



Strategies for reducing needlestick injuries among health care workers

A literature review

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<p>Abstract: Being the frontline health care workers nurses are always at risk of needlestick injuries which could transmit infectious bloodborne pathogens. Prevention of infections and promotion of health is one of the core functions of nursing profession. Therefore, prevention of needlestick injuries is the key to the promotion of occupational safety as well as safety of patient and health promotion. The main aim of this review is to identify evidence based preventive measures of needlestick injuries (NSIs) among healthcare workers. The research question is, ‘What are the evidence based preventive measures of NSIs among healthcare workers?’ Different databases including Pubmed, Academic Search Elite (ESCBO), Science direct and google-scholar were searched systematically and twelve relevant literatures were selected for the analysis. Content analysis was done using inductive approach. According to the literatures, multifaceted intervention such as extensive education and the introduction of safety-engineered devices was found to be more effective than other approaches in the prevention of NSIs. Arcada University of Applied Science has commissioned this review.</p>	
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List of abbreviations

HCWs	Healthcare workers
NSIs	Needlestick injuries
HBV	Hepatitis B virus
HCV	Hepatitis C virus
HIV	Human immunodeficiency virus
AIDs	Acquired immunodeficiency syndrome
PIs	Percutaneous injuries
SIs	Sharp injuries
WHO	World health organization
ACHS	Australian council on healthcare standards
OSHA	Occupational safety and health administration
CDC	Center for disease control and prevention
PPE	Personal protective equipment
ILO	International labour organization
HPM	Health promotion theory
FTEs	Full time equivalent healthcare workers
EU	European union

FOREWORD

Firstly, I would like to express my heartfelt gratitude to Arcada university of Applied Science for commissioning my work.

Likewise, my big thanks goes to supervisor Denise Villikka for her professional guidance and continuous support throughout the thesis writing process. Similarly, I am very thankful toward senior lecturer Pamela Gray for her quality lecture sessions and instructions for thesis writing.

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Vantaa, 2016

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1 INTRODUCTION

The recognition of first case of needlestick-transmitted human immunodeficiency virus (Anonymous, 1984) raised the increasing awareness and concern about the risk to health care workers from needle stick/sharp injuries (Rapiti *et al.*2005). Today, there is no doubt that percutaneous injuries caused by needlestick and other sharps, pose a serious health risk for all healthcare workers (HCWs) with a risk of transmitting more than twenty bloodborne pathogens including hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (Rapiti *et al.* 2005). Globally three million healthcare workers are exposed to blood-borne pathogens annually and the irony is that up to seventy-five percentages (40-75 %) of needlestick injuries (NSI) are not reported (WHO, 2002). It is also estimated that European Union (EU) countries share approximately one million needlestick injuries per year (Prüss-Üstün *et al.*2003).

In Finland, according to the Finnish Institute of Occupational health, approximately 100 pricks/1000 healthcare workers per year have been reported (Anttila *et al.*2008). The true incidence of NSIs may be much higher due to underreporting (Vuoriluoto, 2008). Approximately five hundred cases of needlestick injuries (NSIs) were reported in district of Helsinki and regional capital and among them fifty cases of contamination sources were known to be a carrier of either hepatitis B virus, hepatitis C virus or human immunodeficiency virus (Anttila *et al.* 2008). Similarly, another recent study highlights NSIs contribute to one fourth of the occupational injuries (Salminen & Parantainen, 2012).

Nurses are the major victims to suffer from needlestick injuries. Injuries with the used sharp or needles are terribly distressing. The effective and evidence based preventive measures of NSIs can assure the occupational safety of nurses as well as other health care workers. In addition, prevention of needlestick injuries not only assures occupational safety of the healthcare workers but also improves patient safety. Royal college of Nursing (2009) states that 48% of nurses have been injured by used sharp and 45% have not received any training regarding safe needle use during their employment. Therefore, being the frontline health care workers nurses are always at the risk of needlestick inju-

ries. Prevention of diseases and promotion of health is one of the core factors of nursing profession. If they are acquainted with evidence based preventive measures of needle stick injuries, they can definitely play active role in promotion of occupational health of HCWs along ensuring patient safety

The main aim of this study is to investigate and summarize the evidence based preventive measures of needlestick injuries among health care workers using review of literature and content analysis. Published research articles will be chosen as study materials and content analysis will be done using inductive approach. In addition, a poster will be developed which will be used as a teaching learning material. Arcada University of Applied Science has commissioned the study.

In this section, author has introduced the problem status of the interest area and discussed some of the reasons behind choosing particular study topic. In the next section, readers will be informed about the prevalence, predisposing factors, disease transmission rates and economic burden of needlestick injuries.

2 BACKGROUND

Globally 2 million healthcare workers are exposed to blood borne pathogens each year (World Health Report, 2002). However, the prevalence of NSIs varies in different settings. The prevalence differs in developing and developed countries. But majority of such incidents are preventable. (Prüss *et al.*2003)

2.1 Prevalence of needlestick injuries

In Finland, there are few data on burden of needlestick injuries. Significant numbers of health care workers still lack the adequate level of knowledge and safe practices. Some large healthcare organizations have conducted their own research and created statistics. However, information regarding the entire healthcare sector is not available. (Vuoriluoto, 2008)

Anttila *et al.* (2008) report that the frequency of NSIs at Finnish hospitals averages 100 pricks/per thousand employees per annum. The actual figure is likely to be greater, as all of the accidents are not reported. Approximately five hundred needle prick incidents were reported annually in the Hospital District of Helsinki and regional capital area. The alarming fact is that, approximately fifty contamination sources were known to be a carrier of Hepatitis C, Hepatitis B, or Human Immunodeficiency virus. A recent study conducted by Salminen *et al.* (2012) reported that the prevalence of needlestick injuries among health care workers is 25.3% in three different health care center of Helsinki regions.

Salminen & Parantainen (2012) reveal that needlestick injuries were the highest-ranking occupational injuries during 2006-2008 and made one fourth of the total occupational injuries. The study also reported more than fifty percent (54%) of needlestick injuries occurred among nurses, followed by 13% among physicians (Salminen & Parantainen, 2012).

In developing countries, the incidence of needlestick injuries is much higher. Several studies conducted in India, Nepal, Pakistan, Nigeria report that the annual incidence of NSIs is usually more than 50% (Sayami & Tamrakar, 2013; Kaphle *et al.* 2014; Siddiqui *et al.* 2008; Afridi *et al.* 2013; Chakravarthy *et al.* 2015; Holla *et al.* 2014; Murli-dhar *et al.* 2010; Amira1 & Awobusuyi, 2014; Jahangiri *et al.* 2015).

