The Effectiveness of Disaster Education for Nurses and Other Health Care Professionals: A Systematic Review

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Notice 1

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Abstract

Introduction

Training, drills, and other types of disaster education are designed to increase the disaster preparedness of nurses and other health care professionals. However, the effectiveness of those types of education has yet to be verified. The aim of this study is to systematically identify, select, appraise and review the literature to determine the best available evidence related to the effectiveness of disaster education for nurses and other health care professionals.

Search Strategy

Peer reviewed literature was searched through four databases: MEDLINE, CINAHL, EMBASE, and ERIC and the inclusion criteria were English language, full-text only, and published from 2001 to 2014. Inclusion criteria for the study were Registered Nurses working nurses independently or in a team with other health care professionals. Also included were studies with quantitative design to measure objectively the impact of disaster education. Through the search process, five studies were found and subject to quality appraisal. After the quality appraisal process, the researchers decided to include the five studies in the review.

Results

The effectiveness of disaster education in this review was determined by the evaluation of the evidence on competence, confidence and willingness to respond to a disaster, appropriateness of statistical analysis, and the influence of research method on the intervention outcome. Multiple educational interventions used to deliver educational content were evident in the included studies. Questionnaire was the evaluation tool used in all of the studies. All of the studies reported a significant improvement in knowledge score after intervention, acknowledging the range of methodologies and limitations. Two studies reported a high level of confidence after the intervention took place. However, the evaluation of the concepts of competence and willingness to respond to a disaster was not revealed in the studies. Positions and professions of the participants in their respective workplaces were not a significant factor in the evaluation score.

Conclusion

Disaster education may improve nurses and health care professionals' knowledge, (an essential element of competence) and confidence. However, the available evidence does not adequately report the effectiveness of interventions for improvement of competence (as a whole) and willingness to respond to a disaster. This is due to the evaluation processes in the included studies which placed greater emphasis on knowledge improvement alone, without comprehensive evaluation of competence. Furthermore, most of the educational interventions were designed specifically for local needs.

Further research is recommended regarding disaster preparedness of nurses and other health care professionals that includes learning needs assessment and evaluation of learning retention. A study design that includes a comparison group would add rigour. Research is also required to determine if there is a relationship between improved score in a single disaster education and better performance in responding to a disaster. Finally, research in the area of education and willingness to respond will be important since it is already known that there is a relationship between willingness to respond, culture and the type of disaster.

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Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Harizza Pertiwi
October 17, 2015

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List of Abbreviations

ANOVA	Analysis of variance
COAG	Council of Australian Governments
DON	Director of Nursing
FEMA	Federal Emergency Management Agency
ICN	International Council of Nurses
IFRC	International Federation of Red Cross and Red Crescent Societies
JBI	Joanna Briggs Institute
JCAHO	Joint Commission on Accreditation of Health Care Organizations
PHN	Public Health Nurse
PICO	Population, intervention, comparison, outcome
PRISMA	Preferred Reporting Items for Systematic Review and Meta-Analysis
RCT	Randomised controlled trials
UNISDR	United Nations International Strategy for Disaster Risk Reduction
WHO	World Health Organization

Glossary of Terms

Attrition bias	"The differences in losses of subjects between groups" (Porritt, Gomersall, & Lockwood, 2014, p. 49).
Detection bias	"Outcomes are assessed differently for treatment and control groups" (Porritt et al., 2014, p. 49).
Disaster	"A sudden calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources" (International Federation of Red Cross and Red Crescent Societies, n.d.-c).
Disaster education	An effort of transferring proper knowledge of disaster and disaster risk reduction (United Nations International Strategy for Disaster Risk Reduction, n.d.-a).
Disaster management	"The organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters" (International Federation of Red Cross and Red Crescent Societies, n.d.-a)
Disaster preparedness	"Measures taken to prepare for and reduce the effects of disasters. That is, to predict and, where possible, prevent disasters, mitigate their impact on vulnerable populations, and respond to and effectively cope with their consequences" (International Federation of Red Cross and Red Crescent Societies, n.d.-b)
Disaster Response	"The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected" (OCHA, 2013, p. 7)
Disaster risk reduction	"An effort that aims to reduce the damage caused by natural hazards like earthquakes, floods, droughts, and cyclones" (United Nations International Strategy for Disaster Risk Reduction, n.d.-b)

Forest plot	A graph that shows the strength of intervention effects of multiple quantitative studies addressing the same question (Schneider, 2007)
Narrative synthesis	"An approach to the systematic review and synthesis of findings from multiple studies that relies primarily on the use of words and text to summarise and explain the findings of the synthesis" (Popay et al., 2006, p. 5).
Peer-reviewed articles	Articles are written by experts and are reviewed by several other experts in the field in order to judge that the quality, clarity and rigour of the content and writing are suitable for publication (Schneider, Whitehead, LoBiondo-Wood, & Haber, 2013).
Performance bias	"The differences between groups in the care received" (Porritt et al., 2014, p. 49).
PRISMA flowchart	A diagram that depicts the flow information through the phases of the review process (PRISMA, 2015).
Protocol	"The protocol provides the plan or proposal for the systematic review which details the criteria the reviewers will use to include and exclude studies, to identify what data is important and how it will be extracted and synthesised" (Joanna Briggs Institute, 2014, p. 13).
Quality appraisal	Quality appraisal process aims to identify methodological flaws in a study and assist researchers to make decisions of the quality of research evidence (Joanna Briggs Institute, 2000).
Questionnaire	"An instrument or tool designed to gather information from participants in a quantitative study that consists of a set of purposefully constructed questions that will be used to measure the study variable of interest" (Schneider et al., 2013, p. 206).
Selection bias	"The researchers' allocation of participants to groups that favour one of the treatments" (Porritt et al., 2014, p. 49).
Systematic review	"A research synthesis that aims to provide a comprehensive, unbiased, synthesis of many relevant studies in a single document" (Aromataris & Pearson, 2014, p. 54).

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Chapter One

Introduction

1.1 Introduction

The frequency of disasters has been changing since the 1900s. From 1900 until 1948, the number of disaster incidents around the world was relatively low and steady, ranging from 2 to 18 incidents per year (Emergency Events Database, 2015). Yet, from 1948 until 2014, the number of reported incidents has gradually and significantly increased. The highest number of disasters that has been reported in one year was 527 incidents in 2000 (Emergency Events Database, 2015). The toll for disasters in the last 100 years has been more than 7 billion persons deceased or affected, and economic costs estimated as high as US $16 trillion (Emergency Events Database, 2015). These losses have devastated communities.

In order to manage human casualties effectively and help survivors rebuild their lives after disaster, competent and well-prepared nurses and health care professionals are needed (International Council of Nurses, 2009). Health care professionals are an essential resource for a community in a disaster. Since a requirement of successful disaster management is team work, nurses, physicians, paramedics, and emergency medical service personnel need to work together effectively (Burstein, 2006). To enhance the effectiveness of disaster response, adequate disaster preparedness of health care professionals is needed (Merchant, Leigh, & Lurie, 2010). However, the level of preparedness of health care professionals is still not sufficient (Lim, Lim, & Vasu, 2013) and most hospital staff are not prepared to deal with a disaster (Hsu et al., 2004).

1.2 Disaster Management

Disaster is “a sudden calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community’s or society’s ability to cope using its own resources” (International Federation of Red Cross and Red Crescent Societies, n.d.-cpara. 1). Similar to International Federation of Red Cross and Red Crescent Societies (IFRC), the United Nations International Strategy for Disaster Reduction also emphasises the effects of a disaster that may impact a community (2009).

During disaster, people in the community may be without power, shelter, communication, food and water (Powers & Daily, 2010). These are essential requirements for a community to keep functioning. A quick response to deal with the aftermath of a disaster cannot guarantee to immediately bring back the resources and return functioning of a community. Preparing for the possibility of a future disaster incident is imperative to reduce the negative effects that a disaster may bring (Council of Australian Governments, 2009).

Placing greater emphasis on prevention and recovery phases and disaster risk reduction have been a focus of disaster management during the last decade. In 2005, The United Nations International Strategy for Disaster Reduction (UNISDR) developed a framework as a guide in reducing disaster risk known as the Hyogo Framework. The Hyogo Framework comprises indicators and outcomes to be achieved by 2015 by participating members. As a follow-up effort, in 2015, UNISDR through the World Health Organisation (WHO) launched the latest guide on disaster risk reduction, the Sendai Framework. The Sendai Framework contains outcome, goals and targets to be accomplished by 2030. Prevention, mitigation and preparedness effort in disaster risk reduction are emphasised in the Sendai Framework. Priorities of action are:

1. Understanding disaster risk;
2. Strengthening disaster risk governance to manage disaster risk;
3. Investing in disaster risk reduction for resilience;
4. Enhancing disaster preparedness for effective response, and to build back better in recovery, rehabilitation and reconstruction (United Nations International Strategy for Disaster Risk Reduction, 2015, p. 14). Effective response is affected by the health care professionals who respond to a disaster.

1.3 Health Care Professionals and Disaster Preparedness

In most communities disaster is infrequent and repeated events are rarely identical. Therefore, health care professionals do not have the opportunity to adequately practice their disaster response skills in a real-life disaster experience. In an actual disaster response, health care professionals may find unusual cases of injuries and may be required to practice specific procedures that they are not familiar with in regular emergency settings (Arbon et al., 2006; Gebbie & Qureshi, 2002; Hammad, Arbon, Gebbie, & Hutton, 2012). To be able to meet the special roles required in responding

to a disaster, health care professionals must have adequate disaster-related competence and have had the opportunity to practice relevant skills to feel prepared (Gebbie & Qureshi, 2002).

As the largest professional group among all health care professionals, nurses can be called upon to provide care to many victims of disaster in various environments including the field as part of response (International Council of Nurses, 2009; Langan & James, 2005). Besides having the educational background that emphasises a biological, psychological, social, and spiritual approach in caring for patients affected by disaster, nurses also have critical thinking, problem-solving skills, flexibility, and adaptability necessary for managing difficulties that might arise during disasters (Powers & Daily, 2010; Wynd, 2006). These skills are learned during nursing education in college and when caring for patients (Powers & Daily, 2010).

Having the skills needed in managing disaster is indeed beneficial for nurses, but that does not imply that nurses are ready and prepared to carry out disaster and emergency roles when a disaster occurs (Wisniewski, Dennik-Champion, & Peltier, 2004). A study on nurses' perspective about roles during a disaster shows that half of the participants reported uncertainty about their role in disasters, although the need for clinical roles is similar to regular emergency actions (Hammad, Arbon, & Gebbie, 2011).

As part of the disaster response team, nurses are expected to be able to deliver advanced health care to disaster survivors (Gebbie, Hutton, & Plummer, 2012). Nurses also should have an understanding of basic theoretical information and practice regarding medical and health logistics of managing disasters, especially when clinical facilities become overwhelmed by the event (Hilton & Allison, 2004; Pelaccia, Delplancq, & Triby, 2008). Ill-prepared staff lead to ill-prepared healthcare organisations (Admi, Eilon, & Hyams, 2011; Franco et al., 2006). The basic information on managing a disaster event is provided in the core competencies for healthcare professionals.

1.4 Core Competencies for Health Care Professionals

Core competencies have been developed to describe the role of health care professionals, including nurses, in an emergency and disaster setting (Gebbie & Qureshi, 2002). Clarifying these core competencies has become a focus of attention in the nursing education sector. Clear competencies are essential because competent

health care professionals are expected by the community to be organized, efficient, and effective in responding to a disaster (Gebbie et al., 2012).

Gebbie and Qureshi (2002) developed the core competencies for nurses based on core emergency preparedness for public health workers. The competencies relate to who to call, how to react, and what to do when a disaster happens. More specifically, nurses and health care professionals need to know the chain of command, have skills required in emergency response, and apply creative problem-solving skills. The twelve core competencies are:

1. Describe the chain of command in emergency response;
2. Identify and locate the agency's emergency response (or the pertinent portion of the emergency response);
3. Describe emergency response functions or roles and demonstrate them in regularly performed drills;
4. Demonstrate the use of equipment (including personal protective equipment) and the skills required in emergency response during regular drills;
5. Demonstrate the correct operation of all equipment used for emergency communication;
6. Describe communication roles in emergency response;
7. Describe the agency's role in responding to a range of emergencies that might arise;
8. Identify the limits of your own knowledge, skills, and authority, and identify key system resources for referring matters that exceed these limits;
9. Apply creative problem-solving skills and flexible thinking to the situation, within the confines of your role, and evaluate the effectiveness of all actions taken;
10. Recognise deviations from the norm that might indicate an emergency and describe appropriate action;
11. Participate in continuing education to maintain up-to-date knowledge in relevant areas;
12. Participate in evaluating in every drill or response and identify necessary changes to the plan (Gebbie & Qureshi, 2002, p. 47).

As the organisation which is focusing on advancing nurses and nursing, and bringing nursing together worldwide, The International Council of Nurses (ICN) has also developed a framework of disaster nursing competencies. This framework was built on ICN Framework Competencies for the Generalist Nurse, and works on the premise that in disaster, every nurse is a disaster nurse. Hence the disaster nursing competencies do not address additional competencies required for nurses specialized in particular areas, such as emergency, paediatric or psychiatric nursing (International Council of Nurses, 2009). However, the framework serves as a basis for developing any additional advanced nursing competencies, such as emergency, paediatric, or psychiatric nursing.

Similar to the competencies developed by Gebbie and Qureshi (2002), the ICN Framework of Disaster Nursing Competencies was developed to clarify the role of nurses in disasters and assist in the development of disaster training and education (International Council of Nurses, 2009). Disasters bring uncertainty to what has happened, the number of injured and dead, the extent of devastation, and the urgency that injuries must be treated right away making it essential for nurses to have similar and standardized competencies in order to work together in delivering health care to affected population.

