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Needlestick Injuries, Short Peripheral Catheters, and Health Care Worker Risks

ABSTRACT

Percutaneous exposure (PCE) and mucocutaneous exposure (MCE) to blood and blood-containing body fluids pose risks to health care workers worldwide. Although PCEs have been greatly reduced in the United States, they have not been eliminated and continue to be a significant problem worldwide. MCE seems to be a much smaller problem than PCE; however, the data are limited and confusing. Venipuncture procedures can easily be associated with PCE, but there are no published reports of MCE occurring during insertion, use, and removal of peripheral catheters. This integrative, systematic literature review identifies the risks associated with venipuncture and the insertion of short peripheral catheters.

Exposure to infectious diseases has historically been a major concern for all health care workers (HCWs). In the past 3 decades, however, our attention has been acutely focused on injuries from needles, sharps, and blood exposure. In 1991, the Centers for Disease Control and Prevention (CDC) established a standardized investigation protocol for surveillance of human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS). These reports span the years 1981 to 2010; however, no new documented cases of occupationally acquired HIV in HCWs have been added since 1999. Four possible cases have been added within the past 4 years and are still under investigation.[1,2] A European article reported the total worldwide data on definite and possible occupationally acquired HIV, with 91% of the definite cases being caused by percutaneous exposure (PCE) (Table 1).[3]

Using data from the Bureau of Labor Statistics and the Occupational Safety and Health Administration (OSHA), plus seroprevalence, transmission rates, and the natural history of the disease, the estimated deaths for some occupationally acquired infections have been calculated for the United States. For the hepatitis B virus (HBV), the CDC estimated in 1983 that 10 000 HCWs were infected with HBV. This has greatly decreased since the use of standard precautions and recombinant vaccines, although the CDC estimated that another 400 HCWs were infected with HBV in 2002. For hepatitis C (HCV), it is estimated that 3 to 8 HCWs will die annually of liver disease from occupationally acquired HCV and that 13 to 42 HCWs in the United States will die annually from all infection-related disease (including tuberculosis) due to occupational exposure.[2]

PCEs and mucocutaneous exposures (MCEs) from blood splashes are primary causes of occupational exposure. Percutaneous injury can occur with any sharp device; however, needles, especially those that are large gauge, hollow bore, and blood filled, carry the greatest risk of occupationally acquired bloodborne diseases. Short peripheral catheters used to access veins and arteries meet all of these criteria. Mucous membranes of the eyes, mouth, and nose are also at risk for blood exposure during any procedure in which blood splashing occurs.

The insertion and removal of short peripheral catheters has become a very common procedure for many types of HCWs in a wide variety of health care settings. Sales data for these catheters suggest that at least 330 million of these devices are sold in the United States annually. This number dramatically increases when worldwide use is considered, however.

A systematic literature review was undertaken to identify the risk to HCWs and their facility/employers

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TABLE 1

Occupationally Acquired HIV/AIDS in HCWs

	Documented Cases	Possible Cases
United States	57 • 24/57 (42%) were nurses • 26/57 progressed to AIDS	143 • 35/143 (25%) were nurses • 121 (86%) progressed to AIDS
Europe	35	85
Remainder of the world	14	14

Abbreviations: AIDS, acquired immunodeficiency syndrome; HCWs, health care workers; HIV, human immunodeficiency virus.

associated with the insertion of short peripheral intravenous (IV) catheters. Two search questions were formulated:

1. For HCWs in all clinical settings, what are the possible outcomes associated with the insertion of short peripheral IV catheters with an engineered safety mechanism?
2. For all health care organizations, what are the possible risks associated with the clinical practices of insertion of short peripheral IV catheters with an engineered safety mechanism?