The incidence of needlestick injuries in developed countries also varies. According to the estimation based on data from the Australian Council on Healthcare Standards (ACHS) approximately 18,700 reported needlestick injuries occurred in Australian hospitals annually (Murphy, 2008). Occupational Safety and Health Administration (OSHA)'s estimation shows that 5.6 million health care workers are in the risk of exposure of occupational exposure to blood borne pathogens in USA. OSHA's reports also state that approximately 384,000 hospital based health care workers get percutaneous injuries every year and more than 1,000 injuries per day. (Prüss *et al.* 2005)

In European countries, needlestick and sharp injuries are major occupational hazards, which impose direct threat to health and safety of the health care workers (EU Commission for Employment, 2010). Elmiyeh *et al.* (2004) report around 32,000 needlestick injuries in France. According to Clarke *et al.* (2007) Germany has approximately 0.48 needlestick injuries per employee per year. Costigliola *et al.* (2012) study findings shows that 32% nurses reported needlestick injuries while giving diabetic injection at some point of their work life.

2.2 Predisposing factors of needlestick injuries

Recent studies suggest that highest number of needlestick injuries occur either by recapping of the needle (18%), followed by disposal of sharps (16%) and fifteen percent injuries while transferring a body fluid (blood) to a specimen bottle (Mandal, 2013). Kaphle *et al.* (2014) also reported recapping as the major cause (55.1%) of needlestick injuries. Other studies also reveal similar results, (Siddiqui *et al.* 2008; Amira1&Awobusuyi, 2014). Murlidhar *et al.* (2009) reported blood withdrawal (55%) as the commonest clinical activity associated with needlestick injuries, followed by suturing (20.3%) and vaccination (11.7%).

Lack of adequate resources and tiredness of staffs are also associated with increased risk of NSIs (Aziz, 2012; Adams 2012). A study from Iran shows the association between work shift and incidences of NSIs. About sixty percent of NSIs had occurred in the morning shift and recapping was the most common activity leading to NSIs (Jahangiri *et al.* 2015). Workplaces like Operation Theater, many years of work experiences, long working hours are commonly associated with the incidences of needlestick injuries in comparison to others (Mideska & Fiyera, 2014). Adams (2012) states that there are variety of factors influencing needlestick or sharp injuries, type of devices and procedure undertaken, availability of training on safer sharp use and proper disposal, lack of knowledge and awareness of the consequences of NSIs. Similarly, duration of work experience and knowledge on universal precaution have significant correlation to needlestick injuries (Holla *et al.* 2014).

Similarly nurses' sense of urgency, variable shift-work and low skill level are also reported as major factors leading to needlestick injuries (Karine *et al.* 2013). A recent study has found strong co-relation between the duration of working hours and incidences of needle stick injuries with highest risk among nurses younger than thirty years, with higher than average workload and low autonomy (Stimpfel *et al.* 2015).

2.3 Transmission of Blood Borne Pathogens

In developing countries in Africa and Asia, almost half of hepatitis B and C infection among HCWs are the result of exposure of needle stick or sharp injuries (Prüss *et al.* 2003). The possibility of transmitting infection after needlestick injuries depends on various factors like depth of the injury, type of devices used, and previous placement of injury causing devices, e.g. whether it is in vein or artery, infection status of the source (Jack *et al.* 2013) etc. The risk of disease transmission by a contaminated needle can be one in three for hepatitis B, one in 30 for hepatitis C and one in 300 for human immunodeficiency virus (HPA, 2012). The possible disease transmission rate after NSIs has been tabulated below as table 1.

Table 1. Disease transmission possibility after NSIs

Diseases	Possible Transmission rate
Hepatitis B	6-30%
Hepatitis C	1.8%
HIV	0.3%

(CDC, 2013)

According to Center for Disease Controls and Prevention (CDC), interventions like strict adherence to universal precautions and double gloving during surgical procedures have almost eliminated the possibility of transmitting HBV, HCV and HIV viruses from healthcare provider to patients. The risk of transmitting HBV virus depends on the vaccination status of the injured healthcare worker. Healthcare workers with hepatitis B vaccination and fully developed immunity to the virus are at virtually no risk for infection. On the contrary, the risks for non-vaccinated healthcare workers range from 6%-30%. (CDC, 2013)

2.4 Economic burden of needlestick injuries

According to CDC (2008), one incidence of sharp or NSI can have various direct and indirect costs for health care facility. The facility need to go through cost of investigating the injury, expensive laboratory testing, loss of employee time, cost of treatment for infected staff and cost for replacing staff. The estimated direct cost of testing and follow up treatment of health care workers receiving NSI are up to five thousands dollars. In addition to financial cost, the emotional cost of fear and anxiety on the affected workers and their families are beyond estimation. The social costs associated with sero-conversion of HIV and HCV are impossible to quantify (CDC, 2008).

Glenngård & Persson (2009) has estimated the total cost of needle stick or sharp injures in one of the EU member country, Sweden. The cost of occupational sharp injuries was estimated to be euro 1.8 million or euro 272 per reported sharp injury. However, Sweden seems to have lower cost of injury in comparison to other EU countries or USA. (Glenngård & Persson, 2009)

According to a study conducted by Saia *et al.* (2010), the estimated annual cost due to NSIs may vary from country to country. The estimated annual cost of NSIs in Germany range from €4.6 million to €30 million, \$6.1 million in France (cost only for nurses), €7 million in Italy, 6 million to 7 million euro in Spain, and from £4 million to £300 million in England and Wales. This estimation is based on the reported number of NSIs in different countries and exact cost still can not be estimated because large number of incidences goes unreported (Saia *et al.* 2010).

2.5 Prevention of needlestick injuries

In 1981, McCormick and Maki described the risk of NSIs to HCWs and suggested some preventive strategies. Their main strategies were education programs, avoiding of needle recapping and proper disposal of sharp after use. In the year 1987, CDC recommended universal precaution guidelines. The main themes of the guidelines were injury prevention by careful handling and proper disposal of the sharps (CDC, 2008).

Nowadays many healthcare institutions have adopted 'hierarchy of controls' concept as the NSIs prevention model (CDC, 2008). The industrial hygiene profession uses this concept in order to prioritize preventive interventions. According to the hierarchy of control theory, first priority is to eliminate and reduce the use of needle or sharp as much as possible. Isolation of hazard comes in second place. This concept works with protecting the exposed or used sharp through use of the engineered control devices. When these strategies are not available or are not effective for full protection, the focus shifts to work-practice controls and personal protective equipment (CDC, 2008).

According to the International Health Care Worker Safety center, University of Virginia (2012), every health care institution should aim to eliminate the risk of NSIs whenever possible. There should be the involvement of multiple disciplines like from nursing, medicine, housekeeping pharmacy, laboratory and every one who has the possibility of exposure. The facilities should have periodically reviewed and updated exposure control plan and should make available within fifteen days on request. Educating and training of front line health care workers about the use of needle devices, injury prevention and infection control are very important. In addition, proper selection and use of engineered devices, enforcing sharp injury reporting and recording system can play crucial role in the prevention of NSIs (CDC, 2012).

