodermic needle during the preceding 12 months. Among the physician residents with a prior history of a SNSI, most occurred while working a 12-hour shift. Some (16%) of the physician resident respondents also indicated they were fearful that reporting the SNSI would reflect poorly on their perceived performance. Finally, among physician residents, 41% of respondents who had a previous SNSI indicated that they had not reported it.

4. Discussion

SNSIs among physician residents in the operating room constitute a persistent occupational health challenge. Several important findings were noted from our retrospective and cross-sectional studies. First, physician residents carry a greater burden of SNSIs compared to their nursing counterparts. Physician residents had a three-fold higher rate of SNSI compared to nurses. Likewise, when compared to NaSH CDC surveillance data, the physician resident rate is more than threefold higher than the national average reported for physicians (2 SNSIs/100 physicians per year).[1] In contrast, the rate of SNSI among nurses was found to be lower than the reported NaSH rate of 9 SNSIs/100 nurses per year.

Several factors were identified that contributed to the observed increased rate of SNSIs among physician residents. A significant factor was, in part, the result of them being in training. Procedural tasks are delegated to physician residents because they seek to undertake more procedures (i.e., central line placement, suturing, and peripheral intravenous line placement) in order to become more competent in the procedural tasks enumerated by their training programs. Physician residents' dedication to their learning is noteworthy. However, it is possible that the tasks are delegated to physician residents without adequate oversight to assure their safety while performing new tasks. As postgraduate training experience increased among the physician residents, there was a corresponding linear decrease in the number of SNSIs. This relationship reflects that over time the physician residents are becoming more competent and have learned to safely handle sharps and needles. It is important to note that enhanced prevention efforts are needed to prevent these early career SNSIs. Closer and direct observation of physician residents by attending physicians or even potentially nurses and surgical assistants as sharps and needles are being used may be warranted to prevent inadvertent SNSIs.

A second contributing factor to SNSIs among physician residents was their subspecialty. Surgical subspecialties carried the greater burden of SNSI among physician residents. Surgical residents, especially those in ENT, OB/GYN, neurosurgery, and general surgery had a significantly higher rate of injury than the overall physician resident crude rate. Surgical residents spend a larger portion of their working time in the operating room where they are more likely to come in contact with disposable suture needles during surgical procedures. Redesigning the procedures for management of sharps and needles when physician residents (and others in the operating room environment) are done with them could be considered. For example, a cork be added to suture trays and as a procedure such as suturing is nearly complete, the surgical assistant could remind the person conducting the

suture placement to drive the suture needle into the cord to minimize the risk of a SNSI. The cork becomes a much more visible identifier of a sharp or needle location. Hypodermic needle recapping is likewise a persistent problem. To prevent a recapping injury, a clean conical tube can be placed on instrument trays such as a needle or scalpel can be placed into the tube until it is ready for disposal.[10] Of utmost importance is that attending physicians model and reiterate safety practices as they personally handle sharps and needles.

Of concern, the rate of non-reporting of SNSIs among physician residents is 41 SNSIs/100 physician residents per year, higher than the healthcare worker average (which includes nurses, medical assistants, physicians, and physician residents) reported in the literature.[7] Furthermore, in the cross-sectional survey phase, 16% of physician resident respondents were fearful that reporting a SNSI would reflect poorly on their performance. All in all, the observed trends are consistent with the persistent nature of these occupational injuries among the physician resident worker population and support the need to address any misconceptions about reporting on a systems level. To promote a culture of reporting, attending physicians can discuss their own experiences with suffering from a SNSI during the course of their career, describe the importance of reporting injuries as they occur, and assuring physician residents that they will not be penalized for experiencing or reporting a SNSI.

Limitations

Despite the cross-sectional survey being anonymous, one limitation is survey bias; specifically, response bias. This bias is related to respondent hesitancy to answer truthfully about non-reporting of SNSIs and fear of perceived retaliation given that the survey is conducted in an occupational setting. Furthermore, the rates obtained from the retrospective phase rely on passive surveillance through employee self-report of injury. As is the case with the majority of reportable infectious diseases, passive surveillance is often associated with underreporting.[11] Underreporting also can result from the lack of awareness of reporting procedures and negative worker attitudes towards injury reporting.[11]

5. Conclusions

Our work supports the need to implement interventions that focus on the use of different sharps instruments on medical/surgical floors versus the operating room, as sharps hazards present in the operating room warrant correspondingly different interventions and analyses.

The operating room environment is complex and involves an interplay of multiple workers handling sharps instruments including: physician residents, attending surgeons, and surgical assistants. Patient positioning, operator posture, and instrument hand off techniques during surgeries coalesce to create a complex occupational environment that creates different drivers of SNSI than those present on a medical/surgical floor. An ergonomic analysis of SNSIs in the operating room could delineate drivers of injury among surgical physician residents.

