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DID SAFETY-ENGINEERED DEVICE IMPLEMENTATION CONTRIBUTE TO REDUCING THE RISK OF NEEDLESTICK AND SHARPS INJURIES? RETROSPECTIVE INVESTIGATION OF 20 YEARS OF OBSERVATION IN A SPECIALIST TERTIARY REFERRAL HOSPITAL

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Abstract
Objectives: In Poland, there are numerous cases of injuries caused by sharp instruments annually, still significantly more than in other European Union countries. The aim of this study was to analyze work-related injuries among healthcare workers in a selected hospital before and after the implementation of safety-engineered devices (SED). **Material and Methods:** Retrospective analysis of medical documentation regarding occupational needlestick and sharps injuries (NSSI) in a tertiary referral surgical hospital in 1998–2018. The study group consisted of nurses and doctors who had been injured and reported the incident. The frequency of injury reports, injury rate, and characterization of circumstances surrounding NSSI are presented. **Results:** Over the period of 20 years, a total of 257 NSSI incidents were reported. The average injury rate was statistically significant for nurses ($p = 0.004$) and was higher before the introduction of SED. Moreover, the number of injuries among nurses showed a downward trend during the study period. However, for doctors, there was no statistically significant difference in the median puncture rate ($p = 0.099$), and the number of injuries showed an increasing trend. **Conclusions:** In this study, the authors' have demonstrated not only the occurrence of injuries and punctures in the daily work of medical personnel but also the potential for their reduction through the use of safety equipment at every workstation where healthcare services are provided using sharp medical instruments. Int J Occup Med Environ Health. 2024;37(2):234–43

Key words:
occupational exposure, needlestick and sharps injuries, safety-engineered device, healthcare workers, implementation of European Union Council Directive, 2010/32/EU

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INTRODUCTION

Healthcare workers (HCWs) constitute a group of occupationally exposed workers at risk of contact with potentially infectious biological material during routine healthcare procedures [1–3]. Among many factors influencing this exposure, one can mention needlestick and sharps injuries (NSSIs), which involve contact with blood and/or other potentially infectious biological material originating from the patient (including pleural fluid, pericardial fluid, synovial fluid, peritoneal fluid, or amniotic fluid) [1]. Consequently, a medical worker could be infected with hepatitis B virus (6–30%), hepatitis C virus (1.8%) [4], human immunodeficiency viruses (0.3%) [5] and other pathogens [6]. In Poland, according to the Statistical Classification of Economic Activities in the European Community, infectious diseases have consistently represented the highest percentage of occupational diseases. In 2016, such diseases accounted for >44%, and in 2020, they accounted for >66% of all occupational diseases in the healthcare and social assistance sectors [7,8].

For many years, NSSIs have been a widespread phenomenon worldwide. It is estimated that each year >1 million healthcare workers in Europe and 385 000 healthcare workers in the USA experience percutaneous injuries resulting from accidents involving needles or sharp instruments [9,10].

According to estimates, in healthcare facilities in Poland, there are approx. 100 injuries related to the use of medical equipment by healthcare workers daily (around 37 000 injuries/year) [11].

Disruption of skin integrity and exposure to blood can result from procedures involving the use of needles, intravenous catheters, scalpels, syringes, and other sharp-ended objects. Approximately 89% of injuries in healthcare facilities are related to needlesticks, while 11% are caused by injuries from other sharp medical instruments [12]. Injuries occur in units of various profiles, including surgical and non-surgical departments [12]. Nursing staff is a professional group that is particularly susceptible to injury. This tendency has been observed by the authors of numerous studies, confirming a higher rate of injuries among nurses compared to physicians or other medical professions [2,13–15]. The causes of injuries are multifactorial, which is why attention should be paid to the multidimensional nature of injury prevention measures [2,16,17]. One of the important factors in reducing the risk of injuries among medical personnel is the use of safety-engineered devices (SED) in daily practice [18]. The SED is a blade or needle used for collecting body fluids, gaining access to veins or arteries, administering medications and other fluids, with a built-in safety mechanism that effectively reduces the risk of exposure (according to United States Department of Labor Occupational Safety and Health Administration) [19]. In Poland, attention was drawn to this type of preventive measures in 2013. This was a result of the implementation of the European Union Council Directive (2010/32/EU) [13]. The ensuing legal regulations [20] obliged the managers of healthcare entities to organize the provision of healthcare services in a manner that avoids or minimizes the risk of injury from sharp instruments. The effectiveness of implementing these provisions was assessed in 2019. Despite the obligatory requirement to provide SEDs in healthcare facilities, not all of them comply with these guidelines or are equipped with an adequate number of safety equipment. This is confirmed by the results of a survey conducted among 3954 nurses working in Polish hospitals [13]. Furthermore, it appears that the issue of occupational exposure is underestimated and undervalued by healthcare workers, as evidenced by the concerning phenomenon of underreporting of injury cases [21]. The scale and recurrence of NSSI exposure among healthcare workers indicate that these incidents continue to be a significant health problem in this population. In the context of infection control surveillance conducted in hospitals, it is justified to ensure the safety of healthcare workers, which can result in a reduction in occupational exposure, including injuries. The introduction of safety-engineered devices