The Royal College of Nursing (2009), suggests that engineered control devices like needleless system, retractable syringes, scalpel blades and intravenous catheters are the widely recognized and effective preventive measures of needle stick injuries. The traditional sharp devices should be replaced with engineered control devices whenever pos-

sible. Risk assessment must be carried out periodically and healthcare workers should be consulted while choosing safety devices.

The European Union (EU) published a directive in June 2010 requiring protection for employees from sharps injuries in hospitals and healthcare sector. This directive was introduced as a means of preventing injuries and bloodborne infections to healthcare workers from sharp injuries. The EU Directive states that all its member countries should fully implement its guidelines within the national legislation by May 2013. The main aim of the directive is to achieve safest possible working environment for health care workers and ensure patient safety through preventing injuries to HCWs and patients from sharp instruments. The directive's main focus is to set up an integrated approach to addressing the issue of sharps injuries among the EU members, including establishing policies on risk assessment and prevention, training and education, raising awareness and monitoring, along with the provision of safety medical devices (EU Directive 2010/32).

Promotion and Support of Implementation of Directive 2010/32/EU on the prevention of sharps injuries in hospitals and health care sector, fourteen EU member countries have fully transposed the directive by September 2013 (ICF GHK, 2013). According to the statistics and anecdotal evidences offered from the delegates in the 'Fifth European Biosafety Summit', the implementation of the Directive is not fully satisfactory yet, and the summit delegates its members to take practical actions for proper implementation of it (European Biosafety Network, 2015).

In Finland, the first legislation on occupational safety was passed in year 1889. In 2002, Occupational safety and health care act (738/2002) was enforced. The bases of current legal frameworks are the Occupational Health Care Act (1978) and health care act (2002). As Finland is a member of European Union, its occupational safety and health legislations are based on EU directive (Salminen, 2014).

According to Occupational health and safety act (738/2002), assessment of risks and elimination of hazards or risk factors and adoption of safety measures considering of

technology or use of safety-engineered devices has been emphasized in order to promote the occupational health and safety of the employees in Finland. Occupational health and safety policy of an organization; periodic education, training and guidance about safe work practice and provision of personal protective equipment are also the important means of hazards prevention. Similarly, Finnish Patient Safety Strategy (2009-2013) also suggests training and education activities on infection control and incidence reporting as effective means of ensuring patient safety and quality care. Health Care Act 1326/2010, observes evidence based practices and prevention of injuries as the reflection of quality care and patient safety.

The government of Finland has passed a regulation amending the pre-existing regulation after a long negotiation process with full participation from the worker's representatives, and other stakeholders in may 2013. The Finnish government passed the 'decree on the prevention of Sharps Injuries in the hospital sector 317/2013 ' and came to force from 5.8.2013. The legislation emphasizes the concept of safe equipment and safe working standards, reporting and monitoring obligations (Biosafety Summit, 2013).

In this chapter, author has discussed about the prevalence, predisposing factors, disease transmission rate, financial and emotional cost and prevention of needle-stick injuries. In next chapter, the author will discuss the theoretical frameworks of the study.

3 THEORETICAL FRAMEWORKS

Two theories provided theoretical framework for this review. Both are relevant to prevention of accidental NSIs among HCWs. When viewed together, they provide an effective framework for the prevention of NSIs, either by identifying or eliminating the hazards or modifying risk behavior or adopting safer strategies to achieve the goal. Firstly, ‘hierarchy of control theory’ will be discussed followed by ‘health promotion model’.

3.1 Hierarchy of Control Theory

‘‘Hierarchy of Control Theory’’ was founded by, ‘Industrial Hygiene Community’’ in 1930’s. This theory establishes the priority order, in which hazards and risk controls should be considered according to the level of their effectiveness. Though, it was developed by Industrial hygienist, it is widely adopted in different disciplines and proven to be very effective in preventing occupational hazards.

Levy and Wegman (2000) advocated that a hierarchy of three types of controls should be implemented in a certain order to decrease the risk for occupational exposure. The first level of controls is *engineering controls*. These involve altering the environment or the processes that pose risks, such as replacing all needles without retractable safety devices with those that are engineered with safety in mind. The second level of controls is *administrative*. It includes strategies such as requiring ongoing safety training or setting limits on nursing patient loads or consecutive hours worked each shift (Salazar, 2006). The third set of controls involves *personal protective equipment* (Levy &Wegman, 2000).

According to EU Directive 2010, Sharp injuries prevention measures can best be implemented using the Hierarchy of controls and principles of prevention frameworks. These are mentioned in EU health and safety directives, and used widely by occupational hygiene and safety specialists across the world (International Labour Organization (ILO)/World Health Organization (WHO). Below is the description of the, ‘‘Hierarchy of control’’ as adopted by EU Directive 2010, has been described in table 2.

Table 2. Hierarchy of controls

Hierarchy of controls	Description
Elimination of hazards:	Complete removal of a hazard from the workplace is the most effective way to control hazards. This includes removing sharps and needles when possible or replacing traditional sharps and needle system with needleless intravenous system or needle free connectors.
Engineering controls:	It focus on maintaining safe work environment, either by isolating or removing a hazard from a workplace. Under this control environmental factors like enough measures there should be adequate number of easily accessible sharp disposable lightening and adequate space to carry out procedures and use of safety engineered devices like retractable intravenous cannulas or syringes or scalpel blades, etc.
Administrative controls:	These measures focus on policies and practices guidelines, in-service education, regular trainings and vaccination with hepatitis B. According to administrative controls, every one should know their health and safety responsibilities, from employers to employees and it should be well coordinated and adequately resourced. Presence of sharp injury prevention committee and health and safety committee might play very important role in the occupational health of the health care workers. Sharp policies, infection control measures and safer working system are also in the focus.
Work practice controls:	This controls focus on behavior change strategies in order to reduce the exposure to needle stick or sharp injuries. Practices like no needle recapping, safety engineered sharps containers, and accessibility of them, proper disposal of sharps after use, timely management of sharp containers when three quarter full are the main focus of work practice control.
Personal protective equipment (PPE):	Personal protective equipment's like eye goggles, gloves, gowns, face masks, etc, though found to be least effective measures in the prevention of NSIs, help to limit the exposure to blood splashes (EU Directive, 2010).

(EU Directive, 2010)

Healthcare workers can work alongside their employer in order to reduce the preventable NSIs by identifying the high-risk procedures, devices and implementing effective control measures. These standard occupational principles are usually described as hierarchy of control strategies for occupational health. According to this strategy, elimination of hazards is the most effective control. This level of control focus on seeking alternative routes for medicine administration, for instance substituting injection with tablets, inhaler or intradermal patches and avoiding unnecessary injection (ANA, 2001).

Similarly, engineering controls are reported to be more effective over administrative, work practice and PPE controls. This strategy focuses on removing the hazards at the source or isolating the healthcare workers from the hazards. This concept emphasizes on use of enhanced engineered sharp disposable containers, needles and other sharp devices with injury prevention features such as needle that retract, sheath or blunt immediately after use (CDC, 2008; EU Directive 2010).

