

NEEDLESTICK INJURIES AND THE USE OF SAFETY SYRINGES IN THE PREVENTION OF OCCUPATIONAL BLOODBORNE DISEASES: A SYSTEMATIC REVIEW

Felicidade Niquice¹; J. Santos Baptista²; J. Mohsin Sidat³

¹ Provincial Hospital of Inhambane, Faculty of Engineering, University of Porto, Portugal; felicidade.niquice@gmail.com; ORCID 0000 0002 7985 01922.

² Associated Laboratory for Energy, Transports and Aerinautic, LAETA (PROA), Faculty of Engineering, University of Porto, Portugal; jsbap@fe.up.pt; ORCID 0000 0002 8524 5503.

³ Associate Professor of the Faculty of Medicine, University Eduardo Mondlane, Mozambique; mmsidat@gmail.com.

Abstract

According to the World Health Organization, about 3 million of the 35 million healthcare workers (HCW) are exposed to needlestick injuries (NSI) annually. Needlestick injuries prevention is essential among healthcare workers. However, the first step in planning to prevent needlestick is determining their actual prevalence rate, which is difficult due to a range of factors, including predominantly voluntary reporting, lack of common denominators, scarcity, and national surveillance systems injury underreporting. **Objective:** This study aimed to determine the prevalence of needlestick injuries among HCWs and the impact of the safety-engineered devices in reducing the majority of needlestick injuries. Determining the prevalence and causes of needlestick injuries may enable NSI injuries rate reduction, create safer work environments and safety cultures, reduce turnover rate, reduce costs, and ultimately provide higher quality services among healthcare workers. **Method:** The study was conducted from April to June 2021. The method of reporting the present study was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement. **Results:** The prevalence of needlestick injuries in HCWs was reported in the previous 12 months to be between 5.6% and 94.5%, and career time to be between 36.4% and 81.99%, where the lowest prevalence is observed in studies in High-Income countries. **Conclusion:** The results indicate a high global prevalence of NSIs among HCWs. The high prevalence of NSIs, despite existing strategies, suggests the inadequacy of current management strategies or the lack of adequate adherence to available standard precautions to prevent NSIs.

Keywords: Sharps injuries, Safety-engineered syringes, Healthcare workers.

Introduction

Needlestick and sharp injuries (NSSIs) are among the most critical occupational hazards among healthcare workers (HCWs) globally. According to the Centers for Disease Control and Prevention (CDC) and European Agency for Safety and Health at Work (EU-OSHA) reports in 2012 and 2013, there were more than 385,000 and 1,000,000 needlestick injuries cases annually among hospital healthcare workers in the United States and Europe, respectively (CDC, 2012) (Himmelreich et al., 2013).

The prevalence of various infectious diseases due to NSIs among HCWs is not a single, and integrated phenomenon somewhat is affected by several factors, such as:

- vaccination rates among healthcare workers,
- access to appropriate worker protection equipment,
- post-exposure prophylaxis (PEP),
- compliance with precautionary infection control standards.

Additionally, the prevalence of needlestick injuries (NSIs) is not the same among all HCWs, and NSIs occur more frequently among nurses, surgeons, and emergency personnel (Alhazmi et al., 2017).

Injuries from sharps contaminated with an infected patient's blood can transmit more than 20 diseases, including Hepatitis B (HBV), Hepatitis C (HCV), and Human Immunodeficiency Virus (HIV). Worldwide, 25% of HBV and HCV infections and 2.5% of HIV infections occur among healthcare workers due to needlestick injuries (Roos et al., 2017).

According to the World Health Organization, about 3 million of the 35 million healthcare workers are exposed to needlestick injuries annually. These infections will lead to a burden of 9.18 million disability-adjusted life years (DALYs) between 2000 and 2030 (Bouya et al., 2020).

NSI prevention is essential among healthcare workers. The first step in planning to prevent needlestick injuries is to determine their actual prevalence rate, which is difficult due to a range of factors, including predominantly voluntary reporting, lack of common denominators, lack of national surveillance systems, and suspected frequency of injury underreporting.

Despite the importance of this issue and individual studies, there are currently no accurate statistics on the global prevalence of NSIs among HCWs, especially in developing and less developed countries. Existing statistics are mainly published at the national level and are relevant to a limited number of developed countries (Akazong et al., 2020).

A study conducted in the United States in 2017 referred to NSI as the leading cause of percutaneous injuries in more than 71% of reported cases among HCWs. Moreover, the results of annual surveys, even in developed countries such as the United States, have shown that despite the different strategies implemented, there is still an increasing incidence of NSIs among HCWs (Grimmond, 2014).