involves higher costs at the purchasing stage, however, Hanmore et al. [22] confirmed cost savings from managing fewer needlestick injuries, yielding estimated 5-year overall savings of EUR 51 710, using the example of a 420-bed Belgian hospital.

The aim of this study was to assess the effect of the introduction of SED in preventing NSSIs among HCWs in a selected hospital, in which documentation spanning 20 years was analyzed.

MATERIAL AND METHODS

Characteristics of the hospital and the study group

The data was collected in a specialized tertiary referral surgical hospital in Kraków, Poland. The study was based on a retrospective analysis of annual reports on occupational exposure. The reports were prepared annually by a nurse epidemiologist in 1998–2018. During the study period, the average number of beds in the hospital was 110. The study included a population of healthcare workers, including physicians and nurses. The number of staff employed during the analyzed period was M±SD 203.4±8.1 employees (min. 189 people, max 221 people). The number of employed nurses was M±SD 117±8.2, while for physicians, it was 51.1±7.4. Each case of injury was reported to the occupational health physician and/or occupational health nurse, in accordance with the hospital's directive procedure. Each reported case of injury was documented in the so-called Occupational Exposure Reporting Form. During the study period, the procedure was updated 4 times, taking into account the changing guidelines regarding post-exposure management. The hospital conducted trainings on injury prevention and post-exposure procedures prior to employment, as part of initial training, as well as annually during the so-called refresher trainings.

The analysis of the occurrence of NSSI

The analysis of the occurrence of NSSI among healthcare workers took into account the following criteria: profession (nurse, doctor), location of the injury, frequency of injuries, activities during which the injuries occurred, and the implementation of safe equipment in the hospital (vacuum blood collection system, safe IV cannulas, safe injection and blood collection needles). The locations where injuries occurred were divided on the basis of the specific units within the hospital. Therefore, the analysis included:

- 3 surgical departments (General and Oncological Surgery Department, District Department of Vascular Surgery and Angiology, Day Surgery Department),
- 1 non-surgical department (Internal Medicine, Angiology, and Geriatrics Department),
- 1 Anesthesiology and Intensive Care Unit,
- operating wing, and other organizational units (specialist outpatient clinics, admission ward, specialist medical offices).

The analysis compared the frequency of injuries before the implementation of safe equipment and after its introduction in 2013.

The Director for Medical Affairs of the investigated hospital granted permission to access the medical records.

The analysis of the reported procedures that caused injuries after 2010/32/EU Directive implementation

The analysis of the activities that caused injuries after implementing 2010/32/EU Directive which occurred in 2013–2018, i.e., from the time of the introduction of the EU regulation until 2018.

Statistical methods

The needle stick index was standardized for 100 people according to the following formula:

$$\text{Annual injury rate (AIR)} = \frac{\text{number of injury cases}}{\text{number of staff in the relevant year}} \times 100 \quad (1)$$

Relative risk (RR) was calculated by:

$$RR = \frac{\text{AIR (1998–2018)}}{\text{AIR 2013 (reference point)}} \quad (2)$$

Needlestick and sharp injuries are presented as the median with the lower and upper quartiles and the minimum and maximum value. The frequency of activities leading to exposure is presented as a number and a percentage. Comparisons between the 2 groups were made using the Mann-Whitney U test. The correlation between the studied variables was performed using Spearman's ρ. Two-sided p-values <0.05 were considered significant. Statistical analyses were performed using IBM SPSS Statistics 28.

