

SHARPS INJURIES AMONGST HEALTHCARE WORKERS: REVIEW OF INCIDENCE, TRANSMISSIONS AND COSTS

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SUMMARY

Background: Sharps injuries and the related risk of infections such as hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV) represent one of the major occupational health risks for healthcare workers (HCWs).

Literature Review: An overview of available data on the incidence of sharps injuries and the related HBV, HCV and HIV infections and ensuing costs is provided.

Results: Literature reported incidence rates of sharps injuries ranging from 1.4 to 9.5 per 100 HCWs, resulting in a weighted mean of 3.7/100 HCWs per year. Sharps injuries were associated with infective disease transmissions from patients to HCWs resulting in 0.42 HBV infections, 0.05–1.30 HCV infections and 0.04–0.32 HIV infections per 100 sharps injuries per year. The related societal costs had a mean of €272, amounting to a mean of €1,966 if the source patient was HIV positive with HBV and HCV co-infections.

Conclusion: Sharps injuries remain a frequent threat amongst HCWs. The follow-up and treatment of sharps injuries and the deriving consequences represent a significant cost factor.

KEY WORDS Haemodialysis • Infection • Nursing

INTRODUCTION

In healthcare settings, sharp objects such as needles and ampoules are common items and their handling belongs to one of the most performed daily activities. However, handling sharps

represent a major risk for healthcare workers (HCWs) particularly for nurses. Sharps injuries include needle stick injuries, percutaneous injuries and mucocutaneous (relating to the skin and a mucous membrane) injuries. Studies indicate that about 80% of HCWs are affected by sharps injuries (Glenngård & Persson 2009) and these injuries involve a potential exposure to more than 20 pathogens (Wilburn 2004), including human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV). Other infectious agents potentially transmitted through needle stick injury include human T lymphotropic retroviruses (HTLV I and II), hepatitis D virus (or delta agent, which is activated in the presence of HBV), hepatitis G virus (GB virus or GBV-C), cytomegalovirus, Epstein–Barr virus, parvovirus B19, transfusion-transmitted virus, West Nile virus, malarial parasites and prion agents such as those associated with transmissible spongiform encephalopathies. The probability of infections depends on the prevalence of pathogens in the patient population and the transmission rates of the viruses (Whitby & McLaws 2002; Brewer 2003).

In a general report of the World Health Organisation the incidence of infectious disease transmission from patients to HCWs was 0.39 for HBV, 0.37 for HCV and 0.04 for HIV per 100

BIO DATA

Monique Elseviers is a Professor of the Centre for Research and Innovation Care (CRIC) of the University of Antwerp, Belgium, teaching research methodology and statistics. Her research mainly focussed on epidemiological problems in nephrology, drug utilisation, adherence and nursing activities.



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HCWs per year (Prüss-Ustün *et al.* 2005). Occupational transmission of HIV is divided into definite cases and possible cases (Trim & Elliott 2003). Worldwide, more than 100 HCWs have been infected by HIV due to needle stick injuries related to their work and several thousands have contracted HBV and HCV (Yang & Mullan 2011).

In addition, HCWs may suffer an emotional fear because a percutaneous injury with a potentially contaminated sharp object is a stressful event (Prüss-Ustün *et al.* 2005). Sharps injuries have a significant, although hard to quantify, impact on the psychological well-being of HCWs (Saia *et al.* 2010). For instance, Lee *et al.* (2005a, 2005b) reported that 60% of nurses deal with an enhanced fear of needles and 42% feel anxious, depressed or stressed after a needle stick injury. Exposure to HIV leads to acute severe distress and persistent moderate distress resulting in a number of nurses wanting to leave their job. Furthermore, posttraumatic stress disorder has also been observed in nurses after experiencing a needle stick injury whilst caring for a HIV positive patient.

Our aim was to obtain an overview of available information on:

1. The incidence of sharps injuries amongst HCWs.
2. The incidence of occupational infectious disease transmission due to sharps injuries.
3. The societal costs related to the detection and treatment associated with infectious disease transmission.

MATERIALS AND METHODS

We performed an online literature review in the electronic database PubMed (search engine NCBI—National Centre for Biotechnology Information/NLM—U.S. National Library of Medicine, National Institutes of Health) (see Figure 1).