The World Health Organization has recommended that by 2020 all countries adopt safety injection devices and instruct governments to transition to their exclusive use.

Safety engineering of medical devices is one of the most robust methods to improve safety and has been shown to reduce iatrogenic injuries to patients and needlesticks to healthcare workers (Sibbitt et al., 2011).

These encompass safety phlebotomy needles (retractable needle or shielding), safety cannulae (stylets blunted on removal), safety scalpels and needles, and syringes used for intramuscular and subcutaneous injections, which include syringes with needle guards, syringes with a needle sheath and fixed-needle, auto-retractable safety syringes; all are designed to protect the user from being injured with a needle (Higginson & Parry, 2013).

Fixed-needle, auto-retractable safety syringes are indicated for various clinical reasons, including infection control and staff and patient safety (Zhang et al., 2020).

Previous reviews have examined the prevalence of NSIs only in a specific ward or only at the national level (Pakistan and Iran) or have investigated needlestick-related prevention and cost burden dimensions (Hassanipour et al., 2021).

To the best of our knowledge, there have been very few specific studies on the global prevalence of needlestick injuries so far.

This study aimed to determine the prevalence of needlestick among healthcare workers and the impact of the safety-engineered devices in reducing the prevalence of needlestick injuries.

Determining the prevalence and causes of needlestick may enable needlestick rate reduction, create safer work environments and safety cultures, reduce turnover rate, reduce costs, and ultimately provide higher quality services among healthcare workers.

Methods

The present study is a systematic review of the needlestick injuries and their relationship with safety-engineered needles. The study was conducted from April to June 2021. The method of reporting the present study was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement.

Search strategy

Five databases (PubMed, Scopus, Web of Science, Oxford Journals, and SpringerLink) were searched (April 1 to June 15, 2021). A combination of Boolean operator (AND, OR) Medical subjects Headings (MeSH), Truncations “related keywords were used to search the articles. The search keywords included needlestick or needlestick injury, injuries, injur*, safety needles, healthcare workers (supplementary table1).

Table 1. Supplementary

| A | B | C |
|----------------------|-----------------|----------------------|
| Needlestick injuries | Safety Syringes | Healthcare workers |
| Needlestick injuries | Safety needles | Healthcare personnel |
| Needlestick injur* | | HCW |
| Needle-stick injur* | | Physician, Nurses |

Eligibility criteria

Observational studies (cross-sectional), cohort, and retrospective studies published in peer-reviewed journals from January 2016 to June 2021, conducted on healthcare workers, carried out on at least 95 people, were included in the survey (summary of studies included table 2). In addition, studies that aimed to determine the prevalence and causes of NSIs in at least one healthcare group over the past five years were included. The latest search on databases was performed on June 15, 2021. HCWs in this study are all employees who work in the healthcare system and are exposed to NSIs. HCWs included physicians, nurses, nursing and medical

students, and other health team members such as cleaning staff and laboratory staff. Exclusion criteria included studies published in a non-English language before 2016. Studies that reviewed the prevalence of needlestick among patients were excluded. Reviews, letters to the editor, high-risk studies, short reports, and non-full text studies were also excluded.