RESULTS

In a specialized tertiary referral surgical hospital, a total of 257 reports of NSSIs were recorded between 1998–2018. The highest number of cases (N = 22) of NSSIs was reported in 2007, while the lowest (N = 4) was reported in 1998, considering the period before the implementation of SED. Conversely, after the implementation of SED, the highest number of cases (N = 25) was reported in 2013, and the lowest (N = 4) in 2014. Overall, following the implementation of safe equipment, the number of NSSI reports decreased compared to the period when safe equipment was not used. Assessing the number of injuries by profession, the number of NSSI reports among nurses decreased after the implementation of SED. However, doctors reported NSSIs more frequently than nurses after 2013 compared to the preceding period (Figure 1).

The observed relationships are also reflected in the injury incidence rates per 100 healthcare workers, including nurses and doctors. The overall injury rate for all hospital employees was lower after the introduction of SED, but it did not differ statistically significantly from the rate during the period before the implementation of SED (p = 0.563) (Figure 1a). The AIR was statistically significant for nurses (p = 0.004) and was found to be higher during the period before the introduction of safe equipment (Figure 1b). However, no statistically significant difference in the median incidence rate was found for doctors (p = 0.099) (Figure 1c). Furthermore, the number of injuries in the nurses' group showed a downward trend during the study period (Figure 1g), while the doctors' group showed the opposite, an upward trend (Figure 1f). In non-surgical departments, a lower number of NSSIs was recorded in the period after the introduction of safe equipment (p = 0.031), compared to the period when SED was not used (Figure 1d). For the other types of departments, the incidence rates did not differ statistically significantly (Figure 1e).

The risk of NSSIs was lowest in 1998. That year, the relative risk of injury was 85% lower than in 2013. However, after the introduction of SED in 2013, the lowest risk occurred in 2014, with an 84% reduction compared to 2013. From 1999 to 2012, the risk of NSSIs was lower compared to the risk in 2013 and ranged 21–66%. After the implementation of SED, the RR remained lower and ranged 44–76% (Table 1).

The analysis of reported events that led to injuries despite the implementation of SEDs showed that procedures for which safe equipment was used occurred less frequently than injuries during surgical procedures (Figure 2). Among procedures for which safe equipment was used, injections had the highest risk of injury (31%). In contrast, the safest procedure during the study period was venipuncture (3.4%).

DISCUSSION

In this study, the rate of NSSIs per 100 HCWs throughout the analyzed period was M±SD 6.00±2.59 and was slightly lower in the years 2013–2018 (5.5±4.0) compared to the years 1998–2012 (6.2±2.0). One of the few studies evaluating the reporting of NSSIs conducted for a medical facility in Poland was the paper by Garus-Pakowska et al. [2]. The analysis conducted by the aforementioned team focused on a district hospital in the Łódź Voivode-

