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Needlestick injuries among health care workers: Occupational hazard or avoidable hazard?

Sabine Wicker[1,2], **Ann-Marie Ludwig**[2], **René Gottschalk**[2], **Holger F. Rabenau**[2]

[1]Occupational Health Service, Hospital of the Johann Wolfgang Goethe University of Frankfurt, Frankfurt/Main, Germany
[2]Institute of Medical Virology, Hospital of the Johann Wolfgang Goethe University of Frankfurt, Frankfurt/Main, Germany

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Nadelstichverletzungen bei Mitarbeitern im Gesundheitswesen: Berufsrisiko oder vermeidbare Gefährdung?

Zusammenfassung. *Einleitung:* Ziel dieser Studie war die Erhebung der Häufigkeit und Ursachen von Nadelstichverletzungen bei Mitarbeitern im Gesundheitswesen sowie die Darstellung möglicher präventiver Maßnahmen.

Methoden: Mit Hilfe zweier unabhängiger anonymer Fragebogenerhebungen wurden Daten über Nadelstichverletzungen von Mitarbeitern eines deutschen Universitätsklinikum erhoben. Um die Vermeidbarkeit der Nadelstichverletzungen zu kalkulieren, wurden im ersten Studienabschnitt Anzahl und Art der Nadelstichverletzungen ermittelt, im zweiten Abschnitt die Ursachen und die Arbeitsbedingungen der Mitarbeiter.

Ergebnisse: Nadelstichverletzungen wurden durch unsichere Handlungsabläufe, schwierige Arbeitsbedingungen und unsichere Arbeitsgeräte verursacht.

In unserer Studie hatten innerhalb der letzten zwölf Monate 31,5% (n = 503/1598) der Befragten mindestens eine Nadelstichverletzung erlitten. Die Rate des Underreporting lag bei circa 75%. Durchschnittlich 50,3% (n = 492/978) der stattgehabten Nadelstichverletzungen hätten durch die Verwendung von sogenannten sicheren Instrumenten vermieden werden können, wohingegen lediglich 15,2% der Nadelstichverletzungen durch organisatorische Maßnahmen vermeidbar gewesen wären. Nach der Einführung der sicheren Instrumente, gaben 91,8% der Mitarbeiter an, mit den sicheren Instrumenten zufrieden zu sein, 83,4% der Beschäftigten waren davon überzeugt, dass sich durch die Verwendung von sicheren Instrumente die Arbeitssicherheit erhöhen würde.

Diskussion: Die berufliche Exposition gegenüber Blut ist ein häufiges Problem der Mitarbeiter im Gesundheitswesen. Eine systematische und kontinuierliche Erfassung von Nadelstichverletzungen ist unabdingbar, um riskante Praktiken und Arbeitsbedingungen zu identifizieren. Präventive Maßnahmen, beispielsweise die Einführung von sicheren Instrumenten sowie die Schulung sicherer Arbeitsabläufe, sollten im weiteren Zeitverlauf implementiert werden.

Summary. *Objectives:* The objective of this study was to describe the mechanisms and preventability of occupational percutaneous blood exposure of healthcare workers through needlestick injuries and to discuss rational strategies for prevention.

Methods: To calculate the preventability, we surveyed in a first step the number and kind of needlestick injuries and in a second step the reasons for the injuries and the working conditions of the healthcare workers. Both data sets were collected in independent anonymous questionnaire covering occupational blood exposure among healthcare workers in a German university hospital.

Results: Needlestick injuries were caused through unsafe procedures, difficult working conditions and unsafe devices. On average, 50.3% (n = 492/978) of all needlestick injuries could have been avoided by the use of safety devices, whereas only 15.2% could have been prevented by organizational measures. In our study, 31.5% (n = 503/1598) of participant healthcare workers had sustained at least one needlestick injury in the past twelve months. The rate of underreporting was about 75%.