According to hierarchy of controls theory, third favored control is administrative controls. This control strategy focuses on presence of policies and procedure guidelines in order to limit the exposure hazards. For example availability of sharp injury prevention policy and exposure control plan, infection control committee. In addition, continuous in-service education in the injury prevention and regular training on the use of safety devices are in the priority (CDC, 2008). The EU Directive (2010) also emphasize that every employer are obligated to develop injury prevention policies and providing training and education to their employee.

Work practice control is in second position from the bottom and it focus on behaviour modification strategy in order to limit the exposure to the hazard. For instance, no recapping, accessibility and availability of sharp containers, immediate disposal of used sharps and timely management of sharp container when they are three quarter full. The personal protective equipment control takes the bottom position in hierarchy level and works as the barrier and filters between the workers and hazards. Though, it is least effective control, is recommended to use, according to the nature of the procedures and along with the combination of other effective controls (EU Directive, 2010).

3.2 Health Promotion Model (HPM)

Nola Pender, a nurse developed the health promotion model in 1982, and later revised in 1987 and 1996. According to this theory, health promotion and disease prevention should be primary focus in health care and care of illness should be next in the priority. Health promotion model primarily focuses on disease prevention and describes how individual make decision about their health (Nursing theory, 2015).

The main purpose of HPM model is “to assist nurses understanding the major determinants of health behaviors as a basis for behavior counseling to promote healthy lifestyles” (Pender, 2011). The theory of HPM emphasizes the pursuit of health through health- promoting behavior that increases the well-being of a given individual or group (Pender *et al.* 2011). This model identifies the influencing factors for health behaviors. This model has eight beliefs, which can be assessed by nurses. These eight beliefs are the critical aspects of nursing intervention. Using these models, nurses can assist a client, group or society to adopt health behaviors to achieve a healthy lifestyle (Pender, 2011).

Basically, there are two phases in the Pender model; decision-making phase and action phase. Individual perceptions and modifying risk factors are the keys to decision-making phase Individual perceptions of health, perceived level of risk after needle stick injuries, level of awareness about needle stick injuries and their consequences, desire of competences and perceived benefit of health behaviors are important in decision making phase. The desire for competence and self awareness are the health promoting factors leading to modified or safer behaviors, for example immediate disposal of sharp after use, no recapping of syringes, no handling zone or neutral zone, reporting NSIs (Pender, 1982).

The theorist emphasize that individual’s health perception also influences behaviour modification. For example, nurses perception of risk behaviors like risk of disease transmission after NSIs can influence their behaviors. Nurses, who perceive low of disease transmission after NSI is less likely to adopt healthy behaviors. Desire for compe-

tence or behavior modification is possible through education, training, enforcing sharp policies and protocols, (Pender, 1982). The HPM model gives explanation about how individual characteristics and past experiences lead to behavior-specific cognitions and later behavioral outcomes. Nurses, being the largest group of health care workers; we can use this concept to make health assessment (Alligood & Tomey, 2010). The HPM raise awareness among the nurses about the determinants of health behaviors and encourage adopting health-promoting life styles. For examples; identifying risk factors like use of convention needle devices and recapping of needles, then replacing them with safety engineered devices and avoiding recapping in order to get positive health behaviors (Pender, 2011).

Individual with perceived low level of health are less likely to adopt health-promoting behaviors because they feel constrained by their poor health, for example, nurses perception of urgency in the workplace or working under stressful situation, long working hours, nurses suffering from burnout syndromes are less likely to adopt injection safety or other safety measures while handling sharps. The perception of nature of benefit; short term or long term, also has influence on the continuity of health promoting behaviors. For example, continuous availability of engineered safety devices encourages HCWs to use them. Modifying factors like age, level of knowledge, work experiences, interpersonal variables and situational variables like prior experiences with health promotion behaviors also influence health-promoting behaviour (Pender, 1982).

The “Controls Strategies for Occupational Exposure or Hierarchy of Control Theory” and Health Promotion Model (HPM) are similar in that they both emphasize on prevention of illness. The HPM is not only limited to disease prevention, it provides frameworks for predicting health promoting lifestyles or positive health behaviors, responsibilities and accountabilities. The researcher has chosen Health Promotion Model (HPM) as one of theoretical framework for the study because every health professional should focus on the health promotion either individual, group or community level. Registered nurses, being the largest group of health professionals, they have the potential to contribute effectively in the area of health promotion and disease prevention. The ultimate nursing perspective of this study is also health promotion through disease prevention. Though, it is a patient centered theory and work closely with patient safety and health

promotion, it works for HCW's safety as well because HCWs are also the part of the society and nurses have the responsibility for the health promotion and disease prevention of their fellow co-workers as well.

In this chapter, the researcher explained that how 'hierarchy of controls theory' and 'health promotion model' make the framework for the study. The next chapter will discuss about the aims and research question.

4 AIMS AND RESEARCH QUESTION

An aim determines the objective of the study. It is an overall specification of the intention or purpose of the study and guides the researcher to be on track and reader gets the information about the possible outcomes of the study. It is a straightforward expression of what the researcher is trying to find out through an investigation. It should be clearly and concisely defined (Harvey, 2004-16). The first aim of this review is to investigate on relevant literatures related to epidemiology and prevention of NSIs. Second aim of the study is to identify the evidence based preventive measures of NSIs.

Apart from setting aims, well-formulated research questions will guide the study project and assist in the development of logical argument. It should be developed after doing preliminary research on the interest area. The formulated research questions should be clearly defined and focused. It should identify the phenomena that the researcher has chosen for the study (Brian, 2006). Hulley and colleagues suggested that use of the FINER (F=Feasible, I=Interesting, N=Novel, E=Ethical, R=Relevant) criteria in the formulation of a good research question. The FINER criteria highlight useful points that may increase the chances of developing a successful research project (Hulley *et al.* 2007). Focusing on above-mentioned aims and criteria in mind, the author has formulated the following research question:

What are the evidence based preventive measures of needlestick injuries among health care workers?

In the next chapter, author will discuss chosen methodology, data collection, data analysis and ethical consideration, respectively.

5 METHODOLOGY

The purposed study will be a qualitative study. Literature review and content analysis will be used as research methodology. Twelve systematically searched and selected scholarly articles will be used as research materials. The inductive content analysis approach will be used for the data analysis process.

A literature review is a summary of the existing research, which is relevant to the selected study topic and showing their relation to the study. In other way, it is the full combination of understanding, interpretation, analysis, clarity of thought, synthesis, and development of argument. It aims to provide thoroughly analyzed conclusions of the relevant scientific literatures. The need for evidence-based practice in health and social care today has led to literature review becoming more and more relevant in current practice (Aveyard, 2007).

