ECRONICON OPEN ACCESS

EC EMERGENCY MEDICINE AND CRITICAL CARE
Research Article

A Systematic Review on Interventions to Decrease the Rate of Needlestick Injury Associated Blood-Borne Diseases among the Healthcare Workers in the Low Resource Developing Countries

Wahida Kazi[1] and Shafi Bhuiyan[2]*

[1]University of Waterloo, Ontario, Canada and Toronto Public Health, Canada

[2]Assistant Professor, Dalla Lana School of Public Health, University of Toronto and Adjunct Professor and Co-founder ITMDs Post-Graduate Bridge Training Program, Ryerson University, Toronto, Canada

***Corresponding Author:** Shafi Bhuiyan, Assistant Professor, Dalla Lana School of Public Health, University of Toronto and Adjunct Professor and Co-founder ITMDs Post-Graduate Bridge Training Program, Ryerson University, Toronto, Canada.

Received: November 06, 2018; **Published:** November 27, 2018

Abstract

A needlestick injury is a common risk factor for an occupational exposure to the blood-borne diseases among the healthcare workers. It is a well-known occurrence in the health care settings and is often described as an accidental needlestick injury by the health professionals. In several low resource developing countries, the rate of unsafe injection practices related to the needlestick injuries among the healthcare workers is very high. From the literature review, it was found that, a combination of the prevention interventions is more effective than a single intervention to prevent a needlestick injury and the associated blood-borne diseases among the healthcare workers. In this article, we have recommended a combination of interventions to prevent the needlestick injuries among the healthcare workers. These are (i) Increased knowledge and awareness among the public and health care workers to prevent the overuse of an injection, (ii) Use of Auto-Disabled syringes and safety devices as appropriate, (iii) Healthcare workers education and training, (iv) Hepatitis B vaccination and a post-exposure prophylaxis, and (v) National injection safety strategy. For the meta-analysis, we have gathered data from nine articles which provided information on the Hepatitis B vaccination rate among the healthcare workers who were either the study participants or took part in the survey that was conducted during the study. The study findings show that the rate of the Hepatitis B vaccinations among the healthcare workers is statistically significant, although some selected studies are ambiguous regarding the completion of all the three required Hepatitis B vaccines among these study samples. Moreover, we collected data from four articles in order to see the effectiveness of the healthcare workers' training and education on their behavior and attitude changes towards unsafe injection practices.

Keywords: *Intervention; Needlestick Injury; Healthcare Worker; Hepatitis B Vaccine; Auto Disabled Syringe; Knowledge and Training; Implementation*

Introduction

Needlestick injuries (NSIs) are common among the healthcare workers whose job constitutes providing an injection to their patients, as well as the healthcare workers who deal with the disposal of medical waste containing sharps and needles. In the South Asian developing countries, the healthcare-associated NSIs related data is inadequate to estimate the true risk of the blood-borne pathogens transmission among the patient and staff. For example, in India, out of the 3 to 6 billion injections administered annually, two-thirds of the injections are unsafe [1]. Another literature review conducted by the World Health Organization (WHO) estimated that the unsafe injection

practices (for example, the reuse of a needle or syringe or an unsterile injection) are very rare in the developed world and, in contrast, the reuse of a needle for a therapeutic injection is the highest in the Southeast Asian countries, particularly in the South Asian developing countries [2,3]. The reuse of needles and syringes is one of the common unsafe injection practices in the low resource countries and these practices are associated with an increased number of NSIs among the healthcare providers and patients [2]. Worldwide, there is an annual occurrence of 2 million NSIs among the healthcare workers that result in Blood Borne Diseases (BBDs). According to the WHO, every year, globally, Hepatitis B and Hepatitis C infections constitute 40% and HIV constitutes 2.5% of the total occupational exposure-related diseases [4]. In the developing countries, the data on the NSIs are unavailable due to under-reporting. Due to a lack of reporting requirement, the staff often fails to receive proper post-exposure prophylaxis and subsequent follow-ups to reduce the risk of BBDs. As there is no vaccine for Hepatitis C and the Human Immunodeficiency Virus (HIV), the primary prevention such as the interventions to prevent the Needlestick Injuries (NSIs) [1] are the only way to protect the healthcare workers (HCWs) from an occupational exposure to HIV and Hepatitis C. The NSIs prevention interventions involve the availability of resources, increased staff awareness on the associated issue, staff training on safe injection practices, infection prevention and control guidelines, and occupational health and safety legislation.

Definition

Injection safety program: A program or an intervention at the health care setting to ensure injection providers have adequate knowledge and training prior to administered injection to their patient and health care staffs are also received adequate training before handling used needle and sharps. The health care facility must have administrative procedure and logistic in place to ensure the safe disposal of used needle and sharps to prevent any occupational health hazards. These program and activities must supported by ensuring the availability of the adequate resources, the administrative support and the legislations.

Unsafe injection practices: Unsafe injection practices include overuse of injection, reuse of needles, needle recapping, use of unsterile needle and syringe and improper disposal of used needles and syringe.

Interventions: Intervention includes i) Hepatitis B vaccination program for staff, and a procedure for reporting and post-exposure prophylaxis after an incident of occupational NSI, ii) Increase awareness of unsafe injection practices among public and health care workers, iii) Education and training for HCWs, iv) To ensure a safe and workable environment that is equipped with adequate healthcare resources: a) personal protective equipment, b) proper sharp disposal mechanism v) Alternative Injection device with safety features such as auto disabled (AD) needles and syringes to prevent reuse of needles vi) National injection safety strategies, vii) A safe injection program at the organisational level.

Infection prevention and control Guideline: A written guideline to ensure infection prevention and control practices are in place at the healthcare settings to prevent transmission of infection among patient and HCWs. One of the component of Infection prevention and control is to establish an internal surveillance system to routine monitoring of healthcare associated infection trends and to take immediate action to prevent transmission of infectious diseases.

Health Care Workers: Health care workers are the individuals working at various roles at the health care facilities. These include health care providers (doctor, nurse, intern), non healthcare providers (cleaning staff, food service workers, administrative workers, volunteers).