After introduction of safety devices, 91.8% of the healthcare workers reported being satisfied with the anti-needlestick devices and 83.4% believed that safety devices would increase the safety of the work environment.

Conclusions: Occupational exposure to blood is a common problem among healthcare workers. The introduction of safety devises is one of the main starting points for avoidance of needlestick injuries, and accep-

Correspondence: Dr. Sabine Wicker, Betriebsärztlicher Dienst, Klinikum der Johann Wolfgang Goethe-Universität Frankfurt, Theodor-Stern-Kai 7, 60590 Frankfurt/Main, Germany, E-mail: sabine.wicker@kgu.de

tance among healthcare workers is high. Further targets for preventive measures, such as training in safe working routines, are necessary for improvement of safe work conditions.

Key words: Bloodborne viruses, occupational infections, safety devices.

Introduction

Needlestick injuries (NSIs) are one of the major risk factors in the transmission of hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV) in the healthcare environment. Worldwide, work-related infections are responsible for about 37% of HBV infections among healthcare workers (HCWs), 39% of HCV infections and 4.4% of HIV infections [1].

Recent experiences with SARS have demonstrated the vulnerability of HCWs to occupationally acquired infectious viral diseases. Worldwide, about 320,000 workers die of communicable diseases every year, some 5000 of them in the European Union [2]. The estimated annual death rate for HCWs from occupational events, including infection, is 17–57 per 1 million workers; overall, 9–42 HCWs per million die annually from occupational infections. According to the Occupational Safety and Health Administration, between 1992 and 2002, 28 HCWs died in the USA from complications related to NSIs [3]. Furthermore, antiviral therapy to manage an occupational exposure to HIV has resulted in severe hepatitis requiring liver transplant [4].

Combining the results for injury and disease, the best estimate of the annual number of deaths of workers arising from occupational exposures is about two million, comprising about 350,000 deaths from injury and about 1.65 million from disease [2].

In Germany, 941 workers died from work-related injuries and diseases in 2006 (http://de.osha.europa.eu/statistics/statistiken/suga/suga2006/3_ueberblick.pdf).

According to the German occupational disease number *BK 3101* (work-related infectious diseases), in 2004 at least six HCWs died in Germany (www.dguv.de/inhalt/zahlen/documents/BKDOK_2004_Original.pdf).

Between January 2000 and December 2007, the Employer's Liability Insurance Association in Hesse reported 19 cases of probable cause of occupational infectious diseases in HCWs at the University Hospital Frankfurt, most of them HCV infections resulting from NSIs. Distribution of reported occupational infectious disease in Germany is summarized in Fig. 1.

Because of these high numbers for occupational disease, national and international guidelines such as the Technical Rule 250 – Biological Agents in Health Care and Welfare Facilities [5] (Technische Regeln für Biologische Arbeitsstoffe 2003) in Germany, and the Needlestick Safety and Prevention Act 2001 [6] in the USA (US Department of Labor 2001) were developed to minimize the risk of bloodborne exposure to HCWs. NSI rates declined after better compliance with infection control guidelines and more widespread use of safety devices [7, 8]. Safety devices have been available in the USA since the late 1990s. The implementation of such devices in Germany has failed until now because of the estimated high costs and the vague legal regulation [9].

The aim of this study was to evaluate the preventability of NSIs among HCWs in a German university hospital. In a first step we obtained the number and kind of NSI and in a second step the reasons for the injuries and the working conditions of the HCWs who sustained NSIs. This was done to assess preventive strategies for reducing the rate of NSIs. Identifying ways to