A literature review is a very familiar research method widely used for searching and integrating the literature related to a particular clinical issue or practices. This is the summary of the scientific literatures in a particular area, assesses the studies critically for reliability and validity and synthesizes the findings to inform practice. The main objective of literature review is to synthesize and present current research about clinical knowledge or effectiveness of interventions. Thus, exploring evidence –based practices, and relating them to clinical situation are the key natures of literature reviews (Lo-Biondo-Wood & Haber 2010).

The literature review provides a critical discussion on the topic of interest showing the reader similarities and differences in existing relevant literature. It is also the method of exploring relevant information in the selected topic and very effective learning process for the researcher. In addition, it is also a process of critically exploring, analyzing, evaluating and summarizing of the available scholarly articles (Coughlan 2008). According to Creswell (2012), a review of the literature “is a written summary of journal articles, books and other documents that describes the past and current state of information, organizes the literature into topics and documents a need for a proposed study.”

Basically, there are two types of literature reviews; traditional or narrative literature review and systematic literature review. 'Narrative literature review focuses on exploring the conceptual and theoretical approaches used by several authors in understanding a phenomenon, and offering a critique of the authors' contributions on their study. The assessment and interpretation provide comprehensive understanding of the subject matter. Narrative reviews are usually written by experts and useful for the background information but they don't follow any strict research approach like a systematic literature review (Cronin, Ryan & Coughlan 2007).

A systematic review provides an opportunity for summarizing and critically appraising the literature to improve future practice and encourage higher levels of research methods as possible (Fiegen, 2010). According to Hidalgo Landa *et al.* (2011) systematic literature is a comprehensive tool for gathering explicit information in a research topic by following rigorous and well-defined approach.

Parahoo (2006) suggest that a systematic review should include time frame for the literature selection, as well as methods used to analyze or evaluate, and synthesize findings of the study in with the formulated research questions. The researcher also need to present the precise criteria to formulate research question; inclusion and exclusion criteria; select and access the literature; validity and reliability of the literatures; analyze, synthesize and disseminate the findings of the reviews. According to Talbot (1995), there are five steps of writing a literature review.

Planning is the first step of literature review. At this point, the researcher plans how the study goes or makes the rough outline of the study by identifying the focus question. The focus question determines the forms of review, the classification into which the review fall and the way in which task will be completed. For example If a nurse want to study the incidences of needle stick injuries among the Finnish nurses in hospital setting, the focus question for the review might be 'what is the incidence of needle stick injuries among Finnish nurses in hospital setting?' This phase also define research problem and finds potential method for study (Talbot, 1995).

Another step of planning phase is identification and location of resources. We can do library search or computer assisted search using different databases. This phase also depends on knowledge of information retrieval but if needed we can take experts help. CINAHL, ESBCO, Pubmed, Cochrane Library, google scholar, science direct, etc. are commonly used databases for literature searching. The method of searching should be recorded for reproducibility (Talbot, 1995).

Reading and research is the second step of literature review methodology, in this phase the retrieved articles are read and the process of screening and evaluating is completed. The decision about which articles can be used for the study and which articles are methodologically sound are important. The critical reading is very important which goes from general to the particular. Along with the critical reading, critical thinking is also equally important. The conceptualization process begins to take place as the researcher starts to read. Keeping records of articles in a scientific way is also important for future references (Talbot, 1995).

The third step of literature review is analyzing. At this point, the reviewer analyzes the data and critical appraisal is completed (Talbot, 1995). Drafting is next step after analyzing of the selected literatures. In this stage, the researcher writes the short summary of each article and may include key thoughts, comments, strengths and weaknesses of the publication along with design, sample. It should be written in your own words to facilitate your understanding of the material. It also forms a good basis for the writing of the review (Talbot, 1995).

Revising and writing review is the last step of writing literature review. Once the appraisal of the literature is completed, consideration must be given to how the review will be structured and written. The key to a good review is the ability to present the findings in such a way that it demonstrates researcher's knowledge in a clear and concise way. Sentences should be kept as short as possible with one clear message and spelling and grammar should be accurate and consistent with the form of English being used (Talbot, 1995).

5.1 Data collection

The data retrieval process started from 10th of November 2015, using electronic search in different databases; Academic Search Elite (ESCBO), Pubmed, CINAHL (ESCBO), Science direct and google-scholar. The keywords used for search were; Prevention of Needle stick Injuries (NSIs), Health Care Workers (HCWs) and Nurses. Above mentioned databases were searched systematically, using same keywords for all. Inclusion and exclusion criteria were set and applied to all the databases. Data search and retrieval process has been tabulated below as table 3.

Table 3:Data search and retrieval process

Databases	Keywords	Result	Chosen on the basis of the title	Chosen on the basis of abstract	Final full literatures
Pubmed	Prevention of NSIs and HCWs and Nurses	63	63	56	6
Science Direct	Prevention of NSIs and HCWs and Nurses	56	56	35	3
Academic Search Elite (ESCBO)	Prevention of NSIs and HCWs and Nurses	6	6	3	1
Google scholar	Prevention of NSIs and HCWs and Nurses	973	200	50	2
Total=		1098	325	144	12

During the first phase of the literature search, the reviewer obtained only 63 hits from Pubmed, 56 hits from Science Direct, 6 hits from Academic Search Elite (ESCBO), and 973 hits from Google Scholar, resulting total of 1098 articles. Repeated and similar articles were excluded from the selection process, leaving a total of 144 articles for further screening process.

A total of 144 articles were assessed for inclusion and exclusion criteria. In this phase, researcher read all the articles and extracts carefully and selected only 12 relevant scholarly articles for the analysis with reference to the following inclusion criteria; publication related to the prevention of needle stick injuries, English language, published on 2006 to 2015, primary research articles and free access. Articles other than English languages, pay to read articles, secondary research articles, articles published before 2006 and articles addressing needle stick injuries other than prevention were also excluded in final stage.

In second phase, the researcher studied the titles and the abstracts of the rest of the articles and selected suitable articles for the study. During the selection procedure priority was given to the primary research articles, which answers the formulated research questions properly. Considering the researcher's understanding of the language, articles were limited to English language only. The literature were examined comprehensively and selected, based on their relevance to the research topic. The inclusion criteria (Table 4) and exclusion criteria (Table 5) are presented in tables below.

Table 4. Inclusion criteria

Inclusion criteria
➤ Publication related to prevention of needlestick injuries.
➤ Primary research articles published from 2006-2015.
➤ Literature available in English language only.
➤ Free access literatures and literature available through Arcada University of Applied Science Library (via Nelli portal) only.

Table 5.Exclusion criteria

<p>Exclusion criteria</p> <ul style="list-style-type: none">➤ Publications other than English language.➤ Secondary research articles or literature reviews.➤ Publication before the year 2006.➤ Repeated articles in different databases or similar articles.➤ Publications not available online as free full text and which are not accessible through university's library search portal➤ Literatures not relevant to the study topic.

Twelve articles were selected keeping inclusion and exclusion criteria in mind. Following careful reading of the selected articles, relevant data to the set purpose of this study was selected and tabulated to promote comprehensive overview. The obtained data were categorized and organized into themes. List of selected articles have been presented in appendix 1.

