

Prevalence and prevention of needlestick injuries among health care workers in a German university hospital

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Abstract

Objective Health care workers (HCWs) are exposed to bloodborne pathogens, especially hepatitis B (HBV), hepatitis C (HCV), and human immunodeficiency virus (HIV) through job-related risk factors like needlestick, stab, scratch, cut, or other bloody injuries. Needlestick injuries can be prevented by safer devices.

Methods The purpose of this study was to investigate the frequency and causes of needlestick injuries in a German university hospital. Data were obtained by an anonymous, self-reporting questionnaire. We calculated the share of reported needlestick injuries, which could have been prevented by using safety devices.

Results 31.4% ($n = 226$) of participant HCWs had sustained at least one needlestick injury in the last 12 months. A wide variation in the number of reported needlestick injuries was evident across disciplines, ranging from 46.9% ($n = 91/194$) among medical staff in surgery and 18.7% ($n = 53/283$) among HCWs in pediatrics. Of all occupational groups, physicians have the highest risk to experience needlestick injuries (55.1%— $n = 129/234$). Evaluating the kind of activity

under which the needlestick injury occurred, on average 34% ($n = 191/561$) of all needlestick injuries could have been avoided by the use of safety devices. Taking all medical disciplines and procedures into consideration, safety devices are available for 35.1% ($n = 197/561$) of needlestick injuries sustained. However, there was a significant difference across various medical disciplines in the share of needlestick injuries which might have been avoidable: Pediatrics (83.7%), gynecology (83.7%), anesthesia (59.3%), dermatology (33.3%), and surgery (11.9%). In our study, only 13.2% ($n = 74/561$) of needlestick injuries could have been prevented by organizational measures.

Conclusion There is a high rate of needlestick injuries in the daily routine of a hospital. The rate of such injuries depends on the medical discipline. Implementation of safety devices will lead to an improvement in medical staff's health and safety.

Keywords Bloodborne viruses · Health care workers · Needlestick injury · Occupational infections · Safety devices

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Introduction

In Germany, about 500,000 needlestick injuries occur annually among health care workers (HCWs). These include injuries from syringes, sewing needles, and other sharp objects (Hofmann et al. 2002; Müller-Barthelm et al. 2006). Globally, more than 35 million HCWs face the risk of sustaining a percutaneous injury with a contaminated sharp object every year (Deisenhammer et al. 2006). Overall, the number of HCWs annually exposed to sharps injuries contaminated with hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), is

estimated at 2.1 million, 926,000 and 327,000, respectively (Prüss-Üstün et al. 2005).

These exposures can lead to infections with HBV, HCV, and HIV. The risk of transmission of HBV infection by a needlestick injury is between 6 and 30% for susceptible HCWs without post-exposition prophylaxis or sufficient HBV vaccination (Deisenhammer et al. 2006; Rogers and Goodno 2000). The transmission rate of HCV is estimated between 3 and 10% (Trim and Elliot 2003; Hanrahan and Reutter 1997). The risk of HCV-transmission increases by more than tenfold, with high levels of virus load of the source patient (Yazdanpanah et al. 2005). A lower transmission rate is found for HIV, namely at <0.3% (Cardo et al. 1997; Hofmann et al. 2006). Nevertheless, about 1,000 HIV infections—mostly in developing countries—could occur every year worldwide among HCWs due to their occupational exposure to percutaneous injuries. Although the risk of HIV infection is generally lower than the risk of infection by HBV or HCV, the occupational acquisition of HIV represents a serious consequence of needlestick injuries (Prüss-Üstün et al. 2005). In addition, HCWs suffer from significant anxiety and emotional distress following a needlestick injury (Lee et al. 2005).

Strategies are available to prevent infections due to sharps injuries, including education of HCWs and reduction of invasive procedures (Birnbaum 1993). Also, the use of safer devices can prevent injuries from sharp objects and reduce patients' risk of exposure to the blood of injured personnel (Mendelson et al. 2003; Clarke et al. 2002).