SEARCH METHODOLOGY

The author conducted a thorough search of published literature from January 2000 through December 2010 without limiting the type of articles or research study designs in any way. Articles published in the English language from all over the world were included. The following search terms and combinations were used: *needlestick injuries (NSI), seroconversion and NSI, hepatitis seroconversion and NSI, HIV seroconversion and NSI, mucocutaneous blood exposure, health care worker and NSI, nurses and NSI, physician and NSI*, and *surgeon and NSI*. Databases searched using these terms included MEDLINE through the Internet-based PubMed, ingentaconnect, Cumulative Index to Nursing and Allied Health Literature, and Google Scholar.

The first online search produced thousands of potential published articles. The author reviewed the abstracts of these articles for their relevance to the 2 search questions. From this, 568 were selected for further review. Table 2 provides an explanation of these studies. The final total of articles included in this review is 187.[1-3,5-188]

RESULTS

Types of Diseases

Although HIV, HBV, and HCV remain the primary concern associated with these injuries, there are case reports of malaria,[7] dengue virus,[8] and syphilis[10] documented to occur from NSI. Other diseases reported to have been associated with NSIs include tuberculosis, herpes, diphtheria, gonorrhea, typhus, and Rocky Mountain spotted fever.[186] Other articles referred to more than 20 types of infectious agents documented to be transmitted through NSI.[150,186]

Data Collection and Analysis

There are numerous methods for data collection used in these studies. Many descriptive studies reported on injuries from both clean and contaminated devices, making risk assessment a challenge because clean or unused devices caused the largest majority of these events. Studies from most developed countries include injuries associated with a used device, whereas studies from developing countries tend to include both clean and contaminated devices.

There are multiple methods used to calculate rates and a variety of denominator data. The only agreement seems to be among those who use the processes recommended by the Exposure Prevention Information Network (EPINet) from the International Healthcare Worker Safety Center at the University of Virginia, but use of EPINet is not prevalent in the articles from developing countries. The most frequent and inconsistent variable is the denominator, which could be the number of events per 100 occupied beds, per 100 person-years, or per 100 full-time equivalents.

Incidence rates and/or prevalence rates are provided in some studies but generally without any consistency. Incidence rates report the occurrence of an event within a certain time period and, therefore, rely on denominator data for calculation. Prevalence data report the total number of events or diseases within a specific population. Incidence rates are generally greater in critical care staff and for all staff with fewer years of experience. Prevalence rates are greater among older and more experienced staff because they have more years performing risky procedures.

There are many variables that make it almost impossible for hospitals to conduct useful data comparisons, such as a meta-analysis. The wide range of knowledge about occupational exposure, bloodborne pathogens and the resultant diseases, and reporting processes indicates that there are no consistent educational programs available.