We combined the following keywords [all verified MeSH (Medical Subject Headings) terms]: HCWs, needle stick injuries, incidence, infectious disease transmission patient to professional and healthcare costs.

Search limits were papers in English, for humans, published between 2001 and 2012. This timeframe was chosen to limit to papers published after the publication of the European Directive 2000/54/EC on the protection of workers from risks related to exposure to biological agents at work. We only included peer-

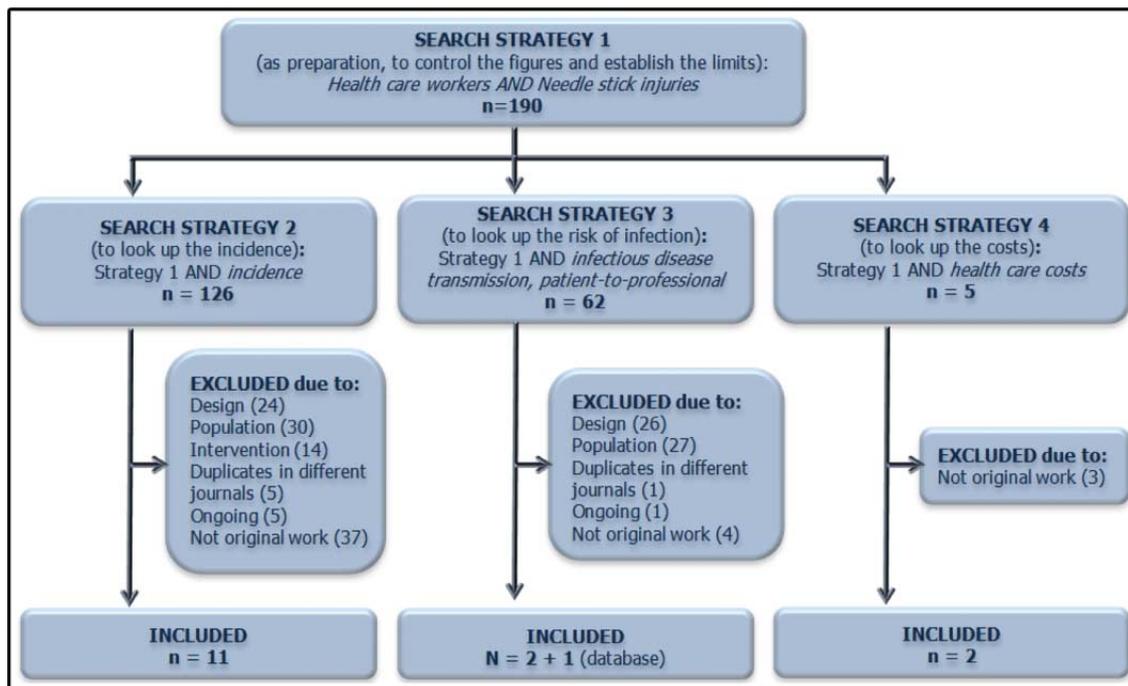


Figure 1: Flow chart of the search strategy.

reviewed original papers providing comparable data (incidence rates expressed per 100 HCWs or per 100 beds). We excluded reviews, editorials and guidelines. We controlled the references of selected papers for additional relevant publications.

We also used Internet resources from the UK: one citation from the EPINet™ (Exposure Prevention Information Network) initiative and one from the Health Protection Agency (HPA) Centre for Infections (2008). Additionally, we received data from the NephroCare surveillance database of Fresenius Medical Care, including all sharps injuries registered in the Fresenius haemodialysis centres in the period 2006–2010.

For background information, we have consulted citations from UK sources, namely the Department of Health, Health and Safety Executive, Health Protection Scotland. We also consulted US sources, namely from the Centre for Disease Control and Prevention, from the National Institute of Occupational Safety and Health and from the Occupational Safety and Health Administration.

RESULTS

INCIDENCE OF SHARPS INJURIES

Based on available literature, we collected incidences of sharps injuries in HCWs (nurses, nurse assistants, midwives, physicians, phlebotomists, students), per 100 person year or per 100 hospital beds, for healthcare settings in Australia, French military

regions, Democratic Republic of Congo, Egypt, France, UK, Ireland, Sweden and the United States (Table 1).