An implementation of the Safety-Lok resheathable winged steel needle in a hospital in New York demonstrated that needlestick injuries declined from 13.41 to 6.41 per 100,000 devices ordered (Mendelson et al. 1998). A safety program at Toronto East General Hospital achieved an 80% reduction in injuries within 1 year (Visser 2006), and a study at the University hospital of Tokyo demonstrated that cases of injury decreased from 19.8 to 5.5% (Suzuki et al. 2006). Safety devices have been available in the United States since the late 1990s. In order to reduce the risk of staff acquiring a bloodborne infection, the US Government released the "Needlestick Safety and Prevention Act" in November 2000 to ensure availability of safety devices to all staff by the employers (US Department of Labour 2001). In Germany, the "Technical Rule 250—Biological Agents in Health Care and Welfare Facilities" (Technische Regeln für Biologische Arbeitsstoffe 2006) requires that spike, sharp, or breakable devices should be replaced by suitable devices or methods, which have zero or low risk for needlestick injuries. This is mandatory for the treatment of sick people, who are infected with bio safety level (BSL) 3, 3** organisms (e.g., HBV, HCV, and HIV). Other areas in which safety devices should be used are in the emergency medical services or in the treatment of

aggressive patients. Safety devices should be used for all procedures when infection relevant body fluids could be transmitted, e.g., blood withdrawal. Nevertheless, the implementation of safety devices in Germany has failed until now because of the estimated high costs (Sulsky 2006).

The aim of this study was to evaluate the prevalence and the risk factors for needlestick injuries among HCWs in a German university hospital. The study focuses on injuries caused by contaminated sharps, which include needles, lancets, scalpels, and other objects. Furthermore, the study aims to analyze to what extent safety devices are a suitable tool in the reduction of needlestick injuries and which role could be addressed to organizational measures.

Methods

Study design

Data was obtained between April and June 2006 by an anonymous, self-reporting survey administered to 919 HCW 327 (35.6%) physicians, 537 (58.4%) nurses, 39 (4.3%) cleaners, and 16 (1.7%) laboratory technicians. We investigated medical disciplines of anesthesia, surgery, dermatology, gynecology, and pediatrics in order to obtain a representative distribution across the university hospital. This selection covered invasive, as well as non-invasive specialties. The physicians and the laboratory personnel were informed of the study by the occupational health service in the course of their regular meetings. The nurses and the cleaners were instructed by their supervisors. All employees received the questionnaire directly from the occupational health service or from their supervisors. The questionnaire included a brief introduction covering the potential risk of needlestick injuries. The responsible occupational physician was nominated as a contact person if there were further questions. This also applied in the case of any conflicts, e.g., sustained needlestick injuries, as well as questions about vaccination status and bloodborne infections.

The occupational health service is located at the site of the university hospital and is well known for its preventive medical checkups, vaccinations and occupational safety inspections.

The questionnaire only covered the occupation group. There were no additional questions about gender, age, or name. The completed questionnaires were collected from various wards and were fetched by the occupational physician or returned anonymously via internal mail. There was no disclosure of persons participated in the feedback process and informed consent was obtained from the participating personnel.

The questionnaire aimed to record the details of needlestick injuries within the last 12 months, under each profes-

sional group, the HBV vaccination status, circumstances resulting in the sharps incident, and additional contributing factors, e.g., the kind of activity and procedure under which the needlestick injury occurred.

By classification in categories of injuries, the proportion of reported needlestick injuries that could have been prevented by using safety devices were calculated. This was done in accordance with the statements of the reported needlestick injuries. A three-point scale (definitely not preventable–probably preventable and presumably preventable) was adopted to score according to the kind of activity and availability of safety devices. The basis of our decision was the catalogue of instruments available in Germany as in March 2007 (Brochure M612/613 BGW 2006). In addition, an allocation concerning organizational measures was carried out (see Table 1). Each injury was allocated to one of the three levels of preventability. The classification process was carried out by two people, who discussed any inconsistency in results and decided on a final evaluation of the data.

The data obtained via questionnaire was manually transmitted into a Microsoft Excel file. This file represented the basis for the detailed analysis using the standard MS Excel capabilities.