5.2 Data analysis

The content analysis is done using inductive approach. According to Stemler (2001), content analysis is a research technique used to make replicable and valid inferences by interpreting and coding textual material. It enables researchers to transfer large volumes of data with relative ease in a systematic format. It can be a useful technique to discover and describe the focus of individual, group, institutional, or social attention. Hsiu-Fang & Shannon (2005) describe three approach of qualitative content analysis; conventional, directed and summative content analysis. The conventional content analysis follows inductive approach, focus on grounded theory and there is no predefined coding of the materials. Directed content analysis follows deductive approach and stem-coding sys-

tem from a theory. The summative content analysis approach is used to percept the word meaning.

Graneheim & Lundman (2004) introduced a concept of qualitative content analysis in nursing research, using inductive approach. According to this approach, selected full text articles are read thoroughly several times in order to obtain the big picture of the context. The second task is to condense the meaning units, coding and classification to determine the main units of analysis and manifest its contents (Graneheim & Lundman, 2004). This study follows Graneheim & Lundman (2004)'s approach for data analysis and steps of analysis has been explained in table 6.

Table 6.Steps of content analysis

<p>Phase I: reading and coding</p> <p>After the data collection process, each unit of analysis was thoroughly read several times, relevant information was picked out and notes were taken. The main keywords of the meaning units were labeled using different codes, different colors and signs.</p>
<p>Phase II: listing and categorizing the codes</p> <p>In this phase, the all the notes, underlined keywords and different meaning units were reviewed several times acquired information were listed, open coding done, each piece of information were categorized and grouping was done.</p>

This study follows Graneheim & Lundman (2004) for content analysis. In the first phase, each unit of analysis was carefully read and relevant information was marked with different colors and notes were taken. In the second phase of the analysis, all the underlined keywords, marks and signs were reviewed several times and information were listed, open coding was done, each pieces of information were categorized and grouping was done.

5.3 Ethical aspects of the study

According to McLeod (2007), ethics refers to the correct rules that should be followed while conducting research activities or process. We have a moral responsibility to protect research participants from harm or any exploitation. According to Fry & Johnstone (2012), ethics includes a system of standards and principles, which guide the actions and they, function by defining the sort of behavior and conduct that are permitted, compulsory and forbidden.

In Finland, Finnish Advisory Board on Research Integrity (TENK) was founded in 1991, which promote the responsible conduct and prevention of misconduct, address the ethical question related to research study and advancement of research ethics in Finland. The main activity of advisory board is to promote responsible conduct of research and formulate and publish the common guidelines in co-operation with the research organizations (TENK, 2012-2014).

This study is a systematic literature review, and the most important ethical principle in such study is to respect for intellectual property of other Author and Organizations. The research materials are scholarly literatures. The author should avoid the use of unpublished articles or results without permission. Likewise, the researcher has the obligation to give full credit to the authors through proper referencing. In addition to this, the author should acknowledge everybody who will be contributing directly or indirectly to complete the study. The author will take this study as a learning process and will try to maintain and improve professional competencies through lifelong education and learning. The author will be open to new ideas or suggestions and criticism.

This study is a review of available literatures, and content analysis to summarize the results. It did not involve any human subject or animal experimentation. Thus ethical approval for this study was deemed not required.

6 RESULTS

After proper study of each unit of analysis, researcher has grouped three intervention approaches namely; education activities, safety engineered devices plus education, and enhanced engineered sharp container. Effectiveness of different intervention groups has been defined by comparing the rate and number of needle stick injuries, before and after the intervention or during the intervention period. Emerged themes and subthemes have been tabulated below in table 7.

Table 7. Illustration of themes and sub themes

Theme	Prevention of needle stick injuries		
Sub themes	Educational Activities	Safety Engineered Devices plus Education	Enhanced Engineered Sharp container
Unit of Analysis	1,2,9 11,12	3,5,6,7,8	4,10

After data analysis process, mainly three themes were identified; educational approach, safety devices plus education approach, and enhanced engineered sharp container approach. The emerged themes will be discussed in the next sub-heading respectively.

6.1 Educational activities

Among the 12 units of analysis, five (1, 2, 9, 11 & 12) reported the impact of educational activities on infection control or sharp injury prevention. The study (1), which conducted intensive infection control education activities focusing on risk of unsafe practices and how to avoid them, in order to reduce the incidence of needle stick injuries, and reported significant decrease of NSIs/PIs from 32.8 in pre-intervention period to 14/1000 HCWs in post intervention period. Reduction rate was significant among nursing staffs 15 vs. 37.6, followed by housekeeping staffs 10 vs. 34.5 during post-intervention.

One of the study (2) implemented quality improvement project among the HCWs in a form of multifaceted educational approach by conducting educational session, interactive session, monthly meeting on ongoing issues, and celebration of infection control weeks, poster competition and workshop on standard precaution. This comprehensive educational program shows remarkable positive impact on the reduction of NSIs among the HCWs and major decline was observed among nurses, 13 to 5 incidences of NSIs among 100 nurses. Another similar study (9), which examined the impact of occupational safety and training protocol among the nursing students, observed tremendous decrease (from 4.65 to 0.16 events/std.nurse) during post intervention period in comparison to pre-intervention (4.65). The protocol implemented five intervention measures; seminars, regular lecture sessions, training, multimedia approach and peer education approach.

The study (11), which evaluated the effect of teaching and training programs for different level of health care workers, claimed 11% to 4% reduction of NSIs. Similarly, another study (12), which was also focused on implementing educational activities, noted 50% reduction of NSIs among the soon graduate vocational nurses. The educational intervention was mainly focused on lectures for the students after internship training and self-study brochures on occupational safety and health. The main focus of the lecture sessions was prevention of blood borne diseases. The developed brochures covered the

information on risk of encountering injuries in hospitals, types of devices and procedures; skilled needed to manage injuries and importance of reporting the incidences.

6.2 Safety engineered needle devices plus educational activities

Out of 12, two studies (5 & 7) evaluated the effect of safety devices on reduction of NSIs/PIs. Both studies had different level of health care workers as the study sample but the significant fall of NSIs/PIs was noted among nursing personnel only. Study (5), which evaluated the effect of safety engineered devices like butterfly system and hypo-dermic needles and a passive mechanisms for peripheral venous catheters, lancets and port needles, reported 21.9% reduction in overall. Annual rate of NSIs decreased from 69.0% to 52.4%/100 HCP. Remarkable reduction was observed among nurses, decreasing frequency of NSIs from 162 to 127. Similar study (7), which evaluated the effectiveness of single use disposable automatically retractable lancet to collect capillary blood by finger prick, also reported significant fall of NSIs among nurses (9.39 to 4.31/100 FTEs (full time equivalent healthcare workers)).