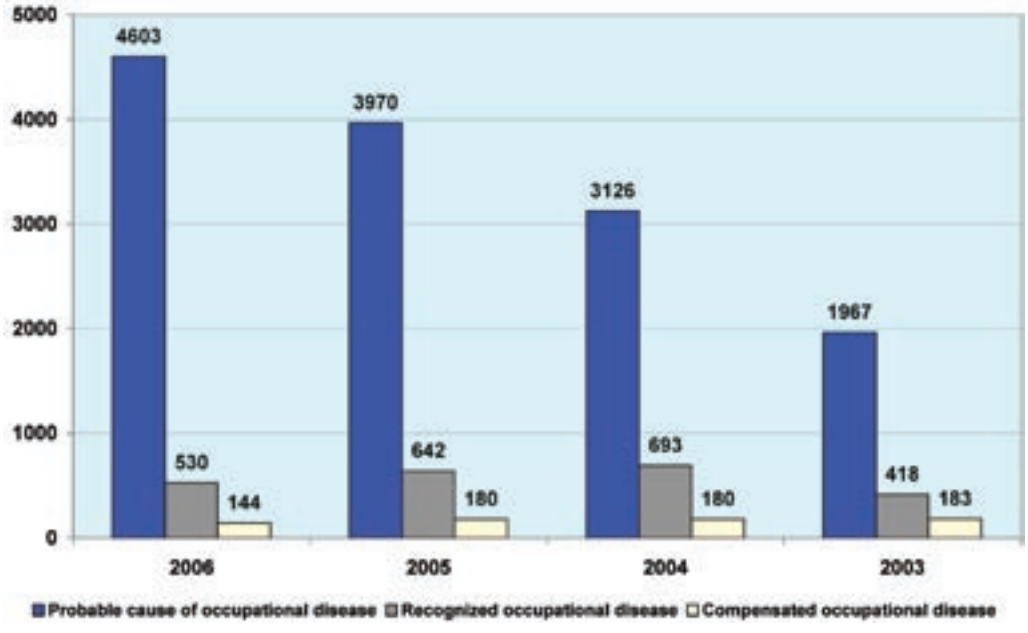

Fig. 1. Reported occupational infectious diseases (BK 3101) of German HCWs

prevent NSIs and measuring their impact is an important step toward ensuring the safety of HCWs.

Methods

Study design

Frankfurt university hospital is a 1247-bed hospital with 4080 employees and 12 medical disciplines. HCWs receive individual regular training from the occupational health service and/or the supervisors in prevention of exposure to blood and other body fluids. Employees whose job involved direct contact with patients and contact with blood or other body fluids or sharp objects were asked to complete a questionnaire.

Data were obtained in a two-step procedure. For statistical reasons and in order to obtain data from all the medical departments, the number of participants was enlarged and the scope of the questionnaire was extended in the second step.

Data were obtained between April and June 2006 (anesthesia, dermatology, gynecology, pediatrics, surgery) and between February and April 2007 (ear, nose and throat medicine, internal medicine, neurology/psychiatry, ophthalmology, pathology/forensic medicine, radiology) using an anonymous survey among 2085 healthcare workers: 687 (32.9%) physicians, 1205 (57.8%) nurses, 54 (2.6%) cleaners, 139 (6.7%) medical technicians and research scientists. The physicians and the laboratory personnel were informed about the study and the questionnaire by the occupational health service in the course of their regular meetings; the nurses and cleaners were instructed by their supervisors.

The questionnaire included a brief introduction on the potential risk of NSIs. It also covered the incidence, reporting rate, risk factors and exposure mechanisms of NSIs, the procedure and instrument involved in the exposure, the circumstances and mechanisms that were thought to be a significant cause of the exposure, the professional group, and the HBV vaccination status. Respondents in 2007 (n = 878) were in addition questioned on compliance and reasons for non-compliance with safety devices that had been implemented in stages in the hospital since May 2006; for example, in relation to permanent venous catheters and venous blood withdrawal.

Classifying injuries in categories enabled calculation of the numbers of reported NSIs that could have been prevented by the use of safety devices or by organizational measures. This was done in accordance with the statements of the reported NSIs. Each injury was allocated to one of the three levels of preventability (presumably, probably, not preventable) as described earlier [10]. The classification process was carried out by two people who also discussed any inconsistent results.