Results

Overall, 720 (78.3%) of 919 HCWs completed the questionnaire. The response rate varied from 82.2% in surgery to 66.7% in gynecology. Altogether, 31.4% ($n = 226/720$) of respondents had sustained at least one needlestick injury in the past 12 months. The number of needlestick injuries per person and year varied significantly from 1 to 55. The highest numbers were reported by surgeons. Of all occupational groups, physicians have the highest risk of being injured by needlesticks, 55.1% ($n = 129/234$) of them reported a needlestick injury in the last 12 months, followed by nurses with 22.0% ($n = 90/410$). Response rate and distribution of needlestick injuries are summarized in Table 2.

Table 1 Scoring of preventability of needlestick injuries

According kind of activity	Definitely not preventable	Probably preventable	Presumably preventable
	Sudden movement	Transferring needles and sharps from one person to another person	Disposal
	Sewing	Remove needle from vein	Used needles are left in the work area or somewhere else
	Incisions during surgery Biopsy	Others	Recapping an used needle Disposal of rubbish Overfilled disposal box
According organizational measures	Not preventable by organizational measures	Probably preventable by organizational measures	Preventable by organizational measures
	Incisions during surgery	Transferring needles and sharps from one person to another person	Used needles are left in the work area or somewhere else
	Sewing	Disposal	Recapping an used needle
	Sudden movement	Others	Disposal of rubbish
	Remove needle from vein		Overfilled disposal box
	Biopsy		
According availability of safety devices	Safety devices for prevention not available	Only limited safety devices for prevention available	Safety devices for prevention available
	Central venous catheter	Sewing (blunt needles)	Capillary blood withdrawal
	Biopsy	Cutting (safety scalpels)	Venous blood withdrawal
	Others		Permanent venous catheter i.m./s.c. injection i.v. injection Arterial blood withdrawal

Table 2 Response rate and reported needlestick injuries (in the last 12 months) within professional groups

	HCW (total)		Physicians		Nurses	
	Response rate (%)	HCW with NSI (%)	Response rate (%)	Physicians with NSI (%)	Response rate (%)	Nurses with NSI (%)
Anesthesia	80.5	32.3	78.7	37.3	75.0	22.2
Surgery	82.2	46.9	65.1	69.5	92.7	31.4
Dermatology	71.6	39.7	76.7	60.6	64.7	27.3
Gynecology	66.7	31.4	56.1	52.2	67.0	25.4
Pediatrics	80.9	18.7	85.5	51.1	75.0	14.4
Overall	78.3	31.4	71.6	55.1	76.4	22.0

Risk of needlestick injuries varied according to procedure: sewing (23%), venipuncture (13%), and capillary puncture (8.7%) present higher risks for injury than other types of procedures—e.g., i.m./s.c. injection (3%). Sewing was mentioned most frequently ($n = 129/561$) (see Fig. 1). The majority of reported injuries occurred in operation rooms. About 39% ($n = 219/561$) of reported needlestick injuries were sustained during a procedure, 9.4% ($n = 53/561$) occurred after the procedure but before disposal and 26.9% ($n = 151/561$) occurred during the disposal of sharps and 24.6% ($n = 138/561$) were classified as “other.” The severity of the needlestick injuries were classified as minor 53.3% ($n = 299/561$), moderate 41.7% ($n = 234/561$), and serious 5% ($n = 28/561$).

About 70.4% ($n = 159/226$) of needlestick injuries occurred when gloves were used, 27.9% ($n = 63/226$) of the HCWs who reported needlestick injury were not wearing gloves, 1.8% ($n = 4/226$) did not specify if they were wearing gloves or not when they sustained their needlestick injury.

Based on the rating of the preventability of needlestick injuries (according to the kind of activity), an average of

34% ($n = 191/561$) of all needlestick injuries could have been avoided by the introduction of safety devices, 29.2% ($n = 164/561$) might have been avoided, while 36.7% ($n = 206/561$) could not have been avoided.

Overall, medical disciplines and procedures safety devices were available to 35.1% ($n = 197/561$) of occurred needlestick injuries, only limited safety devices (blunt needles and safety scalpels) were available to 31% ($n = 174/561$) of occurred needlestick injuries, and safety devices were not available to 33.9% ($n = 190/561$) of occurred needlestick injuries, safety devices are not available.

In our study, only 13.2% ($n = 74/561$) of needlestick injuries could have been prevented by organizational measures.