Three (3, 6 & 8) out of 12 studies examined the impact of safety-engineered devices along with educational activities. The study, which evaluated the impact of hospital wide replacement hollow-bore needles, with safety devices and extensive education program, claimed overall 49% fall in NSIs. All the conventional syringes and needles were replaced with safety devices; retractable syringes and winged butterfly needles. The extensive education program included potential benefits of retractable syringes. The study also reported that virtual elimination of NSIs related to accessing IV lines contribute to the dramatic fall of NSIs. High-risk hollow bore injuries were also reduced to 57%.

The study (6), which compared the effectiveness of two interventions; introduction of needle safety devices and workshop reported that combination of training or education activities along with the introduction of safety-engineered devices was more effective in comparison only education approach. That was the three-armed randomized control trial

and used cluster-sampling method. The study populations were assigned into three groups; Needle safety plus workshop (NW), Workshop (W) and control group. The workshop intervention conducted one-hour interactive power point presentation about needle stick injuries by trained personal. Workshop timing was in between the change of two shifts and every assigned study area received 2-3 workshops along with feedback leaflets at the end of the workshop. NW intervention group received workshop plus needle safety devices were introduced. After the workshop, all existing needle devices were replaced by safety featured needle systems and follow up was done in 6 month (T1) and 12 month (T2) and comparison was made with baseline (T0) data. Six month follow up aimed to gather information on how many HCWs attended workshop and workshop plus training, how many study population are using safety devices. Twelve month follow up actually compared the outcome of the interventions. Questionnaire based statistics showed, statistically significant difference was noted among different groups for the half-year incidence of NSIs ($p=0.046$), reported NSIs for the W group in comparison to control group of 0.45 (95% CI: 0.19–1.06) and NW group in comparison to control group of 0.34 (95% CI: 0.13–0.91). The officially registered NSIs during the study period showed no statistical differences between the groups. However, officially registered NSIs shows no significance difference in the rate.

The study (8), which evaluated the effect of enhanced sharp awareness strategy and introduction of safety devices in the reduction of needle stick injuries. The comprehensive education package consisted of training, road shows, inoculation injuries information on staff payslips, sharp box tray and awareness poster. The safety devices like safety hypodermic needles, insulin units and blunt fill cannulas and automatically retractable syringes were introduced. After the completion of enhanced sharp awareness strategy NSIS decreased from 16.9 to 13.9/100000 devices, while only standard education program intervention showed increasing trend. In contrast, subsequent introduction of safety devices and extensive education intervention yielded most satisfactory results, reducing NSIs to just 6/100000.

6.3 Enhanced engineered sharp container

Two studies (4 & 10) analyzed the effect of introducing sharp container with enhanced engineering. Study (4), which evaluated the impact of replacing conventional sharp containers with enhanced safety featured sharp container claimed 57% reduction in disposal related NSIs/SIs and 81% container associated injuries. The introduced safety featured container had large horizontal aperture, hand safe activation features, sensitive counter balance door and tray, deep atrium, hand-safe activation features, one hand deposit, automatic lock when full, hand entry restriction and highly puncture-resistant walls. The rate of NSIs/SIs was compared along with the control group who were using conventional sharp container for the whole time of the study. There was no noticeable change in the injuries rate among the control group where as study group observed significant fall of NSIs/SIs.

Another study (10), which also evaluated the impact of using large engineered container in comparison to small patient room sharp disposal container, reported remarkable fall in container associated and disposal related NSIs. The intervention was implemented in three phases; phase one consisted using small disposable container, which was carried to and from patient room. This intervention category yielded zero transportation injury but container associated (CASI) injuries were 19.4%. In the second phase of the study, large 32 L safety featured sharp disposable container was mounted in medication room and sharp from patient room were carried using kidney tray. This approach reduced CASI by 94.9% and disposal related injuries by 71.1% but transportation injuries rose significantly. In the third phase of the intervention, the safety-featured device was mounted in patient room, which resulted zero CASI along with 83.1% disposal related injuries and 85.1% fall in recapping of the needles. In this chapter, the author discussed the emerged themes after data analysis process. The next chapter will be about the discussion of the findings.

7 DISCUSSION

The reviewed articles evaluated different interventions using different approaches for reducing the risk of NSIs. Based on the review of literatures, mainly three types of intervention approach emerged; educational activities, safety devices plus education activities, and enhanced engineered sharp disposable container.

Almost 42% of the articles (1, 2, 9, 11& 12) evaluated the impact of educational activities and reported noticeable reduction of NSIs/Sis/Pis among the health care workers and more prominent positive outcome was observed among nurses. This finding is also supported by a latest study (EI-Hay& Seham, 2015), which recommends educational activities as a key factor in improving knowledge and practice regarding needle stick injuries. Every study claimed fall in the rate of NSIs/Pis/Sis but with different rate. The presentation and execution of intervention might have influenced the study groups.

The extensive or comprehensive educational interventions (9) consisting interactive lecture sessions, workshops, good use of multimedia and continuous in-service education on infection control activities proved to be most effective educational approach and claimed approximately 96% reduction of NSIs. On contrary to this result, Meherdad et al (2013) reported significant increase in the number of reported NSIs after education intervention. The researchers argued that increased number of NSIs were because of increased knowledge and awareness about the needle stick injuries and reporting attitude rather than actual raise in the incidences of NSIs.

Two articles (5,7), evaluated the impact of safety-engineered devices and studies shows co-relation between safety-engineered devices and the incidences of NSIs. One study (5), which evaluated the effect of safety devices like butterfly system, hypodermic needles and passive mechanism for intravenous catheter and lancets, reported overall 21.9% reduction of NSIs but rate specific rate was varied among different procedures. The same study claim 50% fall in blood withdrawl related injuries.

Another study (7), examined the impact of single use automatically retractable lancet to collect capillary blood by finger and claimed significant fall of NSIs among nursing staffs. The rate of NSIs decreased from 9.39 to 4.31/100 FTEs. These findings are to some extent consistent with the findings of previous reviewer. They argued that the impacts of safety devices are inconsistent from study to study and various types of study approach are needed in order to evaluate their effectiveness and cost friendliness (Lavoie *et al.* 2014). However, a recent systematic review and meta-analysis concluded that safety engineered devices like safety featured syringes have moderate quality evidence in the prevention of NSIs (Harb *et al.* 2015).

Another three articles (3, 6 & 8) evaluated the effect of safety-engineered needle devices along with the comprehensive educational activities and reported tremendous fall of NSIs. One study (3) reported 49% of fall and argued that such positive outcomes are the result of elimination of risk (devices). Same study claimed 81% reduction in NSIs related to intravenous line access and 57% reduction in hollow bore injuries. The findings from next two articles (6&8) are also consisted with article 3.

The randomized trial study (6) compared two interventions; Safety needle devices (N) and safety needle devices plus workshop (NW). The study data from each study group were compared to control group. The combination intervention (NW) yielded better result than safety needle devices. Results from Adams& Elliott study (8) were also consistent (-70% fall of NSIs) with Whitby et al (3). Finding of this review reflect the conclusion made by Valls *et al.* (2007); their study concluded that properly used engineered devices significantly reduce NSIs but education and training are the important milestones of achieving preventative aspects.

