



Patient Safety:

Nurses' Perception of Human Factors and Ergonomics

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<p>Abstract:</p> <p>This study is part of Arcada's GROW project (Good ethical decision making, Resilient safety, Ongoing reflection, Wise practice) which is commissioned by Arcada Patient Safety and Learning Center (APSLC). This study carry out a qualitative literature review on the importance of nurses' perception on the application of Human Factors and Ergonomics (HFE) on patient safety. HFE is a discipline which uses theories, principles and applications to identify and address problems which arises in a particular system due to people and system interaction. HFE techniques and tools can be used in patient safety improvement in health care sector. In this work how HFE can be used as a tool in patient safety is discussed. High Reliability Theory and Normal Accident Theory is used as a theoretical framework for this work. How nurses' perception on safety culture affect the implementation of HFE, the importance of HFE theories, applications and tools in patient safety, the relationship of safety culture and nurses performance in patient safety are raised as a research question. To answer the research questions, a qualitative data is searched using scientific database as a tool and thirteen relevant articles are selected for content analysis. An inductive content analysis system approach is used in data analysis and interpretation. The importance of HFE in healthcare organization is unquestionable and the findings in this work demonstrate this concept. The findings from selected articles are factors and influences which affects nurses' perception and which in return affects the application of HFE in an organization are categorized as communication factors, individual factors and organizational influence. These findings are presented and discussed in detail in the findings and discussion chapter of this work. This work used recent related scientific study articles in the field of HFE in patient safety. It discussed the use of the HFE in patient safety.</p>	
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FOREWORD

I would like to thank Arcada University of Applied Sciences for giving me a chance to write a thesis of my choice. I am grateful for my thesis supervisors Satu Vahderpää and Pamela Gray for the guidance, support and encouragement they provide me in the process of writing. Love and respect to my beloved wife Ayyaantu who was my strength in the whole journey of my study and this work and to my little Angel Weedduu who shed light on my life.

1 INTRODUCTION

Many principles and approaches have been adopted to improve and optimize patient safety in health organizations. Human Factors and Ergonomics (HFE) is one of the approaches used in organizations to improve patient safety. Nurse's perception and understanding of HFE is an important factor in implementing the tools, methods, theories and principles of HFE in health care sectors. I am inspired to see how the application of HFE in health care makes a difference. I preferred to do a literature review to look at works done in this area, how much is known about HFE and its application in the healthcare sector, what are problems in healthcare sector that could be simplified by applying HFE. This will cover a wide range of research problem and this is beyond the scope of this work. This big research question is narrowed down by focusing only on the impact, application and usefulness of HFE methods, tools and principles on patient safety. This study is part of Arcada's GROW project (Good ethical decision making, Resilient safety, Ongoing reflection, Wise practice) which is commissioned by Arcada Patient Safety and Learning Center (APSLC).

2 BACKGROUND

According to the World Health Organization statistics every tenth patient in Europe faces some preventable harm or adverse events in hospital (WHO, 2014). One of the many global challenges nurses face in delivering quality health care is the ability to detect when patients are at increased risk for harm as a result of their conditions or from medical errors that might occur in the course of their treatment. The ability to recognize warning signals is especially challenging in today's increasingly complex practice settings (Despins et al., 2009). This in turn results in loss for the patient, family and organizations. Various approaches and methods are being adopted to maximize patient safety. Human factors and ergonomics is one of the tools in promoting patient safety in health care sectors.

Patient safety is the prevention of errors and adverse effects to patients associated with health care. While health care has become more effective it has also become more complex, with greater use of new technologies, medicines and treatments. Health services threat older and sicker patients who often present with significant co-morbidities requiring more and more difficult decisions as to health care priorities. Increasing economic pressure on health systems often leads to overloaded health care environments (WHO, 2014).

Human factors and ergonomics are sub domain of human factors engineering. This work focus on the application and implication of this sub domain of engineering in patient safety. Ergonomics or human factors is the scientific discipline which studies how human interact and perform in a particular system and system elements. Ergonomics uses theories, principles and methods to design and redesign system and system elements to fit to human and to improve human performance and system performance (IEA, 2014).

Culture of patient safety in health care sectors plays a vital role in maximizing patient safety and patient safety performance. The more awareness and knowledge present in health care organizations the more it will be practiced. This work focus on component of patient safety which is, human factors and ergonomics in health care as tool in maximizing and utilizing patient safety and safety performance. The aim of this work is to work out a literatures review to find out nurses' perception, understanding, and knowledge of

safety issues mainly human factors and ergonomics concerning safety in caring process in healthcare organizations.

2.1 Why Human Factors and Ergonomics in Patient safety

Patient safety is a major concern worldwide (WHO, 2014). Most incidents and accidents in patient safety happens in health care originations due to not giving attention or not considering human factors and ergonomics when designing new system and in implementing new technologies, process, work flow, jobs, teams and sociotechnical systems in the new or existing system (Carayon *et al.* 2013). Different approaches and methods have been utilized and applied to optimize patient safety issues worldwide. Carayon *et al.* has described some of the HFE methods and approaches. Some of the methods listed are: Vincent and colleagues' Systems Approach and the Carayon and colleagues' Systems Engineering Initiative for Patient Safety (SEIPS) (Carayon *et al.*, 2013). Human factors and ergonomics approach is one of those methods used to optimized patient safety issues in health care sectors. The application of HFE in health care and patient safety is not new (Carayon, 2010). HFE as a patient safety practice can takes different forms: using HFE tools and methods, and increasing HFE knowledge (Carayon, 2010). Nurses' positive perception about HFE is important in application of HFE tools and methods in health care organizations and important in creating HFE awareness and knowledge development among nurses.