Table 1 demonstrates that overall incidences of needle stick injuries ranged from as low as 1.4/100 HCWs through 9.5/100 HCWs per year. Based on the nine papers providing incidence rates per 100 HCWs, a weighted mean incidence of 3.7/100 HCWs could be calculated. Additionally, two papers delivered data per 100 beds resulting in a weighted incidence rate of 6.3/100 beds per year.

Statistics obtained from a Fresenius NephroCare surveillance programme in haemodialysis centres summarise incidences amongst nurses in haemodialysis settings in UK, Slovenia, Portugal, Italy, Hungary, Poland, Slovakia, Spain, Czech Republic and Turkey between 2006 and 2010. Table 2 shows a decrease of the incidences of sharps injuries in haemodialysis units according to Fresenius NephroCare collected data during a five-year period. There is a high internal consistency in the values throughout Europe and between the different years of observation, particularly in UK, Spain and Hungary. The results of Fresenius NephroCare data are comparable with what we found in the literature (Table 1).

EPINet™ (Exposure Prevention Information Network, International Healthcare Worker Safety Centre) data collected between 2003 and 2008 found that 56.8% of all injuries

Author (publication year)	Country	Time period	Setting	Number of HCW included*	Incidence of needle stick injuries per year
					<i>Per 100 HCW</i>
Dia <i>et al.</i> (2012)	French military regions	2007–2009	Ambulatory care	5,969	1.44
Ngatu <i>et al.</i> (2012)	DR of Congo	2009	1 Hospital	977	5.11
Hanafi <i>et al.</i> (2011)	Egypt	2007	1 Hospital	645	4.38
Kessler <i>et al.</i> (2011)	United States	2007	1 Hospital	505	2.26
Glenngård and Persson (2009)	Sweden	2002	18 Hospitals	145,590	3.14
Lamontagne <i>et al.</i> (2007)	France	1999–2000	32 Hospitals	1,506	7.30
Panlilio <i>et al.</i> (2004)	United States	1997–1998	60 Hospitals	23,738	7.10
O'Connell and Hayes (2003)	Ireland	1998–2000	1 Hospital	3,000	3.69
Whitby and McLaws (2002)	Australia	1990–1999	1 Hospital	1,841 Nurses	9.53
				<i>Mean**</i>	<i>3.72/100 HCW</i>
					<i>Per 100 beds</i>
Venier <i>et al.</i> (2007)	France	2004	375 Hospitals	13,041	5.80
Watterson (2004)	UK (EPINet™)	2000–2002	15 Hospitals	1,403	11.30
				<i>Mean**</i>	<i>6.33/100 beds</i>

Table 1: Incidences of sharps injuries.

*Numbers included are different types of HCWs (healthcare workers) unless otherwise mentioned. **Weighted mean incidence per 100 HCWs (considered as full-time equivalents) or per 100 beds, respectively.

Injuries per 100 FTE	2006	2007	2008	2009	2010
Czech Republic	7.32	3.68	6.35	3.59	3.75
Hungary	7.24	5.66	6.04	5.34	4.22
Italy	1.00	1.29	0.33	0.91	1.45
Poland	0.19	1.77	0.37	0.24	0.91
Portugal	0.17	0.34	1.22	1.65	0.76
Slovakia	–	–	–	1.38	3.86
Slovenia	5.97	11.11	8.00	4.00	0.00
Spain	–	4.92	3.71	4.23	3.14
Turkey	–	–	–	–	0.08
UK	6.40	6.29	6.29	5.28	5.35
Summary	3.87	3.88	4.87	3.72	3.48

Table 2: Sharps injuries incidence in Europe.

Data from Fresenius NephroCare surveillance programme in haemodialysis centres. FTE, full-time employee.

happened with nurses, almost twice as much as physicians who only endured 28.8% of sharps injuries. Injuries mainly took place during disposal of sharps and during the normal use of the sharps.

INFECTIOUS DISEASE TRANSMISSION FROM PATIENT TO HEALTHCARE PROFESSIONAL

The limited available information about sharps injuries causing transmission of HBV, HCV and HIV is summarised in Table 2. Sharps injuries resulted in 0.42 HBV infections, 0.05–1.3 HCV infections and 0.04–0.32 HIV infections per 100 sharps injuries (Table 3).