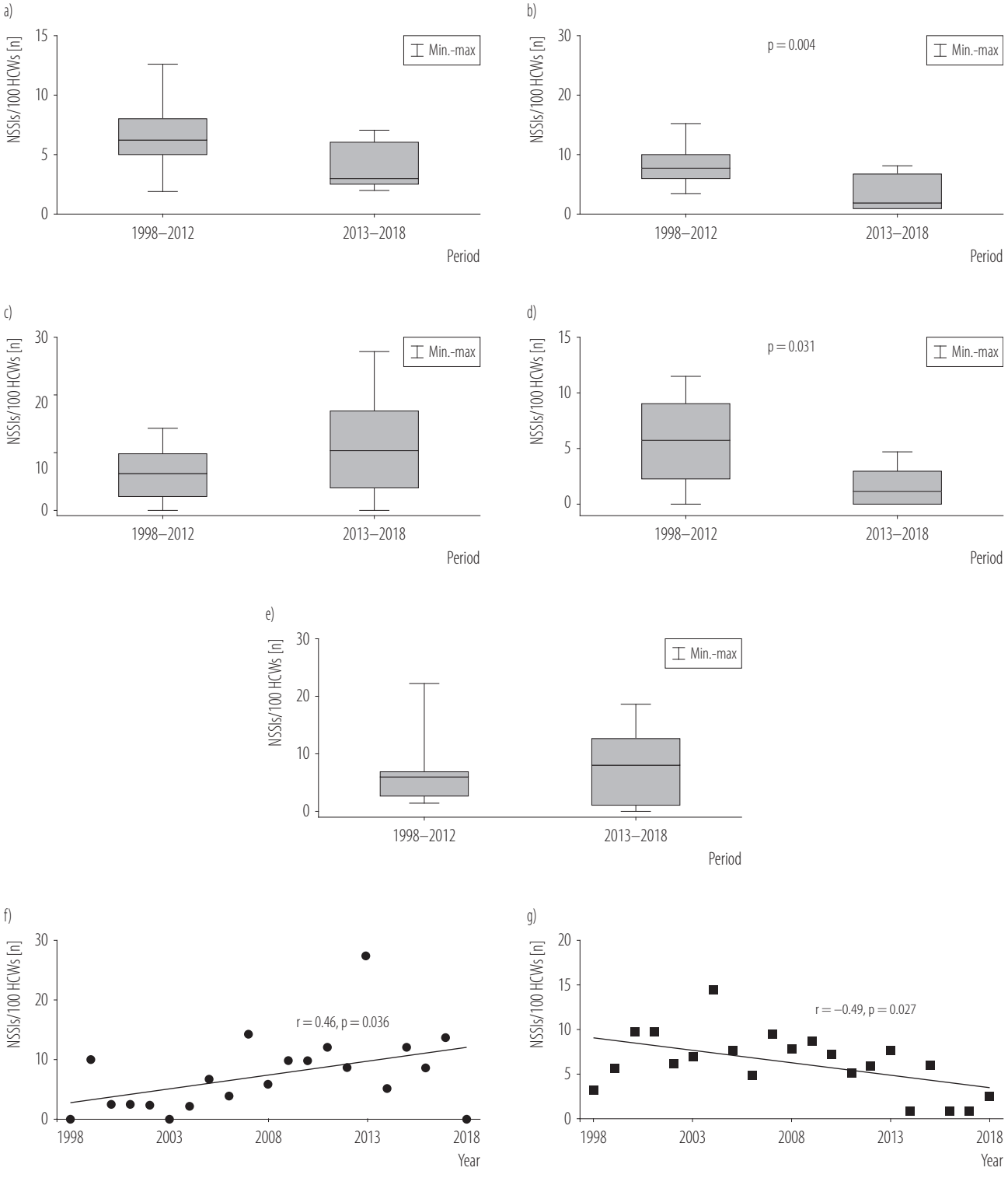

Figure 1. Median of injuries in: a) the entire study group, b) among nurses, c) doctors, and d) non-surgical and e) surgical wards in the period before (1998–2012) and after (2013–2018) the introduction of safety-engineered devices in a specialist 3rd degree surgical hospital and puncture rates for f) doctors and g) nurses in 1998–2018

Table 1. The relative risk of needlestick and sharps injuries (NSSIs) among the employees of the specialized tertiary referral surgical hospital in Kraków in relation to the years during the study period 1998–2018

Year	NSSIs [n/100 HCW]	RR	95% CI
1998	1.90	0.15	0.03–0.68
1999	5.24	0.41	0.15–1.11
2000	6.19	0.49	0.19–1.24
2001	6.19	0.49	0.19–1.24
2002	4.96	0.39	0.14–1.08
2003	4.47	0.35	0.12–1.01
2004	8.72	0.69	0.30–1.58
2005	6.35	0.50	0.20–1.26
2006	4.27	0.34	0.12–0.98
2007	9.95	0.79	0.36–1.74
2008	6.85	0.54	0.22–1.33
2009	8.29	0.66	0.28–1.52
2010	7.32	0.58	0.24–1.39
2011	6.57	0.52	0.21–1.29
2012	6.06	0.48	0.19–1.22
2013	**12.63**	**1 (ref.)**	**0.48–2.10**
2014	2.02	0.16	0.04–0.69
2015	7.07	0.56	0.23–1.36
2016	3.03	0.24	0.07–0.82
2017	5.05	0.40	0.15–1.09
2018	3.03	0.24	0.07–0.82

HCW - healthcare worker.
ref. – reference point for RR.
Bolded are the year and the data for the Council Directive of the European Union (2010/32/EU) [13] implementation in Poland.

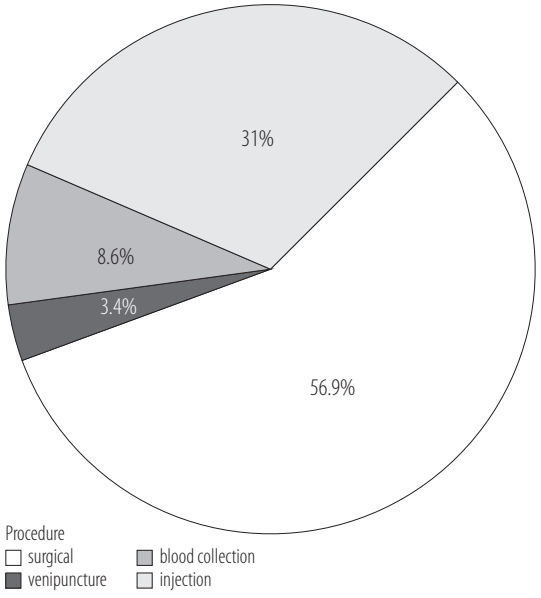

Figure 2. Activities leading to injuries among medical personnel in a tertiary specialty surgical hospital after implementation of the Council Directive of the European Union (2010/32/EU) [13,20] by the end of the analysis (2013–2018)