Objectives of the Study

(1) To determine the evidence-based interventions to prevent the NSIs among the healthcare workers in the low resource developing countries.

(2) To reduce the transmission of the blood-borne infections resulting from the NSIs among the HCWs.

Methods

A systematic review was conducted in order to gather the information on the unsafe injection practices and the associated blood-borne infection transmission risks among the healthcare workers in the South Asian countries. The original review gathered evidence from multiple studies which indicated that the NSIs among the HCWs occur as a result of the unsafe injection practices in the healthcare settings, especially in the south Asian developing countries. One objective of the original literature review was to determine the evidence-based interventions in order to prevent the NSIs among the HCWs in the low resource developing countries. The main focus of this article is to discuss the effective interventions in order to prevent the healthcare-associated NSIs among the HCWs and for this purpose, we have selected articles that provide information on the interventions related to preventing unsafe injection practices as well as needlestick injuries.

Literature Search

For the systematic review, articles were searched for in PubMed, Scopus, and Google Scholar. Only the articles with a full text have been included in this review by using several search strategies. The intervention-focused articles were searched by using the following keywords: 1)"Engineered needle" or "Auto-disabled syringe" or "Safety needle" and "Intervention" or "Experiment" and "Prevention" and "Needlestick Injury" - A total 6 items were found. 2) "Safe disposal of sharp" or "Biohazardous container" and "Prevention" or "Reduction" and "Blood-borne infection" or "Hepatitis B" or "Hepatitis C" or HIV - A total of 7 items were obtained from PubMed. 3) "Healthcare provider" or "Nurse" or "Student" and "Injection Safety" and "Training" or "Education" or "Knowledge" - A total of 4 items were found from PubMed. 4) "Needlestick Injury" and "Healthcare workers" and "Case-control studies" - A total of 202 articles were obtained from Scopus. 5) Google scholars - A total of 22 articles were found. Furthermore, articles were excluded if they were not written in English and if the full text was inaccessible from the online databases. Several articles were excluded as they were not helpful for the analysis of the topic of interest, such as in the case of articles where the information was not relevant to the intervention or prevention of the NSIs. Moreover, articles were excluded if they were not related to the developing or the underdeveloped countries or the South Asian countries.

Limitations

The intervention-related data was retrieved from the limited literature as it was one of the objectives of the original systematic review of the unsafe injection practices. The purpose was to conduct an anecdotal evidence synthesis or a small-scale literature review on selected articles in order to determine the effective interventions.

Meta-analysis

We have utilized comprehensive meta-analysis software to conduct a meta-analysis on the collected data.

Results

Descriptive analysis of findings from the literature review

Evidence-based Interventions to reduce Needlestick injuries and associated Blood-Borne Diseases among HCWs

Increased awareness to prevent overuse of injection

In the developing countries, unsafe injection practices in the healthcare situations not only affect the patient but the healthcare professional as well. The magnitude of the harmful effects of the unsafe injections is usually multiple due to an overuse of the injection. Both, the sociocultural and economic factors, influence the patient to demand an injection from the healthcare providers due to the misconceptions about the strength and overall effectiveness of the injections and the economic position of the patient, especially the poor patients who are spending money out of their pockets for the treatment which creates a desire for a speedy recovery so that they can earn back the money by returning to work [5]. Moreover, the healthcare workers are influenced by the incentives that they receive by prescribing the injections in the form of protecting their reputation by earning the patient satisfaction [6]. The healthcare workers believe that the patients want the injections and in most of the situations, the patients follow the healthcare workers and hardly understand the treatment process. This type of belief is difficult to rectify unless the healthcare workers and the professional bodies play a stronger role to commu-

nicate the message in order to prevent the overuse of the injections and to regulate the prescription policy. As the overuse of the injections and unsafe injection practices occur in the healthcare settings, injection safety awareness programs must commence at the healthcare facilities in order to increase the awareness among the healthcare workers. The interventions targeting the healthcare workers including the activities to raise an awareness of the unsafe injection practices and the associated blood-borne infection risks for the healthcare workers and the patients are important to bring about a change. Furthermore, it is important to increase the awareness regarding the inappropriate use of the commonly prescribed injections and the risks associated with the unsafe injections. Once the healthcare workers are aware of an injection safety issue, they can play an advocacy role for the policy changes and they can counsel their patients on the injection safety as well [7]. There is always a power difference between the healthcare providers and the patients in terms of knowledge and authority. The patients, especially if they are illiterate, have a minimum capacity to make the treatment decisions unless the healthcare workers explain the available options. Circulating an injection safety message in a culturally sensitive manner and through suitable media or large community gatherings is vital in order to attract a majority of the target audiences [8]. The dissemination of a clear message to the public on the differences between the safe and the unsafe injection practices, as well as the misuse of the injections without jeopardizing the importance of the injection as an essential medical procedure is important; otherwise, the public may have a misconception about receiving an injection as per medical indications such as the refusal of receiving a vaccine [7]. In the developing countries, the population receives the injection from various sources, some of which may be trained in medical practices, while some may also be untrained and traditional "healers". Educating the public on safe injection practices will increase their alertness and assist the people to make appropriate healthcare decisions.

Auto-Disabled syringes

Auto-Disabled (AD) syringes are an alternative option to the single-use disposable syringes in order to prevent the reuse of the needles and syringes between the patients [9]. The AD syringes, as suggested by their name itself, have safety features; a needle is permanently fixed with a syringe that cannot be separated from it to be reused and it is additionally engineered with a safety mechanism to disable the needle and syringe after a single use. As the practices of reuse of the needles by the healthcare workers and the collection of the used needles by the illegal sellers have escalated in several low resource developing countries, the World Health Organization has recommended the marketing and the use of the auto-disable syringes in the developing countries [10]. The use of an AD syringe can significantly contribute to the injection safety in the developing countries by preventing the reuse and resale of the contaminated or used needles and syringes. These needles have physical barriers to prevent the reuse and resale, but they cannot prevent the needlestick injuries among the healthcare workers due to accidental needlestick injuries. Inappropriate disposal can cause needlestick injuries among the patient and public [10].