Different kinds of problem in health care organizations can be solved using Human Factors and Engineering as a tool. Patient safety is one of the big problem in patient safety in which Human Factors and Engineering principles and techniques can be applied. Carayon described HFE methods, tools, concepts and theories as an important part in patient safety improvement process and HFE as a key systems engineering tool to design and improve healthcare systems, and produce improvements in quality of care and patient safety (Carayon *et al.*,2010). According to Carayon *et al.* study, some of the areas where HFE can be important and used in healthcare are: in making analysis how new and existing technologies fit in a system, it can also be used in a process of decision-making, design of different health care technologies, equipment and facilities can be improved and rede-

sign using Human Factors and Engineering (Carayon et al., 2010). Using the Human Factors and Engineering approach different components of patient safety can be addressed. Carayon et al. describe five components which can be addressed by Human factors and Engineering approach. These are: how the technology is usable, in human error and the role in patient safety, the effect of health care performance in patient safety, how a system can adapt itself when changes happen in an organization, and Human factors and Engineering system approaches to patient safety (Carayon et al., 2013).

2.2 Patient Safety Definitions

Defining patient safety settles which elements are going to be emphasized in managing safety and which not, in which directions organizational efforts are going to be implemented and in which not. The definition of patient safety tells something about how an organization understands safety as well as what it is going to do to ensure and improve it (Macchi et al, 2011).

List of patient safety definition from different literature is available in Table 1.

Table 1: Patient Safety Definitions.

Definition	Author
"The prevention of harm to patients"	Institute of Medicine/IOM, USA http://iom.nationalacademies.org/ accessed 07.02.2016
"Freedom from accidental or preventable injuries produced by medical care"	Agency for Healthcare Research and Quality, Patient Safety Network http://www.ahrq.gov/ accessed 07.02.2016
"Patient safety is the prevention of errors and adverse effects to patients associated with health care"	WHO, Regional Office for Europe, 2016 http://www.euro.who.int/en/health-topics/Health-systems/patient-safety Accessed 07.02.2016.

2.3 Patient Safety Culture

Safety culture as a concept can be said known to the world recently. The concept came after the Chernobyl nuclear accident in 1980s. The concept was developed to show the poor and unsafe understanding of managements and staff at the nuclear plant (Carayon, 2007, p694).

How individuals and groups in an organization perceive safety, groups and individual attitude and value towards safety is the safety culture of that organization. In organizations where the importance of safety culture is shared among all staff, there is a strong and positive safety culture (ACSNI, 1993).

Creating and encouraging a working environment in health care organizations in which health care professionals have a strong patient safety culture and applying and keeping this concept though out the process is an important process in promoting patient safety practice and improve patient safety. To do so there must be a strong and positive patient safety culture in an organizations and it should be given top priority. Strong patient safety culture include open communication, team work, and acknowledged mutual dependency. Before adopting a strong safety culture in an organization it is important to assess and evaluate the existing safety culture of the organization (El-Jardali et al., 2014).

Singer et al define safety culture as following. Patient safety culture can be defined as what members of an organization give value and think what is important, and the way they interact with system's structure which will create accepted habit in the organization that improve safety practice and safety (Singer et al. 2009).

Reason and Hobbs have identified three main components of a safety culture. These are learning culture, just culture, and reporting culture (Reason & Hobbs, 2003).

Learning culture: in learning culture there must be a willing and effort to improve system design and system's components design which will lead to system redesign (Mayer & Cronin, 2008).

Just Culture: in just culture human error are considered as a system problem. The organization do not blame workers for error or incident made by workers. Workers do not hesitate to tell their error. Therefore organizations learn from a mistake and there will be a progress and improvement in safety (Mayer & Cronin, 2008).

Reporting culture: in reporting culture workers feel free to report safety incidents which occurred in an organization. The system encourages and facilitates incident reporting.

Reporting culture facilitate learning from errors and hence improve safety in an organization (Mayer & Cronin, 2008).

2.4 Relationship of Patient Safety Culture, Safety Climate and Safety Performance

Patient safety climate is knowledge, beliefs, and attitudes that reflect the role of safety in the organization. Flin defined safety climate as the understanding of people who work in an organization about the culture of safety in organization in which they work (Flin, 2007).

Patient safety and patient safety culture are the foundation of excellent health care delivery on which all other care is based (Kear & Ulrich, 2015).

According to Singer et al., patient safety culture in an organization and patient safety have a positive coloration. In such a way that in organization which has higher level of safety climate have high safety performance (Singer et al. 2009).

Patient safety culture has been shown to be related to healthcare clinician behaviors, to patient outcomes, and to positive assessments of care by patients (Ulrich & Kear, 2014).

