AUT UNIVERSITY COMPUTING + MATHEMATICAL SCIENCES

MASTER OF COMPUTER and INFORMATION SCIENCES

Staff Perceptions of a Telemedicine Intensive Care Unit Programme in Saudi Arabia

By

Aljuhara Alshubaily
1253051

A thesis submitted to

Auckland University of Technology

in partial fulfillment of the requirements for the degree

of

Master of Computer and Information Sciences (MCIS)

2014

Primary Supervisor:

Dr. David Parry

AUT UNIVERSITY **POSTGRADUATE**

FORM PGR15 DEPOSIT OF THESIS/EXEGESIS/DISSERTATION IN THE AUT LIBRARY

PLEASE NOTE

- ***This form must be typed. Handwritten forms will not be accepted.***
- ***The completed and signed form should be bound into the copy of the thesis/exegesis intended for the AUT University Library***
- ***If the work is to be treated as confidential or is embargoed for a specified time, form PGR16 must also be completed and bound into the thesis/exegesis.***

Student ID No	1253051	**Name**	Aljuhara Alshubaily
Faculty	Faculty of Design and Creative Technologie	**School/Dept**	Computing and Mathematical Sciences
Programme	Master of Computer and Information Sciences (MCIS)	**Year of submission** (for examination)	2014
Research Output	**Thesis** ☒ **Exegesis** ☐	**Dissertation** ☐	**Points Value** 120
Thesis Title	Staff Perceptions of a Telemedicine Intensive Care Unit Programme in Saudi Arabia		

DECLARATION

I hereby deposit a print and digital copy of my thesis/exegesis with the Auckland University of Technology Library. I confirm that any changes required by the examiners have been carried out to the satisfaction of my primary supervisor and that the content of the digital copy corresponds exactly to the content of the print copy in its entirety.

This thesis/exegesis is my own work and, to the best of my knowledge and belief, it contains:

- no material previously published or written by another person (except where explicitly defined in the acknowledgements);
- no material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

CONDITIONS OF USE

From the date of deposit of this thesis/exegesis or the cessation of any approved access restrictions, the conditions of use are as follows:

1. This thesis/exegesis may be consulted for the purposes of private study or research provided that:
   (i) appropriate acknowledgement is made of its use;
   (ii) my permission is obtained before any material contained in it is published.

2. The digital copy may be made available via the Internet by the AUT University Library in downloadable, read-only format with unrestricted access, in the interests of open access to research information.

3. In accordance with Section 56 of the Copyright Act 1994, the AUT University Library may make a copy of this thesis/exegesis for supply to the collection of another prescribed library on request from that library.

THIRD PARTY COPYRIGHT STATEMENT

I have either used no substantial portions of third party copyright material, including charts, diagrams, graphs, photographs or maps, in my thesis/exegesis or I have obtained permission for such material to be made accessible worldwide via the Internet. If permission has not been obtained, I have asked/will ask the Library to remove the third party copyright material from the digital copy.

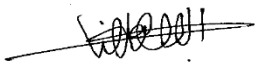
Student's Signature  **Date** 16/6/2014

Table of Contents

List of Illustrations

List of Tables

List of Figures

Abbreviations

AACN: The American Association of Critical-Care Nurses Tele-ICU: Telemedicine

Saudi ARAMCO: Saudi Arabian Oil Company

AMIA: American Medical Informatics Association

EHR: Electronic Health Records

Intensive Care Unit

ICU: Intensive Care Unit

KFSH: King Faisal Specialist Hospital

MOH: Ministry of Health

TAM: Technology Acceptance Model

TAM 2: The revised Technology Acceptance Model

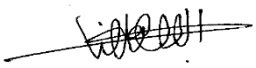
TPB: Theory of Planned Behaviour

TRA: Theory of Reasoned Action

Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly stated in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Aljuhara Alshubaily



February 2014

Acknowledgments

I would love to acknowledge several people who have supported me in this journey, and to whom I am really thankful. First, I am grateful to have received a scholarship from the Ministry of Higher Education in Saudi Arabia, which provided financial support for me to study in New Zealand.