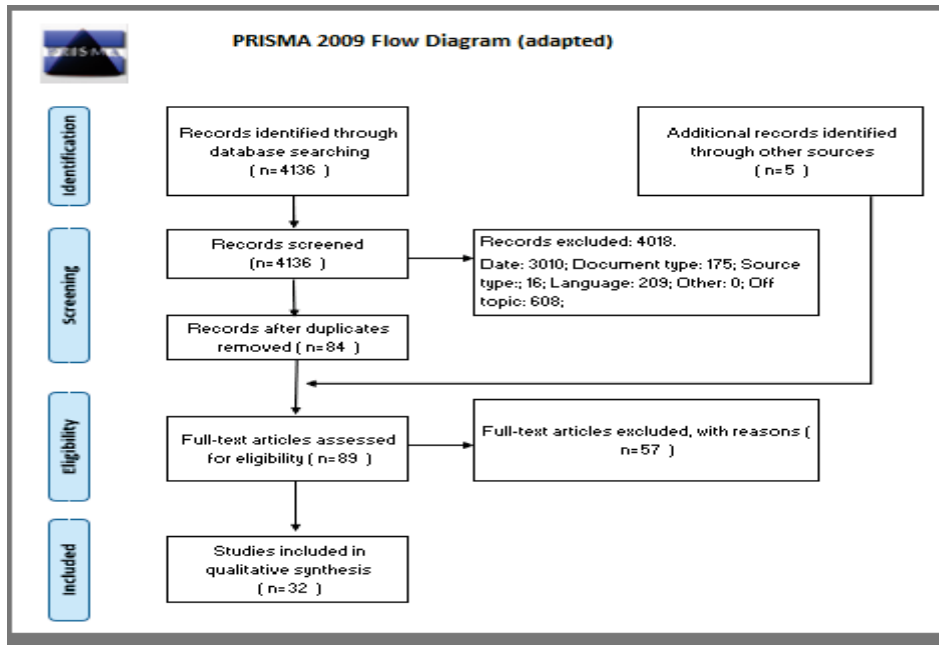


Figura 1. Flow diagram of the systematic review

Table 2. Summary of included studies

| Author, Year | Title | Country | Type of study | Sample size |
|----------------------------------|---|------------------------|-----------------------|-------------|
| Sakr, Carine, et al., 2021 | Occupational exposure to bloodborne pathogens among healthcare workers in a Tertiary care centre in Lebanon | Lebanon | Cross-sectional study | 967* |
| Dulon, Madeleine, et al., 2020 | Causes of needlestick and sharp injuries when using devices with and without safety features | Germany | Cross-sectional study | 835 |
| Akpuh, Ndubuisi, et al., 2020 | Occupational exposure to HIV among healthcare workers in PMTCT sites in Port Harcourt, Nigeria | Nigeria | Cross-sectional study | 337 |
| Hussain, Asfa, 2020 | Awareness about sharps disposal leads to significant improvement in healthcare safety: an audit compliance in the National Health Service during the Covid-19 Pandemic | United Kingdom | Cross-sectional study | 225** |
| Yuniastuti, Evy, et al., 2020 | Needlestick and sharp injuries in an Indonesian tertiary teaching hospital from 2014 to 2017: a cohort study | Indonesia | Cohort Study | 7760 |
| Basie, Getaw, 2020 | Factors associated with needlestick and sharp injuries among healthcare workers in Northeast Ethiopia | Ethiopia | Cross-sectional study | 337 |
| Düzgöl, Mine, et al., 2020 | Risks groups for needlestick injury among healthcare workers in Children's Hospital: a cross-sectional study | Turkey | Cross-sectional study | 249 |
| Ganczak, Maria, et al., 2019 | Frequency of occupational bloodborne infections and sharp injuries among polish paramedics from selected ambulance stations | Poland | Cross-sectional Study | 286 |
| Weldesamuel, Elias, et al., 2019 | Assessment of needlestick and sharp injuries among healthcare workers in central zone of Tigray, Ethiopia | Ethiopia | Cross-sectional study | 444 |
| Ottino, Maria, et al., 2019 | Needlestick prevention devices: data from hospital surveillance in Piedmont, Italy - comprehensive analysis on needlestick injuries between healthcare workers after the introduction of safety devices | Italy | Cross-sectional study | 1640* |
| Hang, Pham TT, et al., 2019 | Knowledge, attitudes, and medical practice regarding hepatitis B prevention and management among healthcare workers in Northern Vietnam | Vietnam | Cross-sectional study | 314 |
| AlDakhil, Lama, et al., 2019 | Prevalence and associated factors for needlestick and sharp injuries (NSIs) among dental assists in Jeddah, Saudi Arabia | Saudi Arabia | Cross-sectional study | 450 |
| Yazie, Teshiwal, et al., 2019 | Knowledge, attitude, and practice of healthcare professionals regarding infection prevention at Gondar University referral hospital, northwest Ethiopia: a cross-sectional study | Ethiopia | Cross-sectional study | 282 |
| Aigbodion, Sunday, 2019 | Occupational blood and body fluids exposures and human immunodeficiency virus post-exposure prophylaxis amongst intern doctors | South Africa | Cross-sectional study | 175 |
| Wahab, Abdullah, et al., 2019 | Occupational sharp injury among healthcare workers in Hospital Melaka 2013 - 2015: a cross-sectional study | Malaysia | Cross-sectional study | 165 |
| Anwar, Manal, et al., 2019 | Safe injection awareness and practices among nursing staff in an Egyptian and a Saudi Hospital | Egypt and Saudi Arabia | Cross-sectional Study | 500 |
| Ishak, A. et al., 2019 | Needlestick injuries among Malaysian healthcare workers | Malaysia | Cross-sectional study | 1234* |