ship, where an average injury rate of 1.22/100 HCWs was reported for the years 2010–2017. This rate was approx. 4 times lower than that observed in the hospital under the analysis. The authors of the cited study also analyzed injury rates depending on the occupational groups, types of departments, activities leading to injuries, and compared the rates in 2010–2012 to those in 2014–2017, considering, as in the authors' analysis, the implementation of the Regulation. Similar to this study, Garus-Pakowska et al. [2] reported relatively higher injury rates among physicians compared to nurses, with rates of 2.02 and 1.22 (per 100 HCWs), respectively. A similar relationship was observed in the study, despite significantly lower values. The highest number of injuries, as noted in the study by Garus-Pakowska et al., was observed in surgical wards, including the operating wing, which is also consistent with the authors' observations. The differences between this study and the one by Garus-Pakowska et al. pertain to the pre- and post-implementation of the provisions of the Regulation [20]. In this study, the number of injuries, including rates per 100 HCWs, decreased (this trend was particularly evident in non-surgical wards, the operating wing, and units classified as "other"). In contrast, Garus-Pakowska et al. reported higher rates in 2014–2017. The authors of the cited study did not provide data about the implementation of SED in the hospital where the analyses were conducted. They attributed the increase in reported incidents to training initiatives in this area. However,

it is currently recognized that the use of SED is considered one of the most effective measures for minimizing healthcare personnel injuries [1,23], and the study results do not specifically address access to SED in the facility [2].

The hospital where Garus-Pakowska et al. conducted their study is a multidisciplinary hospital with an average of 321 beds, which is nearly 3 times higher than hospital surveyed in this study. The hospital's average staff includes 51.5 doctors, 191 nurses/midwives, and 20 paramedics, resulting in a significantly lower ratio of healthcare personnel to the number of beds. These organizational factors indicate better reporting of injury incidents in the surveyed hospital, although it is likely not 100% comprehensive. Survey research among healthcare workers in Polish hospitals reveals significantly underreported needlestick and sharps injuries, which is a very widespread problem. The results of the study among 151 healthcare workers working in conservative and surgical wards indicated that 50% of doctors and 10% of nurses do not see the point of reporting, and when reporting does occur, 45.5% of doctors and 66.7% of nurses do not do it immediately [24].

In another questionnaire-based study among the staff of a department of gynecology and obstetrics, although 60.9% of employees (76.2% of doctors and 57.3% of nurses) reported at least 1 sharp instrument injury in the year preceding the study, 82.5% did not report this incident to the appropriate post-exposure management services. The reasons cited for not reporting included the belief in the non-infectiousness of the patient (59.6%) or lack of time (36.5%) [25]. The aforementioned questionnaire-based studies [24,25] were conducted prior to the implementation of the provisions of the Regulation.

The introduction of legal regulations regarding personnel safety in relation to the provision of services with the use of safe equipment should result in limiting occupational exposure. The first report from the study "Implementation of Council Directive 2010/32/EU in Polish hospitals" was published in 2019 and covered a population of 3954 nurses. The survey-based study revealed that 40% of individuals who experienced workplace injuries or lacerations did not report these incidents [13]. On the other hand, a multicenter study involving 252 Polish hospitals [1] demonstrated that every other NSSI was not reported (45.2%). Interestingly, based on data obtained from 26.3% of all Polish hospitals, the authors of the said study estimated the annual average number of NSSIs for nurses, doctors, and paramedics, which should amount to a total of 13 567 cases. [2]. The authors also calculated rates for the years 2010–2014 for the 252 hospitals. However, the authors do not refer to the implementation of the EU directive, so unfortunately, based on this study, the impact of using SEDs on the occurrence of NSSIs cannot be determined. According to the authors' best knowledge, the only study evaluating the impact of SED on the occurrence of NSSIs among healthcare workers in Poland is a report from 2019. Despite the results of this study, it should be emphasized that reliable data from all hospitals in Poland are still lacking.