The ICN Framework of Disaster Nursing Competencies has four categories of competencies based on each phase of disaster continuum. Disaster continuum is a cycle of disaster phases that always occur continuously. Competencies for each phase are:

1. Prevention/mitigation preparedness: risk reduction, disease prevention, health promotion, and policy development and planning;
2. Preparedness competencies: ethical practice, legal practice, accountability, communication and information sharing, also education and preparedness;
3. Response competencies: care of the community, care of individuals and families, psychological care, and care of vulnerable populations;
4. Recovery/rehabilitation competencies: long-term individual, family and community recovery (International Council of Nurses, 2009, p. 49).

To describe the role of all health care professionals during a disaster, Hsu et al (2006) have developed seven cross-cutting competencies through a systematic evidence-based consensus building approach. These competencies are:

1. Recognize a potential critical event and implement initial actions;
2. Apply the principles of critical event management;
3. Demonstrate critical event safety principles;
4. Understand the institutional emergency operations plan;
5. Demonstrate the effective critical event communications;
6. Understand the incident command system and your role in it;
7. Demonstrate the knowledge and skills needed to fulfil your role during a critical event (Hsu et al., 2006, p. 3).

The competencies developed by Gebbie and Qureshi (2002) and the International Council of Nurses (2009) are designed to support nurses and Hsu et al. (2006) is designed to support all health care professionals, in disaster preparedness and response.

1.5 Key Elements of Disaster Preparedness

There are four key elements that contribute to optimum disaster preparedness for health care professionals in responding the consequences of a disaster (Hope et al., 2010; Lim et al., 2013). These elements are previous experience of disaster response, confidence, willingness to respond and disaster knowledge and education.

1.5.1 Previous Experience

Previous disaster experience covers a wide range of incidents that includes direct and indirect experiences, the frequency and severity of past occurrences, a variety of hazard types, and experience with false alarms (Sharma & Patt, 2012). Having previous disaster experience may positively influence decisions made in events that happen consecutively (Silver & Andrey, 2014). This finding implies that previous disaster experience may develop preparedness for future possible disaster by giving a chance to act in a real-life event. Nurses who have previously contributed in a major disaster event have anticipation and understanding of what to expect (Hammad et al., 2012).

1.5.2 Confidence

Confidence is strongly related to level of knowledge and educational opportunities (Duong, 2009). Studies revealed that the level of confidence of clinicians and public health nurses that attended disaster training programs was significantly increased after the program ended (Chiu, Polivka, & Stanley, 2011; Gershon et al., 2004). Therefore,

confidence is more likely to be the outcome of having adequate knowledge about a specific area.

Confidence is essential when responding to a disaster because it is one of the factors that lessens the willingness of health care professionals to report to work in an event of disaster (Hope et al., 2010). Emergency nurses in a South Australian study reported not feeling confident about their actions in responding to a disaster. Limited education opportunities and previous disaster response experience were assumed to be the reason that caused the lack of confidence among these nurses (Duong, 2009).

1.5.3 Willingness

The willingness of health care professionals to respond to a disaster is influenced by the type of disaster, preparedness of workplace, self and colleague confidence and personal views on responsibilities during a disaster (Arbon et al., 2013; Hope et al., 2010). Personal and family safety is the most frequent consideration that nurses and health care professionals have before deciding to attend to work during a disaster (Arbon et al., 2013). However, it is not a definite hindrance in responding to a disaster. Although chemical, biological, radiological, nuclear and explosive incidents are types of disaster that threaten personal safety of nurses, a study by Mitchell, Kernohan, and Higginson (2012) revealed most emergency nurses were very likely to attend to work.

1.5.4 Knowledge and Education

Knowledge of disaster preparedness may be gained through formal or informal education. Formal education means a degree or diploma course, such as Bachelor or Master of Nursing, while informal education is comprised of training, drills or simulation undertaken in a workplace. Disaster education that covers knowledge needed regarding disaster preparedness would be beneficial in increasing disaster knowledge for health care professionals who have limited disaster experience (Duong, 2009).

1.6 Disaster Education for Health Care Professionals

In order to deal with emergency situations caused by a disaster, health care professionals need to have comprehensive knowledge, skills, and ability (Slepski, 2005). Besides gaining knowledge and skills through disaster response experience,

health care professionals may improve their disaster preparedness by attending disaster-related educational programs. In fact, disaster education is required because the likelihood of having disaster experience is unpredictable.

Despite the importance of disaster education, nursing schools provide limited content on delivering care under disaster and emergency conditions (Tillman, 2011). A study reported that only seven out of 19 nursing schools in Australia included disaster nursing content in their curricula (Usher & Mayner, 2011). This is a startling finding considering nurses are the largest group among health care professionals. Furthermore, nurses are trained to assist patients in meeting their physical, psychological and spiritual needs, therefore highly qualified to manage health care outcomes in disaster event (Tillman, 2011). The findings of the study by Usher & Mayner (2011) reported that the majority of Australian nursing graduates are not equipped with adequate knowledge in the area of disaster nursing when they begin their professional careers.

A study conducted by Lim et al. (2013) found only 558 out of 1534 health care workers who participated felt they were ready to be a part of disaster response team. Duong (2009) also noted that 144 out of 152 respondents of their study perceived they should be trained before being deployed to respond to a mass-casualty incident. These findings signify that not only nurses, but all health care professionals are in need of disaster education to improve disaster preparedness.

Health care professionals may acquire disaster education that aims to improve competence (knowledge, skill and attitude), confidence, and willingness to respond. If this education is delivered effectively and efficiently, health care professionals may feel aware, confident, and less vulnerable when having to face the unexpected (Duong, 2009). Disaster education will also improve the quality of care of those affected (Husna, Hatthakit, & Chaowalit, 2011).

As an effort to improve disaster-related knowledge and skill, various approaches to disaster education have been used to educate health care professionals. These interventions include lectures, discussions, exercises and drills (IFRC, 2000). However, disaster education may be time-consuming, expensive, and divert resources away from other important needs (Hsu et al., 2004). Moreover, the current literature is insufficient to determine whether training interventions are effective in improving knowledge and

skill regarding disaster response (Williams, Nocera, & Casteel, 2008). This prompted the researcher to explore the issue further and provides justification for this systematic review.

1.7 Health Services and Disaster Preparedness

The response of health services also affects disaster preparedness. Disasters may involve a significant human toll. Investment in developing disaster preparedness plans for health care professionals so that staff are trained for disaster management and additional patients should be a priority for health services (Hsu et al., 2004) .

Disaster preparedness plans are required by health services. These plans identify resources within the organisation; determine roles and responsibilities; and policies and procedures to contribute to a timely and effective response to the disaster (International Federation of Red Cross and Red Crescent Societies, 2000). In developing disaster preparedness plans, health services can coordinate with public health systems and appropriate government agencies (Hsu et al., 2004). As an organisation that has a mission to continuously improve health care for the public by evaluating health care organisations, the Joint Commission on Accreditation of Health Care Organizations (JCAHO), has set a standard that requires health services to test their emergency management plan twice a year (Joint Commission on Accreditation of Health Care Organizations, 2015). One of the two drills can be a tabletop exercise, only one of them must involve a simulation of an actual influx of patients (Joint Commission on Accreditation of Health Care Organizations, 2015). This is an option that can be used as a stimulus for providing health care professionals with disaster education.

It is evident that disaster education for health care professionals needs to be improved. Competency-based training that uses recommendations and guidance from experts and multiple organizations should improve disaster preparedness needed during a real disaster event (Powers, 2007). One of the strategies that can be used to improve disaster preparedness is increasing the frequency of disaster education itself (Powers, 2007).

1.8 Working in a Team of Multi-professionals

Nurses are one of the many health care professionals that may need to respond quickly to a disaster. However, collaborative work of a multi-professional team is needed to complement each other's tasks and responsibilities (Silenas, Akins, Parrish, &

Edwards, 2008). Furthermore, the sense of collegiality is a strong factor that brings out emergency nurses' willingness to respond to a disaster (Hammad et al., 2012).

A disaster health care team can be defined as "an intimate group of interpersonally associated providers that works toward the common goal of seeing that disaster victims receive quality disaster care" (Larkin, 2010, p. 497). Through a team based approach, many positive benefits can be achieved. The benefits include optimized resources, enhanced efficiency, promoted collaboration, understanding population problems, access to a wider range of expertise, and reduced stress due to sharing of responsibility (Larkin, 2010; World Health Organisation, 2012).

Due to the benefits that teamwork may bring, disaster education that targets multiple-professions is preferable (Silenas et al., 2008). This way, health care professionals are trained to be collaborative and aware of each other's responsibilities before being deployed into a real disaster event.

1.9 Effectiveness of Disaster Education

Disaster education is emphasised as imperative in building disaster preparedness for health care professionals. Disaster education has also become a requirement for health services in order to meet patient safety standards established by JCAHO (Joint Commission on Accreditation of Health Care Organizations, 2015). Nevertheless, it is unclear whether disaster education improves disaster preparedness (Williams et al., 2008).

Two systematic reviews regarding effectiveness of disaster training for health care professionals have been conducted (Hsu et al., 2004; Williams et al., 2008). Both studies reported lack of scientifically rigorous evaluation in the included literature, resulting in limited conclusions and recommendations being able to be made (Hsu. et al., 2004; Williams et al., 2008). Thus, in this systematic review, a search process of the most recent disaster education-related literature was conducted to investigate the effectiveness of educational intervention to improve disaster preparedness of nurses and other health care professionals and update the previous finding.

1.10 Review Question

In this review, a disaster-prepared nurse or other health care professional is defined as one who has adequate competence, confidence, and willingness to respond to a disaster. Therefore, the review question is:

How effective is disaster education in improving

1. Competence (knowledge, skill, attitude)
2. Confidence
3. Willingness to respond

for qualified and working nurses and health professionals in the hospital and out-of-hospital setting.

1.11 Review Objective

The objective of this systematic review is to systematically review the literature to determine the best available evidence related to the effectiveness of disaster education for nurses and other health care professionals.

1.12 Significance of Study

This systematic review aims to evaluate the current evidence in relation to which educational intervention or combination of educational interventions is effective in improving disaster preparedness among nurses and other health care professionals in their workplace.

The systematic review is expected to be beneficial as a reference for disaster managers in developing disaster education for qualified and working nurses and other health professionals. For researchers, the recommendations of this review is likely to be beneficial in planning future research related to effectiveness of disaster education.

1.13 Thesis Structure

This thesis is presented in five chapters. Chapter One provided the background to the study. The chapter included the introduction, the background to the study including explanations of disaster management, disaster preparedness for health care professionals, core competencies, key elements of disaster preparedness, disaster

education for health care professionals, working in a team of multi-profession and effectiveness of disaster education. This was followed by an outline of the systematic review question, review objective, significance of the study, and thesis structure.

Chapter Two will provide theoretical framework of a systematic review and the methodology background. Inclusion and exclusion criteria, search strategy, search outcome, Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart, quality appraisal of studies, data extraction and data synthesis are also will be discussed.

Results will be presented in Chapter Three. Chapter Three will include the characteristics, results of included studies and effectiveness of interventions from multiple studies and bias assessment will also be presented.

Chapter Four, Discussion, will report the key findings of studies. In this chapter, common themes that emerged from the included studies will be discussed. Finally, conclusions and recommendations from the systematic review will be presented and the limitations of the study are also will be included in Chapter Five.

Chapter Two

Method

2.1 Introduction

Disaster education is conducted to improve the knowledge and skill of health care professionals as a preparation when responding to a disaster (Conlon & Wiechula, 2011; Gillett et al., 2008; Greci et al., 2013; Hsu. et al., 2004; Scott et al., 2013; Williams et al., 2008). While many disaster education programs for health care professionals have been conducted around the world, the effectiveness of educational interventions has not yet been clearly examined (Hsu. et al., 2004; Williams et al., 2008). By systematically reviewing the disaster education literature, the effectiveness of multiple interventions can be investigated.

This chapter outlines the theoretical framework of a systematic review and provides the background of the methodology used in this review. Next, the method of determining

the eligibility of the studies is described including the inclusion and exclusion criteria, followed by the search strategy and the method of quality appraisal and reporting any studies. Data extraction procedures are then described and synthesizing of data follows.

2.2 Systematic Review

Systematic review is "a research synthesis that aims to provide a comprehensive, unbiased, synthesis of many relevant studies in a single document" (Aromataris & Pearson, 2014, p. 54). The studies are collated based on eligibility criteria in order to answer a review question (Hemmingway & Brereton, 2009). This is a common strategy for investigating issues in experimental studies where effect of an intervention or treatment is evaluated (Schneider et al., 2013).

In conducting a systematic review, multiple steps needed to be performed. First, review objectives and questions were clearly identified. Then, inclusion and exclusion criteria that determine the eligibility of studies had to be defined explicitly. Next, a comprehensive search process was conducted to identify all relevant studies. After relevant studies were retrieved, the quality of the studies needed to be assessed. Any excluded studies based on quality assessment were reported. Data from included studies were then extracted and analysed. Synthesizing the extracted data and presenting the findings were the next steps of the review. The methodology and method used in the systematic review will be reported (Aromataris & Pearson, 2014; Presta, 2015).

The steps in conducting a systematic review are the factors that distinguish systematic reviews from traditional literature reviews (Aromataris & Pearson, 2014). A traditional literature review has a high risk of bias since they rely heavily on the author's knowledge and provide limited presentation of a topic (Aromataris & Pearson, 2014).

The transparent process of a systematic review also brings advantages for researchers and readers. A systematic review reduces the risk of subjective interpretation, creates the likelihood of replicating the review process by identifying clear inclusion and exclusion criteria, search strategy and quality appraisal, and resolves controversy between conflicting findings. A systematic review also provides a trustworthy and reliable basis for decision making regarding a particular issue (Cochrane Collaboration, 2002; Munn, Moola, Riitano, & Lisy, 2014; Popay et al., 2006).