2.5 Human Factors and Ergonomics and Principles

Human factors which is an engineering field which studies how people understand their interaction with system components. Human factors using different theories, applications and principles design new system or redesign existing system to increase peoples' safety and system performance (Norris et al. 2012).

A human factors approach to system design considers the characteristics and abilities of the people who have to work in that system, and how to optimize that system. This could include: physical abilities-responses to fatigue, the effects of stress, manual or patient handling and so on. **Perceptual abilities:** how information on charts is read, reactions to alarms and the effect of lighting and noise. **Cognitive abilities:** mental models how things are expected to work, how much information we can remember, what affects our decision making, response times, the types of errors made and what actions we prioritize from conversation. **Social and interpersonal characteristics:** how to work in teams, our response to rules and our willingness to take risks (Norris et al. 2012).

2.6 Characteristics of Human Factors and Ergonomics

Human Factors and Ergonomics covers a wide range of physical, cognitive, and organizational issues involved in system design. Physical HFE issues include physical dimensions of tools that do not fit physical characteristics of users (e.g., too small font size on computer screen), inappropriately designed physical environment (e.g., lighting too bright and creating glare, noisy and distracting environment) and physical layout that does not support clinician work (e.g., monitoring patients from the central nursing station). Cognitive HFE issues include interaction between people and the rest of the system such as perception, memory, attention, mental workload, and support for decision-making. At the organizational level, HFE focuses on communication and coordination, teamwork, job design, sociotechnical system, and system design. (Carayon, et. al. 2013 p. 325)

2.7 Patient Safety and Nurses

Nurses are the front liners in patient care. Nurses are responsible for medication administration, patients' condition assessment, supervision of patients' activities, and all the medical process of patients. The role of nursing play an important part in prevention of patient injury and patient safety (Ramanujam et al., 2008). A study by Cook et al. shows a great percentage of nurses and healthcare personnel and administrators believe that nurses have the primary responsibility for the prevention of harm to patients in the hospital settings (Cook et al., 2004).

Table 2: HFE mechanisms between system design and patient safety

HFE mechanisms	Objective of system design
A work system that is not designed according to HFE design principles can create opportunities for errors and hazards	The objective of HFE- informed system design is to identify and remove system hazards from the design through maintenance phases
Performance obstacles that exist in the work system can hinder clinicians' ability to perform their work and deliver safe care	If some obstacles cannot be removed, for instance, because they are intrinsic to the job, then strategies should be designed to mitigate the impact of performance obstacles by enhancing other system elements
A work system that does not support resilience can produce circumstances where system operators may not be able to detect, adapt to, and/or recover from errors, hazards, disruptions and disturbances	Work systems should be designed to enhance resilience and support adaptability and flexibility in human work, such as allowing problem or variance control at the source
Because system components interact to influence care processes and patient safety, HFE system design cannot focus on one element of work in isolation	Whenever there is change in the work system, one needs to consider how the change will affect the entire work system, and the entire system needs to be optimized or balanced

(Carayon et al., 2013).

3 THEORETICAL FRAMEWORK

A theoretical framework provides a way of looking at nursing phenomena. It contains specific ideas or words, called concepts that a nurse draws on to use in direct patient care as well as for making administrative decisions. These decisions have direct or indirect clinical implications. These concepts have powerful intellectual tools for they direct what is to be observed, they give meaning to the nurse's sense perceptions in nursing situations. Concepts direct the nurse's focus to certain phenomena thus restricting the area of concern. Without this restriction a nurse's attention is consumed by multiple activities that may have little, if any, relationship with the professional nursing service that should be provided. These concepts help nurses organize their observations and thoughts about their moment to moment contact with patients. It applies to administrative nurses in their contacts with their staff or with other people with whom they work (Schmieding, 1990).

In this study a Donabedian's Structure-Process-Model (SPM) of health care quality model as well as High Reliability Theory (HRT) and Normal Accident Theory (NAT) are used as a theoretical framework.

3.1 Structure-Process-Outcome Model

The Donabedian Model is proposed as a tool for measuring and assessing patient safety and quality of care in important components of structures and processes in health care setting (McKay & Wieck, 2014). According to Donabedian health care quality model, improvement in structure of a health care should lead to an improvement in clinical process of health care which in turn will result in a better patient outcome (Moore et al., 2015). The information from which inferences can be drawn about the quality of care can be classified under three categories. These are: Structure, Process and Outcome.

Structure of a health care organization is consists of the platform in which care occurs. This includes the attributes of material resources such as facilities, equipment, and money, of human resources such as the number and qualification of personnel, and organizational structure such as medical staff organization, methods of peer review, and methods of reimbursement. Structure is something relatively permanent and have big role in determining quality.

Process indicates what the health care worker is giving and the patient receiving care. It includes the patient's activities in seeking care and carrying it out as well as the practitioner's activities in making a diagnosis and recommending or implementing treatment. Process is more flexible than structure and can be changed anytime easily.

Outcome is the effects and changes which we can see on the patient health status after receiving care. Improvement in the patient's knowledge and salutary changes in the patient's behavior are included under a broader definition of health status, and is so the degree of the patient's satisfaction with care (Donabedian, 1997).