In various developing countries, the reuse of the needles and syringes is still a major public health crisis. Various studies have shown that the reuse of the needle in the formal healthcare settings in the South Asian countries is still common and a majority of the study participants did not know if the recent injection that they received was administered with a new sterile syringe or not [2,11]. Reuse of a needle means that the HCWs are dealing with a contaminated needle rather than disposing of it immediately. As a result, they are not only causing harm to the person who received the injection but they also increase their risk of getting an NSI while handling the contaminated needle. A lack of the usage of the needle with a safety device (such as AD syringes) at the healthcare settings in the developing countries is one of the determinants of the needlestick injuries [4,12,13]. USA National Institute of Occupational Safety and Health recommended that the engineering controls, such as a needle with safety features, are needed to be included along with a comprehensive injection safety program in order to reduce the NSIs [12]. Due to the extra costs associated with the safety injection devices, the low resource developing countries may face an economic challenge to implement the interventions that promote the use of the AD syringes without the support of the international health organizations like the World Health Organization (WHO) [10]. Staff training constitutes an essential part of implementing the vaccination campaign with an AD syringe in some developing countries in order to ensure a familiarity with the new technology.

HCWs education and training

After receiving training on how to prevent contact with blood, body fluids, and safe injection practices, the healthcare workers' chances of exposure to blood and body fluids drop from a needlestick injury [14]. As a result of the training received by the participants (nurses) in a Harran University study, the rate of the needlestick injuries dropped from 30.6% to 20.8%. The same study showed that 60% of the nurses took preventative measures (e.g. wearing gloves) for the NSIs before the training and it increased to 86.5% (e.g. wearing gloves) after the training. The rates of the Hepatitis B vaccinations among the HCWS also increased due to the training and more HCWs reported NSIs to the authority after receiving the training [14-16]. Several studies on the frequency of injuries among the nurses showed that a systematic and continual education correlated with a reduced frequency of NSIs is required [16]. Other studies conducted by Mohammadi., *et al.* showed that a higher number of activities by the infection control committee can produce a lesser incidence of NSIs. The rate of the mucocutaneous exposure was high due to an inadequate knowledge and the shortage of necessary equipment. The poor handling of the contaminated needles and the subpar containment of needles and the other sharp objects increase the risk of an occupational transmission of the blood-borne diseases such as Hepatitis B [17]. An easy solution would be providing training on how to handle the used needles, as well as supplying immediate and safe disposal methods for the sharp objects/needles (e.g. puncture proof sharp containers) at the point-of-care. Continuous education and established protocols on where and how the person should seek the treatment after the needlestick injuries will reduce the levels of the blood-borne injuries in the hospital staff [16]. It is important to understand the poor compliance with the standard practices by the healthcare workers before implementing interventions. The HCWs perception of risk and the severity of the BBDs exposure from the contaminated needles have a significant influence on the compliance with the standard practice. The perception of the barriers involved in undertaking the desired behavior such as safe injection practice constitutes another determinant of not complying with the standard practices [18]. Education and staff training can influence the perception of risk and therefore improve the HCWs decision-making process. In addition, a safe working environment and an adequate supply of resources help to reduce the negative attitudes resulting from the perception of barriers. Intervention-related studies show that a combination of interventions, such as training and an adequate supply of safety devices, produce better results in reducing the NSIs than the training or a safety device alone [13,19].

Hepatitis B vaccine

The healthcare workers are at an increased risk of blood-borne infections from needlestick injuries. Especially in the developing countries, the unsafe injection practices and improper disposal of needles and syringes puts the healthcare workers at a risk of exposure to the bloodborne infections like Hepatitis B, Hepatitis C, and HIV. Moreover, overwork, fatigue, and busy and prolonged shifts are contributing factors for accidental needlestick injuries among the healthcare workers.

Additionally, the healthcare workers are at a greater risk of acquiring Hepatitis B when the population that they serve has a high prevalence of Hepatitis B. For example, in India, an estimated prevalence rate of HBV among the general population is 4.7% and the Hepatitis B prevalence rate among the healthcare workers is 5% [20]. One of the studies conducted in Sri Lanka indicated that the Hepatitis B vaccine is not free for the medical students, as a result of which several medical students are not aware if they are immune to the Hepatitis B virus or not [21]. One of the sub-groups at a high risk of exposure to Hepatitis B is the healthcare workers. The HWCs must receive complete doses of Hepatitis B for their own protection and to protect their patients from the healthcare-associated Hepatitis B infections; it comprises of 3 doses of the Hepatitis B vaccine at 0, 1, and 2 months, followed by a booster dose given at 12 months [20]. In the USA, there is a sharp decline (in 1995, 800 HCWs became infected with HBV in comparison to 1700 in 1983) of HBV among the HCWs, which occurred as a result of the widespread immunization of the healthcare workers with the Hepatitis B vaccine along with the other measures required by the Occupational Health and Safety Law [12].

Post-exposure prophylaxis

Both, vaccines and post-exposure prophylaxis, help to reduce the risk of occupational exposure related Hepatitis B infections among the health care workers [12,16,20]. Furthermore, post-exposure prophylaxis required the baseline serology to check for immunity against

the Hepatitis B virus. The post-exposure prophylaxis may not work equally for Hepatitis C and HIV. Antiviral medication is used as a post-exposure prophylaxis for the HIV. These drugs may reduce the risk of becoming infected with HIV after the exposure, but there are adverse effects associated with these drugs. The antiviral drug or immunoglobulin is not recommended as the post-exposure prophylaxis for Hepatitis C [12]. The healthcare workers must follow-up for seroconversion and recommended early treatments of Hepatitis C if seroconversion occurs. There is no vaccine for Hepatitis C and HIV. Therefore, the prevention of a needlestick injury is the best approach to preventing occupational exposure among the healthcare workers [12].

Healthcare facilities must have clear guidelines regarding the exposure (for example, NSIs) incident reporting and post-exposure prophylaxis after an exposure to the blood and body fluid of the infected individuals.