If the responding HCWs had any further questions, they could contact the responsible occupational physician. This also applied if they had any other problems, such as sustaining an NSI or questions about vaccination status and bloodborne infections. The completed questionnaires were collected on the various wards by the occupational physician or returned anonymously via internal mail. Feedback was not compulsory and informed consent was obtained by the participating personnel.

Statistical analysis

Data were incorporated into a Microsoft Excel database file that was then used for the detailed analysis using standard Excel capabilities. The program BiAS für Windows 8.3 (Epsilon Verlag, Hochheim Darmstadt 2007) was used for calculating 95% confidence intervals [95% CI] for proportions.

Results

The questionnaire was completed by 1598 of 2085 HCWs (76.6%): 549 (79.9%) physicians, 811 (67.3%) nurses, 46 (85.2%) cleaners, 69 medical technicians and 123 who did not specify their professional group (Table 1). Overall, 58.8% of the participants were female, 38.4% male and 2.8% did not provide the information.

The questionnaire response rate varied from 82.2% in surgery to 66.7% in gynecology. In total, 31.5% (n = 503/1598) of respondents had sustained at least one NSI in the past 12 months. The number of reported NSIs varied widely across disciplines, ranging from 46.9% (n = 91/194) among medical staff in surgery to 18.7% (n = 53/283) among HCWs in pediatrics. The number of NSIs per person and year also varied significantly, from one injury to 55. The highest rate was reported by surgeons. Of all occupational groups, physicians had the

Table 1. Response rate and rate of needlestick injuries (NSI)

	HCW (total)		Physicians		Nurses/medical technician (MT)	
	Response rate	HCW with NSI	Response rate	Physicians with NSI	Response rate	Nurses/MT with NSI
Anesthesia (n = 123)	80.5%	32.3%	78.7%	37.3%	75.0%	22.2%
Dermatology (n = 81)	71.6%	39.7%	76.7%	60.6%	64.7%	27.3%
Ear-nose-throat medicine (n = 73)	69.7%	43.5%	66.7%	75.0%	66.0%	32.3%
Gynecology (n = 129)	66.7%	31.4%	56.1%	52.2%	67.0%	25.4%
Internal medicine (n = 425)	80.7%	40.2%	96.5%	40.4%	61.3%	43.1%
Neurology/psychiatry (n = 404)	68.3%	23.9%	77.4%	29.2%	56.7%	20.7%
Ophthalmology (n = 78)	80.0%	28.6%	91.3%	19.0%	59.6%	32.1%
Pathology/forensic medicine (n = 91)	82.4%	24.0%	95.4%	57.1%	78.3%	18.5%
Pediatrics (n = 350)	80.9%	18.7%	85.5%	51.1%	75.0%	14.4%
Radiology (n = 95)	80.0%	19.7%	87.8%	25.0%	74.1%	11.1%
Surgery (n = 236)	82.2%	46.9%	65.1%	69.5%	92.7%	31.4%
Overall (n = 2085)	76.6%	31.5%	79.9%	49.9%	67.3%	27.0%

Table 2. Circumstances and characteristics of needlestick injuries [%]

