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Introduction

- Needlestick injuries (NSIs) and blood exposure (BE) remains a serious safety concern for healthcare workers (HCWs) across the European Union (E.U.). With an imminent possibility of contracting bloodborne infections from NSI or blood exposure, it is important to understand the clinical, economic and emotional burden on HCWs associated with such events.
- The World Health Organization (WHO) estimated that almost 3 million of 37 million HCWs experienced at least 1 NSI! Over 25 pathogens can be transmitted via needles.¹
- Blood exposure occurring from patients who tested positive for bloodborne viruses, such as HIV, HCV and HBV, can put HCWs at a higher risk of contracting the same bloodborne infections.
- Use of safety-engineered devices (SEDs) can reduce the risk of NSIs and blood exposure among HCWs, reducing the cost burden on healthcare systems.
- This literature review aims to aggregate and investigate the available evidence on NSI and blood exposure among HCWs as well as the impact of SEDs in the E.U. as no previous review has been conducted for this region.

Methods

- A targeted literature review of studies published in English from 2009 to 2019 was conducted using PubMed and the Cochrane Central Register of Controlled Trials (CENTRAL).
- Only high-quality studies that reported clinical, economic or emotional burden of NSI or blood exposure in HCWs were included. Studies were limited to human subjects. Eligibility criteria details are provided in Table 1.
- Titles and abstracts identified by the search were screened by 1 reviewer and verified by another reviewer. The qualifying full texts of relevant studies were then screened for inclusion with strict eligibility criteria.

Table 1. Eligibility criteria

PICO	Inclusion criteria	Exclusion criteria
Population	• HCWs experiencing NSIs or blood exposure experience percutaneous injury/exposure or mucocutaneous exposure	• Non-HCWs • HCWs experiencing NSI or blood exposure only during surgery or in labs, EMT, paramedics
Intervention	• N/A	• NSI/BE from suture needles, diabetic sharps
Comparator	• N/A	• N/A
Outcomes	• Clinical: NSI, blood exposure, infections (bloodborne) • Economic: cost, resources • HCW-related PRO: loss of quality of life, emotional distress, working efficiency • Other: knowledge, guidelines, practice change, prevention, risk factors	• Not NSI or BE relevant
Study designs	• High-quality, well-structured methodology	• Case studies, case series, commentaries, editorials, letters
Settings	• Inpatient	• Other than inpatient

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Results

- A total of 39 out of 1,330 studies were included. Study details are provided in Table 2.
- A significant risk for occupational exposures such as NSI, blood exposure, mucocutaneous exposure, and percutaneous injuries/exposure is found among HCWs within the E.U. Occupational exposures are associated with certain healthcare professions, devices, lack of safety device use, training and improper safety practices. Economic and emotional burden are underreported in the E.U.

Discussion

- This targeted literature review highlights various burden associated with NSIs and blood exposure for HCWs in the E.U.
- Burden of NSI and mucocutaneous exposure is high among European countries, and nurses and physicians are impacted the most.^{3,9}
- Severe underreporting of occupational exposure exists in the E.U.^{4,5,7,8,11-14}
- Although prevalence of bloodborne infections is low, it represents a significant burden among HCWs. SEDs and training programs can reduce the burden.^{16,20,22-25}
- NSIs and blood exposures are associated with fear of seroconversion and significant anxiety among HCWs.^{11,26,27}
- This targeted literature review can improve the awareness of HCWs in the E.U. on the burden associated with NSI and blood exposure.
- Limitation of these results stem from limited evidences for economic and emotional burdens in the E.U. region.

Conclusion

- NSI and blood exposure impose significant clinical, economic and emotional burden on HCWs in the E.U.
- Training and SEDs may reduce such burden and are cost effective within certain parameters.^{16-20,22-24,28}
- Decision- and policy-makers at the hospital and national level should promote the use of SEDs and training programs to enhance HCWs' safety in healthcare institutions.