3.2 High Reliability Theory and Normal Accident Theory

Whether a robust patient safety culture exists within the practice environment can influence nurses' ability to detect and respond to warning signals. A theoretical construct that may assist in understanding how safe practice environments are created and sustained is high reliability theory. High reliability theory has been useful in examining why inherently high-risk work sites such as nuclear power plants, air traffic control centers, and missile launch facilities nevertheless have relatively low accident rates (Despins et al. 2009).

According to high reliability theory, a combination of attentive-cognitive process and responsive actions produce high reliability organizations (HROs) that are able to manage unexpected events effectively. These cognitive processes involve actively processing information with the assumption that the unexpected will occur during the performance of routine tasks (Despins et al. 2010).

Normal Accident theory was developed by Charles Perrow. Perrow suggested that organizational factors contributed to the occurrence of catastrophic accidents and these catastrophes were in some conditions inevitable. Two key attributes of organizations contributed to 'normal' or 'system' accidents. Normal accidents occur when the failure in one component in a process sets up a chain reaction, which individual operators are powerless to control, either because they lack the knowledge, authority or capacity to intervene at a system level (Cooke, 2009).

According to the theory for normal accident to occur; organizational coupling is tight rather than loose, processes are characterized by interactive complexity rather than linearity (Cooke, 2009).

Tight coupling: in tight coupling organizations have a structure which allows leaders to have a control system which monitors and assess each workers and work flow in all work units. The order of work flow is important in tight coupling. In tight coupling workers have less decision-making power. Leaders make all decision (Perrow, 1984).

Loose coupling: in loose coupling workers have more freedom in decision-making. Different units work independently. The order in which a work flow goes does not matter. Leaders in loose coupling organization encourages individual workers and teams to achieve the organization's goal (Perrow, 1984).

Complex systems: in complex system, components of a system are interconnected. When a system failed it is not possible to take out the failed component. In complex system a particular work is highly specialized in a particular job and have a narrow vision of the whole system (Perrow, 1984).

Linear systems: in linear system, unlike the complex system, there is no much interconnected components in a system. When a system fails it is easy to identify the failed component. Workers in an organization which have a linear system have an understanding of the whole system in which they work (Perrow, 1984).

3.3 Comparing HRT and NAT Theories to Hospital Organization

Table 3: Comparing HRT and NAT

	HRT	NAT	Hospital Organizations
Assumptions			
Main concern	Improve reliability in high-hazard settings	Raise awareness	
Orientation	Optimistic	Pessimistic	
Applications			
Objectives	Reliability is first priority	Safety competes with other objectives	Administrators confront competing objectives
Redundancy	Technical and social redundancies enhance reliability	Redundancy can contribute to accidents	There are many social redundancies and some technical ones
Structure and process	Decision making migrates toward expertise Flexible structure enables rapid response	Decision making migrates toward powerful	Decisions sometimes migrate toward powerful Decision making tends to be decentralized
Culture	Culture norms enhance reliability and safety	Safety culture is necessary, but not sufficient for safety	Multiple subcultures Conflicting beliefs and norms
Assumption about risk	Assume that risk exists and that they can devise strategies to cope with risk	Politics and personal interests influence risk interpretation	Sources of risk are ambiguous
Rewards	Rewards should be consistent with desired behavior	Reward system influences and is influenced by politics	External organizations influence internal allocation of rewards
Cognition	Emphasizes cognition and developing culture of mindfulness	Limited treatment of cognition	Few empirical studies of cognition

(Cooke, 2009).

3.4 High Reliable Organizations

A highly reliable organization is one that is known to be complex and risky, yet safe and effective. Critical elements of highly reliable organizations include a commitment of safety, a culture of continuous learning and improvement, and redundancy in safety measures and personnel. The primary premise of this theory is that although errors can occur within highly reliable organizations, they rarely do so. Another tenet of the theory is that when near misses or errors occur, highly reliable organizations use knowledge gained from the event to prevent similar errors from occurring in the future (Beyea, 2005). Highly reliable organizations value team work, communication, and learning together. A number of characteristics have been ascribed to highly reliable organizations, including a preoccupation with failure and safety, deference to expertise, sensitivity to operations, a commitment to resilience, and reluctance to simplify interpretations. In other words, highly reliable organizations: focus on identifying how mistakes can be done, take a team approach to decision making, understand how decisions may affect all other activities, use creative problem-solving strategies, and examine errors to determine their root cause instead of blaming individual for a problem (Beyea, 2005).

4 AIM OF THE STUDY AND RESEARCH QUESTIONS

The aim of this work is to explore the applicability of Human Factors and Ergonomics in patient safety. How safety culture and perception of safety among nurses in organization affect patient safety.

The following research questions are designed while finding out the relationship between safety culture and patient safety.

1. How nurses' perception of safety affects the implementation of HFE and what is the role of HFE in patient safety
2. How human factors can be incorporated with nurses activities in promoting patient safety
3. What is the relationship of safety culture and performance and how patient safety culture is improved in an organization

5 METHODOLOGY

In this work, using a qualitative data, to solve a research questions systematically and in performing research operation, an inductive content analysis approach by a literature review of the selected articles is used by the author.