TABLE 2

Classification of Papers in Literature Review

Type of Studies	Number of Articles Included	Strength of the Body of Evidence—INS[4]	Summary of Contents
Case studies[5-10]			
	6	V	Reports of 12 health care workers who contracted malaria, dengue fever, syphilis, and HIV
Descriptive studies			
Health care worker surveys[11-83]	73	V	Surveys were sent via mail or delivered in person to a variety of HCWs in multiple countries, including the United States, Canada, China, Taiwan, Japan, South Korea, Malaysia, Cambodia, Nepal, Iran, India, United Arab Emirates, Pakistan, Afghanistan, Egypt, Tanzania, South Africa, Nigeria, Uganda, Ethiopia, Australia, Italy, Germany, Turkey, Romania, Denmark, England, and Ireland, among other countries. All relied on the memory of HCWs to recall number of exposures within a specific time period, usually the past year.
Surveys to facilities/ organizations[84-97]	14	V	Surveys sent to multiple hospitals to obtain data about various practices or rates of documented or reported PCE Studies from European countries, the United States, Canada, Australia, Iran, Pakistan, India, China, Taiwan, Japan, and England
Surveillance[98-138]	41	V	These studies report on PCE/MCE documented at the time of the incident according to facility policy and procedures.
HCW survey and surveillance data combined[139,140]	2	V	Combination of HCW survey data and surveillance data. This is 1 method for calculating rates of underreporting, but the survey process still relies on memory.
Device or process change[141-145]	5	V	Data collection of PCE/MCE before and after a change in device or process
Educational intervention[146-148]	3	V	Data collection of PCE/MCE before and after an educational program
In vitro studies[149,150]	2	V	Bench testing of a double-gloving practice and study on blood splatter from different venipuncture devices
Cohort studies[151-154]			
	4	IV	Assessed impact of BBP training on knowledge and behavior of nursing students in China Epidemiology of PCE in interns and relationship to extended work hours Occupational exposure in 10 HCWs followed for 32 months for HCV monitoring
Case-controlled studies[155-157]			
	3	IV	Risk factors for HCV transmission Risk and protective factors for PCE in Brazilian hospital HCWs from multiple US and Canadian cities with PCE and MCE; differentiated data between those personnel scrubbed for OR in procedural setting (continual risk) vs those not scrubbed working in other settings (noncontinual risk)
Correlational studies[158]			
	1	IV	Australian study of perioperative nurses Survey results correlated to barriers for reporting PCE and MCE Identified changes in process for reporting
Randomized controlled trials[159]			
	1	III	Evaluated the difficulties with insertion of nonsafety vs safety IV catheters

(*Continues*)

TABLE 2 Continued

Classification of Papers in Literature Review

Type of Studies	Number of Articles Included	Strength of the Body of Evidence—INS[4]	Summary of Contents
Systematic literature reviews of articles of various prospective designs[160-162]			
	3	II	17 studies since 1995 that evaluated effect of safety-device implementation ~400,000 PCEs annually in hospital-based HCWs Alternative settings not included, but these account for 60% of health care labor force UK sharps injury rates from review of 24 papers 12.74/100 beds/year Lower than US rate of 18-24/100 beds/year Underreporting up to 61% IV catheter stylets had highest rates of 15.7 to 18.4/100 000 devices. Assessed risk of disease transmission with emphasis on higher disease prevalence in general populations, greater disease severity on admission, higher viral loads, and higher proportion of chronic HBV carriers in developing countries Reported problems in developing countries with lack of resources
Meta-analysis[163]			
	I	1	Assessed HIV infectivity following single exposure by accidental PCE or contaminated blood product
Miscellaneous[1-3,164-188]			
	28	V Regulatory for all OSHA documents	Editorials, letters, opinion pieces, etc

Abbreviations: BBP, bloodborne pathogens; HBV, hepatitis B virus; HCV, hepatitis C virus; HCW, health care worker; HIV, human immunodeficiency virus; INS, Infusion Nurses Society; IV, intravenous; MCE, mucocutaneous exposure; OR, operating room; OSHA, Occupational Safety and Health Administration; PCE, percutaneous exposure.

Terminology

Numerous terms, phrases, and abbreviations are found in the literature. These terms are used interchangeably and have been grouped together by the manner in which the exposure occurs—percutaneous or mucocutaneous (Table 3). Data on PCE usually have many more details about the incident.

Data on MCE include the type of professional receiving the splash and where it occurred (eg, patient room, operating room, other). MCE reporting may not include the procedure being done or the details of why the event happened. The largest body of data on all blood splashes comes from the operating room and laboratory settings. No reports have been found of MCE occurring concurrently with a venipuncture procedure or in association with a PCE from a catheter insertion procedure. Although a few studies report PCE and MCE occurring at the same time, there are no details provided that point to this occurring during the use of any type of peripheral catheter or venipuncture procedure. Most MCE data highlight that personal protective equipment (PPE) was not being used when the event occurred.