	[%]	95% CI	n
Severity of needlestick injuries			
Minor	56	[53.0–59.3]	(549/978)
Moderate	37.2	[34.2–40.3]	(364/978)
Serious	4.3	[3.1–5.8]	(42/978)
No response	2.4	[1.5–3.5]	(23/978)
Timing			
During procedure	26.2	[23.4–29.1]	(256/978)
After procedure before disposal	11.9	[9.9–14.1]	(116/978)
Disposal	40.3	[37.1–43.4]	(394/978)
Not specified	21.7	[19.1–24.4]	(212/978)
Use of gloves			
Yes	76.9	[74.1–79.5]	(752/978)
No	19.7	[17.3–22.4]	(193/978)
No response	3.4	[2.3–4.7]	(33/978)
Procedure			
Capillary blood withdrawal	19.4	[17.0–22.0]	(190/978)
Venous blood withdrawal	22.4	[19.8–25.1]	(219/978)
Permanent venous catheter	5.3	[4.0–6.9]	(52/978)
i.m./s.c. injection	5.6	[4.3–7.3]	(55/978)
i.v. injection	1	[0.5–1.9]	(10/978)
Arterial blood withdrawal	1.8	[1.1–2.9]	(18/978)
Sewing	13.9	[11.8–16.2]	(136/978)
Cutting	4.8	[3.6–6.3]	(47/978)
Central venous catheter	2.4	[1.5–3.5]	(23/978)
Biopsy	1	[0.5–1.9]	(10/978)
Others	22.3	[19.7–25.0]	(218/978)

highest risk of NSI: 49.9% reported such an injury in the past 12 months. Response rate and distribution of NSIs are shown in Table 1.

Most of the participants (39.6%) had experienced 2–5 NSIs during their professional career, 24.9% had had no NSIs, 21.8% reported one NSI, 8.7% 5–10 NSIs, and 3.5% 10–50 NSIs.

Risk of NSI varied by procedure: blood withdrawal and sewing caused most of the injuries. The majority of NSIs occurred during needle disposal (46.6%). Other causes of NSI, such as recapping a used needle (5.2%), unexpected patient movements (4.8%) or transferring needles and sharps from one person to another (1.5%), were relatively rare. Circumstances of NSIs are summarized in Table 2.

Most of the NSIs occurred during routine activities (80.8%) but a few happened in emergency situations (13.4%). Stress (39.6%) and fatigue/lapses in concentration (39.4%) were the most common reasons for NSI. Extended working hours and night shifts were associated with 16.4% and 22.1%, respectively, of percutaneous injuries.

Regarding the rate of preventability of NSI, an average of 50.3% (n = 492/978) of all NSIs could have been avoided by the introduction of safety devices and a further 24% (n = 235/978) might have been avoided, but 25.7% (n = 251/978) could not have been prevented. However, the rate of NSI that could have been avoided varied widely across the different medical disciplines. Only 15.2% (n = 149/978) of NSIs could have been prevented by organizational measures such as training in safe working routines and improvement of the disposal of used needles. The preventability of NSI across medical disciplines is summarized in Table 3.

Within occupational groups, only 20.4% of injured physicians reported the NSI to a consultant in emergency medicine, compared with 40.0% of nurses (Fig. 2). Reasons for a lack of reporting were: little or no perception of risk by the employee (15.3%), self-care for NSI (7.2%), patients did not pose an infectious threat (10.2%), too busy (29.0%) and dissatisfaction with waiting times and follow-up procedures (28.9%).

On analyzing the working conditions of the HCWs, it was evident that two-thirds of the physicians had direct contact with infectious patients. Overall, around 90% of the HCWs were satisfied with the introduction of safer devices and believed that they would increase the safety of the working environment (Table 4).

Discussion

NSIs are associated with several bloodborne infections, such as HBV, HCV and HIV [11, 12]; however, most NSIs

Table 3. Preventability of needlestick injuries

	Anesthesia	Dermatology	Ear-nose-throat	Gynecology	Internal medicine	Neurology/psychiatry	Ophthalmology	Pathology/forensic medicine	Pediatrics	Radiology	Surgery	Overall
Through safety devices												
Presumably preventable	59.3%	33.3%	40.0%	83.7%	91.2%	66.3%	55.6%	16.1%	83.7%	52.9%	11.9%	50.3%
Probably preventable	13.0%	52.8%	56.7%	14.0%	2.4%	7.9%	22.2%	58.1%	4.3%	17.6%	41.1%	24.0%
Not preventable	27.8%	13.9%	3.3%	2.3%	6.5%	25.8%	22.2%	25.8%	12.0%	29.4%	47.0%	25.7%
Through organizational measures												
Presumably preventable	14.8%	22.2%	16.7%	37.2%	22.5%	13.3%	33.3%	0.0%	27.2%	14.3%	5.1%	15.2%
Probably preventable	48.1%	19.4%	50.0%	39.5%	68.2%	74.4%	60.0%	76.5%	54.3%	71.4%	50.0%	56.8%
Not preventable	37.0%	58.3%	33.3%	23.3%	9.3%	14.4%	6.7%	23.5%	18.5%	14.3%	44.9%	28.0%