Health care professionals and policy makers are faced with a significant amount of evidence related to effective disaster education. Many considerations arise in applying the evidence immediately into practice without further appraisal on the effectiveness of the educational intervention. Systematically reviewing the evidence may provide a reliable and more precise answer (Popay et al., 2006). Although previous systematic reviews on the effectiveness of disaster education have been undertaken (Hsu. et al., 2004; Williams et al., 2008), the included studies could not provide clear evidence of an effective intervention on improving disaster preparedness among nurses and other health care professionals. Therefore, reviewing the most recent literature from 2008-2015 and providing an update on previous systematic reviews is imperative to determine the effectiveness of disaster education.

2.3 Methodology

For this systematic review, the methodology was adapted from Joanna Briggs Institute (JBI), an international non-profit research and development centre that focuses on supporting evidence-based practice in nursing, medicine and allied health fields (Aromataris & Pearson, 2014; Joanna Briggs Institute, 2015a). JBI is one of the groups worldwide, along with Cochrane Collaboration and Centre for Reviews and Dissemination at the University of York that conduct systematic reviews.

JBI has its own unique approach in conducting systematic reviews. The approach by JBI considers international evidence related to the framework of feasibility, appropriateness, meaningfulness and effectiveness of health care interventions. The systematic review on JBI includes different forms of evidence that is assessed in a formal manner. JBI also disseminates information in appropriate, relevant formats to inform health systems, health professionals and consumers globally and has designed programs to enable the effective implementation of evidence and evaluation of its impact on health care practice (Joanna Briggs Institute, 2015b).

The result of JBI's systematic review is expected to provide reliable information for health care professionals and policy makers related to health issues. Hence, the included studies must be valid and reliable. To confirm the validity and reliability of a study, JBI has developed checklists for both quantitative and qualitative studies (Porritt et al., 2014).

2.4 Review Objective and Question

As stated in Chapter One, the review question is how effective is disaster education in improving

1. Competence (knowledge, skill, attitude)
2. Confidence
3. Willingness to respond

for qualified and working nurses and health professionals in the hospital and out-of-hospital setting.

2.5 Eligibility of the Studies

In this review the next step was to explicitly define the inclusion and exclusion criteria that determine the eligibility of the studies for this review.

2.5.1 Inclusion Criteria

The following criteria were used to determine whether a study was eligible to be included in the systematic review.

2.5.1.1 Types of Studies

To obtain objective and comparative measurement of the effectiveness of an intervention, only studies reporting primary research that used a quantitative approach with experimental and quasi-experimental design were included in the systematic review.

According to JBI, experimental designs, which include RCT, are the highest level of research evidence. Experimental designs are classified as Level One, followed by quasi-experimental designs as Level Two. Observational-analytic designs are grouped into Level Three. Level Four is observational-descriptive studies. Finally, expert opinion and bench research ranked as the lowest level of evidence, Level Five (Joanna Briggs Institute, 2013). To further describe the levels of evidence, a table showing the new levels produced in 2013 is presented in Table 2.1.

Table 2.1 JBI Levels of Evidence

Level 1 – Experimental Designs
Level 1.a – Systematic review of Randomized Controlled Trials (RCTs)

Level 1.b – Systematic review of RCTs and other study designs
Level 1.c – RCT
Level 1.d – Pseudo-RCTs
Level 2 – Quasi-experimental Designs
Level 2.a – Systematic review of quasi-experimental studies
Level 2.b – Systematic review of quasi-experimental and other lower study designs
Level 2.c – Quasi-experimental prospectively controlled study
Level 2.d – Pre-test – post-test or historic/retrospective control group study
Level 3 – Observational – Analytic Designs
Level 3.a – Systematic review of comparable cohort studies
Level 3.b – Systematic review of comparable cohort and other lower study designs
Level 3.c – Cohort study with control group
Level 3.d – Case – controlled study
Level 3.e – Observational study without a control group
Level 4 – Observational –Descriptive Studies
Level 4.a – Systematic review of descriptive studies
Level 4.b – Cross-sectional study
Level 4.c – Case series
Level 4.d – Case study
Level 5 – Expert Opinion and Bench Research
Level 5.a – Systematic review of expert opinion
Level 5.b – Expert consensus
Level 5.c – Bench research/ single expert opinion

(Joanna Briggs Institute, 2013)

2.5.1.2 Types of Participants

The systematic review explored studies of research including qualified and nurses working independently or in a team with other health care professionals, including physician, paramedic, and emergency medical services.

2.5.1.3 Types of Interventions

Educational interventions included hospital in-service type short courses, drills, simulations and other forms of education program (excluding formal education for award degree). The intervention/s was provided for nurses and other health care professionals in order to increase disaster preparedness.

2.5.1.4 Types of Outcome Measures

This systematic review targeted studies that contained a quantitative measurement of increased competence, confidence and willingness.

2.5.1.5 Time and place

Studies included were conducted in any country published in English between 2006 until 2015. Previous systematic review on the effectiveness of disaster education conducted by Williams et al. (2008) used studies published until 2005. To update the result, studies conducted from 2006 onwards were included.

2.5.2 Exclusion Criteria

The following criteria were used to determine if studies should be excluded.

1. Language other than English;
2. Studies conducted before 2006;
3. Published in journals that were not peer reviewed;
4. Did not include nurses in the sample of the study;
5. Included students as the sample for the study;
6. Did not measure objectively the components of disaster preparedness (competence, confidence, or willingness).

2.6 Search Strategy

Prior to undertaking systematic review, a protocol that outlines the review question and methods that was used to locate, select, and critically appraise studies related to the research objective was prepared for publication (Appendix A). The protocol also specifies how to extract and analyse data from included studies. This protocol was based on the JBI protocol template (Joanna Briggs Institute, 2015c).

In this systematic review, articles from peer-reviewed literature were searched for in four electronic database: MEDLINE, CINAHL, EMBASE, and ERIC. Keywords used were nurse, education, training, drill, simulation, teaching, “disaster preparedness”, “disaster planning”, and “disaster exercise”. The inverted commas were used so that both words would appear in a single article while performing search process. These key words were matched to medical subject headings and then combined by Boolean phrases (Table 2.2). These words represent the population, intervention, context and outcome (PICO) (Moyer, 2008). Nurse was the keyword that represents the targeted population but other health professionals were included such as paramedics and first responders. Intervention was represented by the words education, training, drill, simulation, and teaching. The key words for context were represented by the combined

words of “disaster preparedness”, “disaster planning”, and “disaster exercise”. The key words for outcome were confidence, competence and willingness to respond.

Table 2.2 Combined key terms

Population		**Intervention**		**Context**	**Outcome**
nurse OR health professionals including paramedics, first responders	AND	education OR training OR drill OR simulation OR teaching	AND	“disaster preparedness” OR “disaster planning” OR “disaster exercise”	confidence OR competence OR willingness

Details of databases searched, keywords used and number of articles identified, included and excluded in each step of the review process were recorded. The search results were entered into an EndNote database.

2.7 Search Outcome

By entering keywords, language and year limitations on the listed electronic databases, a total of 153 articles were retrieved. From MEDLINE 45 articles were retrieved, 53 articles from CINAHL, 51 articles from EMBASE, and four articles from ERIC. Duplicate studies (n = 13) were then removed by the researcher, resulting in 140 studies included in the next screening phase.

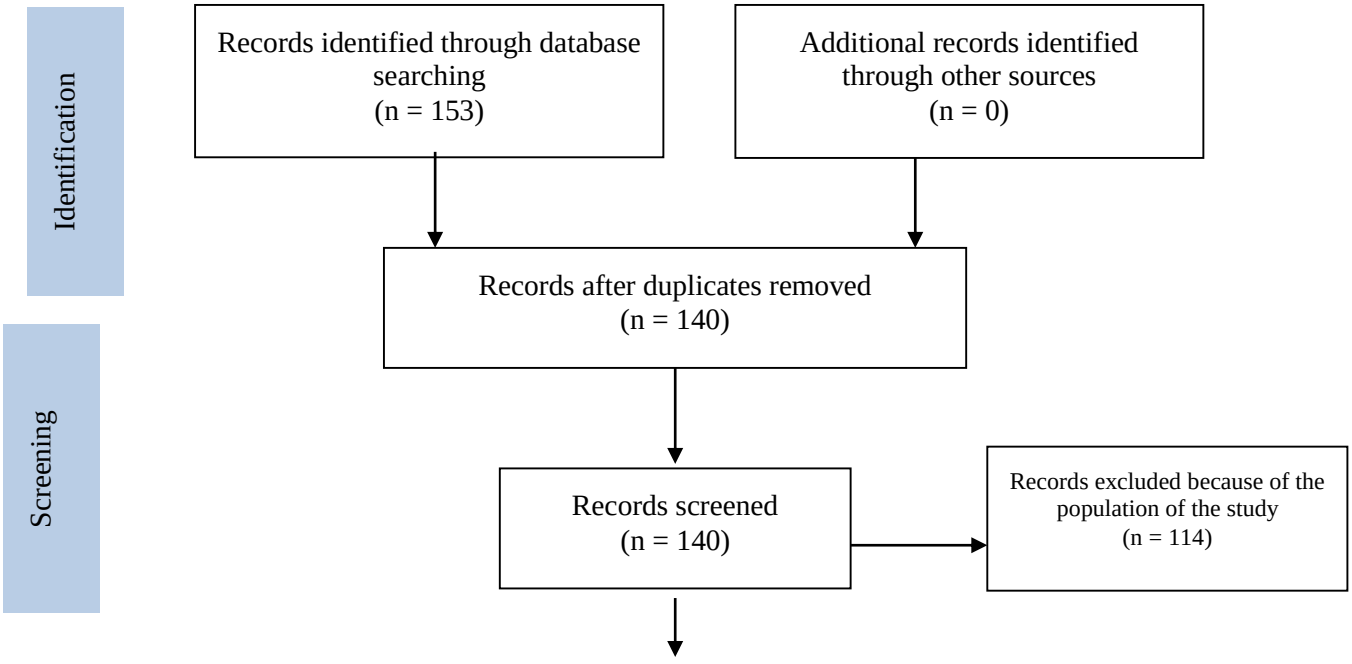
Remaining articles (n = 140) were screened by title and abstract by the researcher to determine the adherence to inclusion and exclusion criteria. During this process, 114 studies were excluded because they did not meet the inclusion criteria. Reasons for not meeting the inclusion criteria include nursing and medical student participants, which indicated that the intervention was a part of an educational program for award degree, and nurses were not included in the sample group.

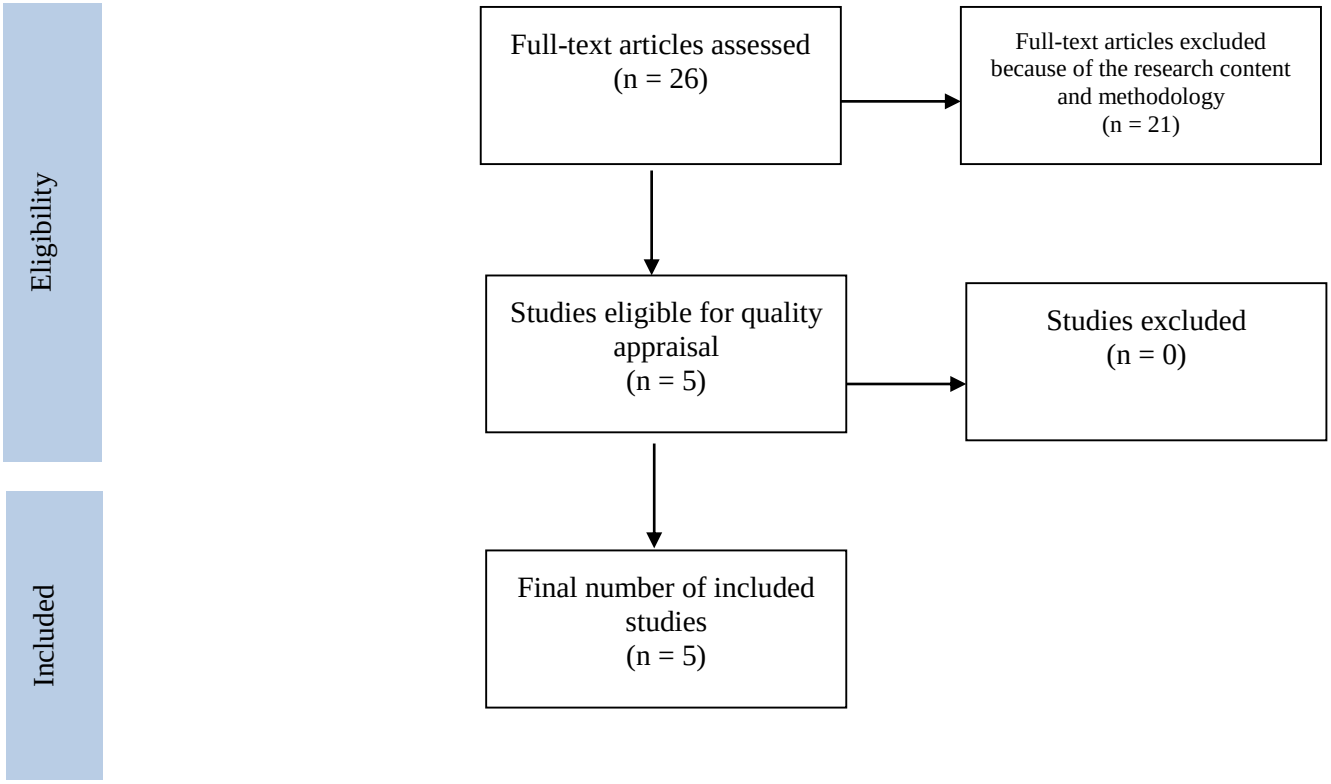
Full text versions of the remaining 26 studies were then analysed by the researcher to determine whether or not the studies met the inclusion and exclusion criteria (Appendix

D). Three studies did not measure the effects of an educational intervention for participants. These studies only provided guidance in delivering disaster education and were therefore not included in the review. Another 15 studies did not use experimental or quasi-experimental design as a methodology, thus an objective measurement of intervention effect was not performed. The improvement of score between before and after intervention was not presented in the 15 studies and were excluded. As a result, the researcher identified five studies to undertake the quality appraisal process (Bartley, Stella, & Walsh, 2006; Bistaraki, Waddington, & Galanis, 2011; Chiu et al., 2011; Collander et al., 2008; Glow, Colucci, Allington, & Noonan, 2013).