However, the share of needlestick injuries, which could have been avoided varies significantly across various medical disciplines.

Estimated preventability of needlestick injuries through safety devices depending on the kind of activity, availability of safety devices and according to organizational measures across various medical disciplines are summarized in Figs. 2, 3, 4.

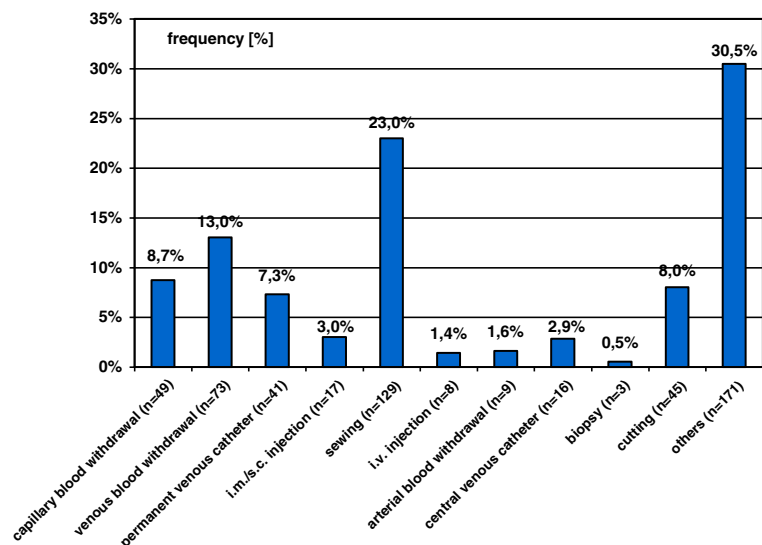
Fig. 1 Invasive procedure under which needlestick injuries occurred ($n = 561$)

Fig. 2 Estimated preventability of needlestick injuries through safety devices in dependence on kind of activity across various medical disciplines

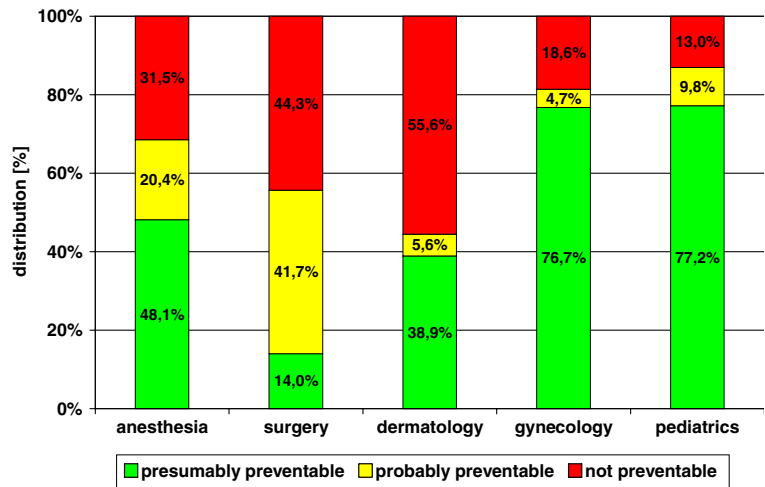


Fig. 3 Estimated preventability of needlestick injuries through safety devices in dependence on availability of safety devices across various medical disciplines