COSTS RELATED TO THE DETECTION AND TREATMENT OF INFECTIOUS DISEASE TRANSMISSION

The available cost information for sharps injuries and related infectious disease transmission is presented in Table 4. It has been clearly demonstrated that testing and investigations account for almost all of the costs and that costs were merely

influenced by the infectious disease status of the source patient. In case of infectious disease transmission, costs increased considerably.

In Sweden, the annual health cost for investigation and treatment for HCV, HBV and HIV resulting from 1,183 sharps injuries reported in 18 hospitals in 2002, was estimated to amount to €1.8 million. The cost per reported injury was €272 on average (Glenngård & Persson 2009). In the event of infectious disease transmissions, these costs rose due to treatment costs and loss of productivity (O'Malley et al. 2007). In the event of HIV transmission, an additional €1,590 was required for treatments, physician visits and psychological support. Absence from work and loss of productivity will add additional costs (Glenngård & Persson 2009).

DISCUSSION

Occupational sharps injuries amongst HCWs are common. Available literature on sharps injuries amongst HCWs shows widely varying numbers from 1.4 up to 9.5 (worldwide) per 100 HCWs per year. This variance is mainly due to the different sources of information. Surveillance systems show lower numbers due to underreporting whilst surveys focussing on sharps injuries show much higher numbers. However, these different study methodologies do not allow a strict comparison between studies (Trim & Elliott 2003).

It is clear that incidences obtained through surveillance systems must be considered as absolute minimum numbers, as several studies indicated a great underreporting of sharps injuries varying between 26% and 90%. The main reason for underreporting was the estimated low risk of transmission (Elmiyeh

Author (publication year)	Country, setting, year	Infections incidence: transmissions as a result of sharps injuries
Glenngård and Persson (2009)	Sweden, 18 hospitals, 2002	HBV: 0.42 HCV: 0.56 HIV: 0.04
Elder and Paterson (2006)	UK (Scotland), 19 hospitals, 1990–2003	HBV: not mentioned HCV: 0.05 HIV: 0.32
<i>From database</i>		
Health Protection Agency Centre for Infections (2008)	UK, hospitals, 1997–2005	HBV: not mentioned HCV: 1.30 (1997–2005) HIV: 0.10 (1997–2005)

Table 3: Incidence of infectious disease transmissions due to sharps injuries (expressed per 100 sharps injuries).

Author, publication year, country setting	Cost per sharps injury
Glenngård and Persson (2009), Sweden, 18 hospitals	€272 (average), including (if applicable)* €31: blood screening for HBV, HCV and HIV (person + source patient) €2: ASAT/ALAT-testing €14: HBV vaccine testing €24: HBV vaccination if source patient pos. and person not vaccinated €24: if extra booster shot after vaccination needed €10: testing if exposed has full HBV vaccine coverage €11: if source patient positive for HCV, HCV-testing three and six months after €736: if source patient infected with HIV: doctor and four weeks of treatment €854: assumed exposed person makes six visits €1,590: extra treatment costs in case of HIV infection
O'Malley <i>et al.</i> (2007), United States, four healthcare facilities	Mean total costs according to the infectious status of the source patient** €323: if source patient HIV negative €558: if source patient HCV positive only €2,211: if source patient HIV positive only €2,410: if source patient HIV and HBV positive

Table 4: Societal costs related to sharps injuries.

*Costs were converted from Swedish kronor (SEK) to euro (€) according to price levels of 2007. **Costs were converted from US dollars to euro (€) according to price levels of 2003.

et al. 2004). Additional important reasons for underreporting were the fear of stigmatisation, a lack of time, the fact that reporting was a time-consuming process and a lack of routine in the reporting process (Glenngård & Persson 2009). Also, the healthcare setting and related workload and stress and the number of sharps handled were likely to influence the incidence of sharps injuries.

Specifically for renal care, data from the Fresenius NephroCare surveillance programme in haemodialysis centres revealed that their incidence rates are comparable with what is found in literature in terms of needle stick injuries reported with a mean incidence of 3.48/100 full-time employees and 3.72/100 HCWs, respectively. Additionally, the NephroCare data demonstrated that a decrease in the incidence rate could not be observed in the period 2006–2010, despite preventive efforts introduced in recent years.