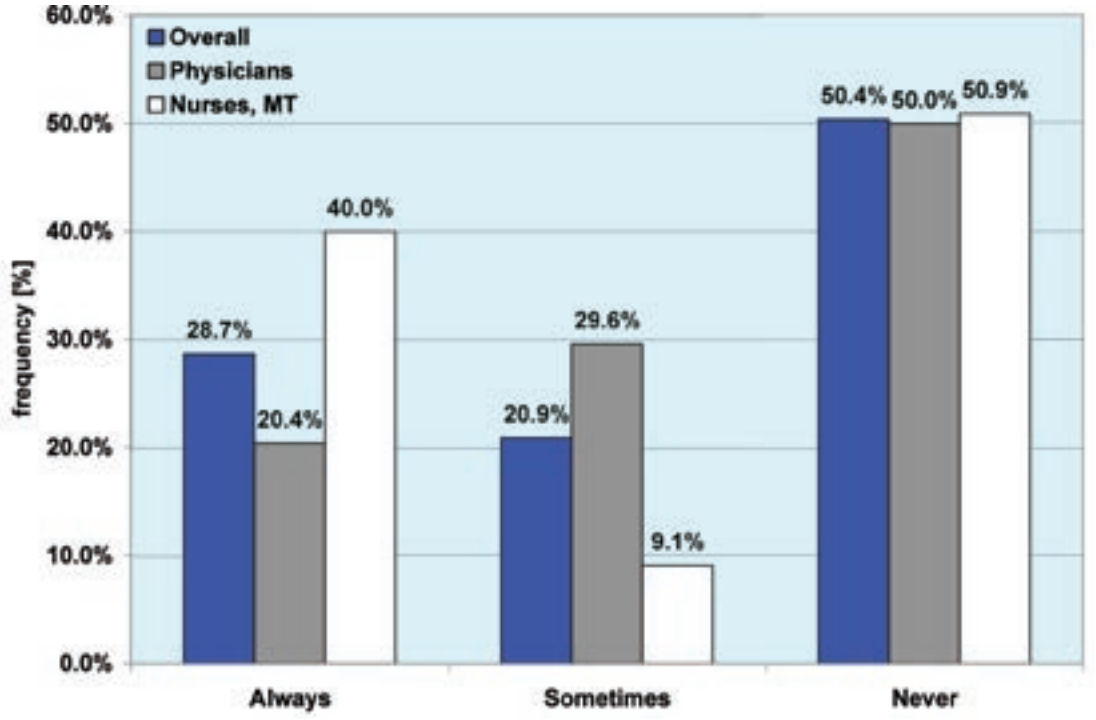

Fig. 2. Reporting rate according to job description (physicians, nurses and medical technicians, overall)

do not result in disease and rarer yet are those that lead to fatal infection. Thus, rate of NSI, although meaningful, may not accurately reflect the outcomes of greatest interest: disease and death. Further complicating this problem, the latent period from initial infection to disease may be measured in years or decades. For example, a HCW may sustain an NSI, become infected with HIV, and not develop clinical symptoms for several years. In the interval, the HCW may have changed jobs several times, making linkage of the exposure to the disease difficult [3].