The process of identification, screening, eligibility and inclusion is diagrammatically represented in an adapted version of the PRISMA flowchart (Moher, Liberati, Tetzlaff, Atmann & The PRISMA Group, 2009) (Figure 2.1). PRISMA flow is a diagram that depicts the flow information through the phases of the review process (PRISMA, 2015). PRISMA flow shows the records of number of studies identified, included and excluded, and the reasons for exclusion.

Figure 2.1 PRISMA Flow Chart





2.8 Quality Appraisal of Studies

The next step of the process was appraising the quality of the five studies by two reviewers. Through the screening process, five studies were eligible for quality appraisal. Quality appraisal process aimed to identify methodological and/or ethical flaws in a study and assist researchers to make decisions of the quality of research evidence (Joanna Briggs Institute, 2000). Studies that have low or questionable quality are usually excluded from the review process (Aromataris & Pearson, 2014). Thus, subjective reports can be minimized which leads to comprehensive, thorough, and clear findings of the systematic review.

Joanna Briggs Institute's Critical Appraisal Checklists were selected to assess the quality of the five studies. Two checklists, experimental and descriptive, were chosen based on study design and method (Table 2.3). Experimental studies checklist was used for one study (Bistaraki et al., 2011) which used a non-equivalent control group. For

the other four studies (Bartley et al., 2006; Chiu et al., 2011; Collander et al., 2008; Glow et al., 2013) the descriptive studies checklist was used since the studies used a one group pre-test post-test design. Although this design is a type of quasi-experimental, the reviewers decided to use the descriptive checklist. The questions provided in the descriptive checklist are more relevant to the studies compared to the experimental checklist.

Table 2.3 JBI Quality Appraisal Checklists

Checklist	Questions
Experimental	1. Was the assignment to treatment groups truly random? 2. Were participants blinded to treatment allocation? 3. Was allocation to treatment groups concealed from the allocator? 4. Were the outcomes of people who withdrew described and included in the analysis? 5. Were those assessing outcomes blind to the treatment allocation? 6. Were the control and treatment groups comparable at entry? 7. Were groups treated identically other than for the named interventions? 8. Were outcomes measured in the same way for all groups? 9. Were outcomes measured in a reliable way? 10. Was appropriate statistical analysis used? (Joanna Briggs Institute, 2014, p. 182)
Descriptive	1. Was study based on random or pseudo-random sample? 2. Were the criteria for inclusion in the sample clearly defined? 3. Were confounding factors identified and strategies to deal with them stated? 4. Were outcomes assessed using objective criteria? 5. If comparisons are being made, was there sufficient descriptions of the groups? 6. Was follow up carried out over a sufficient time period? 7. Were the outcomes of people who withdrew described and included in the analysis?

	8. Were outcomes measured in a reliable way? 9. Was appropriate analysis used? (Joanna Briggs Institute, 2014, p. 187)

All five of the studies were initially assessed by the researcher. Then, the second and third researchers independently assessed two (KI) or three studies (VP) each. Then, the researcher met with the second and third researchers separately to discuss the outcome of the assessment. The result was agreement all of the studies were methodologically eligible to be included in the systematic review. The quality appraisal of included studies is presented in Table 2.4 and Table 2.5.

Table 2.4 Quality Appraisal of Experimental Study

No	Studies	Questions									
		1	2	3	4	5	6	7	8	9	10
1	Bistaraki et al. (2011)	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓

Table 2.5 Quality Appraisal of Descriptive Studies

No	Studies	Questions									
		1	2	3	4	5	6	7	8	9	10
1	Chiu et al. (2011)	✗	✓	✓	✓	✓	✓	✗	✓	✓	-
2	Glow et al. (2013)	✗	✓	✓	✓	✓	U	✗	✓	✓	-
3	Collander et al. (2008)	U	✗	U	✓	✓	✓	✗	✓	✓	-
4	Bartley et al. (2006)	✗	✓	✓	✓	✓	U	✗	✓	✓	-

Key: N/A = Not Applicable; U = Unclear

The final number of studies that were included in the systematic review was five studies. As described earlier in this chapter, the summary of search process and quality appraisal is presented in the PRISMA Flow (Figure 2.1).

2.9 Data Extraction

Quantitative data was extracted from the papers manually. The data extracted included specific details about the intervention, population, measurement tool (e.g survey, questionnaire), location, study methods and intervention outcomes. Participants' score from evaluations were also extracted.

2.10 Data Synthesis

For data synthesis, the description of extracted data will be presented and elaborated using narrative synthesis. A data synthesis of study results will also be provided to answer the review question. Then, the characteristics of studies and results will be summarised and tabulated.

Narrative synthesis is "an approach to the systematic review and synthesis of findings from multiple studies that relies primarily on the use of words and text to summarise and explain the findings of the synthesis" (Popay et al., 2006, p. 5). Narrative synthesis uses a textual approach in telling the story of findings from included studies to construct a trustworthy and convincing story that brings multiple paradigms of evidence together and bridging the gap between research, policy and practice (Popay et al., 2006; Schneider, 2007).

Performing narrative synthesis to synthesize data in a systematic review can answer questions focusing on effectiveness, particularly those that relate to implementation of interventions in experimental context (Popay et al., 2006). Since this systematic review aims to collect evidence that shows the improvement of disaster preparedness after a particular educational intervention, narrative synthesis is the appropriate approach to be applied. Meta-analysis could not performed in this systematic review because the interventions and results between included studies were not similar enough to be analysed together in a statistical method. Homogeneity amongst study results is the requirement in conducting meta-analysis (Schneider et al., 2013).

If similarities of outcomes of the factors and methods of the statistical analysis between articles were revealed, a summarized version of statistical analysis of multiple studies using a forest plot is provided. Forest plot is a graph that shows the strength of an intervention effect of multiple quantitative studies addressing the same question (Schneider, 2007). In this systematic review, the forest plot will serve as a graphical illustration of the degree of effectiveness of intervention in the included studies.

2.11 Conclusion

A systematic review can provide objective evaluation on effectiveness of an intervention. A step by step process, based on JBI's systematic review process, was undertaken in order to obtain reliable results. In order to answer the review question, objective eligible studies, based on the inclusion and exclusion criteria, were retrieved from various databases using appropriate keywords.

A total of 153 articles were retrieved. Then, articles were screened for duplicates and by title and abstract and full-text. As a result, five studies were found to be eligible to be included into the quality appraisal process. Using JBI quality appraisal checklists for experimental and descriptive studies all researchers agreed to include the five studies into the systematic review after these processes. Data was extracted from the included articles and will be presented in a narrative synthesis.

Data synthesis, tabulation of characteristics of studies, and forest plot will be presented in Chapter Three Results.

Chapter Three

Results

3.1 Introduction

The effectiveness of an intervention from multiple studies can be analysed and summarized through conducting a systematic review. The process of undertaking this systematic review began with deciding on the review question and objectives. Then, after determining the inclusion and exclusion criteria, a search of the literature was performed. Collected articles were then put through a quality appraisal process. In the end, five studies were included in the systematic review.

This chapter synthesizes the findings of the included studies. Firstly the characteristics of included studies, study design, sample, sampling method, educational intervention, evaluation tool, statistical analysis, and time interval of evaluation. The results of included studies and the effectiveness of intervention from multiple studies are also provided. Then, bias appeared in the studies is provided at the end of this chapter.

3.2 Characteristics of Included Studies

This section presents the characteristics of included studies, including study design, sample size and profile, sampling method, content of education, description of intervention, evaluation tool, statistical analysis, time interval of evaluation and results. Summarised characteristics of included studies are presented in Table 3.1.

3.3 Study Design

All of the included studies used a pre- and post-test design to evaluate the effects of an educational intervention. Only one study used a control group to compare the outcome (Bistaraki et al., 2011). The other four studies used one group as both the intervention and control group (Bartley et al., 2006; Chiu et al., 2011; Collander et al., 2008; Glow et al., 2013).

3.4 Sample

From the included studies, only Chiu et al. (2011) used nurses only as the sample, including public health nurses (n = 54). Bartley et al. (2006) (n = 50) and Collander et al. (2008) (n = 84) used a sample of medical, nursing and administrative staff. First responders including firefighters, Emergency Medical Services and law enforcement (n = 175) were participants in a study by Glow et al. (2013). Finally, Bistaraki et al. (2011) included 56 healthcare workers including medical, nursing, administration and paramedical.

3.5 Sampling Method

In recruiting the respondents for an educational intervention, Bistaraki et al. (2011) and Bartley et al. (2006) used a stratified sampling method. While the other three studies

conducted by Chiu et al. (2011), Collander et al. (2008) and Glow et al. (2013) have unclear description of sampling method.

3.6 Educational Intervention

Various educational interventions were used in the included articles (Appendix B). Using a combination of interventions was evident in all of the studies. The most common combination method used was classroom lecture and tabletop exercise. Bartley et al. (2006), Bistaraki et al. (2011) and Collander et al. (2008) used this combination for their studies. Disaster simulation was used as an additional method by Bartley et al. (2006) and Collander et al. (2008). Glow et al. (2013) used a combination of lecture, disaster simulation and group discussion.

Another combination of interventions that was used in one of the studies was lecture and online learning. Chiu et al. (2011) compiled 12 online, self-learning modules for participants of the study.

3.7 Evaluation Tool

All of the included studies used a form of questionnaire as an evaluation tool for the intervention (Appendix B). These questionnaires were used to assess the score of knowledge regarding the content of education before and after the intervention (Bartley et al., 2006; Bistaraki et al., 2011; Collander et al., 2008; Glow et al., 2013), participant's confidence score (Bartley et al., 2006; Chiu et al., 2011) and participant's evaluation of the intervention (Bistaraki et al., 2011; Collander et al., 2008).

Bartley et al. (2006) used a questionnaire that consisted of six questions on basic knowledge. A self-assessment survey using five-point scale to evaluate the general perception of preparedness was also used. Similarly, Glow et al. (2013) also used a knowledge questionnaire that consisted of 18 questions. Bistaraki et al. (2011) used a questionnaire consisting of 19 multiple choice knowledge questions. While Collander et al. (2008) used a questionnaire that consisted of 23 questions. Besides assessing participants' knowledge, Bistaraki et al. (2011) and Collander et al. (2008) also assessed participants' evaluation of the educational intervention using five-points scale.

In contrast to other included studies, Chiu et al. (2011) measured a different element of disaster preparedness. Confidence was evaluated instead of knowledge using a

questionnaire evaluating self-perceived confidence. Collander et al (2008) assessed confidence in using the new knowledge.

3.8 Statistical Analysis

Data analysis varied between the included studies. Bistaraki et al. (2011) and Chiu et al. (2011) used the repeated measures of variance ANOVA and t-test as statistical analysis method. While Collander et al. (2008) and Glow et al. (2013) applied the t-test method only. The study conducted by Bartley et al. (2006) used a combination of t-test and Mann-Whitney test.

3.9 Time Interval of Evaluation

All authors of included studies conducted a pre-test (Appendix B). Bistaraki et al. (2011), Collander et al. (2008), and Glow et al. (2013) delivered the post-test immediately after intervention ended. Next, Bistaraki et al. (2011) held a follow-up post-test one month after intervention to compare the results between immediate and delayed post-test. While Bartley et al. (2006) conducted the post-test four to six months after intervention and Chiu et al. (2011) 12 months after intervention.

3.10 Results of Included Studies

The studies were set in The United States of America (3), Greece (1) and Australia (1). The clinical settings were hospitals (3), Emergency Medical Service (1) and, Public Health Agency (1). The detailed profiles of the studies can be found in Table 3.1.

3.10.1 Knowledge

Four studies measured participant's knowledge regarding disaster preparedness (Bartley et al., 2006; Bistaraki et al., 2011; Collander et al., 2008; Glow et al., 2013) (Appendix B). Improvement of knowledge score was evident in the results. Bistaraki et al. (2011) reported a change of mean score from 44.5 ± 1.7 (out of 100) for pre-test to 86 ± 2 for immediate post-test. One month later, the score decreased to 77.2 ± 2.3. Even though the score decreased on delayed post-test, it is still higher compared to pre-test score. While the participants in the control group achieved a lower mean score than participants in the intervention group before, immediately after, and one month after the intervention (40 ± 2.4).

Bartley et al. (2006) reported participants' post-test mean score for emergency department participants significantly increased to 15.8 (out of 20) from 12.1. While for non-emergency department participants, the post-test mean score reached 10.6 from 6.2. In the study conducted by Glow et al. (2013) participants' post-test mean score also increased to 13.64 ± 1.83 (out of 18) from 9.68 ± 2.33. Similar to the three other studies, Collander et al. (2008) reported a significant increased post-test score of 89.5 ± 6.7 (out of 100) from 69.1 ± 12.8.

3.10.2 Confidence

From the included studies, two studies measured participants' confidence mean score, presented as a number (Chiu et al., 2011; Collander et al., 2008) (Appendix B). Chiu et al. (2011) reported an increase and sustained post-test confidence, the mean score divided into three categories: preparedness, response and recovery. For preparedness category the score increased from 30.2 ± 6.7 to 36.2 ± 4.9, for response category the score increased from 26.0 ± 5.5 to 30.9 ± 4.5 and for recovery category the score increased from 23.1 ± 5.5 to 28.8 ± 4.18. Collander et al (2008) reported confidence score in using newly learned knowledge (out of 5) 4.24 ± 0.8.