Two (4 & 10) out of 12 studies evaluated the impact of using enhanced safety featured sharp disposal container. Grimmond *et al.* (4) evaluated the impact of replacing conventional sharp container with enhanced safety featured horizontal aperture with large atrium, puncture proof wall and automatic lock when full. This intervention reported 81% container related injuries and 57% disposal related injuries. Another study (10), evaluated a three phase interventions. In phase I; small portable disposable sharp con-

tainer were carried to and from patient room, in phase II; a enhanced safety featured large and reusable sharp disposal container mounted only in medication room and sharps from patient rooms were carried using kidney tray, and in phase III; safety featured sharp container was mounted in patient room. The last intervention yielded best results, claiming zero container associated injuries and 83.1% disposal related injuries. Findings from two studies were very close to each other and suggested that engineered sharp container are very useful in reducing container associated as well as disposal associated needle stick injuries.

The different studies findings from this review reflect that every intervention discussed above have different level of quality evidence in preventing NSIs/SIs/PIs. However, combination of safety engineered devices and education have shown to be most effective approach in the prevention of NSIs among the nursing personnel.

Hierarchy of control strategies for occupational exposure and health promotion model describes how implementing certain controls can prevent NSIs in nurses and other HCWs (Levy & Wegman, 2000; Salazar, 2006) and by adopting health promoting life styles using individual characteristics or previous experiences to get positive health behaviors or modifying risk behaviors (Pender, 1982). Engineering controls measures can be used in order to structure working environments to eliminate or reduce harm. For example, safety engineered needle devices can replace traditional needle devices or sharps. The employer can buy safety-engineered devices and educate HCWs for their proper use. Administrative controls also seem to be equally important in the prevention of NSIs. This control emphasize regular training and education sessions on prevention of NSIs or infection controls, good implementation of occupational safety and health protocols /policies, adequate information about the roles and responsibilities of different stakeholders (Levy & Wegman, 2000). According to studies (1,2,9,11&12) administrative control activities are the keys to enhancing knowledge and incorporating healthy behaviors.

8 CONCLUSION

In this chapter, the author will discuss the brief summary of the study at first. Then, the strength as well as the limitations of the study will be discussed. Similarly, the author will also discuss about the future recommendation.

The different interventions approaches; education, safety engineered needle devices plus education, and enhanced engineered sharp disposable container have different level of quality evidences in the prevention of needlestick injuries among nurses and other health care workers. The study reports also suggest that providing comprehensive education and training session is better than just introducing safety devices. Different researchers also believe that educational activities are the first milestones of enhancing knowledge and training helps to gain competency in skill. Evidences from this review emphasize that the most effective approach for the prevention of NSIs/PSs/SIs is the combination of administrative and engineering controls. Continuous education on the prevention of NSIs or infection control, strict adherence to occupational health and safety policies and protocols along with the introduction of safety engineered devices have yielded the most significant results. This approach is more significant among nursing personnel in hospital setting.

This review explored the existing evidence based preventive measures of NSIs among the health care workers and the author had gained in-depth knowledge through extensive literature review. The ethical aspect of the research study is strictly followed and all the intellectual properties are referenced with respect. The author has tried her best to answer the formulated research question and maintain the trustworthiness of the findings. Considering credibility, dependability and transferability in mind, most relevant and recent articles were chosen for analysis and Graneheim & Lundman (2004) content analysis for nursing research has been followed for analysis process. Study findings are applicable in preventing needlestick injuries among healthcare workers in hospital settings.

This was a small-scale study and was conducted for partial fulfillment of the academic requirement and result can't be generalized in all setting. Only 12 articles were selected for the analysis and there is always the possibility of finding new evidences with different study approach or different study population. Only English language and freely accessible full text articles were selected for the study.

No matter how much author has tried to analyze the every aspect of the research unit, there is always the possibility of emerging new knowledge and practices. Therefore, more studies are needed with different study designs and different settings such as emergency care unit, intensive care units and hospital ward, etc. There is the need of more nursing research in order to safeguard nurses and promote occupational health and safety of them. Nursing researches are also equally important for the professional development of nursing profession along with the utilization of new technology.

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APPENDICES

Appendix 1. List of the selected literatures

No.	Author	Year of publication	Title of the study	Name of journal	Theme of the study
1	Beltagy et al	2012	Impact of infection control educational activities on rate and percutaneous injuries (PIs) at a tertiary care hospital in Saudi Arabia.	Journal of Infection Control	Impact of infection control educational activities.
2	Zafar et al	2009	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 Disease	Impact of infection control activities.
3	Whitby et al	2008	Needle stick injuries in a major teaching hospital: The worthwhile effect of hospital-wide replacement of conventional hollow-bore needles.	American Journal of Infection Control	Educational Programme and SED Intervention
4	Grimmond et	2010	Sharp Injury Reduction using a sharps container	American Journal of	Enhanced Engineering Sharp

	al		with enhanced engineering: A 28 hospital non-randomized intervention and cohort study.	Infection Control	Container Intervention
5	Hoffman et al	2013	Reduction of needle stick injuries in health care personnel at a university hospital using safety devices.	Journal of Occupational Medicine	Introduction of safety devices
6	Molen et al	2011	Better effect of the use of needle safety device in combination with interactive workshop to prevent needle stick injuries.	Safety Science	Intervention workshop and introduction of needle safety devices
7	Menezes et al	2014	Impact of Single safety engineered device on the occurrence of percutaneous injuries in a general hospital in Brazil.	American Journal of Infection Control	Introduction of Safety engineered device
8	Adams & Elliott	2006	Impact of safety needle devices on occupationally acquired needle stick injuries; a four-year prospective study.	Journal of Hospital Infection	Implementation of enhanced sharp education program Impact of only standard sharp education program Comprehensive training program Intervention
9	Yao et al	2013	Occupational Safety training and education for needle stick injuries among nursing students in China:	Nurse Education Today	Occupational Safety training and education Protocol Intervention

			intervention Study.		
10	Grimond & Naisoro	2014	Sharp injury reduction: a six-year three-phase study comparing use of small patient room sharps disposal container with a larger engineered container.	Journal of Infection Prevention	<p>Three phase before and after intervention;</p> <p>Use of small (1.4l) portable sharp container to and from patient room.</p> <p>Stopping use of portable sharp container and mounting of safety-engineered reusable (32 L) container in medication station only.</p> <p>Mounting of safety – engineered sharp disposable container in patients room</p>
11	Brussafero et al	2009	Educational programs and sharp injuries in health care workers.	Occupational Medicine	Education Program intervention on sharp injury
12	Yang et al	2007	The effectiveness of a training program on reducing needle stick /sharp object injuries among soon graduate vocational nursing school students in southern Taiwan.	Journal of Occupational Health	Educational intervention