Table 2. Summary of studies reporting clinical, economic and emotional burden for NSI and blood exposure

Study name	Study type	Outcomes studied and significance
CLINICAL BURDEN		
United Kingdom and Ireland (15 studies)		
Flynn et al. ²¹ 2012	Prospective study	- Between 2008–2011, 415 OBEs reported - PE accounted for 87% of OBEs, MEs for 11% - Nursing staff accounted for 59% of the total exposures
Flynn et al. ³ 2015	Retrospective study	- In 2012, 110 OBEs were reported - PE accounted for 83% of OBEs, MEs for 15% - Nursing staff accounted for 52% of the total exposures
Riddell et al. ³⁰ 2015	Review	4,830 healthcare-associated occupational exposures to body fluid were reported between 2004 and 2013 71% of these for percutaneous injuries
Gabriel et al. ⁶ 2009	Review	37% of nurses reporting that they have sustained an NSI or sharps-related injury at some stage during their career
Varsoou et al. ⁵ 2009	Retrospective study	11% of students had experienced at least 1 contaminated sharps injury in 2007 and, of those, 40% had reported the most recent incident
Burrows et al. ¹⁰ 2010	Retrospective study	62.6% reported 1 or more instances of NSI from incapacitated patients
Salzer et al. ³¹ 2011	Retrospective study	34% reported at least 1 NSI during medical school 76 respondents did not report their most recent injury to an employee health office 78% of those who had suffered an NSI were not aware of the patient's HIV status
Tomkins et al. ³² 2012	Retrospective study	15 reported cases of documented HCV seroconversion occurred after PE - Seroconversion rate was 2.2% for occupationally acquired HCV among HCWs
Naghavi et al. ¹¹ 2013	Retrospective study	54% had sustained at least 1 NSI during their training 38% of injuries were not reported
Roff et al. ³³ 2014	Prospective study	Study suggests that spatter is produced from manually activated safety needle devices
Rice et al. ⁶ 2015	Retrospective study	14 HCWs acquired HCV following a sharps injury - Most common locations for significant sharps injuries were hospital wards, operating theaters and EDs - Injuries among medical and nursing staff in wards and operating theaters accounted for 53% of all reports
Beynon et al. ¹⁶ 2015	Retrospective study	170 NSIs from 2010–2011, 151 NSIs from 2011–2012, 165 NSIs from 2012–2013 (introducing new devices in May 2013), 122 NSIs from 2013–2014 26% reduction after introduction of the new sharp-safe needles
O'Sullivan et al. ³² 2011	Retrospective study	26% of interns sustained an NSI within the first 8 months of internship 75% of the interns reported their NSI
O'Connor et al. ¹³ 2011	Retrospective study	48.5% of medical reported past NSI - The mean number of NSI is about 2.4
Kevitt et al. ¹⁴ 2015	Retrospective study	325 sharps injuries were reported: 124 (38%) in 2008, 103 (32%) in 2009 and 98 (30%) in 2010 - Glove use was reported in 80% of reported injuries from 2008–2010 compared with 74% from 1998–2000
Italy (7 studies)		
Sossai et al. ¹⁷ 2010	Prospective study	NSI rate was 24.1 per 100,000 cases when conventional catheters were used and 0.4 per 100,000 cases with safety catheters (98% reduction)
Stefanati et al. ⁷ 2015	Retrospective study	909 biological accidents were reported (81.18% in nurses and 18.82% in students) - Blood was the main biological material involved (83.72%), mostly by PE (84.16%) 53% of subjects reported having had at least 1 injury during their career and 5.72% did not report it
Sossai et al. ¹⁸ 2016	Prospective study	- Average NSI rate of 23.4 per 10,000 person-years - Risk of NSIs due to conventional and safety catheters was 44.9 and 1.8 per 10,000 person-years
d'Ettorre et al. ¹⁵ 2017	Retrospective study	103 cases of NSIs reported: cumulative 4-year incidence of NSIs was 13.20 per 100 FTE positions - No injured RNs reported more than 1 NSI
Brusaferrero et al. ¹⁸ 2009	Retrospective study	Between 1998 and 2006, incidence of sharps injuries was reduced from 11% per year to 4% after implementation of training program (education on biological risk, availability of protective devices)
Petrucchi et al. ² 2009	Retrospective study	10.29% of students had experienced at least 1 accidental exposure to blood or other potentially infected biological materials - MEs were more frequent than PEs (62.2%), and hollow-bore needle was the device most often involved 39.5% of the exposed students claimed they did not report the accident
Triassi et al. ³³ 2018	Review	- Average rate of percutaneous and ME is 5–13 exposures/100 beds per year, and 63% of PEs are due to accidental punctures with a needle, 33% to puncture/injury with other needle/sharp devices and 4% to other objects/devices - Adoption of NPDs reduced consequences of occupational exposure to biological risk by 63%–100% - According to the SIROH study, introduction of NPDs in Italy reduced specific exposure rates by about 75%
Netherlands (5 studies)		
Van Wijk et al. ¹⁸ 2010	Retrospective study	Estimated 6,500 blood exposure accidents annually occur in hospitals (10/100 FTE)
Schneeberger et al. ¹⁶ 2012	Retrospective study	2,927 OBEs were reported. Incidence rate was 68.5 per 1,000 person-years for private clinics, 54.3 for hospitals
Frijstein et al. ⁷ 2011	Retrospective study	66% of exposures are from NSIs, occurred among experienced nurses (27%) and medical students (18%) - In 34% of the accidents, the source patient tested negative for HBV, HCV and HIV - In 8% of accidents, the patient tested positive for 1 or more of the bloodborne viruses
Van der Molen et al. ³⁰ 2012	RCT	Use of relatively simple protective NPDs and interactive communication workshops are effective measures for reducing NSIs – NPD + workshop OR 0.34; workshop only OR 0.45
Schuermans et al. ²¹ 2018	Retrospective study	Incidence of NSIs increased from 1.9 per 100 HCWs before the introduction of SEDs to 2.2 per 100 HCWs after the introduction of SEDs