3.10.3 Personal and Departmental Preparedness

One study conducted an evaluation of personal and departmental preparedness (Bartley et al., 2006) (Appendix B). In pre-test, the most common response from participants to the statement "I am personally prepared" was "disagree" (16 out of 50 participants). For the statement "My department is prepared", most participants also responded "disagree" (22 out of 50 participants). Then, a shift of response was reported in post-test result for the statement "I am personally prepared", 19 out of 42 participants responded "agree". While for the statement "My department is prepared", "disagree" remained the most common response (13 out of 42 participants).

3.10.4 Demographic Characteristic Effect on Evaluation Score

Two studies evaluated whether or not there was an effect of gender on pre-test and post-test score (Bistaraki et al., 2011; Glow et al., 2013) (Appendix B). Bistaraki et al. (2011) reported that there was no significant effect of gender on pre-test score. Male participants achieved the mean score of 43.6 ± 2.6, while females achieved 44.9 ± 2.2. Similarly, Glow et al. (2013) also stated that male and female participants reached the

pre-test score of 10.1 (2.2) and 9.5 (2.5) out of 18. After the immediate post-test was conducted, it was discovered that the improvement of mean score between pre-test and post-test was also not significant. In Bistaraki et al. (2011)'s study, the improvement score of male and female was 45 ± 4.4 and 39.9 ± 2.9. While in Glow et al. (2013)'s study, the improvement score of male and female was 3.50 (SD = 2.45) and 4.09 (SD = 2.51) respectively.

Besides measuring the effect of gender on evaluation score, Glow et al. (2013) also investigated the effect of participants' age characteristics to score. There was no difference in pre-test scores between age groups. All of the participants aged between 19-81 years old achieved the score of 9.6 (SD = 2.5) to 9.9 (SD = 2.6) out of 18. Likewise, the overall score improvement between age groups was similar, ranging from 3.73 (SD = 2.46) to 4.03 (SD = 2.38) out of 18.

Work experience is another demographic characteristics that was examined by one of the included studies (Chiu et al., 2011). Chiu et al. (2011) reported that there was no significant difference in perceived confidence score for nurses employed five or fewer years compared to nurses employed more than five years. No definite score was presented in the study.

Bistaraki et al. (2011) examined the education characteristic of the participants. For pre-test, participants with higher and lower degree of formal education achieved similar score. Participants with higher education achieved the mean score of 44.3 ± 2, while participants with lower education achieved 44.9 ± 3.5. For post-test, there was a slight difference of score. Participants with higher education achieved the mean score of 87.5 ± 2.3, while participants with lower education achieved 81 ± 4.2.

3.10.5 Position Effect on Evaluation Score

All of the authors of included studies explored the effects of participants' position in their respective workplace on pre-test and post-test score (Bartley et al., 2006; Bistaraki et al., 2011; Chiu et al., 2011; Collander et al., 2008; Glow et al., 2013) (Appendix B). Bartley et al. (2006) reported that participants from Emergency Department achieved higher pre-test and post-test scores compared to participants from non-ED setting. In pre-test, ED staff obtained 12.1 while non-ED staff acquired 6.2 (out of 18). In post-test, ED staff gained15.8 while non-ED staff achieved 10.6 (out of 18). Similarly, Chiu

et al. (2011) categorized the intervention results into two groups: Director of Nursing (DON) and Public Health Nurse (PHN). In pre-test, the preparedness competency confidence score of DONs was higher than PHNs: 33.2 (5.5) compared to 27.3 (5.9). In post-test, DONs' score remained higher than PHNs': 36.8 (4.6) compared to 34.1 (5.1). Yet, PHNs improved more than DONs.

Bistaraki et al. (2011), Collander et al. (2008), and Glow et al. (2013) segregated results based on the profession of participants. The scores varied but there was no significant difference. In Bistaraki et al. (2011)'s study, nurses gained the highest pre-test score among all professions (46.7 ± 2.7), but in immediate post-test, administrators reached the highest score (91.7 ± 3). Likewise, Glow et al. (2013) declared that fire-related professionals had higher pre-test score compared to other profession: 10.4 (2.0) out of 18. However, nurses eventually had the highest score improvement: 5.29 (2.95). On the contrary, Collander et al. (2008) reported similarities of pre-test and post-test score between professions with all professions significantly improved.

3.10.6 Previous Disaster Education Effect on Evaluation Score

One study analysed the effect of disaster education on participants who attended before the intervention on pre-test and post-test score (Bistaraki et al., 2011) (Appendix B). Participants who attended previous disaster education had higher score compared to participants who did not (50.7 ± 3.4 compared to 42 ± 1.8). Then, the post-test results showed that both group of participants improved similarly. The difference of score was not significant (88.5 ± 2.4 compared to 85 ± 2.7).

3.10.7 Disaster Intervention Evaluation

Three studies reported an evaluation of a disaster intervention that was conducted (Bartley et al., 2006; Bistaraki et al., 2011; Collander et al., 2008) (Appendix B). Bartley et al. (2006) conducted a self-assessment evaluation on participants' impressions of personal and departmental improvement. The majority of participants (41 out of 50) reported some degree of personal improvement, whether it was minor, moderate or major. Regarding departmental improvement, 24 out of 38 participants reported some degree of departmental improvement. Likewise, Bistaraki et al. (2011) reported that 34 out of 56 participants would definitely use the knowledge gained from the education intervention, and 35 participants stated that the education intervention

fulfilled their educational needs. Collander et al. (2008) also declared similar finding with participants feeling confident in using their newly learned knowledge in their respective positions (4.24 ± 0.8).

3.10.8 Need for Further Training

One study examined participants' need for further training after the educational intervention was conducted (Chiu et al., 2011) (Appendix B). Before the intervention started, participants' need for further preparedness training was scored 31.7 (7.4) for DONs and 34.1 (8.1) for PHNs. After the intervention was held, the score decreased to 19.5 (10.0) for DONs and to 24.1 (8.8) for PHNs.

Table 3.1 Characteristics of Included Studies

Author & Location	Study Design	Setting & Sample	Content of Education	Description of Intervention	Evaluation Tool	Statistical Analysis	Result
Bartley, B. Stella, J. Walsh, L. (2006) Geelong, Victoria, Australia.	Quasi-experimental: one group pre-test post-test design	50 participants: • ED staff (medical consultants and registrars, Associate Nurse Unit Manager, and critical-care certificated nurses) • Non-ED staff (department Director, Nurse Unit Managers, Associate Nurse Unit Managers, shift-in-charge nurses, and Emergency Control Team staff).	Readiness for facing hazards that are likely develop into a disaster, and simulating "Exercise Kardinia Express" scripted by the local State Emergency Service officers.	1-h lecture, compressed time disaster simulation, and tabletop exercise	6 questions about basic knowledge of hospital disaster plan. Self-assessment survey using five point scale. Follow-up survey.	t-test and Mann-Whitney test.	Significant improvement of knowledge test score. Pre-intervention mean score (out of 20): ED: 12.1 Non-ED: 6.2 Post-intervention score (out of 20): ED: 15.8 Non-ED: 10.6 p-value <0.001 No significant increase in the general perception of preparedness. Pre-intervention (median answer): "not sure" and "disagree" Post-intervention (median answer): "agree" and "disagree"
Bistaraki, A. Waddington, K. Galanis, P. (2011) Athens, Greece.	Quasi-experimental: non-equivalent control group	56 participants (25 nurses, 13 physicians, 12 administrators, 6 paramedics). Junior staff who may have worked <1 year is included.	Basic principles of hospital disaster management.	2-h lecture with PowerPoint presentation 2-h tabletop exercise 30-min lecture on the use of fire-fighting equipment.	19 multiple-choice knowledge questions about hospital disaster plan and its procedures. A 5-points scale survey was used	Repeated measures of variance (ANOVAs) and paired and unpaired t-tests.	Significant improvement in knowledge. Scores (out of 100): Before intervention score: 44.5±1.7 Immediate intervention mean score: 86±2 Follow-up mean score: 77.2±2.3

					in seminar evaluation		p-value <0.001 Control group mean score (before, immediately after, and 1 month after intervention): 40±2.4 p-value <0.001
Chiu, M. Polivka, B. Stanley, S. (2012) Ohio, USA.	Quasi-experimental: one group pre-test post-test design	54 participants (nurses who worked in a public health agency and attended one of six regional Ohio Hiking Workshops between 2007 and 2008).	25 disaster surge competencies for public health nurses.	Combination of online learning (12 self-learning modules) and 6-h face-to-face interactive classroom Hiking Workshop session.	A parallel survey of self-perceived confidence and need for further training using Likert-type scale.	Summed scores, repeated measures ANOVA and t-tests.	Confidence in preparedness, response, and recovery public health nurse disaster surge competencies significantly increased, whereas self-perceived need for further competency training significantly decreased. Preparedness pre/post : 30.2±6.7 / 36.2±4.9 Response pre/post : 26.0±5.5 / 30.9±4.5 Recovery pre/post : 23.1±5.5 / 28.8±4.18 p-value <0.01
Collander, B. Green, B. Millo, Y. Shamloo, C. Donnellan, J. DeAtley, C. (2008) Washington DC, USA.	Quasi-experimental: one group pre-test post-test design	84 participants (11 physicians, 40 nurses, 23 administrators/directors, and 10 other hospital personnel). Participants had to attend both days of the Hospital Disaster Life Support (HDLS)	Hospital incident command structure, protecting the staff and facility, biological Mass-Casualty Incident (MCI) and hospital response, conventional MCI and hospital response, radiological MCI and hospital response,	Two-day, 16-h Hospital Disaster Life Support (HDLS) course with a combination of classroom lectures, skills sessions, tabletop	Web-based pretest, 23 item post-test, and course evaluate on survey.	t-tests.	Significant improvement in post-test score. Scores (out of 100): Pre-test mean: 69.1 ± 12.8 Post-test mean: 89.5 ± 6.7 p-value <0.0001 Confidence score in using newly learned knowledge (out of 5): 4.24 ± 0.8

		course, complete both pre and post test evaluations, and a course evaluation survey.	chemical MCI and hospital response, paediatric aspects of a MCI, and system restoration and recovery.	sessions, and disaster exercise.			
Glow, S. Colucci, V. Allington, D. Noonan, C. Hall, E. (2013) Montana, USA.	Quasi-experimental: one group pre-test post-test design	175 participants (firefighters, Emergency Medical Service, law enforcement, nurses, physicians).	Communications, incident command, roles and responsibilities of the medical branch, and triage using the Simple Triage and Rapid Transport (START) method.	1-h pre-course exercise, 4-h reviews and discussions, pre and post functional exercise	18 items that assessed participants' general knowledge of communications, incident command system, and triage ability using START method.	ANOVA and paired t-test.	Significant higher scores on the post-test. Scores (out of 18): Pre-test mean: 9.68 ± 2.33 Post-test mean: 13.64 ± 1.83 p-value < 0.001

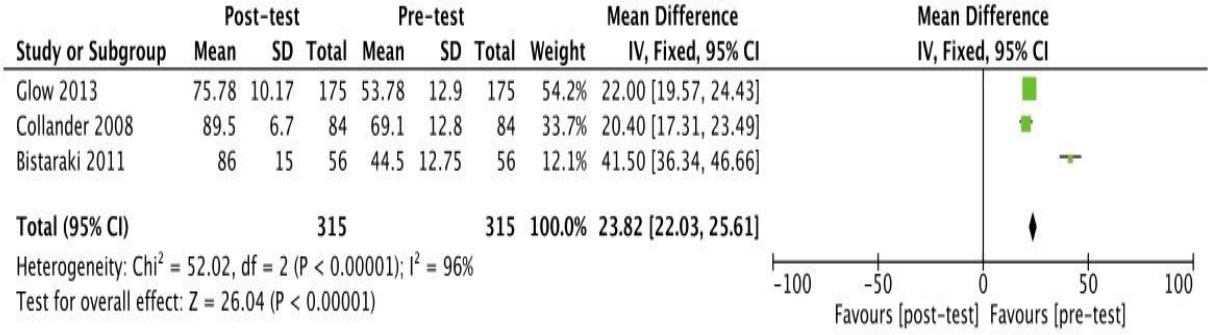
Key: h = hour; min = minute/s

3.11 Effectiveness of Intervention from Multiple Studies

Studies included in this systematic review are highly heterogeneous. Study design and evaluation tool were similar to each other, but the scoring and statistical data provided varied. However, a similarity of statistical data between three studies was discovered (Bistaraki et al., 2011; Collander et al., 2008; Glow et al., 2013) (Appendix C).

The scoring system of studies conducted by Bistaraki et al. (2011) and Collander et al. (2008) was a maximum score of 100, while the maximum score in the study conducted by Glow et al. (2013) was 18. Therefore, a modification of scores was undertaken. The mean score and standard deviation in Glow et al. (2013)'s study was multiplied by 5.5555 to adjust for a score of 100. Congruence was achieved from scores from the three studies; statistical analysis in the form of forest plot was conducted. The result is presented in Figure 3.1.

Figure 3.1 Forest plot



The forest plot analysis shows that the post-test mean scores for all studies are significantly higher than that of pre-test mean scores and the overall mean score for post-test is also significantly higher than that of pre-test mean score (mean difference 23.82, 95% CI 22.03 - 25.61). The chi-squared test shows that the studies are heterogeneous, thus a random effect model is appropriate (Chi = 52.0, P<0.001). The overall effect of the intervention was also significant (Z=26.04, P<0.001).

3.12 Bias Assessment

There is a risk of bias in the included studies. Bias can lead to underestimation and overestimation of the effects of an intervention (Cochrane Collaboration, 2015). Therefore, the assessment of bias is presented in this section.

3.12.1 Selection Bias

Two of the included studies used a stratified sampling method to recruit participants (Bartley et al., 2006; Bistaraki et al., 2011). Although it is not truly random, the use of stratified sampling method may reduce the risk of selection bias (Porritt et al., 2014).