| | | | | |
|--------------------------------------|---|-------------|-----------------------|--------|
| Ong, M. et al., 2019 | Knowledge, attitudes, and behaviour towards needlestick injuries among junior doctors | Singapore | Cross-sectional study | 95 |
| Saadeh, Rami, et al., 2018 | Needlestick and sharp injuries among healthcare workers | Jordan | Retrospective Study | 393* |
| Ongete, George, et al., 2018 | The impact of splash, sharps, and needlestick injuries (SSNSIs) on the quality of life of healthcare workers in a Kenyan university hospital | Kenya | Cross-sectional study | 416 |
| Ditching, Nelson, et al., 2018 | Factors associated with nursing student's intention to report needlestick injuries: Applying the theory of planned behaviour | Philippines | Cross-sectional study | 233 |
| Cui, Zhuo, et al., 2018 | Sharp injuries: a cross-sectional study among healthcare workers in a provincial teaching hospital in China | China | Cross-sectional study | 901 |
| Alhazmi, Riyadh, et al., 2018 | Needlestick injuries among Emergency Medical Services providers in Urban and Rural areas | USA | Cross-sectional study | 181*** |
| Kimaro, Lucina, et al., 2018 | Prevalence of occupational injuries and knowledge of availability and utilisation of post-exposure prophylaxis among healthcare workers in Singida District Council, Singida Region, Tanzania | Tanzania | Cross-sectional study | 239 |
| Akagbo, Sandra, et al., 2017 | Knowledge of standard precautions and barriers to compliance among healthcare workers in the Lower Manya Krobo District, Ghana | Ghana | Cross-sectional study | 100 |
| Lee, Ju, et al., 2017 | Occupational blood exposures in healthcare workers: incidence, characteristics, and transmission of bloodborne pathogens in South Korea | South Korea | Cohort Study | 10452 |
| Dulon, Madeleine, et al., 2017 | Causes of needlestick injuries in three healthcare settings: Analysis of accident notifications registered six months after implementation of EU Directive 2010/32/EU in Germany | Germany | Cross-sectional study | 533 |
| Huang, Sheng-Li, et al., 2017 | Sharp instruments injuries among hospital healthcare workers in mainland China: a cross-sectional study | China | Cross-sectional study | 223149 |
| Kebede, Awoke, et al., 2016 | Prevalence of needlestick injury its associated factors among nurses working in public hospitals of Dessie town, Northeast Ethiopia | Ethiopia | Cross-sectional study | 258 |
| Nouetchognou, Julienne, et al., 2016 | Accidental exposures to blood and body fluid among healthcare workers in a Referral Hospital of Cameroon | Cameroon | Cross-sectional study | 150 |
| Aluko, Olufemi, et al., 2016 | Knowledge, attitudes, and perceptions of occupational hazards and safety practices in Nigerian healthcare workers | Nigeria | Cross-sectional study | 290 |
| Türe, Zeynep, et al., 2016 | Predictive factors for percutaneous and mucocutaneous exposure among healthcare workers in a developing country | Turkey | Retrospective design | 331 |

*Sample size was determined by the number of injuries and not healthcare workers

**Sample size was sharp disposal bins

***Sample size was hospitals surveille

Results

Study selection

A total of 4136 articles were retrieved from searches in five databases. Out of 4018 excluded studies, 3010 were out of the date determined for the review. One hundred and seventy-five studies were reviews, letters to the editor, brief reports. Two hundred and nine studies were published in a non-English language, and 608 studies were off-topic. Seventy-four studies did not meet the minimum overall quality requirements for inclusion in the study. Out of 89 studies, 32 met eligibility criteria and were included for analysis.

Studies characteristics

In the 32 eligible studies included a total of 249023 healthcare workers participated in studies. The countries where the studies were conducted are Lebanon (Sakr, Carine, et al., 2021), Germany (M. Dulon et al., 2017) (Madeleine Dulon et al., 2020), Poland (Ganczak et al., 2021), United Kingdom (Hussain et al., 2020), Jordan (Saadeh, Rami, et al. 2018), Indonesia (Yunihastuti, Evy, et al. 2017), Egypt (Anwar et al., 2019), Saudi Arabia (Anwar et al., 2019) (Aldakhil et al., 2019), Netherlands (Schuurmans et al., 2018), Tanzania (Kimaro et al., 2018), Turkey (Türe et al., 2016), USA (Alhazmi et al., 2017), South Africa (Aigbodion, Sunday, et al. 2017, Jager, P. et al. 2018), Malaysia (Wahab, Abdullah, et al. 2016), Singapore (Ong et al., 2019), Ethiopia (Kebede & Gerensea, 2018) (Weldesamuel et al., 2019) (Yazie et al., 2019) (Basie, Getaw, et al. 2018), Cameroon (Nouetchognou et al., 2016), Nigeria Akpuh et al., 2020, Aluko et al., 2016), South Korea Lee et al., 2017), Philippines (Ditching, Nelson. et al. 2018), USA (Alhazmi et al., 2018) and China (Cui et al., 2018) (Huang, Sheng-Li, et al., 2017). Most studies were conducted in Low and Middle-Income countries (18), and six in High-Income countries (7).