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Study name	Study type	Outcomes studied and significance
France (5 studies)		
Deuffich-Burban et al. ³⁷ 2011	Review	- Occupational exposure incidence rate per 100 beds: 8.9 in 2004; 8.0 in 2006; 7.4 in 2008 (estimates from the French national surveillance network) - Material involved in occupational exposure: needle (37%), syringe (17.5%) and catheter (9.8%) - Patient source status: HIV+ (2.7%), HCV+ (4.4%), HBV+ (1.4%) and unknown (20.8%)
Floret et al. ² 2015	Retrospective study	- BFE incidence rate per 100 beds: 7.5 in 2003, 6.3 in 2012 - Percutaneous injuries were the most frequently reported BBFE (84.0% in 2003 and 79.1% in 2012) - SED use increased from 2008 to 2012, and using SED was systematically associated with a lower frequency of percutaneous injury, whatever the implied device (<i>P</i> = .003)
Noe et al. ³⁸ 2015	Prospective study	52% of blood exposure incidents have not been declared as occupational accidents - Reasons for nursing students underreporting of BE incidents: negative perceptions and feelings (personal fault 55% and awkwardness 82%), fear of negative consequences (31%) on the evaluation of their internship and on their nursing training
AES-Raisin Network. ³⁹ 2015	Surveillance	At the AES-Raisin Network in France, exposure of blood and bodily fluids among HCWs occurred at a rate of 3.8 per 100 nurse FTE, with the most common incidents primarily caused by NSI (66%)
Tosini et al. ²³ 2010	Retrospective study	453 fully documented NSIs that involved SEDs were reported. Overall NSI incidence rate for IV catheter was 3.78 NSIs per 100,000 purchased - NSI (per 100,000 devices purchased) associated with vascular catheterization with active manually sliding shield device was 4.34 (3.24–5.44), with active semiautomatic safety feature was 2.54 (0.51–4.58), with passive device was 1.31 (0.00–2.80)
Belgium (2 studies)		
Deuffich-Burban et al. ²⁶ 2011	Review	8.4 incidence rate per 100 beds from 2003–2009; material involved in occupational exposure: needle (56%) and catheter (10.8%) - Patient source status: HIV+ (2.1%), HCV+ (4.4%), HBV+ (1.6%) and unknown (47.7%)
Hanmore et al. ⁴⁰ 2013	Budget impact analysis	This study refers to the Lamontagne 2007 study, which shows NSI rates per 100,000 devices reduced from 26.0 with conventional devices to 8.8 with SEDs (66% reduction)
Denmark (1 study)		
Eskandarani et al. ⁴¹ 2014	Retrospective study	- During the 2003–2012 period, 2,274 BBFEs were recorded. In 2012, 90% of cases were PE, whereas 10% were MEs - Prevalence and incidence of HIV, HBV and HCV among HCWs was 0
Sweden (1 study)		
Glenngard et al. ²⁸ 2009	Retrospective study	3.14/100 FTE average reported sharp injuries in 2002; ~3,906 number of sharps injuries involve hollow-bore needles per year - Incidence of transmission of bloodborne viruses to HCWs after PE to an infected source patient is estimated at 10%–30% for HBV, 3% for HCV and 0.3% for HIV