Literature review covers the research question, the retrieval and selection of original scientific articles and the estimation of their quality as their analysis and presentation. Literature review has been established as the most reliable and valid means of summarizing previous research findings. It can avoid systematic bias and to highlight potential shortcomings as well as to identify existing but nonsystematic scientific knowledge. Thus, literature review may either increase the need for primary research or prevent the start-up of unnecessary new studies (Kangasniemi, 2010).

5.1 Data Collection

In collecting academic articles for this work, nursing databases CINAHL (an EBSCO database), Academic Search Elite (an EBSCO database) and PubMed is used. These databases were chosen in accordance with the relevancy to my study program and this work. Published scientific articles written in English from year 2000 to 2015 were targeted in searching for articles. Basic key words used in searching the databases in CINAHL and Academic Search Elite were: "patient safety", "ergonomics", "human factors", and "nurses' perception". Key words "patient safety", "ergonomics", "human factors" and "nurses' perception" is used in PubMed builder.

Data Collection Process:

CINAHL

Table 4: CINAHL Database Searching Process.

Search #	Key Word	Field		Limitation		Hits	selected
				Full Text	Year		
#1	Patient Safety	Title		x	2000-2015	1320	-
#2	Ergonomics	Title		x	2000-2015	77	-
#3	Human Factors	Title		x	2000-2015	80	-
#4	Nurses Perception	Title		x	2000-2015	53	-
#5	#1, #2	Title	AND	x	2000-2015	8	-
#6	#1, #3	Title	AND	x	2000-2015	40	1
#7	#1, #4	Title	AND	x	2000-2015	1	1
#8	#1, #4	Title, All Text	AND	x	2000-2015	8	2

Academic Search Elite (an EBSCO database)

Table 5: EBSCO Database Searching Process.

Search #	Key Word	Field		Limitation		Hits	se- lected
				Full Text	Year		
#1	Patient Safety	Title		x	2000-2015	1277	-
#2	Ergonomics	Title		x	2000-2015	390	-
#3	Human Factors	Title		x	2000-2015	1216	-
#4	Nurses Perception	Title		x	2000-2015	447	-
#5	#1, #2	Title	AND	x	2000-2015	2	-
#6	#1, #3	Title	AND	x	2000-2015	6	2
#7	#1, #4	Title	AND	x	2000-2015	4	1
#8	#1, #4	Title All Text	AND	x	2000-2015	60	1

PubMed Builder

Table 6: PubMed Searching Process.

Search #	Key Word	Field	Search Modes/Boolean phrase	year	F u l l t e x t	Hits	Selected
#1	Patient Safety	Title	-	2000-2015	x	4724	-
#2	Ergonomics	Title	-	2000-2015	x	809	-
#3	Human Factors	Title	-	2000-2015	x	491	-
#4	Nurses' Perception	Title	-	2000-2015	x	6	-
#5	#1, #2	-	AND			13	2
#6	#1, #3	-	AND			44	3
#7	#1, #4	-	AND			0	-

5.1.1 Inclusion and Exclusion Criteria

This work examined thirteen scientific articles from the year 2000 to 2015. These thirteen articles were selected for content analysis from a total of 178 selected articles. In selecting the articles, key concepts for this work which are "patient safety", "ergonomics", "human factors" and "nurses perception" were given emphasize. Articles were eliminated if it is not published. Articles which only discussed in the area of healthcare were selected and articles which discussed only other disciplines other than healthcare like nuclear plant and engineering were eliminated. Articles which discussed nurses and hospital settings

were selected. Articles which are older than ten years since published were not selected for content analysis and discussion.

5.1.2 Presentation of Selected Articles

Thirteen articles are selected for content analysis. Here below is the list of selected articles with summary of aims and findings. Articles are listed in alphabetical order of titles. A number is assigned for each article and this assigned number will be used in the following sections of this work.

1. Clinical human factors: the need to speak up to improve patient safety. Reid, J. & Bromiley, M., 2012, Nursing Standard.
Aim: to inspire nurses to recognize how human factors affect individuals and team performance.
Findings: the relationship of understanding human factors and individual behavior and of colleagues in providing safer and better health care.

2. Human factors and ergonomics as a patient safety practice. Carayon et al., 2013, The International Journal of Healthcare Improvement.
Aim: to find out the importance of human factors and ergonomics to patient safety and to understand system and complexity on patient care.
Findings: have proposed interventions which are based on Human Factors and Ergonomics for patient safety.

3. Human factors and ergonomics in home care: Current concerns and future considerations for health information technology. Calvin, K., et al., 2009, PMC Journals.
Aim: to review the consideration of Human Factor and Ergonomics in problems which arises in home care services in information access, communication and patient self-monitoring and self-management in patients which are discharged to home.
Findings: proper consideration of human factors and ergonomics is an essential part in implementing new technologies.