National injection safety strategy

A national injection safety strategy must be put in place in order to bring consistency to the safe injection practices in various healthcare settings across the country (such as vaccine providers, family medicine, family planning clinics, and the emergency department) [22]. The core elements or components of the national injection safety strategies must be unchangeable but the peripheral components must be tailored according to an individual program's requirement and must be modified according to the available resources. The South Asian nations should adopt a national injection safety strategy in order to stop the unsafe injection practices from occurring, particularly, the reuse of needles. The ultimate goal of the national strategy is to reduce the morbidity and mortality associated with the injection-associated BBDs transmission. The main objections are (i) to reduce the misuse of injections by policy changes, (ii) to prevent the unsafe injection practices by providing staff training and making infrastructure related changes, (iii) to ensure that vaccination is provided with auto-disabled (AD) syringes and to promote AD syringes to provide other therapeutic/curative injections, where it is applicable, and (iv) to ensure safe medical waste management [22]. One of the benefits of having a national injection safety strategy is to engage the key stakeholders to receive a long-term commitment and to ensure the budget to sustain the program. Besides being part of the national program, at the regional level, the program receives adequate attention from the target audiences. On the other hand, the collaborative efforts from various stakeholders are beneficial for the program and help to mitigate the challenges such as resource scarcity. Benchmarking or defining the standard practices constitute an important first step of any national strategy or program [22]. Through this process, the current situation can be measured by comparing it to the benchmark or the standard situation [22]. At the beginning of the planning phase of the national infection safety program, an assessment of the current situation is required at the national level. By assessing the current situation, the most important and common problems related to the injection practices can be identified and prioritized [22]. Moreover, it is required for determining the health disparities and, subsequently, the identification of high-risk geographical areas or sub-groups.

It is important to have a systematic process to monitor the progress of the implemented program. The qualitative and quantitative indicators must be set up to evaluate the injection safety program at the national and organizational level. The input, process, and outcome evaluation must be done to assess the effectiveness of the program in order to ensure the sustainability [22].

Meta-analysis

In the meta-analysis section, we have incorporated table 1 related to the Hepatitis B vaccine rate among the healthcare workers in the low resource countries. The figure 1.1 and figure 1.2 shows that the Hepatitis B vaccination rate among the healthcare workers is statistically significant. Such findings are not very straightforward to interpret because most of the studies did not clarify if the staff members have completed all of the three doses of the Hepatitis B vaccines in order to consider them as immune to the Hepatitis B infection. The table 2 is related to the effectiveness of the staff training and the subsequent change in the knowledge and practices related to the injection safety and the needlestick injury prevention measures. The figure 2.1 and figure 2.2 show that the effectiveness of the staff training yielded statistically significant differences between the pre-intervention and post-intervention knowledge and attitudes of the HCWs.

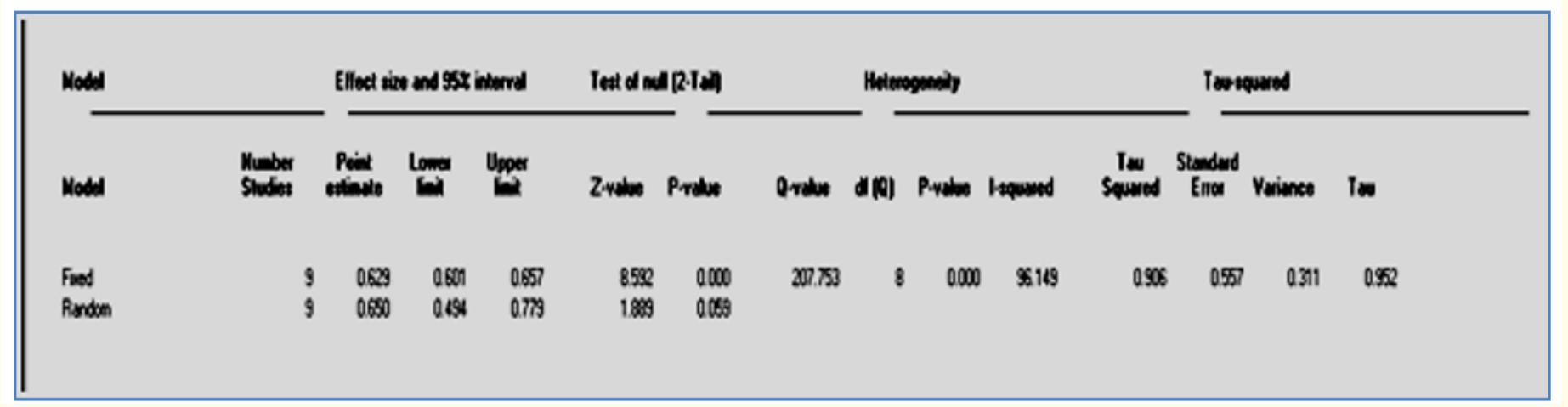
Identifying #	Author's name and Year	Study type	Geography	Study participant/ target population	Rate of Hepatitis B vaccine among HCWS	Serology check or prove of immunity against Hepatitis B	Post exposure prophylaxis (antiviral medication)	Reporting of NSIs	
1	Liyanage, 2012 [21]	CSS	Srilanka, Colombo	n = 190 medical student.	154 (92%)	10%	5.7% (% of students followed the accepted post exposure prophylaxis).	Not reported = 89(47%).	
2	Yao, 2013 [23]	CSS	China	n = 246 nursing student	123 (50%).	Not provided.	Not provided.	Not provided.	
3	Gorar, 2014 [24]	CCS	Pakistan, Sindh province, Jamshoro district.	Case = 81 and Control = 83. Total # of participant = 164.	Case = 50 (61.7%) and control 59 (71%). Total = 109 (66.35%).	Not provided.	Not provided.	Not provided.	
4	Vong, 2005 [25]	CSS	Cambodia (Takeo province and Phnom Penh).	n = 30+30 = 60 (Injection provider).	20% or 12	Not provided.	Not provided.	Not provided.	
5	Gyawali, 2015 [26]	CSS	Western Nepal, Kaski District.	96 HCWs (45 urban and 51 rural) from 69 primary health care facilities.	Urban = 26(57.8%) + rural 31 (60.8%). Total = 57 (59.4%).		No PEP guideline and no process available to follow WHO's recommended PEP procedure..	Not provided.	Chi square 0.090. p value = 0.765.
6	Chowdhury, 2011 [27]	CSS	Bangladesh, 6 divisions.	n = 120 (Injection providers).	Injection providers had at least one hepatitis B vaccination. Average 24.3 or 20.25%.	Not provided.	Not provided.	Not provided.	
7	Ersin, 2016 [14]	Semi experimental study.	Turkey, Sanliurfa	n = 144 nurses.	Hepatitis B vaccine = 30 (20.8%) and hepatitis B-tetanus vaccine = 66 (45.8%). Total = 96(66.66%).	Not provided	Not provided.	Reporting of NSIs = 14 (31.8%) and not reporting = 130 (90.27%).	
8	Mohammadi, 2011 [16]	CSS	Central Iran, Qazvin.	n = 150. Total response = 138	3 doses of hepatitis B vaccine completed = 133 (96.4%).	Post vaccination antibody titration = yes 103 (74.6%). and not done = 35 (25.4%).	Conducted antibody titration after NSI (% of total NSI) = 22 (15.9%) and no titration done after NSI = 116 (84.1%).		Immunization status OR = 0.94 95% confidence interval = (0.89 to 0.99) and Antibody titer conducted after NSIs, OR = 1.06 95% CI of odds ratio (0.71 to 1.42).
9	Samargandy, 2016 [28]	Retrospective chart review/ CSS	Saudi Arabia	n = 326 Total number of HCWs exposed by percutaneous injuries = 302)	219 (67%) of exposed individuals were immune to Hepatitis B at the time of exposure)	72 (8.28%) followed up after exposure.			