Numerous words and phrases are used to describe infusion-related procedures, including *infusion, IV sampling, IV injection, putting up IV line, IV line related*, and *flushing IV lines*. These terms could be referring to the venipuncture procedure to insert a short peripheral catheter, a winged steel needle, or some other type of straight needle; connecting IV administration sets together; or giving medication(s) and/or flush and lock solutions into the catheter. Some, but not all, studies provide NSI data separately for a blood sampling venipuncture versus a venipuncture to insert a short peripheral catheter. Additionally, several studies reported a greater risk of NSI from winged steel needles, also known as "butterfly" needles, but no studies have separated these needles from other catheter stylets. In the United States, winged steel devices are primarily used for drawing blood samples and possibly a 1-time dose of a medication. In other countries, this is often the preferred device for infusion therapy. Reports have indicated that the attached extension

TABLE 3
Terms Used in These Studies

Term	Definition
Percutaneous exposure (PCE)	Puncture with any contaminated sharp device
Also known as Sharps injury (SI) Needlestick injury (NSI)	Needles are separated into 2 categories: Hollow-bore devices including all needles used for intramuscular, subcutaneous, and intravenous injection Solid needles such as those used for suturing Sharps include scalpels, glass ampoules, and any other instruments.
Mucocutaneous exposure (MCE) Also known as Accidental blood exposure (ABE) Blood and body fluid exposure (BBFE)	Three types of exposure: Direct contact of intact skin of the HCW and blood or blood-containing body fluid of a patient—considered to pose no risk Direct contact of nonintact skin (eg, dermatitis, cuts, abrasions) with blood or blood-containing body fluid of a patient Direct contact of mucous membranes of the HCW (eg, eye, mouth, nose) with blood or blood-containing body fluid from a patient

Abbreviation: HCW, health care worker.

tubing gets tangled with tape, making it difficult to place safely in a sharps container.

Types of HCWs

All studies focus on the HCW at the bedside performing patient-care tasks. A few studies also report downstream injuries to housekeeping staff and waste-management personnel. Most experts agree that these downstream NSIs can be eliminated and that workers can be protected by correct management of all sharp devices.

The professional group with the greatest risk depends on the scope of practice for each group. In most countries, nurses have the greatest risk of NSI because they are the group using the majority of hollow-bore needles. The specific professional performing venipuncture procedures varies between countries. Whereas nurses have this responsibility in the United States, junior physicians in many countries perform this procedure. Studies that assessed risks only for surgeons in the operating theater focused on suture needles and other types of blood splashes and were omitted from this analysis.

HCWs employed in home care have a different set of issues. The home is not generally regarded as a workplace, and the HCW may have little to no control over the environment. Challenges come from inadequate space to perform procedures, poor lighting, limited access to hand-washing facilities, work interruptions from other family members, issues associated with pets, the presence of vermin or pests, and varying levels of cleanliness within the home. HCWs in the home are usually working alone with heavy caseloads and need to travel great distances between homes.[177]

Paramedics are reported to have rates of blood exposure to nonintact skin more than double the rate of NSI. This type of MCE represents about half of all exposures for this group. These survey data highlight that there could be variations in the definition of *nonintact skin*, and thus the data might be unreliable. Exposure rates to eyes, nose, and mouth in this group are similar to rates for NSI. No additional details of how MCE occurs for paramedics were included in these studies.[77,177]

Underreporting of Exposures

Severe and serious underreporting of PCE and MCE is included in all of these studies, with some reporting extremely high rates. This compromises the ability of the organization to provide postexposure prophylaxis (PEP) and monitoring of the HCW's health status (data such as critical laboratory values or mental health). In countries where applicable, underreporting would have a negative impact on an employee's ability to claim worker's compensation if illness did occur. Reporting behavior is strongly influenced by the HCW's personal assessment of the perceived risk for each event.