In this review, needlestick injuries data were extracted from eight groups of HCWs, including doctors, nurses, medical students, nursing students, laboratory technicians, and cleaning staff. Many of the studies included different healthcare workers as the studies population, ranging from doctors to cleaning staff. Only two studies used nurses as a population; one study used paramedics, the other chose nursing students, chose hospitals, and chose dental assistants.

The mean age was 35 years old.

In terms of study design, 28 were cross-sectional studies, two cohorts, and two retrospective studies. Sample sizes range from 95 to 223149 healthcare professionals.

Prevalence of needlestick injuries

The prevalence of needlestick injuries in HCWs was reported in the previous 12 months to be between 5.6% and 94.5%, and career time to be between 36.4% and 81.99%, where the lowest

prevalence is observed in studies in High-Income countries. In the included articles, five articles reported both prevalence of NSI in career time and previous 12 months, while only 3 stated the prevalence in last 12 months.

Of the 32 studies, 20 studies reported needlestick injuries distributed by sex, were 62793 male and the 123230 female HCWs. The prevalence was slightly higher in women than in men.

Among the included studies, all studies reported hollow bore (hypodermic) needle causes for the prevalence of NSIs, of which ten studies reported suture needle, eight reported IV cannula, seven reported lancets, and four reported scalpels.

The emergency department, surgical department, medical ward, operating room, critical care unit and cleaning service were among the most stated settings to have the highest needlestick injuries.

Much of the studies reported that drawing blood, injections, surgical procedure, suturing, and disposal was the most involved with needlestick injuries.

Two studies outlined that the source of patients' bloodborne infections status was unknown primarily (66.5%) by the HCW.

Three studies reported that although the prevalence of NSI was high in their settings, there are still problems with underreporting of NSI among HCW's, indicating that 54.29% and 66.1% did not report. Causes for underreporting include the perception of risk of infection, bureaucracy on filling the papers and being afraid to be found accountable.

One study used sharps disposal containers as a sample and concluded that 60% of HCW who had sharp disposal containers were more likely not to sustain NSI.

Needlestick injuries and safety-engineered devices

Only four studies assessed safety-engineered devices and their relationship with needlestick and sharp injuries.

Following two studies, almost 23% of injuries were SED-related. Fifty per cent of nurses were most exposed to SED-related injuries, as they were exposed to 78% of total SED accidents. Most injuries (47%) occurred with the use of the device. The vast majority (92%) of accidents occurred with SED that requires manual activation of the safety mechanism. Butterflies' needles were the most common security device involved in injuries.

Regarding the training of HCW's regarding the use of the safety devices, two studies stated that specific training was present in 93% and 62% of the cases, respectively.

Discussion

Needlestick injury is one of the significant safety challenges in the healthcare system worldwide.

Thirty-two studies performed on 249023 people from 25 countries were included in the final stage of the analysis. The mean prevalence of NSIs among HCWs was 44.5%. Thus, the results of this study indicate a high prevalence of NSIs among HCWs.

Such a high prevalence can be attributed to demographic characteristics (young age and educational level), history of training on needlestick management.

Although the exact cause for the various prevalence rates in regions is unknown, the lower prevalence in developed regions such as Europe and the United States compared to the other areas of the world may be due to the following: the difference in methodology and the number of studies included from each region in the present study, different rules, different methods and the level of supervision on the measurement of the prevalence of needlestick injury in other areas, the differences in national and regional policies in preventing needlestick injury, and fewer available details on particular prevention programs and annual national surveillance systems in less developed regions.

In developed countries, lower prevalence of NSIs could be due to the existence of comprehensive hospital-level NSI prevention programs, the provision of training courses and the provision of information related to the management of NSIs, incentive systems for reporting NSI cases in hospitals, categorising NSIs as a priority, establishing a preventive perspective on NSIs among HCWs, introducing practical policies including the use of new equipment to reduce NSIs, banning of recapping of needles, and supporting HCWs in the event of NSIs, including tests required, post-exposure prophylaxis (PEP), counselling, rehabilitation and compensation for the financial and psychological damage of the affected person, and creating a safe work environment (De Lima et al., 2015) (Center for Disease Control, 2008).