Table 1: *Rate of Hepatitis B vaccination among HCWs/Reporting and post exposure prophylaxis among HCWs after Needle sticks Injuries.*

Identification #	Author and year of publication.	Type of study.	Geography	Study sample size = n	Outcome (changes in knowledge, attitude and practice after intervention).	Pre-intervention.	Post- intervention.	p value.
1	Sangeetha, 2015 [29]	CSS	India	n = 157	Knowledge (related to recapping and NSIs) among HCWs.	33.75%	42.03%	p = 0.01
1	Sangeetha, 2015 [29]	CSS	India	n = 157	Knowledge (related to reporting of NSIs).	73.88%	78.98%	p = 0.16
1	Sangeetha, 2015 [29]	CCS	India	n = 157	Practice (related to hand washing before and after patient care).	52.20%	82%	p = 0.0001
1	Sangeetha, 2015 [29]	CSS	India	n = 157	Practice (related to avoid recapping the needle after use).	24.20%	56%	p = 0.0001

2	Ersin, 2016 [14]	Semi-Experimental study.	Turkey	n = 144 (89%) of total 161 participant responded.	Percentage of nurses took preventive measures for NSIs before and after training.	60%	86.50%	
2	Ersin, 2016 [14]	Semi-Experimental study.	Turkey	n = 144 (89%) of total 161 participant responded.	Sharp container must be changed when it gets full (2/3) - number of HCWs answered correct before and after interventions.	95 or 66%	140 or 97.2%	
2	Ersin , 2016 [14]	Semi-Experimental study.	Turkey	n = 144 (89%) of total 161 response.	Is vaccination important in prevention of Hepatitis B?-answered before and after training.	109 or 75.7%	121 or 84.0%	
3	Yao, 2012 [23]	Observational study	China	n = 248 (nursing student).	Recapping before and after education provided.	230 (20.11%)	4 (10%)	Chi-square value = 85.71
3	Yao, 2012 [23]	Observational study.	China	n = 248 (nursing student).	Blood assay after NSIs.	11(0.96%)	40 (100%)	Chi-square value = 85.71
3	Yao , 2012 [23]	Observational study.	China	n = 248 (nursing student).	Reporting after NSIs.	43 (3.76%)	39 (97.5%)	Chi-square value = 175.77
3	Yao, 2012 [23]	Observational study.	China	n = 248 (nursing student).	Used needle or sharps are timely placed into a specific container.	76.09%	100%	Chi-square value = 27.15
3	Yao, 2012 [23]	Observational study.	China	n = 248 (nursing student).	Placed in a special container and sent to the designated place for disposal.	73.86%	100%	Chi-square value = 30.07
3	Yao, 2012 [23]	Observational study.	China	n = 248 (nursing student).	Hepatitis B vaccine received.	50%	100%	Chi-square value = 2875.55
4	Altaf , 2013 [8]	Observational study.	Pakistan (Tando Allayar, Sindh)	n = 300 (study population).	Knowledge (related to reporting of NSIs).	27 or 9%	234 or 78%	
4	Altaf, 2013(8).	Observational study.	Pakistan (Tando Allayar, Sindh)	n = 300 (study population).	Knowledge (related to reporting of NSIs).	45 or 15%	87 or 29%	

Table 2: *Injection Safety Training among HCWs (Pre-intervention and Post-intervention outcomes).*



Model	Effect size and 95% interval			Test of null (2-Tail)		Heterogeneity				Tau-squared			
Model	Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
Fixed	9	0.629	0.601	0.657	8.592	0.000	207.753	8	0.000	96.149	0.906	0.557	0.311	0.952
Random	9	0.650	0.494	0.779	1.889	0.059								

Figure 1.1: *Shows the overall effect size and 95% confidence interval, p values of data from selected studies (in Table 1) both by random and fixed model.*