Analyzing the results in comparison to the findings of other authors, both from Poland and other countries, the authors can conclude that the reporting rate of such incidents, although not 100%, is at a fairly satisfactory level. While the number of annual reports varies across different wards, the chosen time frame allowed the authors to observe trends in the phenomenon and confirm that the introduction of safe equipment translates into a lower risk of injuries. Among the available safety-engineered devices, the most commonly used are cannula access devices (82%) and blood collection needles (76%) [13]. In the surveyed hospital, these were: a vacuum blood collection system, safe peripheral venous catheters, as well as safe needles for injections and administering medication. As a result, the strongest downward trend in exposure was observed in conservative wards, with a slight upward trend in surgical wards. The majority of the reported injury cases occurred during surgical procedures, such as suturing and the use of scalpels, for which there is no available equipment with injury pre-

vention mechanisms. It is worth noting that in the surveyed hospital, which has an average of 110 beds and an average of 203 staff members, it may be easier to implement infection control procedures due to potentially lower anonymity of the staff, resulting in nearly 4 times higher reporting rates compared to the previously cited study by Garus-Pakowska et al. [2]. This confirms the importance of training and organizational factors in implementing effective infection prevention programs, which, combined with the availability of safe equipment, improve workplace safety and hygiene. The significance of training is supported by the findings of de Curli et al. [26], who assessed the impact of implementing Directive 2010/32/EU in 97 and 117 Italian hospitals in 2017 and 2021, respectively. In the cited study conducted in 2021, a decrease in the number of training sessions attended by healthcare personnel was observed compared to 2017. This decline was accompanied by a decrease in knowledge levels regarding the prevention of bloodborne infections, as well as a sustained injury rate at a similar level, despite the implementation of multiple safety-engineered devices. Specifically, this involved 89% of SEDs for blood collection and 83% for venous access [26]. Training is also necessary when using safe equipment. According to the findings of a survey study by Dulon et al. among 835 healthcare workers, injuries still occur even when SEDs are used. The reasons cited by the respondents include technical problems, unexpected patient movement and problems during disposal [27]. The same observations were made by Schurmans et al. [28] in a study among 3778 HCWs in a 700-bed hospital in the Netherlands as well as by Grimmond [29] in a study involving 7 hospitals in New Zealand. Schurmans et al. also did not find a decrease in the percentage of injuries, which they attributed to differences in circumstances [28]. However, a decrease in the number of injuries was confirmed in multicenter studies, similar to the authors' study [22,30]. Ottino et al. [30] analyzed data from 42 acute care hospitals in Piedmont and confirmed an 18% decrease in the number of injuries when using SEDs.

This study has several strengths, particularly the duration of observation and the analysis within the context of diverse organizational and situational exposure circumstances. In the surveyed hospital, monitoring of injuries among staff was implemented before it became mandatory, and this monitoring continues to this day. This advantage allows for the identification of trends in the occurrence of injuries among healthcare workers. Unfortunately, it is not possible to compare the authors' findings with other centers or at the national level in Poland. Furthermore, the data may differ from other studies due to differences in methodology, so direct comparison of results obtained from annual reports with survey-based studies may vary. The study not only identified the occurrence of injuries and needlestick incidents among healthcare personnel in their daily work but also demonstrated the potential for their reduction through the implementation of safety-engineered devices at every healthcare delivery point that involves the use of sharp medical instruments.

The study also highlighted the need for systemic changes in Poland that would enable data collection, analysis, and facilitate the comparison of injury rates across different healthcare facilities.

CONCLUSIONS

Injuries are significantly more common among nurses than physicians. The most common injuries among physicians relate to performing surgical procedures using scalpels and a surgical needle in the operating block. Using safe equipment by medical workers significantly reduces the incidence of injuries, especially among nurses. The frequency of injuries after implementation of safe equipment is significantly reduced in non-surgical wards compared to surgical wards, although the number of reports varies annually. Keeping a long-term record of data on employee injuries when providing health services using sharp equipment and their analysis is the basis for introducing changes in creating a safe workplace.

Author contributions

Research concept: Anna Szczypta

Research methodology: Anna Szczypta, Katarzyna Talaga-Ćwiertnia

Collecting material: Anna Szczypta, Katarzyna Talaga-Ćwiertnia

Statistical analysis: Kamil Drożdż

Interpretation of results: Anna Szczypta, Katarzyna Talaga-Ćwiertnia, Anna Różańska, Małgorzata Siewierska, Kamil Drożdż, Mirosław Szura

References: Anna Szczypta, Katarzyna Talaga-Ćwiertnia, Anna Różańska, Małgorzata Siewierska

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