3.12.2 Performance Bias

All of the included studies have risk of performance bias (Bartley et al., 2006; Bistaraki et al., 2011; Chiu et al., 2011; Collander et al., 2008; Glow et al., 2013) due to the non-blinding of participants to the intervention (Porritt et al., 2014). Moreover, Bistaraki et al. (2011) reported that two months before the intervention was conducted, a disaster occurred near the study setting which may be a factor that can contaminate the result.

3.12.3 Detection Bias

None of the included studies presented information of whether or not the assessor of evaluation was blinded to the intervention (Bartley et al., 2006; Bistaraki et al., 2011; Chiu et al., 2011; Collander et al., 2008; Glow et al., 2013). Therefore, these studies are open to detection bias (Porritt et al., 2014).

3.12.4 Attrition Bias

Withdrawal of participants is not reported in two of the included studies (Bistaraki et al., 2011; Collander et al., 2008). The number of participants in pre-test and post-test evaluation is the same. Hence, these studies had low risk of attrition bias (Porritt et al., 2014). Even though Bartley et al. (2006) declared a decrease of participants from 50 to 42 people, Chiu et al. (2011) from 182 to 54 people, and Glow et al. (2013) also had less participants for post-test evaluation (from 193 to 175), attrition bias risk was low. This is possible because Bartley et al. (2006), Chiu et al. (2011) and Glow et al. (2013) only included and calculated the data from participants who attended both pre-test and post-test.

3.13 Conclusion

All of the studies used pre-test and post-test design in conducting the research. For the sample, only one study included only nurses as participants. Other studies had a team of nurses and other health care professionals as participants. To recruit these participants, stratified sampling and was applied in two of the included studies. Three other studies did not mention the sampling method clearly.

Educational intervention varies between the studies. No study used a single educational intervention to deliver the learning material. The most common combination of interventions used was lectures and tabletop exercises. Questionnaire was the most common tool to measure outcomes. For statistical analysis, ANOVA and t-tests were the most common method used. The post-tests were conducted at different times, from as soon as the intervention was finished until 12 months later.

From the results of the studies, a significant improvement of knowledge score regarding disaster preparedness was found. Confidence score also improved. Personal improvement was reported as more improved compared to departmental preparedness. Demographic characteristics were not a significant factor that influenced the difference in evaluation scores. Score improvements varied between each position that the participants held in their respective workplace. Nevertheless, the differences were not significant. Previous disaster education influenced the difference of pre-test score, but it did not bring a meaningful effect on post-test score. The evaluation of intervention showed that the intervention fulfilled participants' educational needs and participants' felt confident in using the knowledge gained. The need for further training score was decreased after the intervention was conducted.

Three studies had similar scoring system to knowledge level of participants. By modifying the maximum score of one of the studies, a statistical analysis that combined the results from those three studies was performed and resulted in a forest plot. The forest plot confirmed that the educational interventions were able to increase participants' post-test score. Finally, there was a discussion on risk of bias that may affect the result of the intervention. In the next chapter, educational intervention and evaluation tools used during included studies will be discussed, as well as improvement in disaster preparedness.

Chapter Four

Discussion

4.1 Introduction

This systematic review explored the effectiveness of disaster education in improving competence, confidence and willingness to respond by nurses and other health professionals in the hospital and pre-hospital setting. Five studies that used pre-test post-test design were included in the systematic review after a systematic search of four databases. Various educational interventions for improving disaster preparedness were identified. The outcomes for those interventions were also reported. The score for post-test evaluation reported by the authors of the included studies showed an improvement of knowledge and confidence of the participants in disaster-related subject.

This chapter discusses the findings presented in Chapter Three. The discussion is presented in five sections: study settings, samples, types and effectiveness of educational intervention, evaluation tool, and improvement of disaster preparedness. Then, limitations found during the review process are also discussed. Next, the quality of evidence included in the review and potential bias that may appear is examined. At the end of the chapter, a comparison between this systematic review and other previous systematic reviews with the same topic is presented, followed by the findings of recent study.

4.2 Key Results

4.2.1 Study Settings

The study settings of the included studies were quite diverse. Three were hospitals and two were clinics. Three studies were conducted in the United States of America, Greece, and Australia. However, communities in more populous areas and has high risk for disasters such as Asia and other European countries were not represented in this systematic review. This is relevant as each community has its own characteristics, strengths, and weaknesses regarding learning improvements (Colorado Children's Campaign, 2005; Hawley & Nieto, 2010).

4.2.2 Sample Characteristics

Almost all of the included studies recruited various health care professionals and first responders to the study sample. Regarding homogeneity of participants, the description of the entire sample in the majority of the studies were not clearly described. Results that were grouped based on participants' age was only presented in Glow et al. (2013)'s study. Several factors that may influence the result of intervention, such as length of work experience and previous exposure to disaster education were not well discussed. Bistaraki et al. (2011)'s study was the only study that considered participants' exposure to previous disaster seminars as one of the characteristics of participants.

4.2.3 Types and Effectiveness of Educational Intervention

Educational interventions found in the included studies varied. Each educational intervention had its own positive and negative impact for learners. Yet, it remains uncertain whether or not one intervention is more effective than other interventions.

The most common intervention used was classroom lectures (Bartley et al., 2006; Bistaraki et al., 2011; Chiu et al., 2011; Collander et al., 2008; Glow et al., 2013). Lecture is a traditional educational intervention that is most commonly used to deliver learning materials to learners in the educational system (Beers, 2005). Lectures may be a cost-effective and efficient strategy to deliver information to large number of people at the same time. Lecture is also an effective approach for cognitive learning, but it is ineffective in influencing affective and psychomotor behaviours (Bastable, Gramet, Jacobs, & Sopczyk, 2011). Therefore, lectures provide limited stimulation or participatory involvement of learners (Bastable et al., 2011).

Another intervention that was used was group discussion (Glow et al., 2013). This intervention can enhance learning in both affective and cognitive domains. Group discussion stimulates learners to think about issues and problems. Nevertheless, it might be easy to digress from the topic, which interferes with achievement of the objectives of the learning (Bastable et al., 2011). A limitation is there may be a possibility that a shy learner can become passive and will refuse to participate or be involved in the learning process (Bastable et al., 2011).

Compared to group discussion, lectures are well-known to be a passive learning intervention when learners sit still and listen to the teacher. Group discussion is usually

a complement or a substitute to lectures so that learners become more active in the learning session. Learners gained more knowledge and higher motivation toward learning trough group discussion if compared to lecture-based learning (Penjvini & Shahsawari, 2013). On the contrary, other studies revealed that lectures and group discussion had similar effect on learners regarding knowledge improvement (Beers, 2005; Lacoursiere, Snell, McClaran, & Duarte-Franco, 1997; Yang et al., 2014). Also, lectures have the same effect as group discussion regarding improvement of motivation in learning (Wijnia, Loyens, & Derous, 2011). Furthermore, group discussions can cost more than lectures (Lacoursiere et al., 1997).

Group discussions may have similar outcome to lectures, but when it was combined with lectures as educational intervention, the impact for knowledge improvement on learners was significant (Johnson & Mighten, 2005). The outcome of conducting small or large size of group discussion had no significant impact for the outcome, however, smaller group size would help learners dig deeper into the educational content being explored and were forced to think more about the subject (Bristol & Kyarsgaard, 2012; Mettiainen & Vahamaa, 2013). Moreover, group discussion had an impact on learners achievement and attitude (Shana, 2009). Learners became more critical on the learning subject by connecting theoretical knowledge with the practice (Mettiainen & Vahamaa, 2013; Shana, 2009).

One study used a self-instruction intervention with a form of online learning (Chiu et al., 2011). This type of intervention allows learners to self-pace and stimulates active learning. Online learning also provides opportunity to review and reflect on information. Nonetheless, it is limited with learners who have low literacy skills and require a high level of motivation (Bastable et al., 2011).

Online learning can develop critical-thinking of learners. Online learning makes the possibility of learners being responsible for their own progress in learning that to motivate themselves to understand the subject independently. Also, this kind of educational intervention is more feasible, efficient, and cost effective than lectures (Spickard III, Alrajeh, Cordray, & Gigante, 2002). Therefore, online learning can become an alternative option of educational intervention since it had no significant difference of outcome compared to lectures (DiRienzo & Lilly, 2014; Mehrdad, Zolfaghari, Bahrani, & Eybpoosh, 2011; Spickard III et al., 2002). To make online

learning successful in improving learning outcome, five critical factors were identified and needed to be strengthened: institutional management, learning environment, instructional design, services support, and course evaluation (Cheawjindakarn, Suwannatthachote, & Theeraroungchaisri, 2012).

Simulation is another intervention that the authors of the included studies used (Bartley et al., 2006; Collander et al., 2008; Glow et al., 2013). This type of intervention is excellent for developing psychomotor skill, enhances higher level problem-solving ability, and provides involvement in a real-life situation. However, arranging a simulation as an education intervention can be expensive (Bastable et al., 2011).

Simulation is a different kind of intervention compared to lectures, group discussions, and online learning. Simulation emphasizes the improvement of skill rather than knowledge. Simulation can be performed with or without the assistance of computer-based learning. Compared to a traditional face-to-face lecture, simulation provided good practical and theoretical learning (Flo, Flaathen, & Fagerstrom, 2013). Simulation also aids learners in gaining knowledge, critical thinking ability, satisfaction or confidence (Cant & Cooper, 2010), and develop interpersonal communication competence (Saaranen, Vaajoki, Kellomaki, & Hyvarinen, 2015).

Another type of educational intervention used in disaster preparedness was tabletop exercise (Bartley et al., 2006; Bistaraki et al., 2011; Collander et al., 2008). Tabletop exercise is a common intervention in emergency and disaster education. Tabletop exercise is a discussion-based session where team members meet and discuss their roles and responsibilities during an emergency and their responses to a particular emergency situation (Federal Emergency Management Agency, 2012). The purpose of a tabletop exercise is to practice problem-solving, to resolve questions of coordination, and to assign responsibilities in a nonthreatening environment (Holloway, 2007; Moyer, 2005). Compared to real-life simulation, tabletop exercise is more cost-effective, results-oriented, time-managed approach, and can be flexible allowing the group to go on their own journey in finding solutions (Federal Emergency Management Agency, 2012; Holloway, 2007). However, the disadvantages of this intervention is it may not be realistic in that one person often represents the actions of many (Renner, 2001).

Each educational intervention has its own weaknesses and strengths. By implementing a combination of learning interventions, the weakness and limitation of an intervention is possible to be complemented by another method. Lectures may be relied on in a one-way approach of delivering information from the lecturer to the learner, whereas tabletop exercise uses an inclusive approach. Tabletop exercise, uses group discussion and simulation, facilitates learners to become more active and involved in the learning process (Bastable et al., 2011). Tabletop exercise and group discussion may help develop the attitude needed in responding to a disaster, while disaster simulation promotes the psychomotor aspect needed to improve skills of a learner. These skill and attitude components are crucial in forming competence for nurses and other health care professionals.

Due to the weaknesses and strengths of educational interventions, an intervention may not necessarily be more effective than other interventions. To be effective, an educational intervention needs to be adapted to learners' need and the objective of the intervention, in terms of which aspect that needs to be improved, whether it is knowledge, attitude, skill, confidence, or willingness. An intervention that meets learners' needs may improve the effectiveness of the intervention that can lead to expected outcome.

4.2.4 Evaluation Tool

The evaluation tool used in the included studies was a questionnaire. Questionnaire is "an instrument or tool designed to gather information from participants in a quantitative study that consists of a set of purposefully constructed questions that will be used to measure the study variable of interest" (Schneider et al., 2013, p. 206). The questionnaire is prepared to have a definite purpose that is related to the objectives of the research (Oppenheim, 1992).

Questionnaires were probably used because the questionnaire is suitable to evaluate the knowledge level of a large number of participants at the same time. Therefore, it is cost and time effective (Bastable et al., 2011). However, the level of skill and attitude could not be measured.

Evaluating the level of skill and attitude needs an additional evaluation method. Observation and interview can be integrated with a questionnaire in order to collect

more complete information about the intervention being evaluated (Bastable et al., 2011). However, these methods have high risk of bias, since they depend on the perception and standard of the evaluator (Bastable et al., 2011). Difficulties arise when relying on a single evaluator to collect observation and interview data from a large number of participants, therefore, several evaluators need to be involved that may have different perspectives.

Measuring objectively whether or not an intervention is effective in increasing disaster preparedness is indeed difficult. Therefore, a standardized evaluation tool is needed. With an evaluation tool being standardized, studies measuring effectiveness of each intervention for disaster preparedness will be more homogenous. This way, a more reliable and general finding could be identified.

4.2.5 Improvement of Disaster Preparedness

As mentioned in Chapter One, competence in responding to a disaster includes adequate knowledge, skill, and attitude regarding disaster preparedness. This competence may reinforce the confidence to perform and willingness to respond when a disaster actually occurred (Couig, 2012; Duong, 2009; Gebbie & Qureshi, 2002). In the included studies, the main focus of disaster preparedness was the improvement of disaster-related knowledge. No study measured all of these elements together despite the fact that a high score of knowledge alone may not guarantee that a nurse or a health care professional is prepared to respond to a disaster (Hsu. et al., 2004; Williams et al., 2008).

All of the included studies reported a significant increase of score after the intervention was conducted. The results showed that attending a single disaster education could bring an impact to the improvement of participants' cognitive or confidence level. Yet, attending a single disaster education session alone could not maintain the knowledge level after a particular period of time. This shows in the pre-test and post-test result. Post-test that is administered immediately after an intervention cannot measure the knowledge that participants still retain and the application of the knowledge after a particular period of time (International Training & Education Center for Health, 2010), while delayed post-test aims to measure the application and impact of learning although depends on the nature of the intervention and the pattern of impacts over time (Olsen, Unlu, Price, & Jaciw, 2011). One included study conducted an immediate and delayed

(one month) post-test. After one month passed, participants' knowledge score was lower than the immediate post-test score. While the evaluation of confidence level is high even after a long period of time. This suggests that disaster education conducted regularly is needed in order to preserve the knowledge that has been gained in previous disaster education.