Several countries, such as the USA, Brazil, Taiwan, UK, Canada, and EU countries, have enacted NSI and safety-engineered devices. Although this has happened, needlestick injuries are still a dilemma in some countries due to deficit enforcement. The use of SED has been reported as one of the reasons why NSI rates are lower in Europe and the United States (Ottino et al., 2019) (Madeleine Dulon et al., 2020)(M. Dulon et al., 2017). Although Schuurmans et al. reported that data collected suggested that the number of NSI has increased after introducing safety-engineered devices (SED), the rise of number is substantially lower than in Low-Middle Income countries (Schuurmans et al., 2018). Previous studies have reported that one reason why safety devices fail to reduce the number of needlestick injuries is a lack of acceptance by healthcare workers if they do not receive a comprehensive training program, which is in line with Ottino et al.

Other studies have examined the problem of under-reporting. There are many possible reasons for under-reporting, which should be analysed to improve the reporting rates. The main reason for not reporting an NSI in our study was that the individual had not considered that the exposure constituted a significant risk and was afraid to be found accountable.

Conclusion

In conclusion, the results indicate a high global prevalence of NSIs among HCWs. The high prevalence of NSIs, despite existing strategies, suggests the inadequacy of current management strategies or the lack of adequate adherence to available standard precautions to prevent NSIs.

Education concerning universal precautions is critical to reducing injuries by sharp medical devices, but education alone has proved inadequate for preventing needlestick injuries.

This study can be used as a basis for planning by health policymakers and healthcare workers. Paying attention to the following items can reduce the NSI rate:

- Applying standard precautions.
- Periodic training to the HCWs on NSIs prevention and correct recapping.
- Develop a long-term NSIs reporting system for better management.
- Creating an appropriate safety and organisational culture among HCWs encourages them to report NSIs cases to the management.
- Establish clear and uniform policies across all hospitals about the management of NSIs.
- Hospital infection control committees should regularly monitor the implementation of standard precautions guidelines.
- Perform periodic verbal and practical tests on staff knowledge, attitude, and performance regarding standard precautions of NSIs.

Needle-protective devices have been investigated and marketed for decades for the task of protecting healthcare workers against deadly bloodborne pathogens from contaminated needles or sharps during patient care. They have not been used worldwide because of economic burden and sophisticated manipulation. The experience of countries with SED legislation tells us that not only is a widespread use of SED required, but continued education in SED use and activation is paramount.

Bibliography

- Akazong, E., Tume, C., Njouom, R., Ayong, L., Fondoh, V., & Kuate, J.-R. (2020). Knowledge, attitude and prevalence of hepatitis B virus among healthcare workers: a cross-sectional, hospital-based study in Bamenda Health District, NWR, Cameroon. *BMJ Open*, 10, 31075. <https://doi.org/10.1136/bmjopen-2019-031075>
- Akpuh, N., Ajayi, I. O., Adebawale, A., Idris Suleiman, H., Nguku, P., Dalhat, M., & Adedire, E. (2020). Occupational exposure to HIV among healthcare workers in PMTCT sites in Port Harcourt, Nigeria. In *BMC Public Health* (Vol. 20, Issue 1). <https://doi.org/10.1186/s12889-020-08528-5>
- Aldakhil, L., Yenugadhati, N., Al-Seraihi, O., & Al-Zoughool, M. (2019). Prevalence and associated factors for needlestick and sharp injuries (NSIs) among dental assistants in Jeddah, Saudi Arabia. In *Environmental Health and Preventive Medicine* (Vol. 24, Issue 1). <https://doi.org/10.1186/s12199-019-0815-7>