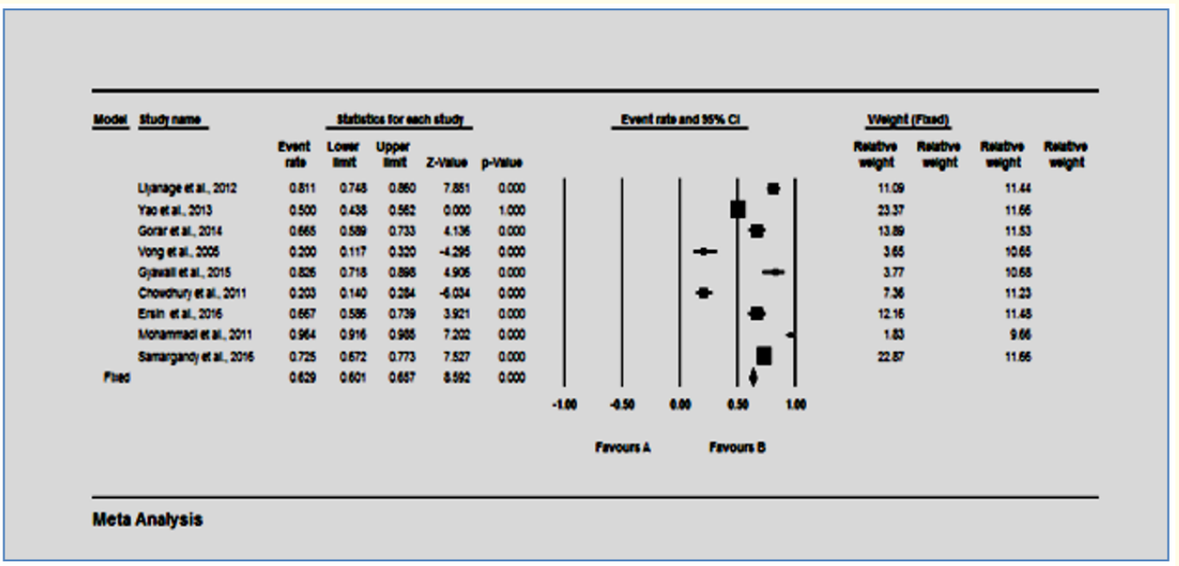


Figure 1.2: *This forest plot shows the crude event rate for the 'Hepatitis B vaccination rate among HCWs ' in each study and pooled event rate of the 'Hepatitis B vaccination rate among HCWs' in all included studies. By fixed model, the p value is 0.000 which is < 0.05 and the finding is statistically significant.*

Effect size and 95% interval				Test of null (2-Tail)		Heterogeneity				Tau-squared			
Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
4	0.214	0.153	0.299	-9.053	0.000	13.678	3	0.003	78.067	0.421	0.444	0.197	0.649
4	0.199	0.097	0.408	-4.395	0.000								

Figure 2.1: *Shows the overall effect size and 95% confidence interval, p values of data from selected studies (in Table 2) both by random and fixed model.*

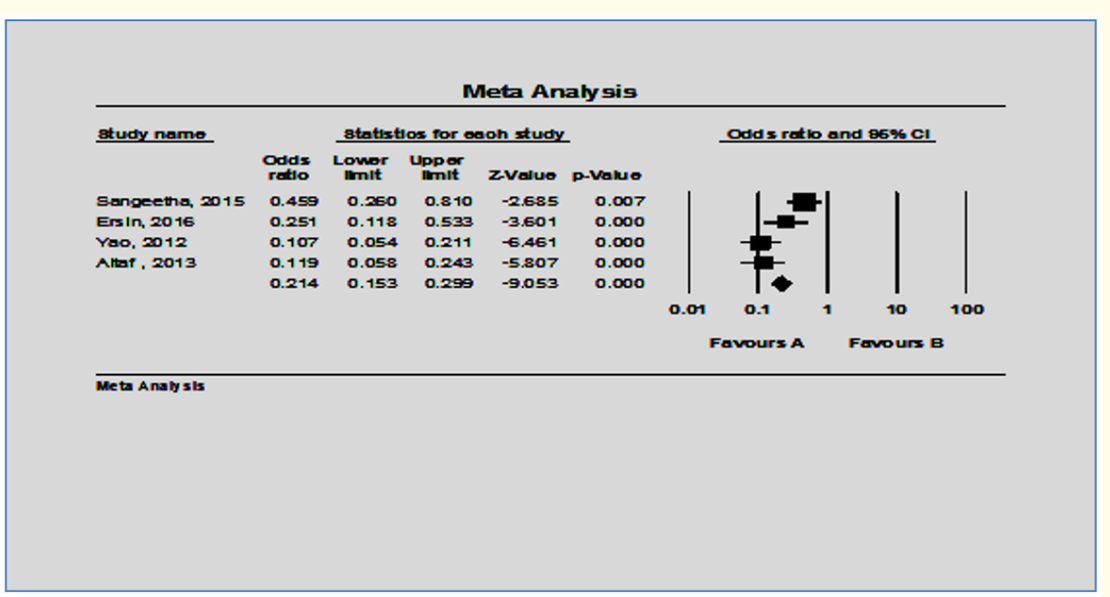


Figure 2.2: *This forest plot shows the OR for staff training and subsequent 'changes in injection safety knowledge, behaviour and attitude' in each study and pooled result in all included studies. By fixed model, P value is 0.003 and the finding is statistically significant.*

Discussion

In the low resource developing countries, there are multiple factors that act as a barrier to the successful implementation of the needle safety program or the interventions discussed in the earlier section. Inadequate supplies (e.g. puncture proof sharps disposal container) and the lack of safety equipment (personal protective equipment), inadequate training on injection safety, understaffing, high flow of the patients, long working hours and time constraints are stated by the study participants as contributory factors for the NSIs among the HCWs [14]. Without careful consideration of these factors, the implementation of the injection safety intervention may not yield the expected outcomes. One of the major barriers of the safe injection practices in the developing countries is that the healthcare facilities are not completely patient-focused [30]. Like several developed countries, the universal health care system is not available, so the healthcare facilities deal with poor patients who cannot pay the cost of the health care services and the healthcare facilities, most often, cannot meet patient's healthcare needs. As per the consolidated framework for the implementation research (CFIR), the patient's characteristics such as the vulnerabilities in terms of the socioeconomic background, age, income, and gender must be considered in order to design an intervention [30]. Healthcare organizations must ensure how many resources they have and how these resources can be distributed in order to meet the patient's needs. For example, the injection safety program must secure a budget in order to ensure that the poor patient can receive essential injections with sterile needles, routine health check-ups, and screenings to identify the blood-borne diseases among the population that they served. Adaptability is an important intervention characteristic [30]. According to this concept, the injection safety programs must ensure that the core components are intact, irrespective of the situation. For example, the uses of the core process of safe injection administration cannot be compromised, but the peripheral processes can be modified as required. For example, the successful implementation is possible if the program is adaptable to the local needs. For example, if the core component is to discard the used needles and sharps into a puncture-proof sharps container, the program must have tailored peripheral components according to local need. For example, to ensure the final disposal of these biohazardous containers by contracting out the service or destroying those by putting them into the onsite incinerator based on the local need.