4.3 Limitations

Most of the included studies were conducted in English-language countries. Thus, the results in this systematic review assessed the improvement of disaster preparedness for English-speaking people. This is mainly due to the language limitation set in the inclusion criteria, while studies presented in other language than English may carry valuable and relevant findings to the systematic review. Studies written in English were selected because this was the common language of the three reviewers.

The population in this systematic review was broad. The population was nurses and health care professionals who were employed both in a hospital and out-of-hospital health care institution. The broad population was determined based on the assumption that when an actual disaster occurs, all qualified healthcare resources workers in an area will be deployed to the disaster site, not just hospital staff. Therefore, the result of this systematic review is general to every healthcare professional that will be involved in disaster education. However, the result is unspecific for a particular healthcare profession.

Only one of the included studies had nurses as the only profession considered as the sample of the study. Other studies had multiple professions who were most likely to be working together in a hospital as the sample for the study. This matter implied that limited research had been undertaken to evaluate the impact of a disaster education for nurses as a specific profession. One of the reasons might be because the nature of responding to a disaster is team-work, when all health care professions collaborate and coordinate to deliver health care service at the most needed time (Hsu et al., 2006).

4.4 Quality of Evidence

Methodology of a study influences the quality and generalizability of the finding of a study. Almost all of the studies included used one group pre-test post-test as study design. This type of design is lacking randomization and a control group. Yet, it is a

preferred method to measure the degree of change occurring as a result of a treatment or intervention (International Training & Education Center for Health, 2010; Olsen et al., 2011).

The method that most of the authors of included studies used to collect samples for their study may lead to sampling bias. Only two of the included studies collected sample using stratified random sampling, which may reduce the probability of bias. Three other studies do not have a clear description of sampling method used. Thus, the sample in these three studies might not represent the whole targeted population (Schneider et al., 2013).

Four out of the five included studies did not have a control group as a comparison to intervention group. Consequently, the internal validity and generalizability of the findings were limited. Only Bistaraki et al. (2011) recruited a control group which consisted of 35 health care workers from the same population as the intervention group. Hence, the characteristics between control group and intervention group were similar.

Among all of the studies, Bistaraki et al. (2011)'s study is the only one that the authors considered to be the most methodologically robust. The sampling method was clearly stated. A comparison of results between intervention and control group was reported. The difference of score was clearly showed and tabulated. The limitation of this study is that the content of education was developed based on the hospital's specific needs. Therefore, the course cannot be used by other hospitals without being adjusted beforehand.

4.5 Potential Bias in the Review Process

The search process for identifying eligible articles was undertaken by the researcher only. This may be a source of bias since there was no verification from the other researchers during the search process. However, all of the researchers collaborated together throughout data extraction and quality assessment process. This way, the risk of bias could be reduced.

Another source of bias was this systematic review only targeted published studies from relevant electronic databases. Searching for grey literature, unpublished study reports, journal hand-searching were not performed, while doing so may broaden the search

result (Relevo & Balshem, 2011). Moreover, published studies has the risk of having systematic differences between unreported and reported findings. In a published study, the analysis of results from intervention group that is statistically significant is more likely to be reported than the non-significant one (Chan & Altman, 2005; Cochrane Collaboration, 2015). Therefore, emphasizing the evidence from published studies may lead to the misunderstanding of what is significant for the target population, and the result from this review could be misleading (Dwan et al., 2008).

4.6 Comparison to Other Reviews

Other systematic reviews that had a similar research topic and question were found while searching for eligible studies to be included in this systematic review. Despite the fact that evidence of effectiveness of disaster training is limited, two systematic reviews about this topic were discovered (Hsu. et al., 2004; Williams et al., 2008).

The systematic review conducted by Hsu. et al. (2004) had very specific review objectives. It aimed to find the effectiveness of three education methods: disaster drills, technology-based interventions, and tabletop exercises applied in hospital setting. These three methods were compared to find the most effective way in improving participants' knowledge of responding to a mass-casualty incident. Thus, the focus was only on knowledge acquisition, which is one of three elements that develop competence.

The finding Hsu. et al. (2004)'s systematic review was that the gathered evidence was not yet strong enough to make a definitive recommendation on the most effective way to improve hospital staff's knowledge of hospital disaster procedure. This is due to little objective data revealed in the included studies to measure the change of knowledge score between before and after intervention (Hsu. et al., 2004). This finding is contrary to the findings of this systematic review. All but one study in this review presented the change of knowledge score objectively. Yet, the evaluation of knowledge aspect alone cannot answer the review question that aims to find the effective method to improve disaster preparedness defined in this systematic review.

The quality of included studies was not described clearly in Hsu. et al. (2004)'s review. Study quality was evaluated using standardized criteria, but no further explanation was presented. The preferred methodology of studies that were included was also not

described. Therefore, it was not known whether a study used a quantitative or qualitative design. It is also not known what type of evaluation tool the included studies used.

On the other hand, the systematic review conducted by Williams et al. (2008) has a clear description of inclusion criteria, critical appraisal, and quality of included studies. Different from Hsu. et al. (2004) whom focused on hospital staff as population, Williams et al. (2008) included out-of-hospital based health care workers in the inclusion criteria. This made studies on first-responders profession such as firefighters, paramedics, and emergency medical services were eligible to be included. This description of the target population was similar to the target population for this systematic review.

A quantitative outcome that measured change in knowledge and skill was one of the inclusion criteria of Williams et al. (2008)'s review. The outcome result must also be compared to a control or comparison group. With this inclusion criteria, Williams et al. (2008) succeeded in identifying a total of nine studies to be included in the review. While in this systematic review, the authors could only find one article that compared the score between intervention and control group.

Critical appraisal in Williams et al. (2008)'s review was explained clearly, although the appraisal tool used was not mentioned. Quality of included studies was tabulated and covers study design, population and sampling, potential for contamination, measurement of outcome, statistical analysis used to measure effectiveness, and internal and external validity. The content of this table was similar to this systematic review's characteristic of included studies (Table 3.1).

In the study, Williams et al. (2008) stated that conducting a study that accurately measures the effectiveness of a disaster education intervention was difficult. They also declared that an improvement of knowledge may not predict an improvement of performance in responding to a real disaster. This statement was almost identical to the discussion regarding the result the authors found in the included studies of this systematic review. Therefore, this evidence emphasized the need to have standardized interventions for disaster education so that the findings of each study can be

comparable. This way, the ability to draw conclusions about effectiveness of an intervention can be reinforced.

This systematic review was the only review that aimed to explore the effectiveness of intervention methods that may improve competence, confidence, and willingness regarding disaster preparedness of nurses and other health care professionals altogether.

4.7 Recent Study

A literature search was conducted after the review process of this systematic review was undertaken. A possibly eligible study measuring the effectiveness of disaster education conducted by Pesiridis, Sourtzi, Galanis, and Kalokairinou (2015) was found. This study used a switching replications randomized controlled trial as study design, where there were three waves of measurement for both intervention and control group, then the roles were switched and the control group became the participants while the initial intervention group became the control group. The population was focused on nurses. A total of 112 nurses were assigned randomly to the intervention group, and 95 nurses to the control group. Questionnaire was used as an evaluation tool to measure the effectiveness of intervention.

The result of this study showed that the educational interventions consisted of case studies, workshops, tutorials, group discussions, role playing, demonstration, and lecturing improved nurses' knowledge mean score significantly: pre-test 6.43 (2.8), post-test 16.49 (1.7). Regarding the behavioural intention in providing care for patients during disaster, the participants gained high mean score during pre-test: 17.65 (3.5). Yet, there was no significant change on the behavioural intention mean score after the intervention was conducted. This study is a higher level of evidence compared to the studies included in this systematic review. Unfortunately, this article was found after the data synthesis process has been undertaken and completed.

Chapter Five

Conclusion

5.1 Introduction

Adequate disaster preparedness for nurses and other health care professionals is crucial for delivering care in disaster. Disaster education is one method to improve the elements that build disaster preparedness: competence (knowledge, skill and attitude), confidence, and willingness to respond. However, the effectiveness of disaster education in improving those elements is not yet certain.

After undertaking this systematic literature search process and quality appraisal for evidence regarding effectiveness of disaster education for nurses and other health care professionals, five studies were eligible to be included in the systematic review. The results presented in the included studies showed that a single attendance at a disaster education could significantly improve knowledge and confidence scores on the post-intervention test if compared to the score from pre-intervention test. However, an improvement of knowledge and confidence score cannot guarantee that a nurse or health care professional can perform well and/ or indeed is willing to respond to a particular disaster.

Disaster education may improve nurses' and other health care professionals' knowledge, (an essential element of competence) and confidence. However, the available evidence does not adequately report the effectiveness of interventions for improvement of competence (as a whole) and willingness to respond to a disaster. This is due to the evaluation processes in the included studies which placed greater emphasis on knowledge improvement alone, without comprehensive evaluation of competence.

Evidence that measures the impact of an intervention to the improvement of overall competence and willingness to respond to a disaster could not be found. A standardized educational intervention for improving disaster preparedness and a development of comprehensive evaluation tool that can measure the improvement of competence, confidence, and willingness of participants is recommended.

5.2 Implications for Practice

The findings from this systematic review are likely to inform health service educators and disaster managers in planning disaster education for their staff. Both the educational content and an evaluation tool that measures the improvement of competence, confidence, and willingness must be developed.

This systematic review revealed that using just one type of educational intervention in disaster education may not be enough in facilitating the improvement of disaster preparedness. Each educational intervention and method has its own advantages and disadvantages. Combining several interventions to be applied in a single disaster education may be a solution to overcome the weaknesses of a particular intervention.

A standardized evaluation tool for disaster education is important to make the measurement of the effectiveness more reliable, but it has not yet been developed. This future work for disaster managers or educational experts will be important to develop the standardized evaluation tool and apply it in their respected workplaces, regions or country.

5.3 Implications for Research

The findings revealed in this systematic review were the outcome of educational intervention for various health care professions. These findings remain relevant for nurses in disaster. However, a more helpful finding could be achieved if future research focuses on the nursing profession so that the findings can specifically inform the education of the nursing workforce and their role in the inter-professional disaster team in all phases of disaster; planning, preparation, response and recovery.

All of the studies included in this systematic review used pre-test post-test design. More high quality primary research on nursing education interventions for disaster is needed. This would facilitate greater homogeneity in future reviews. Further research is recommended regarding disaster preparedness of nurses and other health care professionals that includes a learning needs assessment and evaluation of learning retention. In addition study designs that include a comparison group would add rigour (Bistaraki et al., 2011). Research is also required to determine if there is a relationship between improved score in a single disaster education offering and better performance in responding to a disaster. Research in the area of education and willingness will also

be important. Moreover, two previous systematic reviews and one published at the same time as completion of this study with similar characteristics and results, suggest a systematic review of systematic reviews should be conducted.

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Appendix A Review Protocol

Review Title

The effectiveness of disaster education for nurses and other health care professionals: A systematic review.

Reviewers

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Review Objective/ Question

The objective of this review is to identify the effectiveness of disaster education for nurses and other health care professionals. More specifically, the objectives are to identify the effectiveness of disaster education on

1. Raising competence (knowledge, skill, attitude);
2. Raising perception of confidence;
3. Encouraging willingness to respond;

Background

The frequency of disasters has been changing since the beginning of 1900s. From 1900 until 1948, the number of disaster incidents around the world was relatively low and steady, ranging from 2 to 18 incidents per year (Emergency Events Database, 2015). Yet, from 1948 until 2014, the number of reported incidents has gradually and significantly increased. The highest number of disasters that has been reported in one year was 527 incidents, in 2000 (Emergency Events Database, 2015). The toll for disasters in the last 50 years has been 12 million persons deceased, billions affected, and economic costs estimated as high as US $4 trillion (Powers & Daily, 2010). These losses have devastated communities.

Disaster is "a sudden calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources"

(International Federation of Red Cross and Red Crescent Societies, n.d.-c). Similar to IFRC, the United Nations International Strategy for Disaster Reduction also emphasises the effects of a disaster that may impact a community (2009).

During disaster, people in the community may be without power, shelter, communication, food and water (Powers & Daily, 2010). These are essential matters for a community to keep on functioning. A quick response to deal with the aftermath of a disaster cannot guarantee to immediately bring back the resources and return the function of a community. An effort in preparing for the possibility of future disaster incident is imperative to reduce the negative effects that a disaster may bring (Council of Australian Governments, 2009).

In most communities disaster is infrequent and repeated events are rarely identical. Therefore, health care professionals do not have the opportunity to adequately practice their disaster response skills in a real-life disaster experience. In an actual disaster response, health care professionals may find unusual cases of injuries and may be required to practice specific procedures that they are not familiar with in regular emergency settings (Arbon et al., 2006; Gebbie & Qureshi, 2002; Hammad et al., 2012). To be able to meet the special roles required in responding to a disaster, health care professionals must have adequate disaster-related competence and have had the opportunity to practice relevant skills to feel prepared.

As the largest professional group among all health care professionals, nurses can be called upon to provide medical care to victims of disaster events (International Council of Nurses, 2009; Langan & James, 2005). Besides having the educational background that emphasises a biological, psychological, social, and spiritual approach in caring for patients affected by disaster, nurses also have critical thinking, problem-solving skills, flexibility, and adaptability necessary for managing difficulties that might arise during disasters (Powers & Daily, 2010; Wynd, 2006). . These skills are learned during nursing education in college and when caring for patients (Powers & Daily, 2010).