A study of Australian operating room nurses attempted to correlate rates of PCE and MCE events with self-protective behaviors supported by the application of standard precautions. Data were collected through a survey of perioperative nurses and observation of practice. The intention to report PCE/MCE events was very high; however, compliance with reporting was very low. Nurses did not perceive that a great risk of contracting a bloodborne disease was present with most of these exposure events. They also did not perceive a benefit in reporting these events. The most significant problems with reporting occurred especially with reporting MCE, and these problems included the time required for reporting, embarrassment associated with reporting, the paperwork required, and the inconvenience of reporting.[158]

Physicians have the worst rates of reporting exposure events, a common theme among numerous studies. Some of the same issues create barriers to reporting, including the time and paperwork required and the perception that, as physicians, they can do a self-evaluation of the risks from each event.

MCE is reported to be significantly lower than PCE, which might cause a perception that this is less of a problem than it truly is. The low rates of reporting MCE could be related to the HCW's perception that the risks of disease transmission from MCE are extremely low. Data on occupationally acquired HIV infection included 51 PCEs (all from a hollow-bore needle) and 8 MCEs. In this report, 2 HCWs had concurrent PCE and MCE events. Descriptions of the 8 MCE events did not include insertion of a short peripheral IV catheter.[119]

Knowledge and Attitudes About Standard Precautions

The use of standard precautions, derived from the merger of universal precautions and body substance isolation, is the primary strategy to prevent transmission of infectious agents in all health care settings. The basic principle is that all blood, body fluid, secretions, excretions (except sweat), nonintact skin, and mucous membranes may contain transmissible infectious agents. Standard precautions should be applied to all patients, regardless of suspected or confirmed infection status, in all health care settings. The components of this strategy include hand hygiene; use of PPE such as gloves, gown, mask, eye protection or face shield depending on the anticipated exposure; and safe injection practices.

The HCW must make appropriate decisions about the type of PPE to be used for a given procedure or patient interaction. This means that education and training are a significant part of implementation of standard precautions. Moreover, the large majority of articles highlight numerous breaches of standard precautions and a serious lack of understanding about how to employ this set of precautions. The nature of the HCW-patient interaction and the extent of anticipated exposure to blood, body fluid, and pathogens guide the choice of PPE. The CDC guidelines document discusses venipuncture as an example of a procedure in which only gloves may be needed. Whereas face masks are recommended for insertion of central venous catheters and epidural/spinal catheters, there are no recommendations to use any type of face protection during insertion of a short peripheral catheter.[189] The following quotation is taken from the CDC document:

> Use PPE to protect the mucous membranes of the eyes, nose and mouth during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions and excretions. Select masks, goggles, face shields, and combinations of each according to the need anticipated by the task performed. *Category IB/IC*[189(p80)]

Safe injection practices include the use of single-dose vials and single use of all needles and syringes. Replacement of the cap or covering on used needles is addressed in standard precautions and in OSHA's Bloodborne Pathogen Standards. The following is taken from the CDC guidelines document: "Do not recap, bend, break, or hand-manipulate used needles; if recapping is required, use a one-handed scoop technique only; use safety features when available; place used sharps in puncture-resistant container."[189(p129)]

Recapping is reported to be extremely high in most studies, including a significant number from studies conducted in the United States. HCWs may not believe or accept that leaving a needle exposed is safe. This is primarily because there may not be enough access to sharps containers in the right locations, or the containers may not be made of the right material or design.

Short peripheral catheters with all types of engineered safety mechanisms would eliminate the need for recapping. Assuming no failure of the safety device, there would be no needle exposed after the safety mechanism has been correctly deployed. Part of the problem occurs when the HCW fails to properly activate the safety mechanism on some designs.

Cultural Issues

Cultural issues are numerous. Several HCW surveys from China, Japan, and other Asian countries frequently reported the HCW's belief that he or she would not be unlucky enough to get a disease. This seems to be based in the cultural beliefs associated with luck or fortune, along with knowledge deficits about the scientific facts associated with disease transmission.