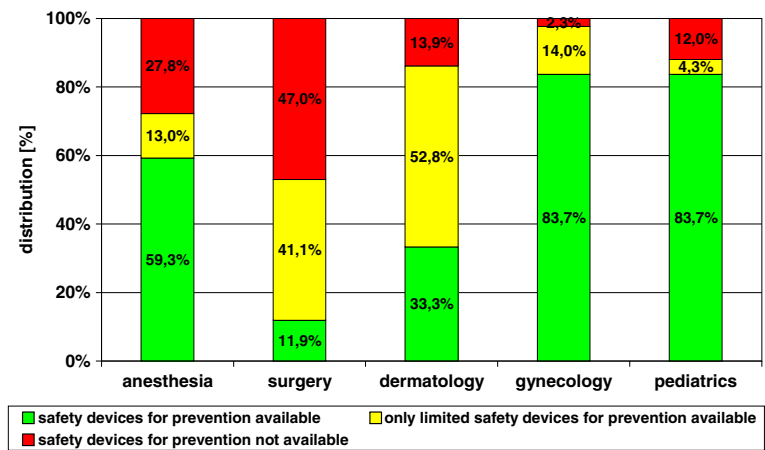
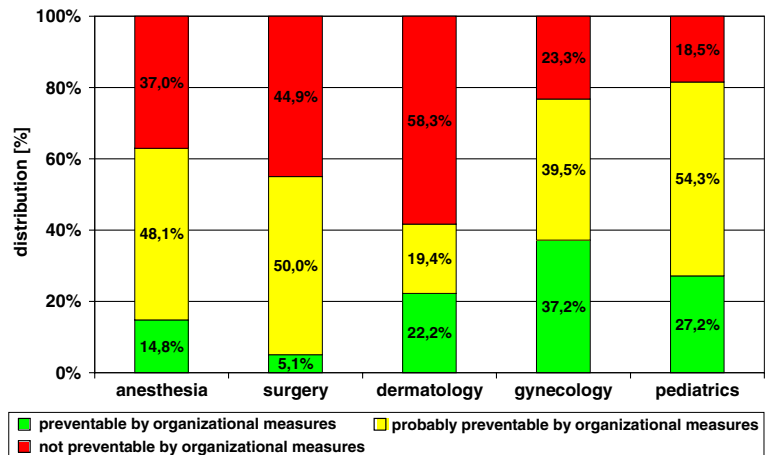


Fig. 4 Estimated preventability of needlestick injuries in dependence on organizational measures across various medical disciplines



Only 28.7% of injured HCWs reported the needlestick injury, 50.4% did not report the needlestick injury and 20.9% only reported occasionally, respectively, gave no response in the questionnaire. Within occupational groups, only 20.4% of injured physicians reported the needlestick injury to a consultant in emergency medicine, 50% did not report the needlestick injury and 29.6% only reported occa-

sionally. Comparatively, in case of nurses, 40% reported the needlestick injury to a consultant in emergency medicine, 50.9% did not report the injury and 9.1% only reported occasionally.

The number of HBV vaccinated HCWs ranged from 65.6% in dermatology to 87.6% in surgery. The average of vaccinated persons was 78.2% ($n = 563/720$), as opposed to

3.1% ($n = 22/720$) with no vaccination. About 15.7% ($n = 113/720$) of the participants did not know if they had had a vaccination against HBV, while 3.1% ($n = 22/720$) did not respond.

Discussion

Needlestick injuries of HCWs are an important occupational hazard leading to infections with bloodborne pathogens like HBV, HCV, or HIV (Smith et al. 2006a; Pellissier et al. 2006; Saberifirozi et al. 2006; Sadoh et al. 2006). It is important to improve the knowledge about the prevalence and reasons for such injuries in order to find ways to prevent them.

The present study describes the prevalence and the risk factors for needlestick injuries among HCWs in a German university hospital. The survey was carried out through an anonymous questionnaire and it focused on injuries caused by contaminated sharps, including needles, lancets, scalpels, and other objects. Only 28.7% of injured HCWs reported the needlestick injury and had seen a physician after the incident. In Germany, a special consultant in emergency medicine is responsible for reporting occupational accidents and post-exposure prophylaxis. The data of a Japanese teaching hospital also show a poor reporting rate (Smith et al. 2006b). A potential limitation of our study is the use of reported sharps injuries as total sharps injuries in needlestick injuries rate calculation. It is not known whether the HCWs who did not respond to our anonymous questionnaire had the same rate of needlestick injuries as the HCWs who did respond.

In our study, HCWs of five medical disciplines of the University clinic, Frankfurt were involved. This selection covered invasive as well as non-invasive specialties. We assume that the medical disciplines which have not been investigated so far would show comparable results.