4. Human factors engineering in healthcare systems: The problem of human error and accident management. Cacciabue, P., & Vella, G., 2010, International Journal of Medical Informatics.
Aim: looking at the availability of methods and techniques to identify a root causes of events.
Findings: finds out Safety Management System as a useful tool in identifying root causes events.
5. Human factors in patient safety as an innovation. Carayon, P., 2010, Journal of Applied Ergonomics.
Aim: to sort out factors which either inhibit or encourage in application of Human Factors and Ergonomics in health care sector and patient safety.
Findings: draw a series of recommendations for Human factor and Ergonomics professionals, researchers and educators.
6. Human factors systems approach to healthcare quality and patient safety. Carayon et al., 2013, Journal of Applied Ergonomics.
Aim: highlighting importance of work system issues in medication safety.
Findings: solution to how to redesign healthcare systems and processes to benefit for both patients and healthcare workers.
7. Improving patient safety in hospitals: Contributions of high-reliability theory and normal accident theory. Tamuz, M., & Harrison, M., 2006, Health Research and Education Journal.
Aim: to identify the distinctive contribution of high-reliability theory and normal accident theory as frameworks for examining five patient safety practices.
Findings: high-reliability theory highlights how double checking, which is designed to prevent errors, can undermine mindfulness of risk. Normal accident theory emphasizes that social redundancy can diffuse and reduce responsibility for locating mistakes.

8. Influence of work place demands on nurses' perception of patient safety. Ramanujan, R. et al., 2008, Journal of Nursing and Health Sciences.
Aim: to find out the relationship between work demand and patient safety culture.
Finding: work place demand and nurses' perception of safety have indirect or negative relationship.
9. Nurses' perception of safety culture in long-term care settings. Wagner, L. et al., 2009, Journal of Nursing Scholarship.
Aim: to describe perception of workplace safety culture among nurses employed in long-term care settings.
Findings: nurse managers have a better understanding of safety culture compared to registered nurses.
10. Patient safety and patient safety culture: Foundation of excellent health care delivery. Ulrich, B. & Kear, T., 2014, Nephrology Nursing Journal.
Aim: to provide an overview of the concepts of patient safety and patient safety culture.
Findings: understanding of patient safety and patient safety culture makes nurses a leader in patient safety process.
11. Patient safety, system design and ergonomics. Buckel et al., 2006, Journal of Applied Ergonomics.
Aim: to present the design challenges and emphasizes the specialized needs of the health care sector, when dealing with patient safety.
Findings: highlighted the design challenges that exists in the health care sector and the importance of engaging with the design community if patient safety is to be improved, highlighted one method which is mapping workshops to inform safer system requirements.
12. Relationship of safety climate and safety performance in hospitals. Singer et al., 2009, Journal of Health Research and Education Trust.
Aim: to examine the relationship between measures of hospital safety climate and hospital performance on selected patient safety indicators.

Findings: hospitals with better safety climate overall had lower relative incidence of patient safety indicators.

13. The importance of applying human factors to nursing practice. Norris et al., 2012, Journal of Nursing Standard.

Aim: to introduce human factors and to show how it can be used in nursing practice.

Findings: when nurses understand clinical human factors, it is easier to understand the system in which they work and eventually this leads to a safe care and a better patient safety.

5.2 Content Analysis

Content of the selected articles were analyzed to find out the essential elements of this thesis's topic. To do so a qualitative conceptual content analysis and systematic review of the selected articles by inductive approach is used by the author.

The process of inductive content analysis includes open coding, creating categories and abstraction. Open coding means that notes and headings are written in the text while reading it (Elo & Kyngäs, 2007). After this open coding, the lists of categories are grouped under higher order headings. According to Elo & Kyngäs, the aim of grouping data is to reduce the number of categories by collapsing those that are similar or dissimilar into broader higher order categories (Elo & Kyngäs, 2007).

5.2.1 Analyzing the data

To identify concepts and ideas which are very important in the selected thirteen articles, the author used word frequency counts and then used key word in context. Most frequently identified topics are presented in table 7.

Table 7: Word Frequency Count.

Article Number	Headings(Most frequented)
1	<ul style="list-style-type: none"> • Team work • Human factors • Communication
2	<ul style="list-style-type: none"> • Performance • System
3	<ul style="list-style-type: none"> • Communication • Information access • Self-management
4	<ul style="list-style-type: none"> • Safety management • Safety assessment
5	<ul style="list-style-type: none"> • Innovation
6	<ul style="list-style-type: none"> • Health care quality • Work system
7	<ul style="list-style-type: none"> • High Reliability Theory • Normal Accident Theory
8	<ul style="list-style-type: none"> • Nurses' perception • Nurses' role • Workplace demand
9	<ul style="list-style-type: none"> • Nurses' perception • Safety culture
10	<ul style="list-style-type: none"> • Safety culture
11	<ul style="list-style-type: none"> • System approach • Organization
12	<ul style="list-style-type: none"> • Safety climate • Safety culture
13	<ul style="list-style-type: none"> • System • Standardization

After coding and heading, the author created categories which are based on the emphasis and the main highlights and findings given by authors of the selected articles. The main findings from the selected articles is analyzed and categorized for the purpose presenting in this study. The results which are categorized into three main categories are discussed in the finding chapter of this work.

5.3 Ethical Considerations

Research ethics is a set of fundamental moral principles and rules applying to any researchers to follow with a responsibility when doing research. Ethical merit embraces respect for the dignity of research participants, in terms of their integrity, privacy, safety, and human rights (Cho & Shin, 2013).

Dr. Nilesh B. Gajjar in his work has laid down some general ethical principles that various codes address. These are *Honesty, Objectivity, Integrity, Carefulness, Openness, Respect for Intellectual property, Confidentiality, Responsible Publication, Responsible mentoring, Respect for colleagues, Social responsibility, Non-discrimination, Competence, Legality* (Gajjar, 2013).