Additionally, in Asian countries, there are very high rates of all injections because of patient expectations that an injection is always required to get well. Financial considerations are an issue in some countries when reimbursement is greater for injections than for oral medication.[57]

Many articles discussed the culture of silence that fosters the serious lack of reporting for all NSIs and PCE/MCE events. Many facilities, especially in developing countries, lack an established process for documenting injuries. No formal encouragement or mandates come from administration; therefore, this lack of prominence discourages HCWs from reporting their injuries.

HCWs are generally interested in safe work practices, yet many may be fearful of allowing their blood samples to be taken. In some countries, a positive blood test for HIV could mean losing a job.[188] Also, some Middle Eastern countries employ many foreign HCWs and may have policies requiring repatriation to one's native country if the worker tests positive for a bloodborne disease. Several studies show that HCWs fear punitive measures because their employers blame the HCW in such cases.

Fear of caring for HIV/AIDS patients is culturally centered also. The HCW fears contracting the disease and, therefore, may refuse to provide needed care to these patients.

The culture among paramedics in the United States is associated with the thought that blood on uniforms is a badge of honor. This culture also discourages reporting of PCE and MCE events. Nevertheless, women tend to have better rates of reporting than men.[71]

RISKS IDENTIFIED

Risks associated with PCE and MCE cannot easily be divided between HCW and employer because the HCW is the one who will suffer the greatest number and severity of risks. The HCW bears the burden of disease transmission; device design and use; knowledge deficits; numerous fear-based and emotional issues; lack of access to safety devices, vaccines, and PEP; and legal issues.

The employer's risk would revolve around failure to protect employees from these hazards. Failure to provide safety devices increases the risk of injury. Failure to provide vaccines and PEP enhances the chance that the exposure will convert to actual infection—an infection that must be managed for the remainder of the HCW's life. The employer's legal risk depends on the specific laws in each country, and very few studies or reports are available except from the United States. This creates responsibility for employers to mitigate these risks for their employees. Extensive efforts have been made to quantify the risks of seroconversion by infectious agent (Table 4).

Disease Transmission From PCE

Exposure to PCE from needles remains a problem, with rates of these injuries being much greater than MCE. EPINet reported 951 PCE and 247 MCE events occurring in 2007, the most recent year for which data are available.[190] The risk of infection from these exposures increases with injuries to deep tissue, from a device with the patient's visible blood, and from a procedure with a hollow-bore needle placed in a vein or artery. PCEs from any needle used for venipuncture would meet these criteria.

Seroconversion to HIV, HBV, and HCV is dependent on the seroprevalence of each disease within the given population. In countries with high rates of infection among the general population, the risk of actual infection would be greater. The titer level or stage of active disease for each source patient also increases the risk of transmission to the HCW. Conversely, exposure does not always mean that infection will occur.

There have been no documented cases of HIV seroconversion in the United States for more than 10 years. This is attributed to the use of safety-engineered devices and PEP. The use of HBV vaccines is another method of reducing active disease from HBV. Provision of these protections is far from consistent throughout the world.

TABLE 4
Risk of Seroconversion

Disease	Rates of Seroconversion
Hepatitis B	6%-30% after PCE
Hepatitis C	0.5%-10% (average 1.8%) after PCE
HIV	0.3% after PCE
HIV	0.09% after MCE

Abbreviations: HIV, human immunodeficiency virus; MCE, mucocutaneous exposure; PCE, percutaneous exposure.

Disease Transmission From MCE

According to the published literature, disease transmission from MCE is a much smaller problem than PCE. The published data on MCE are limited to statistics on the type of HCW involved and the location within the organization where the event occurred. Studies from the operating room are much more detailed about MCE events, with data available for different types of surgeries. No reports have been found of MCE events resulting from any type of venipuncture procedure in any health care setting.