Acknowledgements

We would like to acknowledge MB Rao, PhD; Kelley Crandell, MS; Andrew Freeman, MD; Lauri Heck, RN; and Ericka Purtee, MSN, RN for critical review of this work.

Authors contributions

Alexei Krainev: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing. Wali Jahangiri: Conceptualization, Formal Analysis, Investigation, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing. Sofia Villaveces: Conceptualization, Formal Analysis, Investigation, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing. Hannah Phipps: Conceptualization, Formal Analysis, Investigation, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing. Victoria Wulsin: Conceptualization, Methodology, Resources, Supervision, Writing – Review & Editing. Kermit G. Davis: Conceptualization, Funding Acquisition, Methodology, Project Administration, Resources, Supervision, Validation, Writing – Review & Editing. Gordon Lee Gillespie: Conceptualization, Methodology, Supervision, Writing – Review & Editing.

Funding

The study was supported by the National Institute for Occupational Safety and Health through the Pilot Research Project Training Program of the University of Cincinnati Education and Research Center Grant #T42OH008432.

Conflicts of Interest Disclosure

The authors declare they have no conflicts of interest.

Informed consent

Physician resident respondents provided informed consent for participating in the cross-sectional survey phase. A waiver of signed consent was approved by the IRB for this phase. Because data were anonymous for the retrospective phase, no interaction took place with nurses and physician residents from this phase.

ETHICS APPROVAL

The Publication Ethics Committee of the Association for Health Sciences and Education. The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

PROVENANCE AND PEER REVIEW

Not commissioned; externally double-blind peer reviewed.

DATA AVAILABILITY STATEMENT

Due to facility restrictions, the data are not available.

DATA SHARING STATEMENT

The study respondents did not give consent for their data to be shared publicly, therefore, the data are not available for sharing.

OPEN ACCESS

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (http://creativecommons.org/licenses/by/4.0/).

COPYRIGHTS

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

REFERENCES

[1] U.S. Centers for Disease Control and Prevention. Sharps safety program resources. 2024. Accessed January 26, 2025. Available from: https://www.cdc.gov/sharpssafety/index.html

[2] U.S. National Institute for Occupational Safety and Health. ALERT: Preventing needlestick injuries in health care settings. DHHS (NIOSH) Publication No. 2000-108. 1999. Accessed January 26, 2025. Available from: https://www.cdc.gov/niosh/docs/2000-108/pdfs/2000-108.pdf?id=10.%2026616/NIOSHPU/B2000108

[3] Mannocci A, De Carli G, Di Bari V, et al. How much do needlestick injuries cost? A systematic review of the economic evaluations of needlestick and sharps injuries among healthcare personnel. Infect Control Hosp Epidemiol. 2016; 37(6): 635-646. PMid: 27022671. https://doi.org/10.1017/ice.2016.48

[4] 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(11): e0224142. PMid: 31697746. https://doi.org/10.1371/journal.pone.0224142

[5] Rapiti E, Prüss-Üstün A, Hutin Y. Sharps injuries: Assessing the burden of disease from sharps injuries to health-care workers at national and local levels. World Health Organization. Environmental Burden of Disease Series. 2005; 11: 1-58. Accessed January 26, 2025. Available from: https://iris.who.int/bitstream/handle/10665/43051/924159232X.pdf?sequence=1

[6] Massachusetts Department of Health. Data brief: Sharps injuries among hospital workers in Massachusetts: Findings from the Massachusetts Sharps Injury Surveillance System, 2020. 2022. Accessed January 26, 2025. Available from: https://www.mass.gov/doc/sharps-injuries-among-hospital-workers-in-massachusetts-2020/download

[7] Lee JM, Botteman MF, Xanthakos N, et al. Needlestick injuries in the United States: Epidemiologic, economic, and quality of life issues. AAOHN J. 2005; 53(3): 117-133. PMid: 15789967. https://doi.org/10.1177/216507990505300311

[8] Makary MA, Al-Attar A, Holzmueller CG, et al. Needlestick injuries among surgeons in training. N Engl J Med. 2007; 356(26): 2693-2699. PMid: 17596603. https://doi.org/10.1056/nejmoa070378

[9] Mengistu DA, Tolera ST. Prevalence of occupational exposure to needle-stick injury and associated factors among healthcare workers of developing countries: Systematic review. J Occup Health. 2020; 62(1): e12179. PMid: 33314610. https://doi.org/10.1002/1348-9585.12179

[10] University of Michigan. Safety needle guide. 2017. Available from: https://ehs.umich.edu/wp-content/uploads/2017/10/Safe-Needle-Guide.pdf

[11] U.S. National Institute for Occupational Safety and Health. Needlestick injuries are preventable. 2021. Accessed January 26, 2025. Available from: https://archive.cdc.gov/#/details?q=Needlestick%20%20injuries%20are%20preventable&start=0&rows=10&url=https://www.cdc.gov/niosh/newsroom/feature/needlestick_disposal.html