In this work the author was honest in reporting data, results, methods, procedures and publications status. The author had tried to avoid or minimize bias for the reader from personal understanding and past educational background in data analysis and data interpretation. In respecting intellectual property the author used general research ethics guidelines. Arcada's thesis writing guidelines and Arcada's "Good Scientific Practice in Studies at Arcada" were also used as a guidelines throughout the writing process.

6 FINDINGS

The findings from selected articles are presented in detail here. Formulated research question of this study is answered from the findings. These findings are nurses' perception of safety and factors which affect nurses' perception of safety, relationship of safety culture and performance and factors which affect safety culture and safety performance, issues and considerations which help patient safety improvement in an organization and considerations in incorporating HFE with nurses' activities in promoting patient safety. These findings are generally categorized into three main categories by the author. These are communication factors which includes information access, technologies and tools of communication, personal or individual factors, and organizational influence or environmental influence. These three general categories are reflected in the following sub section of this unit.

6.1 Nurses' Perception of Safety and its Implication on HFE

A finding from a study by Ramanujam et al. shows that workplace demand and nurse's perception of safety have a negative relationship. Meaning, as a workplace demand increases, nurses' perception to deliver safe care will decrease (Ramanujam et al., 2008). On the other hand nurses' employment status and nurses' education have a positive relationship with nurses' perception of patient safety. Full time nurses and nurses who have higher education think the unit they are working is less safe for patients. Nurses' experience have a negative relationship with patient safety, in which it decreases patient safety (Ramanujam et al., 2008).

Calvin et al. finds out the HFE problems in information access, communication, and self-management and relates them to a poor fit to the structural elements of a system (Calvin et al., 2009). At the same time a finding by Read and Bromiley shows the understanding of how human factors affects individual person's behavior and others behavior will promote a safer and better healthcare (Read & Bromiley).

6.2 Human Factors in Promoting Patient Safety

A study by Carayol et al. shows that healthcare professionals, leaders and organizations believe that Human Factors and Engineering can produce knowledge to redesign healthcare systems and process and will improve patient safety and quality of care (Carayol et al., 2014). HFE using feedback loop as a tool to identify problems from patient caring process outcomes to redesign system process and structure (Carayol et al., 2014). To minimize accidents and incidents and at the same time to maximize patient safety in a complex health care service system, a tool which Human factors and Engineering is needed (Buckle et al., 2006). As a study by Buckle et al. Human Factors and Engineering help health care organization solve problems and challenges in system design by identifying areas that require much effort (Buckle et al., 2006). And Buckel et al. stress if patient safety problems related to system design is to be improved, consideration of HFE is an important step in promoting patient safety (Buckle et al., 2006).

According to Carayon et al. Human Factors and Engineering plays a role in creating understanding among health care personnel so that it proved success in promoting patient safety, improving quality of care and working environment in health care organizations by health care system and process redesign. But to have a maximum benefit from HFE in patient safety the understanding of the whole system is important (Carayon et al., 2013).

6.3 Relationship of Safety Culture, Safety Climate and Performance

A study by Wagner et al. considers poor nursing management and poor working condition and absence of team work in an organization as a big obstacle to patient safety culture to be practiced in an organization (Wagner et al., 2009).

Reid & Bromiley concluded that hierarchal or authority gradient between professionals and within the profession and between regulated and non-regulated staff have a negative impact on patient safety performance and reduced team communication (Read & Bromiley, 2012).

A finding by Singer et al. shows how the interpersonal values, beliefs, daily activities, experience at work influences and affects hospital safety climate. Those interpersonal values have big influences on individual attitude and behavior towards patient safety (Singer et al., 2009).

In addition, administrators' decision-making and resource management influence workers' and unit's safety climate attitude (Singer. Et al., 2009). Other factor which affects interpersonal value is work place demand. On the other hand, Wagner et al. point out that nurses and administrators perceive safety culture as a culture of blame or a culture of distrust (Wagner et al., 2009). A study by Singer et al. supports this finding in which it finds that hospitals in which personnel's reported more problems with fear of shame and fear of blame had significantly greater risk of experiencing patient safety incidents (Singer et al., 2009).

In general a finding by Singer et al shows that higher safety culture in an organization is associated with higher safety performance (Singer et al., 2009). And a report shows increased number of registered nurses in nursing home implies increased safety culture in the organization (Wagner et al., 2009).

7 DISCUSSION

The application of Human Factors and Ergonomics in healthcare sectors as a tool for patient safety improvement is discussed. Factors which affect nurses' perception of safety and its impact on human factors and ergonomics in patient safety are discussed. Findings from the selected articles are factors that facilitate or hinder for HFE theories, principles and tools being applied in healthcare organization. The importance of implementing HFE in patient safety is highlighted. The relationship between safety culture and performance and the integration of human factors and ergonomics in nurses' activities are presented.

The findings of this study from the selected articles are discussed here. To support or to argue the findings, the author used the theoretical framework used in this work.