Overall, 31.4% ($n = 226/720$) of respondents had experienced at least one needlestick injury in the previous year. Operation room personnel had the highest risk of needlestick injuries (46.9%; $n = 91/194$) and these HCWs were most intensively exposed to blood and body fluids. A previous study among HCWs in a Danish hospital revealed similar results (Nelsing et al. 1997). It is striking that the physicians in gynecology in our study had the lowest response rate. Since the gynecology represents a surgical discipline, we assume that a higher response rate from this group would have resulted in a higher number of sustained needlestick injuries reported. The low injury rate of nurses in pediatrics might be a result of the fact that within pediatrics most invasive procedures are performed by physicians.

Former studies showed that self-assessment of low risk and self-care for needlestick injuries were a reason for und-

erreporting by physicians (Haiduven et al. 1999). In contrast to other authors, in this study the share of physicians was highest (55.8%) followed by nurses (22.2%). While in other studies nurses were exposed to the highest risk, there was no clear explanation why in our study collective physicians reported the most injuries. Nevertheless, previous data showed a similar number of needlestick injuries among physicians and nurses. Within occupational groups, the use of full-time equivalent employees showed physicians to have a five times higher risk compared with nurses (Luthi et al. 1998).

Many sharps injuries (36.3%) happened after the procedures, either before disposal or during disposal. These incidents would not have occurred if a safety device were used and the needle safety mechanism had been activated. The present study revealed that 35.1% ($n = 197/561$) of the reported occupational needlestick injuries sustained by HCWs could have been prevented by the use of safety devices. These are, for example, injuries through venipuncture and injection, reported injuries after the procedure but before sharps disposal, during sharps disposal and due to unsafe sharps disposal boxes. These findings were supported by the results of recent studies in USA, Canada, Japan, UK, and Germany (Tuma and Sepkowitz 2006; Clarke et al. 2002; Visser 2006; Suzuki et al. 2006; Adams and Elliott 2006; Müller-Barthelm et al. 2006).

However, the share of needlestick injuries, which could have been avoided varies significantly across various medical disciplines. Reasons for this variation were different procedures under which needlestick injuries occurred within the varying medical disciplines. At present, there are no appropriate devices available, which allow a significant reduction of injuries during surgical procedures. Furthermore, many injuries of operation room personnel were caused by bone fragments. The study did not cover the degree of extended work shifts, time pressure or understaffing that influenced the number of needlestick injuries.

There are different strategies to prevent infections due to sharps injuries, including training HCWs and reduction of invasive procedures. In our study, only 13.2% of needlestick injuries could have been prevented by organizational measures. Similar data were found in a study in several acute care hospitals (Birnbaum 1993). This emphasizes that organizational measures are not sufficient. Therefore the implementation of technical measures is required.

Vaccination is one of the best ways to protect HCWs from infections, but vaccination is only available for HBV. In the present study, the number of vaccinated HCWs ranged from 87.6% in surgery to 65.6% in dermatology. Similar data were found in a Swedish university hospital (Dannetun et al. 2006). Due to this low vaccination rate, a greater awareness of the HBV vaccination is required (Wijk et al. 2006a).

The best way to protect against needlestick injuries is use of safety devices. These devices are a suitable and important tool in the reduction of needlestick injuries, and the implementation of safety devices should result in an improvement in medical staff's health and safety (Cullen et al. 2006; Clarke et al. 2002; Suzuki et al. 2006; Visser 2006). The safety devices need to fulfill National Institute for Occupational Safety and Health (NIOSH) criteria as a recognized technical standard (NIOSH 2000; Wittmann 2005) (e.g., safety devices should be easy to activate, intuitive to use, can be activated with one hand, do not hinder use, have clear awareness of activation, etc.).

A frequent argument against safer devices is the higher price compared with conventional sharps. Nevertheless, besides the commercial relevance there are ethical values that should not be ignored (Wijk et al. 2006b). HCWs should be protected from needlestick injuries that are a risk for infection, illness, disability and death from acute hepatitis, chronic hepatitis, hepatocellular carcinoma and AIDS.

As a result of the ascertained causes of needlestick injuries, the introduction of safety devices was launched at the university hospital of Frankfurt/Main. There were several meetings and briefings to inform the hospital staff about the results of the questionnaire. To improve the reporting process of needlestick injuries, the procedure is now displayed step by step on the website of the occupational health service. In addition, potentially required post-exposure prophylaxis measures are explained in detail. Further measures about the implementation of safety devices will take place.

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