The target audience of the injection safety intervention comprises of the healthcare workers, and the healthcare workers behavioral change constitutes one of the core components for the successful implementation of the safe injection practices [31]. The targeted behaviors of the healthcare workers that need to change are:

(1) Reduce an overuse of the injection or avoid unnecessary injections.

(2) Ensure that the administration of each and every injection is accompanied by safe injection practices.

(3) To ensure the health-care worker's adherence to the preventative measures (both pre and post-exposure prophylaxis) in order to avoid the harm associated with the unsafe injection practices.

According to Michie., *et al.*'s, behaviour change wheel, all of these targeted behavioral changes are possible if these efforts are accompanied by the appropriate behavior change interventions and policy guidelines to enable the HCWs to change their targeted behavior [31]. For example, to reduce the overuse of the injection or to avoid unnecessary injections is possible by a way to determine when the injection administration is unnecessary and what procedure must be in place that prevents the staff to provide unnecessary injections. One of the interventions can be a continuing education and training opportunity for the staff to keep their knowledge up to date. Keep a record of the number of injections administered and an indication of administration of an injection. The associated intervention must be supported by clinical practices, guidelines, and a strict regulation of the pharmaceutical products. Additionally, it is important to know what the alternatives are if the injection is not a proper treatment. The staff must be administered with an appropriate oral medication or supportive treatment as required. If the illness does not need any oral or injection medication, the health care workers must counsel their patients on why the overuse or unnecessary use of medication or injection is harmful in the concurrent particular situation. The healthcare workers must receive training to empower them to be an advocate to prevent overuse of injection.

Lesson learned

1) The NSIs resulting from unsafe injection practices constitute one of the major risk factors for the transmission of the BBDs among the HCWs. The review suggested that there are various factors that are associated with the unsafe injection practices among the HCWs in the low resource developing south Asian countries. A combination of various injection safety-related interventions has a better outcome than a single intervention.
2) Implementation of an intervention will be successful once the healthcare workers' perception and attitudes towards the implemented intervention change through training and education. At the same time, targeted behavioral changes are only possible if these efforts are accompanied with the appropriate behavioral change interventions (for example, safe environment, adequate resources, infection prevention and control guidelines, internal communication from the organizational authorities) and policy guidelines (occupational health and safety legislation and regulation of prescription drugs) in order to enable the HCWs to change their targeted behavior [31].
3) It is very important to ensure that the healthcare workers receive Hepatitis B vaccines and booster doses as required. Universal Hepatitis B vaccination is also an option to eliminate or reduce the prevalence of the Hepatitis B infection.
4) Implementation of the national program for the safe and appropriate use of the injection across all the involved health care programs and services areas in a geographical area or country (for example, vaccination, family planning, primary health care) will bring the required consistency in the safe injection practices at various level of the healthcare sectors and to ensure that emphasis is given to reduce the health disparity [22].
5) As the burden of the blood-borne infection through the unsafe needle and syringe use are huge in the developing and underdeveloped countries, the WHO has been promoting auto-disabled syringes and has a future plan to subsidize the cost of the auto-disabled needles to ensure the acceptance and adaptation of these new devices in several low resource countries [9].
6) An average risk of acquiring HIV from a needlestick injury is 0.3%. The risk of the Hepatitis B transmission among the susceptible healthcare workers ranges from 6% to 30% after a single needlestick injury to an HBV infected patient. The seroconversion rate (suggest infection) among the HCWs exposed to the HCV through a needlestick or percutaneous injury averages 1.8% (range 0% to 7%) [12]. There is no vaccine for Hepatitis C and HIV. Therefore, the prevention of a needlestick injury constitutes the best approach to preventing occupational exposure among the healthcare workers [12].
7) It is also important to develop a framework to plan, implement, and evaluate any of these above-mentioned interventions. The consolidated framework of implementation science by Damschroder., *et al.* [30] has provided various details regarding how multiple factors are associated with the successful implementation. We would like to suggest this framework as it constitutes a comprehensive tool that has addressed multiple factors which the program planner can consider prior to the implementation of an injection safety program.

Conclusion

The consequence of Hepatitis B and C and HIV is premature death, chronic illnesses that lead to loss of productivity; they increase the burden on healthcare from an outpatient visit and hospitalization [32]. Some studies conducted in the South Asian countries indicated that the HCWs knowledge on the unsafe injection practice, NSIs, and associated BBDs are inadequate [33]. Various studies have concluded that the healthcare workers are at the highest risk of exposure to the blood-borne infections from needlestick injuries [14,24,28]. There is no vaccine for Hepatitis C and HIV. Therefore, the prevention of a needlestick injury is the best approach to preventing occupational exposure among the healthcare workers [12]. In several developing countries, a combination of underreporting, a lack of monitoring, and no surveillance systems imply that assessing the NSIs among the healthcare works is difficult. A study conducted under the WHO estimated that every year, unsafe injections cause 1.3 million early deaths, a loss of 26 million years of life, and direct medical costs of 535 million US dollars [34]. **In conclusion,** we would like to re-emphasize on the fact that the healthcare-associated infections such as the BBDs from the NSIs constitute a significant public health issue and the healthcare authorities should take every step to implement an effective multifaceted intervention in order to mitigate the impacts of the NSIs among the healthcare workers in the developing countries.