As first responders, nurses are expected to be able to deliver advanced health care to disaster survivors (Gebbie et al., 2012). Nurses also should have an understanding of basic theoretical information and practice regarding medical and health logistics of managing disasters, especially when clinical facilities can become overwhelmed by the event (Hilton & Allison, 2004; Pelaccia et al., 2008). Ill-prepared

staff lead to ill-prepared healthcare organisations (Admi et al., 2011; Franco et al., 2006).

Core competencies have been developed to describe the role of a health care professional in an emergency and disaster setting (Gebbie & Qureshi, 2002). Clarifying these core competencies has become a focus of attention in the education sector. Clear competencies are essential because competent health care professionals are expected to be organized, efficient, and effective in responding to a disaster (Gebbie et al., 2012).

Identifying the roles that need to be implemented may clarify the tasks and improve disaster preparedness of health care professionals during a disaster event. Yet, there are four other elements that contribute to optimum disaster preparedness for health care professionals as identified by Hope et al. (2010) and Lim et al. (2013): previous experience of disaster response, confidence, willingness to respond and disaster knowledge and education.

In order to deal with emergency situations caused by a disaster, health care professionals need to have comprehensive knowledge, skill, and ability (Slepski, 2005). Besides gaining knowledge and skill through disaster response experience, health care professionals may improve their disaster preparedness by attending disaster-related educational program. In fact, disaster education is the preferable option because the likelihood of having disaster experience is unpredictable.

Health care professionals may acquire a disaster education that aims to improve competence (knowledge, skill and attitude), confidence, and willingness to respond. If this education is delivered effectively and efficiently, health care professionals may feel aware, confident, and less vulnerable when having to face the unexpected (Duong, 2009). Disaster education will also improve the quality of care of those affected (Husna et al., 2011).

As an effort to improve disaster-related knowledge and skill, various interventions of disaster education have been used to educate health care professionals. These interventions include lectures, discussions, exercises and drills (IFRC, 2000). However, disaster education may be time-consuming, expensive, and divert resources away from other important needs (Hsu et al., 2004). Moreover, the available evidence is insufficient to determine whether training interventions are effective in improving knowledge and skill regarding disaster response (Williams et al., 2008).

Disasters may involve a significant human toll. Hence, health services are assumed to be fully filled with patients suffering from medical casualties (Powers,

2007). Because health services are medical centres that always ready to accept patients, and immediate demand of resources is required anytime a disaster strikes, health services must invest significant efforts in developing disaster preparedness plans for health care professionals so that staff are trained for disaster management (Hsu et al., 2004) .

Nurses are one of the many health care professionals that may respond quickly to a disaster. However, collaborative work of a multi-professional team is needed to complement each other's tasks and responsibilities (Silenas et al., 2008). Hence, disaster education that targets multiple-professions is preferable. (Silenas et al., 2008). This way, health care professionals are trained to be collaborative and aware of each other's responsibilities before being deployed into a real disaster event.

Two systematic reviews regarding effectiveness of disaster training for health care workers have been conducted (Hsu. et al., 2004; Williams et al., 2008). Both studies reported lack of scientifically rigorous evaluation in the included literature, which leads to an indefinite conclusion and recommendation regarding the effectiveness of disaster education. Thus, in this systematic review, a search process of the most recent disaster education-related literature will be conducted to investigate the effectiveness of the educational intervention to improve disaster preparedness of nurses and other health care professionals and update the previous finding.

Inclusion Criteria

Studies

To obtain objective and comparative measurement of the effectiveness of an intervention, only studies reporting primary research that used quantitative approach with designs of randomised controlled trials (RCT), experimental and quasi-experimental design will be included in the systematic review.

Population

The systematic review will explore studies of research including qualified and working nurses independently or in a team with other health care professionals, including physician, paramedic, and emergency medical services.

Intervention

Educational interventions includes hospital in-service type short courses, drills, simulations and other forms of education program (excluding formal education for award degree). The intervention/s were provided for nurses and other health care professionals in order to increase disaster preparedness.

Outcomes

This systematic review will target studies that contained a quantitative measurement of increased competence, confidence and willingness.

Time and Place

Studies that will be included were conducted in any country and published in English between 2006 until 2015.

Search Strategy

In this systematic review, articles from peer-reviewed literature will be identified. Four electronic database identified as most relevant were searched: MEDLINE, CINAHL, EMBASE, and ERIC.

Keywords used will be nurse, health professionals, education, training, drill, simulation, teaching, "disaster preparedness", "disaster planning", and "disaster exercise". These key words are combined by Boolean phrases (Table 1).

Table 1 Combined key terms

Population		**Intervention**		**Context**	**Outcome**
nurse OR health professionals including paramedics, first responders	AND	education OR training OR drill OR simulation OR teaching	AND	"disaster preparedness" OR "disaster planning" OR "disaster exercise"	confidence OR competence OR willingness

Details of databases searched, keywords used and number of articles identified, included, and excluded in every step of the review process will be recorded. The search result will be recorded in an EndNote database for ease of access.

The studies identified in each of the database will then be put through a screening process. Duplicates of studies will be searched and removed. Then, titles and abstracts of the studies will be analysed. Studies that do not meet the inclusion and exclusion criteria will be removed. After this phase, full-text version of the studies will be examined to determine the eligibility. In the end, a number of selected studies will be included in the assessment of methodological quality phase.

Assessment of Methodological Quality

The selected studies will be assessed for the eligibility for inclusion in systematic review using Joanna Briggs Institute critical appraisal tool for quantitative studies. This assessment will be conducted by two reviewers. Any disparity between reviewers will be solved through discussions until a conclusion is reached.

Data Collection

Quantitative data will be collected from the papers manually. The data extracted includes specific details about the intervention, population, measurement tool (e.g survey, questionnaire), location, study methods and intervention outcomes. Participants' score from evaluations will also be extracted.

Data Synthesis

For data synthesis, the description of extracted data will be presented and elaborated in a narrative text. A data synthesis of studies' results will also be provided to find the answer of the review question. Then, the characteristics of studies and results will be summarised and tabulated.

If similarities of outcomes of the factors and methods of the statistical analysis between articles are revealed, a summarized version of statistical analysis of multiple studies using a forest plot will be provided. Forest plot is a graph that shows the strength of intervention effects of multiple quantitative studies addressing the same question (Schneider, 2007). In the systematic review, the forest plot will serve as a graphical illustration of the degree of effectiveness of intervention in the included studies.

Conflicts of Interests

The authors have no relevant disclosures to make and there is no conflict of interest regarding this systematic review.

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Appendix B Summary of Key Results of Included Studies

Types of Intervention

Bartley et al. (2006)	Lecture, tabletop exercise, simulation
Bistaraki et al. (2011)	Lecture, tabletop exercise
Chiu et al. (2011)	Lecture, online learning
Collander et al. (2008)	Lecture, tabletop exercise, simulation
Glow et al. (2013)	Lecture, simulation

Evaluation Tool

Bartley et al. (2006)	Six questions questionnaire and 5-points scale of self-assessment survey
Bistaraki et al. (2011)	19 multiple choice questionnaire and 5-points scale survey for seminar evaluation
Chiu et al. (2011)	Survey of confidence using Likert type scale
Collander et al. (2008)	23 questions questionnaire and 5 points course evaluation survey
Glow et al. (2013)	18 questions questionnaire

Time Interval Between Intervention and Post-Test

Bartley et al. (2006)	Post-test was conducted 4-6 months after intervention
Bistaraki et al. (2011)	Post-test was conducted immediately and one month after intervention
Chiu et al. (2011)	Post-test was conducted 12 months after intervention
Collander et al. (2008)	Post-test was conducted immediately after intervention
Glow et al. (2013)	Post-test was conducted immediately after intervention

Change of Number of Participants

Bartley et al. (2006)	Pre-test 50 participants, post-test 42 participants
Bistaraki et al. (2011)	Same number of partiipants on pre-test and post-test (56 participants)
Chiu et al. (2011)	Pre-test 182 participants, post-test 54 participants

Collander et al. (2008)	Same number of partiipants on pre-test and post-test (84 participants)
Glow et al. (2013)	Pre-test 193 participants, post-test 175 participants

Results

Bartley et al. (2006)	• The results were divided into emergency department staff and non-emergency department staff score • Emergency department staff gained higher pre-test and post-test score • Significant improvement of knowledge test score. Pre-intervention mean score (out of 20): ED: 12.1 Non-ED: 6.2 Post-intervention score (out of 20): ED: 15.8 Non-ED: 10.6 p-value <0.001 • Self-assessment "I am personally prepared" Pre-test: 16 out of 50 answered "disagree" Post-test: 19 out of 42 answered "agree" • Departmental preparedness "My department is prepared" Pre-test: 22 out of 50 answered "disagree" Post-test: 13 out of 42 answered "disagree" • Impressions of improvement 41 out of 50 reported some degree of personal improvement (minor, moderate, major) 24 out of 38 reported some degree of departmental improvement
Bistaraki et al. (2011)	• Significant improvement in knowledge. Scores (out of 100): Before intervention score: 44.5±1.7 Immediate intervention mean score: 86±2

	Follow-up mean score: 77.2±2.3 p-value <0.001 • Control group mean score (before, immediately after, and 1 month after intervention): 40±2.4 p-value <0.001 • Participants who attended a previous disaster seminar gained higher score on pre-test • There was not any significant differences in pre-test score based on other demographic characteristics of the participants • There was not any significant differences in post-test score based on other demographic characteristics of the participants • Reported high level of satisfaction of participants in the seminar evaluation, 34 out of 56 participants stated that they will use the knowledge they gained from the seminar • Participants who had higher and lower level of education achieved the similar pre-test and post-test score
Chiu et al. (2011)	• Confidence in preparedness, response, and recovery public health nurse disaster surge competencies significantly increased, whereas self-perceived need for further competency training significantly decreased. Preparedness pre/post : 30.2±6.7 / 36.2±4.9 Response pre/post : 26.0±5.5 / 30.9±4.5 Recovery pre/post : 23.1±5.5 / 28.8±4.18 p-value <0.01 • The need for further training of the participants was decreased after intervention was conducted • Public helath nurses improved higher than director of nurses

	• There was no significant difference of perceived confidence or need for further trainingfor nurses employed less than five years with those employed more than five years
Collander et al. (2008)	• Significant improvement in post-test score. Scores (out of 100): Pre-test mean: 69.1 ± 12.8 Post-test mean: 89.5 ± 6.7 p-value <0.0001 • Confidence score in using newly learned knowledge (out of 5): 4.24 ± 0.8 • All participants had similar pre-test scores with no position scoring statistically higher or lower than any other position • All position significantly improved • Seminar evaluation: the course material was relevant to the participants positions and the course fulfilled their educational needs
Glow et al. (2013)	• Significant higher scores on the post-test. Scores (out of 18): Pre-test mean: 9.68 ± 2.33 Post-test mean: 13.64 ± 1.83 p-value < 0.001 • No difference of score by sex or age • Fire-related positions had higher baseline score • Score improvements varied according to position, size of community, agency, and licensing.

Appendix C Data from Three Studies to Conduct Statistical Analysis of Effectiveness from Multiple Studies

Variables/Article	Bistaraki et al.	Glow et al.	Collander et al.
	Mean ± SE	Mean, SD	Mean ± SD
Pre-test All Participants	44.5 ± 1.7 (SD = 12.75)	9.68 (2.33) = 53.78 (12.9)	69.1 ± 12.8
Immediate post-test All Participants	86 ± 2 (SD = 15)	13.64 (1.83) = 75.78 (10.17)	89.5 ± 6.7

Appendix D Excluded Studies

Author	Title	Reason of exclusion
Goodhue, Burke, Chambers, Ferrer, and Upperman (2010)	Disaster olympix: A unique nursing emergency preparedness exercise	Improvement score between before and after intervention was not measured
Scott et al. (2013)	Competency in chaos: Lifesaving performance of care providers utilizing a competency-based, multi-actor emergency preparedness training curriculum	Medical students were included as participants
Silenas et al. (2008)	Developing disaster preparedness competence: An experiential learning exercise for multiprofessional education	Medical students were included as participants
Tillman (2011)	Disaster preparedness for nurses: A teaching guide	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Powers (2007)	Evaluation of hospital-based disaster education	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Farra, Miller, Timm, and Schafer (2012)	Improved training for disasters using 3-D virtual reality simulation	The participants were nursing students

Conlon and Wiechula (2011)	Preparing nurses for future disasters – The Shichuan experience	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Gillett et al. (2008)	Simulation in a disaster drill: Comparison of high-fidelity simulators versus trained actors	Nurses were not included in the group of partcipants
Williams et al. (2008)	The effectiveness of disaster training for health care workers: A systematic review	Systematic review is not eligible to be included in another systematic review
Greci et al. (2013)	vTrain: A novel curriculum for patient surge training in a multi-user virtual environment (MUVE)	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Wise (2007)	Preparing for disaster: A way of developing community relationships	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Chapman and Arbon (2008)	Are nurses ready? Disaster preparedness in the acute setting	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Ruder (2012)	Emergency preparedness for home healthcare providers	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster

Landry and Stockton (2008)	Evaluation of a collaborative project in disaster preparedness	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Phillips, Niedergesaess, Powers, and Brandt (2012)	Disaster preparedness: Emergency planning in the NICU	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Anderson (2012)	Using disaster exercise to determine staff educational needs and improve disaster outcomes in rural hospitals: The role of the nursing professional development educator	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Lowe & Hummel (2014)	Disaster readiness for nurses in the workplace	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Shah et al. (2012)	Waterworks, a full scale chemical exposure exercise: Interrogating pediatric critical care surge capacity in an inner-city tertiary care medical center	Nurses were not included in the group of partcipants
Duong (2009)	Disaster education and training of emergency nurses in South Australia	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster

Gonzales and Brunstein (2009)	Training for emergencies	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster
Savoia, Agboola, and Biddinger (2014)	A conceptual framework to measure system's performance during emergency preparedness exercise	Does not provide objective measurement of participants' knowledge, skill, attitude, confidence, or willingness to respond to a disaster