For the healthcare provider, complete surveillance of exposure is necessary for identification of high-risk activities and environments in order to define new targets for preventive measures and to monitor the success or failure of these measures. The true number of NSIs sustained by HCWs is still unclear, primarily due to under-reporting [13, 14]. HCWs must be made aware of the importance of reporting NSIs so that they receive the appropriate medical treatment. In our study, only 28.7% of injured HCWs reported all NSIs and had seen a physician after the incident. Other studies have examined the problem of under-reporting: Panlilio et al. found an under-reporting rate of 57% [15]. Our results illustrate the importance of targeting prevention measures at specific groups, such as physicians, that would otherwise not be identified by routine reporting mechanisms. Physicians in particular often fail to report NSIs, as confirmed in a number of studies [16]. Previous studies have shown that self-assessment of low risk and self-care for NSIs are reasons for under-reporting by physicians [17]. In our study, reasons for not reporting an NSI included little or no perception of risk by the employee (15.3%), being too busy (29.0%) and dissatisfaction with long waiting times and follow-up procedures (28.9%). HCWs who do not report injuries because they are too busy create a challenge for preventive measures and must be made aware of the long-term risks of possible seroconversion as opposed to simply the short-term impact on their work load. Dissatisfaction with follow-up procedures is an important criticism. Standardizing the post-exposure procedures might help, as well as minimizing waiting times, so that staff can report injuries even if they are busy. All staff should report injuries and should do so quickly. Delays in reporting may subsequently delay interventions; for example, administration of antiretrovirals or other medical treatments that may lessen the risk of acquiring a bloodborne infection [17].

The 978 NSIs described in this study reflect both unsafe working procedures and difficult working conditions. However, the impact of each of these factors varied with the instruments and procedures involved and also with the specialty. Our data indicate that a change in routines and an increase in technical interventions are necessary to reduce the incidence of NSI in the different specialist areas. Preventive measures should be introduced in all specialties. The use of cut-resistant gloves may reduce NSIs; for example, from bone fragments during palpation. Double gloving lowers the risk of inner-glove perforations [18]. The implementation of safety devices has provided HCWs with new ways of reducing NSIs. Healthcare providers should evaluate the efficacy and usability of these safety devices, as well as their acceptability by employees. In our study, approximately 90% of the HCWs

Table 4. Working conditions of HCWs

	Physicians		Nurses, medical technicians		Total	
	[%] (n)	95% CI	[%] (n)	95% CI	[%] (n)	95% CI
Infectious patients						
yes	66.0 (208/315)	[60.5–71.3]	63.1 (253/401)	[58.2–67.8]	59.6 (523/878)	[56.2–62.8]
occasionally	23.2 (73/315)	[18.6–28.2]	22.7 (91/401)	[18.7–27.1]	22.8 (200/878)	[20.0–25.7]
no	9.2 (29/315)	[6.3–13.0]	11.7 (47/401)	[8.7–15.3]	14.7 (129/878)	[12.4–17.2]
no response	1.6 (5/315)	[0.5–3.7]	2.5 (10/401)	[1.2–4.5]	3 (26/878)	[1.9–4.3]
Briefing about needlestick injuries						
yes	50.8 (160/315)	[4.5–5.6]	74.8 (300/401)	[70.3–79.0]	60.1 (528/878)	[56.8–63.4]
no	46.3 (146/315)	[40.7–52.0]	20.7 (83/401)	[16.8–25.0]	35.0 (307/878)	[31.8–38.2]
no response	2.9 (9/315)	[1.3–5.4]	4.5 (18/401)	[2.7–7.0]	4.9 (43/878)	[3.6–6.5]
Satisfied with safety devices?						
yes	87.6 (219/250)	[82.9–91.4]	96.7 (261/270)	[93.8–98.5]	91.8 (512/558)	[89.2–93.9]
partly	5.2 (13/250)	[2.8–8.7]	1.5 (4/270)	[0.4–3.7]	3.5 (20/558)	[2.2–5.5]
no	7.2 (18/250)	[4.3–11.1]	1.8 (5/270)	[0.6–4.3]	4.7 (26/558)	[3.1–6.8]
Safety devices increase work safety?						
yes	88.9 (280/315)	[84.9–92.1]	86.0 (345/401)	[82.3–89.3]	83.4 (732/878)	[80.7–85.8]
don't know	4.1 (13/315)	[2.2–7.0]	8.5 (34/401)	[5.9–11.6]	8.2 (72/878)	[6.5–10.2]
no	5.7 (18/315)	[3.4–8.9]	3.0 (12/401)	[1.6–5.2]	4.9 (43/878)	[3.6–6.5]
no response	1.3 (4/315)	[0.3–3.2]	2.5 (10/401)	[1.2–4.5]	3.5 (31/878)	[2.4–5.0]