Data from the US national surveillance system for occupationally acquired HIV infection published in 2003 provide details of 8 MCE events that resulted in seroconversion. These events included contact with nonintact skin, the eyes, nose, and mouth. One MCE occurred during wound pressure to create hemostasis, another from an apheresis machine spill, 3 from broken blood collection tubes, 1 from splashes in an HIV production laboratory, 1 resulting from restraining a combative patient, and 1 from exposure to other bloody body fluids.[189] None of these events reported any type of needle involved with the event. One article contained a report of a nurse sustaining such a splash while drawing a blood sample from a dialysis patient. There were no details about exactly how or why this occurred.[191]

An Australian report of surveillance data on 931 blood and body fluid exposures (594 PCE, 337 MCE) used a phrase not seen in other studies: *parenteral mucocutaneous exposures*. There was no further explanation of the meaning of this phrase.[90]

Table 5 lists the risks identified through this literature review.

TABLE 5

Identified Risks Associated With Short Peripheral Catheter Insertion

Risk	Evidence
Device design	Surveillance data from 61 French hospitals[96] • 1.8 million IV catheters purchased • NSIs per 100 000 devices ○ 4.34 with active safety mechanism ○ 2.54 with semiautomatic mechanism ○ 1.31 with passive safety mechanism Active devices require HCW to activate mechanism. Passive devices automatically operate with the use of the device. Multiple elements influence successful use of all devices including • Training provided • Ease of use • Required changes in technique • Patient safety issues
	Randomized trial with 3 devices assessed[159]: • Insertion difficulty by number of attempts • Difficulties with stylet withdrawal • Number of blood exposures Blood exposure to staff on skin, gloves, mask, and/or clothing • Nonsafety catheter ○ 16 (6.3%) • Passive safety catheter ○ 18 (7.2%) • Active safety catheter ○ 39 (15.4%) Blood splashes to environment (eg, bed, floor) • Nonsafety catheter ○ 10 (3.95%) • Passive safety catheter ○ 21 (8.4%) • Active safety catheter ○ 30 (11.8%) Staff reported feeling more protected with a safety device, but there was greater exposure to blood with the safety devices. Passive safety design was reported to be easier to insert and had less blood exposure.
	In vitro study to evaluate amount of blood splatter from safety-engineered phlebotomy, an IV catheter, and butterfly device[150] Filter were sponges placed above and below venipuncture device on anatomical model with blood substitute. Weights of sponges were taken before and after each venipuncture. Weights were converted to blood volume. Catheter and butterfly showed greater difference in filter weights than phlebotomy device. Catheter • 13% of postactivation filters had weight increase of > 13% • 23% showed visible blood Butterfly • 11% of postactivation filters had weight increase of > 1.0 mg • 40% showed visible blood Authors discussed importance of face protection during venipuncture. Study did not measure distance or direction of blood splashes or splatters.
Knowledge deficits	Lack of knowledge among all types of HCWs, including physicians and nurses: • Disease seroprevalence in populations being served • Methods of disease transmission • Rationale for standard precautions • Correct methods to apply standard precautions

(*continues*)

TABLE 5
Identified Risks Associated With Short Peripheral Catheter Insertion

Risk	Evidence
Fears and emotional distress	HCW refusal to provide care to HIV/AIDS patients in Africa Retribution or punishment from employers who do not understand the multitude of causes Loss of job and being unemployable after contracting a disease Deportation to native country with documented seroconversion Loss of work time and salary due to testing and emotional response Extended periods of anxiety and depression, posttraumatic stress disorder for HCWs, spouses/domestic partners, and other family members
Lack of access	HCWs may lack access to the following protective measures: • Safety-engineered catheters • HBV vaccines • Testing of source patients • Initial and periodic testing of HCW after exposure • PEP treatment for HIV and noncompliance with drug regimen due to side effects • Immunoglobulin for HBV
Legal	In the United States, employers must meet requirements of SP and OSHA's BBP standard: • Provision of safety equipment • Postinjury testing • Vaccines • Postexposure prophylaxis HIPAA allows HCWs to have access to results of source patient's blood tests for purposes of "health care operations." Recourse for injured HCW is only through worker's compensation system rather than lawsuit for negligence against employer[184] Many legal differences exist in other countries. South African law requires source patient to be able and willing to give consent for blood testing. HCW has no recourse to compel the patient to provide consent.[183]
Voluntary vs mandatory provision of safety devices	Nonbinding nature of rules in Europe produces concerns. Voluntary provision in the United States before 2000 was weak. In 2000, an enforceable law was created, driving up adoption of safer devices dramatically and greatly reducing injury rates.[167,180]