- Alhazmi, R. A., David Parker, R., & Wen, S. (2017). Needlestick Injuries Among Emergency Medical Services Providers in Urban and Rural Areas. *Journal of Community Health*, 43, 518–523. <https://doi.org/10.1007/s10900-017-0446-0>
- Alhazmi, R. A., Parker, R. D., & Wen, S. (2018). Needlestick Injuries Among Emergency Medical Services Providers in Urban and Rural Areas. In *Journal of Community Health* (Vol. 43, Issue 3, pp. 518–523). <https://doi.org/10.1007/s10900-017-0446-0>
- Aluko, O. O., Adebayo, A. E., Adebisi, T. F., Ewegbemi, M. K., Abidoye, A. T., & Popoola, B. F. (2016). Knowledge, attitudes and perceptions of occupational hazards and safety practices in Nigerian healthcare workers. In *BMC Research Notes* (Vol. 9, Issue 1). <https://doi.org/10.1186/s13104-016-1880-2>
- Anwar, M. M., Mohamed Lotfy, A. A., & Alrashidy, A. A. (2019). Safe injection awareness and practices among nursing staff in an Egyptian and a Saudi hospital. In *Journal of the Egyptian Public Health Association* (Vol. 94, Issue 1). <https://doi.org/10.1186/s42506-019-0018-5>
- Bouya, S., Balouchi, A., Rafiemanesh, H., Amirshahi, M., Dastres, M., Moghadam, M. P., Behnamfar, N., Shyebak, M., Badakhsh, M., Allahyari, J., Mawali, A. Al, Ebadi, A., Dezhkam, A., & Daley, K. A. (2020). Global prevalence and device related causes of needle stick injuries among health care workers: A systematic review and meta-analysis. *Annals of Global Health*, 86(1), 1–8. <https://doi.org/10.5334/aogh.2698>
- CDC. (2012). Updated CDC Recommendations for the Management of Hepatitis B Virus – Infected Healthcare Providers and Students. *MMWR*, 61(3).
- Center for Disease Control. (2008). Workbook for Designing, Implementing, and Evaluating a Sharps Injury Prevention Program. *Cdc*, VI, 1–168.
- Cui, Z., Zhu, J., Zhang, X., Wang, B., & Li, X. (2018). Sharp injuries: A cross-sectional study among health care workers in a provincial teaching hospital in China. In *Environmental Health and Preventive Medicine* (Vol. 23, Issue 1). <https://doi.org/10.1186/s12199-017-0691-y>
- De Lima, G. M. N., Kawanami, G. H., & Romeiro, F. G. (2015). Preventing Needle Stick Injuries in Health Care Injuries. *Niosh*, 15(3), 194–199.
- Dulon, M., Lisiak, B., Wendeler, D., & Nienhaus, A. (2017). Causes of needlestick injuries in three healthcare settings: analysis of accident notifications registered six months after the implementation of EU Directive 2010/32/EU in Germany. In *Journal of Hospital Infection* (Vol. 95, Issue 3, pp. 306–311). <https://doi.org/10.1016/j.jhin.2016.11.015>
- Dulon, Madeleine, Stranzinger, J., Wendeler, D., & Nienhaus, A. (2020). Causes of needlestick and sharps injuries when using devices with and without safety features. In *International Journal of Environmental Research and Public Health* (Vol. 17, Issue 23, pp. 1–11). <https://doi.org/10.3390/ijerph17238721>
- Ganczak, M., Topczewska, K., Biesiada, D., & Korzeń, M. (2021). Frequency of occupational bloodborne infections and sharps injuries among Polish paramedics from selected ambulance stations. In *International Journal of Environmental Research and Public Health* (Vol. 18, Issue 1, pp. 1–11). <https://doi.org/10.3390/ijerph18010060>
- Grimmond, T. (2014). Frequency of use and activation of safety-engineered sharps devices: A sharps container audit in five Australian capital cities. *Healthcare Infection*, 19(3), 95–100. <https://doi.org/10.1071/HI14009>
- Hassanipour, S., Sepandi, M., Tavakkol, R., Jabbari, M., Rabiei, H., Malakoutikhah, M., Fathalipour, M., & Pourtaghi, G. (2021). Epidemiology and risk factors of needlestick injuries among healthcare workers in Iran: a systematic reviews and meta-analysis. In *Environmental Health and Preventive Medicine* (Vol. 26, Issue 1). <https://doi.org/10.1186/s12199-021-00965-x>
- Higginson, R., & Parry, A. (2013). syringes : a review of the literature. 22(8), 4–9.