were satisfied with the introduction of safer devices. Earlier studies have shown similar results [19].

The use of safety devices is considerably lower in Germany than in the USA and this may be the reason for the higher injury rate in Germany: 500,000 NSIs among 750,000 HCWs in Germany [20] versus 100,000 to 1 million NSIs among 6 million HCWs in the USA [3, 15]. Wider availability of safer technologies, together with the introduction and stronger enforcement of occupational safety and health regulations, would probably lower NSI rates [21]. Despite this, unsafe devices are still in use and safer alternatives do not exist in some areas of work; for example, in some parts of pathology.

Safer devices are not consistently protective and are often only effective if used correctly. A study by the Centers for Disease Control and Prevention identified that over 5% of all NSIs were sustained while using a safety device, highlighting that these devices do not provide complete protection [22]. Injuries that occur despite the use of a safety device may be due to failure of activation or an inherent risk in the activation procedures. However, we agree with Vaughn et al that safety devices would probably not completely eradicate NSI [23]. Other organizational factors, such as workload and management support, continue to be important areas for improvement.

A study from the Work and Health Research Center in Baltimore demonstrated that working 13 or more hours per day, noonday shifts, or weekends and having less than 10 hours off were significant factors in the occurrence of NSI [24].

A study by Harvard medical school found that fatigue and lapses in concentration were the two most common factors (31% and 64% of injuries, respectively) [25]. Percutaneous injuries were more frequent during extended shifts than in regular working hours, and injuries were more frequent during the night than the day (1.48/1000 opportunities versus 0.7/1000 opportunities, respectively) [24, 25]. Long work hours and sleep deprivation among medical trainees resulted in a 3-fold increase in the risk of NSI [26]. In our study, stress (39.6%) and fatigue/lapses in concentration (39.4%) were the most common factors in NSI. Inexperience was a relatively rare cause of NSI (4.6%).

Our study has some limitations: individuals who had suffered NSI may not have responded to the questionnaire, and when calculating injury rates we used reported sharps injuries as total sharps injuries.

Nevertheless, our data demonstrate the need to improve, and to evaluate the impact of prevention measures and to implement prevention strategies. It is clear that HCWs need to receive more training to make their work environment safer.

Because the costs of NSI are high, not just economically but psychologically and physically, preventive measures are paramount. A change in working conditions and the wider use of safety devices could further reduce NSI [24].

The prevention of percutaneous injuries is vital, because they are one of the commonest injuries among HCWs and the most efficient mechanism of transmission of bloodborne pathogens.

The 4.3 million persons employed in the healthcare setting in Germany merit better protection for their health and greater recognition for their contribution. We propose that national organizations assume responsibility for accurately tracking occupationally acquired infections [3]. A worldwide surveillance system of oc-

cupationally acquired infections and deaths would determine the magnitude of the problem and could lead to future interventions.

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Contributions

Roles played by each author: *Sabine Wicker:* author of the publication. Also provided analysis and interpretation of data, responsible for study design. *Ann-Marie Ludwig:* data collecting, data analysis. *René Gottschalk:* statistical analysis, scientific supervision. *Holger F. Rabenau:* co-author of the publication. Also contributed analysis and interpretation of data, responsible for study design.

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