Bibliography

1. Muralidhar S., *et al*. "Needle stick injuries among health care workers in a tertiary care hospital of India". *Indian Journal of Medical Research* 131 (2010): 405-410.

2. Hutin YJF., *et al*. "Use of injections in healthcare settings worldwide, 2000: literature review and regional estimates". *British Medical Journal* 327.7423 (2003): 1075.

3. "Injection Practices in India. IPEN Study Group". *WHO South-East Asia Journal of Public Health* 1.2 (2012): 189-200.

4. Wilburn SQ and Eijkemans G. "Preventing Needlestick Injuries among Healthcare Workers: A WHO-ICN Collaboration". *International Journal of Occupational and Environmental Health* 10 (2004): 451-456.

5. Gupta E., *et al*. "Unsafe Injection Practices: A Potential Weapon for the Outbreak of Blood Borne Viruses in the Community". *Annals of Medical and Health Science Research* 3.2 (2013): 177-181.

6. Shill MC., *et al*. "Injection practices at primary healthcare units in Bangladesh: Experience at six upazilla health complexes". *Australasian Medical Journal* 4.1 (2011): 26-42.

7. Kermode M. "Unsafe injections in low-income country health settings: Need for injection safety promotion to prevent the spread of blood-borne viruses". *Health Promotion International* 19.1 (2004): 95-103.

8. Altaf A., *et al*. "Lessons learned from a community-based intervention to improve injection safety in Pakistan". *BMC Research Notes* 6 (2013): 159.

9. World Health Organization. "WHO calls for the worldwide use of smart syringes" (2015).

10. Lloyd JS and Milstien JB. " Auto-disable syringes for Immunization: Issues in technology transfer". Bulletin of the World Health Organization 77.12 (1999): 1001-1007.

11. Khan AJ., *et al*. "Unsafe injections and the transmission of hepatitis B and C in a periurban community in Pakistan". *Bulletin of the World Health Organization* 78.8 (2000): 95-103.

12. Centers for Diseases Control and Prevention. National Institute for Occupational Safety and Health(NIOSH). Preventing needlestick injuries in health care settings. [DHHS (NIOSH) Publication No. 2000-108] (1999).

13. van der Molen HF., *et al*. "Interventions to prevent needle stick injuries among health care workers". *Work* 41.1 (2012): 1969-1971.

14. Ersin F., *et al*. "Effect of the training provided for nurses on sharp-needle stick injuries and reporting process". *International Journal of Caring Sciences* 9.2 (2016): 561-568.

15. Tomkins SE., *et al*. "Occupational transmission of hepatitis C in healthcare workers and factors associated with seroconversion: UK surveillance data". *Journal of Viral Hepatitis* 19.3 (2012): 199-204.

16. Mohammedi N., *et al*. "Percutaneous exposure incidents in nurses: Knowledge, practice, and exposure to hepatitis B infection". *Hepatitis Monthly* 11.3 (2011): 186-190.

17. Zafar A., *et al*. "Impact of infection control activities on the rate of needle stick injuries at a tertiary care hospital of Pakistan over a period of six years: an observational study". *BMC Infectious Diseases* 9 (2009): 78.

18. Osborne S. "Influences on compliance with standard precautions among operating room nurses". *American Journal of Infection Control* 31.7 (2003): 415-423.

19. Mehta A., *et al*. "Interventions to reduce needle stick injuries at a tertiary care centre". *Indian Journal of Medical Microbiology* 28.1 (2010): 17-20.

20. Franco E., *et al*. "Hepatitis B: Epidemiology and prevention in developing countries". *World Journal of Hepatology* 4.3 (2012): 74-80.

21. Liyanage IK., *et al*. "Sharps injuries among medical students in the faculty of medicine, Colombo, Sri Lanka". *International Journal of Occupational Medicine and Environmental Health* 25.3 (2012): 275-280.

22. World Health Organization. "Managing an injection safety policy. A framework to benchmark, assess, plan, implement and evaluate a national strategy for the safe and appropriate use of injections" (2003).

23. Yao W., *et al*. "Occupational safety training and education for needlestick injuries among nursing students in China: an Intervention study". *Nurse Education Today* 33.8 (2013): 834-837.

24. Gorar ZA., *et al*. "Risk factors for bloodborne viral hepatitis in healthcare workers of Pakistan: a population based case-control study". *BMJ Open* 4 (2014): e004767.

25. Vong S., *et al*. "Rapid assessment of injection practices in Cambodia, 2002". *BMC Public Health* 5 (2005): 56.

26. Gyawali S., *et al*. "Knowledge and practice on injection safety among primary health care workers in Kaski district, western Nepal". *Malaysian Journal of Medical Sciences* 23.1 (2016): 44-55.

27. Chowdhury AK., *et al*. "A comprehensive situation assessment of injection practices in primary health care hospitals in Bangladesh". *BMC Public Health* 11 (2011): 779.

28. Samargandy SA., *et al*. "Epidemiology and clinical consequences of occupational exposure to blood and other body fluids in a university hospital in Saudi Arabia". *Saudi Medical Journal* 37.7 (2016): 783-790.

29. Sangeeta S., *et al*. "Standard precautions: An assessment of awareness among healthcare personnel in a teaching hospital, South India". *Journal of Evidence Based Medicine and Healthcare* 2.6 (2015): 638-644.

30. Damschroder LJ., *et al*. "Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science". *Implementation Science* 4 (2009): 50.

31. Michie S., *et al*. "The behaviour change wheel: A new method for characterising and designing behaviour change interventions". *Implementation Science* 6 (2011): 42.

32. Chowdhury A. "Hepatitis B virus-related liver disease. The burden in South Asia". *Euroasian Journal of Hepato-Gastroenterology* 1.2 (2011): 44-46.

33. Gurubacharya DL., *et al*. "Knowledge, attitude and practices among health care workers on needle-stick injuries". *Kathmandu University Medical Journal (KUMJ)* 1.2 (2003): 91-94.

34. World Health Organization. WHO global injection safety campaign: Summary (2016).

Volume 2 Issue 4 December 2018