- Himmelreich, H., Rabenau, H. F., Rindermann, M., Stephan, C., Bickel, M., Marzi, I., & Wicker, S. (2013). The Management of Needlestick Injuries. *Deutsches Arzteblatt International*, 110(5), 61–67. <https://doi.org/10.3238/arztebl.2013.0061>
- Hussain, A., Shah, Y., Raval, P., & Deroeck, N. (2020, October). Awareness about sharps disposal leads to significant improvement in Healthcare safety. *SN Comprehensive Clinical Medicine*, 2550–2553. <https://pubmed.ncbi.nlm.nih.gov/33163860/>
- Kebede, A., & Gerensea, H. (2018). Prevalence of needle stick injury and its associated factors among nurses working in public hospitals of Dessie town, Northeast Ethiopia, 2016. In *BMC Research Notes* (Vol. 11, Issue 1). <https://doi.org/10.1186/s13104-018-3529-9>
- Kimaro, L., Adinan, J., Damian, D. J., & Njau, B. (2018). Prevalence of occupational injuries and knowledge of availability and utilisation of post exposure prophylaxis among health care workers in Singida District Council, Singida Region, Tanzania. In *PLoS ONE* (Vol. 13, Issue 10). <https://doi.org/10.1371/journal.pone.0201695>
- Lee, J. H., Cho, J., Kim, Y. J., Im, S. H., Jang, E. S., Kim, J. W., Kim, H. Bin, & Jeong, S. H. (2017). Occupational blood exposures in health care workers: Incidence, characteristics, and transmission of bloodborne pathogens in South Korea. In *BMC Public Health* (Vol. 17, Issue 1). <https://doi.org/10.1186/s12889-017-4844-0>
- Nouetchognou, J. S., Ateudjieu, J., Jemea, B., & Mbanya, D. (2016). Accidental exposures to blood and body fluids among health care workers in a Referral Hospital of Cameroon. In *BMC Research Notes* (Vol. 9, Issue 1). <https://doi.org/10.1186/s13104-016-1923-8>
- Ong, M. W., Hwang, J., Lim, S. M., & Sng, J. (2019). Knowledge, attitudes and behaviour towards needlestick injuries among junior doctors. *Occupational Medicine*, 69(6), 436–440. <https://doi.org/10.1093/occmed/kqz090>
- Ottino, M. C., Argentero, A., Argentero, P. A., Garzaro, G., & Zotti, C. M. (2019). Needlestick prevention devices: data from hospital surveillance in Piedmont, Italy-comprehensive analysis on needlestick injuries between healthcare workers after the introduction of safety devices. *BMJ Open*. <https://doi.org/https://doi.org/10.1136/bmjopen-2019-030576>
- Roos, A., Hellgren, A., Rafatnia, F., Hammarsten, O., Ljung, R., Carlsson, A. C., & Holzmann, M. J. (2017). Global Health Sector Strategy on Viral Hepatitis 2016-2021. WHO Press, 232(June 2016), 111–116. <https://doi.org/10.1016/j.ijcard.2017.01.044>
- Schuermans, J., Lutgens, S. P., Groen, L., & Schneeberger, P. M. (2018). Do safety engineered devices reduce needlestick injuries? In *Journal of Hospital Infection* (Vol. 100, Issue 1, pp. 99–104). <https://doi.org/10.1016/j.jhin.2018.04.026>
- Sibbitt, W. L., Band, P. A., Kettwich, L. G., Sibbitt, C. R., Sibbitt, L. J., & Bankhurst, A. D. (2011). Safety syringes and anti-needlestick devices in orthopaedic surgery. *Journal of Bone and Joint Surgery - Series A*, 93(17), 1641–1649. <https://doi.org/10.2106/JBJS.J.01255>
- Türe, Z., Ulu Kiliç, A., Cevahir, F., Altun, D., Özhan, E., & Alp, E. (2016). Predictive factors for percutaneous and mucocutaneous exposure among healthcare workers in a developing country. *Journal of Epidemiology and Global Health*, 6(3), 141–146. <https://doi.org/10.1016/j.jegh.2015.06.003>
- Weldesamuel, E., Gebreyesus, H., Beyene, B., Teweldemedhin, M., Welegebriel, Z., & Tetemke, D. (2019). Assessment of needle stick and sharp injuries among health care workers in central zone of Tigray, northern Ethiopia. In *BMC Research Notes* (Vol. 12, Issue 1). <https://doi.org/10.1186/s13104-019-4683-4>
- Yazie, T. D., Sharew, G. B., & Abebe, W. (2019). Knowledge, attitude, and practice of healthcare professionals regarding infection prevention at Gondar University referral hospital, northwest Ethiopia: a cross-sectional study. In *BMC research notes* (Vol. 12, Issue 1, p. 563). <https://doi.org/10.1186/s13104-019-4605-5>

Zhang, L., Ai, Y., Liu, J., Yue, N., Xuan, J., Bal, V., Gala, S., Erdal, E. P., & Gao, X. (2020). Economic burden of needlestick injuries among healthcare workers in China. In *Journal of Medical Economics* (Vol. 23, Issue 7, pp. 683–689). <https://doi.org/10.1080/13696998.2020.1737534>