Spain (1 study)		
Campins et al. ²⁵ 2009	Case control study	- A total of 512 injuries were included. Education in occupational risk prevention was found to be a protecting factor - Increased risks were found for those younger than 25 years, physicians, those working in operating theaters, emergency services, intensive and life-support units, and those exposed to poor lighting
ECONOMIC BURDEN		
Italy (2 studies)		
Mannocci et al. ²⁴ 2016	Systematic review	Overall aggregate direct + indirect costs: \$650–\$750 managing an NSI (\$425 direct and \$322 indirect costs)
Triassi et al. ⁷ 2018	Review	Each event of exposure to biological agents resulting from NSSI is estimated to cost around €375 (\$416)
Netherlands (1 study)		
Van Wijk et al. ³⁵ 2010	Retrospective study	A single blood exposure accident may cost between €65 and €620 among HCWs
Belgium (1 study)		
Hanmore et al. ⁴⁰ 2013	Budget impact analysis	€51,710 – Estimated 5-year savings of managing fewer NSIs after introducing SEDs
Sweden (1 study)		
Glenngard et al. ²⁸ 2009	Retrospective study	1.8 (SEK 16.3) million – Estimated annual cost of investigation and treatment for HCV, HBV and HIV in Sweden. For hollow-bore injuries alone among HCWs, the annual cost is estimated to be 1 (SEK 9.8) million
EMOTIONAL BURDEN		
United Kingdom (3 studies)		
Naghavi et al. ⁴² 2013	Retrospective study	12% of doctors who suffered NSI during their training showed evidence of PTSD - Doctors who had NSI were 4.28 times more likely to report PTSD than those in the general population
Green et al. ²⁷ 2013	Retrospective study	24% of post-NSI patients described an initial period of up to 2 days of acute anxiety, disbelief, tremor and profound sleeplessness consistent with an acute stress reaction; 76% of post-NSI patients had a diagnosis of adjustment disorder
Hambridge et al. ⁴² 2016	Systematic review	1 nursing student said they would have considered suicide if seroconversion occurred. 1 student still felt “numb” 2 months after the sharp injury, fearing they may have acquired HIV
Abbreviations: BBF , blood and body fluids; FTE , full-time employee; HCW , healthcare worker; ME , mucocutaneous exposure; NPD , needlestick prevention devices; NSSI , needlestick and sharps injuries; OBE , occupational blood exposure; PE , percutaneous exposure; PTSD , post-traumatic stress disorder; SED , safety-engineered device.		

Abbreviations: **BBF**, blood and body fluids; **FTE**, full-time employee; **HCW**, healthcare worker; **ME**, mucocutaneous exposure; **NPD**, needlestick prevention devices; **NSSI**, needlestick and sharps injuries; **OBE**, occupational blood exposure; **PE**, percutaneous exposure; **PTSD**, post-traumatic stress disorder; **SED**, safety-engineered device.