The environment we are living in and working is always in a continuous dynamic change. The change in working environment, the change in policies, the change in technology, and the change in patients' demography all affects patient safety practice in a particular healthcare organization. Norris et al. emphasizes the needs of safety to be reviewed, re-designed and managed by organizations and governing party (Norris et al., 2012). One of the recommendation by Norris et al. to keep up with the changing environment and variation in work process is the standardization of equipment and work process in which equipment and work processes are standardizing in a way easier to use but function the same way (Norris et al., 2012). According to Norris et al. one way to introduce standardization and allow local adaptation is to use generic design principles and develop basic requirements that are standardized in all settings. Applying this principles in everyday nursing practice and management is not easy but it can be applied in managing safety at work (Norris et al., 2012). Work by Calvin et al. supports this recommendation. Though bringing additional equipment and tools bring additional human factors and ergonomics and patient safety problems, effective use of technologies facilitates nurses' performance (Calvin et al., 2009). And it is important to take into account the HFE consideration when designing and implementing new technologies (Calvin et al., 2009). But considering HFE when designing and implementing is not an easy task. The reason behind the difficulty of implementing HFE is described well by Cacciabue & Vella. The consideration of human factors to patient safety presents further complexity in a process. This is due to less developed data and methods on human behavior and performance (Cacciabue & Vella,

2010). In High Reliability Theory, key structural concept is flexibility and it assumes a flexible structure and process enables rapid response. From Donabedian health care quality model, structure is the most important component of health care organization in quality care but it is not flexible and difficult to change (Donabedian, 1997). The structural components of an organization consists of the physical facilities, human resources and human resource management (Donabedian, 1997). Highly reliable organizations are characterized by flexibility in their structure which enable them to be on high level of safety (Beyea, 2005). High Reliable Theory describes high reliable organizations as follow: “highly reliable organizations focus on identifying how mistakes can be done, take a team approach to decision making, understand how decisions may affect all other activities, use creative problem-solving strategies, and examine errors to determine their root cause instead of blaming individual for a problem.” For health care organizations to be on high level of safety and to provide quality care, the structure should be flexible. On contrary in Normal Accident theory, key structural concepts include interactive complexity, tight and loose coupling and this theory assumes these structural concepts create potential for catastrophic or major system failure (Cooke, 2009). According to the High Reliability Theory, hospitals are considered as loosely coupled in which coupling of routine activities and culture enables organizations to spot problems and intervene before a problem causes harm (Tamuz & Harrison, 2006).

Understanding and a positive perception of safety culture facilitates the application of Human factors and Engineering in health care organizations (Ramanujam et al., 2008). Using HFE as a tool in patient safety helps to understand and see the whole components of a system in an organization (Carayol et al., 2014). For nurses to have make a difference in patient safety the understanding of the concepts and models of HFE is essential (Norris et al., 2012). According to Donabedian model of quality care to measure and assess safety and quality of care one should have the understanding of all the components of the system which are structure, process and outcome. Human factors and Engineering is a perfect tool for this application.

8 CONCLUSION

Human Factors and Engineering is a multidisciplinary field which uses theories, principles and data to understand the interaction of people with system. It is only less than two decades since it is given critical attention to this field in health care sectors. The use of this field in health care in patient safety is now becoming more common and important. This work perform a literature review to explore works done in on the areas of Human factors and Engineering in health care sectors particularly in patient safety. The study explorer the application areas of Human Factors and Engineering in health care organizations, benefits of the application, obstacles in applying the application. The study finds applying Human Factors and Engineering in health care in patient safety not only improve and promote patient safety, enhance quality of care but also changes health care organization and system to a better and a safer level of operation.

8.1 Critical Discussion

The author of this work tries to see the connection of the application of Human Factors and Engineering in health care sectors in patient safety. Enormous amount of research articles and publication is available in field of Human Factors and Engineering. In recent years the application of human factors and engineering in health care for patient safety is widely studied. Recent scientific articles have chosen for this study. However most articles in patient safety discuss hospital settings. Therefore the author of this study had difficulties in finding articles and connecting to the real world nursing working environment in which nurses can benefit from. But, in author's opinion the findings are more idealistic and will help more policy makers, decision-makers, and administrators in health care organizations. The author believes more applicable, concrete and tangible results could have been explored if different research approach is used. For instance a combination of quantitative research and a literature review with more articles would produce more applicable results which will be used and applied in real nursing working environment settings.

8.2 Recommendations

The importance of Human Factors and Ergonomics in healthcare organizations in patient safety is indisputable. However, a further and detail study on specific applications of HFE theories, principles and tools which will be applicable and practical to nursing settings in healthcare is recommended by the author. From the findings of this work, it have been found that the very important step in implementing HFE in a healthcare organizations is to create awareness of safety culture among nurses. The author of this work recommends to healthcare organizations in Finland to work on creating a safety culture among nurses and individuals working in patient care and patient safety. Finally an action to support HFE applications and implementation in patient safety is recommended to healthcare organizations.

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APPENDICES

LIST OF ABBREVIATIONS

ACSNI	Advisory Committee on the Safety of Nuclear Installations
HFE	Human Factors and Ergonomics
HRT	High Reliability Theory
NAT	Normal Accident Theory
IEA	International Ergonomics Association
IOM	Institute of Medicine
SEIPS	Systems Engineering Initiative for Patient Safety
SPO	System-Process-Outcome