However, during the last decade, several European and national interventions have been initiated, aiming to prevent sharps injuries and reduce the associated risks on infections. The concern over safer workplaces in healthcare settings and the avoidance of sharps injuries have stimulated the healthcare sector to work towards safer alternatives such as needles with safety capping or devices allowing intravenous drug applications without requiring sharp objects. Such alternatives prove that occupational exposures to percutaneous injuries and consequent infections with blood-borne pathogens amongst

HCWs are highly preventable and should be eliminated (Prüss-Ustün *et al.* 2005; Laramie *et al.* 2011). Although the more widespread use of safer application modes may further limit incidence rates of sharps injuries, only the introduction of needle-free methods may solve the problem definitively.

The latter would be particularly valuable in renal care, where the dialysis machine and the blood lines can offer opportunities to develop needle-free methods for the application of intravenous (IV) medication. Needle-free applications are placed at the top priorities in view of the most successful methods of protection (Wittmann *et al.* 2007). The method was tested in epoetin beta administration to patients on dialysis via the venous bubble trap short line of the haemodialysis circuit. No needle stick injuries were reported, haemoglobin levels were maintained and the system was well accepted by the nursing staff (Chow *et al.* 2009).

On appraising the effectiveness of available control measures, Hanafi *et al.* (2011) showed that indicative protective agents against needle stick injuries were utilising devices with safety measures [OR (odds ratio) 0.41], comfortable room temperature (OR 0.32), accessibility of a written protocol for ready reporting (OR 0.37), allegiance to infection control guidelines (OR 0.42) and instruction in injection safety (OR 0.14) (Hanafi *et al.* 2011). The latter finding emphasised once more the importance of continuous training efforts for all HCWs aiming to improve the

safe handling of sharps, particularly contaminated sharps, in the healthcare setting.

In 2010, additional, more specific requirements to protect HCWs from sharps injuries were introduced at the European level (Official Journal of the European Union 2010: EU Council Directive 2010/32/EU). Key points of the EU directive in achieving the safest possible workplace included a combination of planning, awareness raising, information, training, prevention and monitoring. For risk elimination, the EU recommended to eliminate unnecessary use of sharps, to train and adopt safer working practices and safer sharps disposal, to ban re-capping of needles and to use safety-engineered devices. All EU Member States had to bring into force the regulations to comply with this directive by May 2013 at the latest. As a result, for instance, regulations implementing the EU 'Sharps Directive' came into force across the UK on 11 May 2013. All NHS employers and employees need to be aware of and act upon the additional requirements (over and above existing health and safety legislation) resulting from the new regulations (NHS European Office 2013).

Sharps injuries also represent a serious cost factor. One should account for multiple laboratory testing, absence from work, treatments (both preventive and curative) and the efforts in finding the cause of injury and detecting the source of infection. Assuming mean values from published literature on the incidence and distribution of sharps injuries amongst nursing populations, an annual national burden of 65 million dollars was calculated for costs in the immediate period following sharps injuries in the United States (Lee *et al.* 2005a, 2005b). In Sweden, a conservative estimate indicated that sharps injuries cost annually €1.8 million (Glenngård *et al.* 2009). However, in reality these costs could easily increase substantially due to a significant underreporting, since the majority of sharps injuries are not reported and therefore not appropriately managed (Kessler *et al.* 2011).

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IMPLICATIONS FOR PRACTICE

The potential cost savings as well as the potential improvement of the occupational environment for HCWs are both arguments to be used to seek alternatives that reduce or ideally avoid the use of sharps objects in health care and particularly in renal care.

CONCLUSION

Sharps injuries remain a frequent threat amongst HCWs being a cause of severe infections. Incidences of sharps injuries range from 1.4 to 9.5 per 100 HCWs per year. Although safety procedures for potentially HIV-, HBV- or HCV-infected patients contribute to fairly low transmission numbers, follow-up of sharps injuries and treatment of infections still represent a significant cost.

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CONFLICT OF INTERESTS

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AUTHOR CONTRIBUTIONS

MME: conceived study, participated in design and coordination, participated in literature search, and draft the final manuscript. MA-G: Participated in design and literature search, helped to draft the manuscript, read and approved the final manuscript. AG: Participated in design and literature search, helped to draft the manuscript, read and approved the final manuscript. H-JA: conceived study, participated in design and coordination, read and approved the final versionfinal manuscript.

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