Abbreviations: AIDS, acquired immunodeficiency syndrome; BBP, bloodborne pathogens; HBV, hepatitis B virus; HCW, health care worker; HIPAA, Health Insurance Portability and Accountability Act; HIV, human immunodeficiency virus; IV, intravenous; NSI, needlestick injury; OSHA, Occupational Safety and Health Administration; PEP, postexposure prophylaxis; SP, standard precaution.

DISCUSSION

The original goal of this review was to identify the risks to HCWs and their employers associated with the insertion of short peripheral IV catheters. Studies from all over the world were included, and, therefore, this review could not be limited to only safety-engineered IV catheters.

There is a lack of enforceable mandates to use safety-engineered devices except in the United States. Hospitals in the United States have seen a rise in the number of OSHA citations and fines in the years after the enactment of the Needlestick Safety and Prevention Act of 2000, a serious concern that drives compliance with the law. Small alternative health care facilities (eg, private doctors' offices, clinics, laboratories, etc.) in the United States remain slow to adopt safety-engineered devices, primarily because there is a lesser degree of enforcement in these organizations.[167] The US experience demonstrates that enforceable mandates, rather than voluntary compliance, are what increase the use of safety devices.

In the years after the US law went into effect, the number of NSIs has decreased. Whereas most data show a gradual decline across many years, data from Memorial Sloan Kettering Medical Center in New York showed a distinct and sharp decrease because there were no safety devices used in this facility until the law took effect. The number of injuries from hollow-bore needles dropped by 71% when safety-engineered devices were introduced.[20]

Many issues still remain to be addressed with research. The data on MCE are very limited. The occurrence of MCE during venipuncture has not been documented. The need for face protection during all venipuncture attempts has not been suggested. Because of the application of standard precautions, the decision about which PPE to employ for each procedure is generally left to the individual HCW, and it is assumed that all patients are managed as if they were potential sources of infection transmission. More data are needed about which safety designs on short peripheral IV catheters produce blood splashes, along with the distance and direction of those splashes. Armed with these data, HCWs can make more informed decisions about changing their practices associated with face protection.

The lack of knowledge among HCWs worldwide is alarming and is in need of improvement. Application of standard precautions should become the international standard for practice by all HCWs; however, use of standard precautions will not change until the knowledge gap is closed through expanded educational opportunities. Employers must also be required to enforce standard precautions along with providing the other components, but there may be no political will in many countries to enact such measures.

This literature review has some limitations, like all other similar projects. This type of literature review usually includes the cross-referencing of the bibliography list found in all articles to ensure that all literature has been found. The large volume of articles found, along with time limitations, did not allow for this comparison.

Data collection varies between studies, making an attempt at meta-analysis almost impossible. Meta-analyses are typically done only with randomized controlled trials, and this review process produced only 1 study of this design.

Finally, there may be numerous articles published in other languages that could not be included because no English translation is available.

This has been a serious attempt to evaluate what is known about the risks to HCWs associated with the insertion of short peripheral catheters as derived from the literature on NSIs and other types of sharps injuries. It is clear that the United States has made significant improvements but has not eliminated the problem. It is also clear that these injuries occur in other countries frequently but are seriously underreported by HCWs. The safety mechanism on short peripheral IV catheters continues to be refined, but it seems unlikely that the device alone will eliminate the problem. Changes in the behavior of HCWs must accompany the use of safety devices.

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