I am especially thankful to my supervisor, Dr. Dave Parry, who helped at every step of my research with his guidance, support and, more importantly, his patience with my wandering mind that seemed to resist concentrating on the same subject.

And I would like to thank Mrs. Krassie Petrova who provided valued time to share some thoughts on the design of this study. And my kindest regards to Mrs Sue Beguely for her treasured input and ideas that made this thesis more comprehensive, and I am especially appreciative of her lovely thoughtfulness.

And to Mr Ali Almshary for his kind support, allowing me insight into the tele-ICU project in KFSH. And to the health outreach department at KFSH who approved this study. However, the findings of this study do not express the views of Mr Almshary or KFSH or their policies regarding their use of tele-ICU.

I would like to thank the Ethics Committee at AUT (AUTEC) for approving my ethics application – reference number 13/81 dated 3 July 2013 – which allowed me to commence the research.

More importantly, I want to record my gratitude to the participants without whom I could not have compiled this study. To those individuals who donated their time to participate in my research, I am very thankful and appreciative.

I would love to dedicate this study to my family, and especially my parents, who believed in me. To my husband for his continued support through my journey of research. And, most importantly, to the jewels of my life, Fasial and Sarah who, even with their complaints – when mammy was busy and under stress –were compassionate and eager to cheer me up. Finally to my grandmother who is not with us anymore to share the joy of completing this degree. She has always supported me through life's ups and downs.

I would love to have the opportunity to say thank you to all these people,

Aljuhara Alshubaily

January 2014

Abstract

This research presents a case study for the evaluation of a telemedicine intensive care unit (tele-ICU) project implemented by King Faisal Specialist Hospital (KFSH) in Saudi Arabia. The aims of the research were to identify the tele-ICU users' perspectives about the motives and barriers they face and to present their suggestions about the system.

The total number of consulted cases from January 2008 until the end of the study on August 2013 was 1089 cases. The connected centres were classified into high-usage and low-usage centres. Of the 26 hospitals participating in the project, staff from 13 centres responded and agreed to participate in the study. Twenty users were interviewed regarding their experience using the tele-ICU facilities. All interviews were transcribed then analysed by using qualitative data management software (QSR NVivo 10 ©) to identify common themes which repeated. The data were then categorised into motives, barriers and suggestions.

The top identified motives of tele-ICU users were Providing Clinical Support, Providing Quality Care, and the opportunity of Continuing Medical Education. The chief barriers fell under the categories of Lack of Exposure and Administration Issues. Finally, the most frequent suggestions were the ability to connect to Other Centres instead of only KFSH and having additional Training and better education for a wider range of staff.

A data comparison between high- and low-usage centres showed similar patterns, but users from high-usage centres provided more motives, barriers and suggestions to improve the system. The suggestion of Continuing Medical Education was referenced more often from respondents in the low-usage centres.

Health care providers who use the system were more interested in improving patient care, providing quality care and continuing medical education. The administrative staff

were more concerned with addressing patient satisfaction and the immediacy of patient access. There are opportunities to conduct further research on similar telemedicine case studies to cover any possible gaps in this research.

Chapter 1. Introduction

Health care has improved by utilising telemedicine as an additional intervention that can improve standards and connect health care staff using a new technology. *Telemedicine technology* has become a broad term covering a wide range of systems, which principally links patients to their health care providers more rapidly when they are in different geographical locations (Field, 1996; Hicks et al., 2001; Wootton, 2001). Although the use of telemedicine has advanced health care, it is very important to evaluate each system to uncover any limitations that can be fixed, in order to ensure the safety of the patients (Currell, Urquhart, Wainwright, & Lewis, 2000; Yoo & Dudley, 2009).

This thesis presents a research study evaluating the use of a telemedicine project in Saudi Arabia implemented by KFSH as the central hospital with associated secondary hospitals. The project, launched in 2008, is known as a Tele-Intensive Care Unit (tele-ICU), and connects ICU staff at KFSH to 26 hospitals around the kingdom of Saudi Arabia. Tele-ICU is defined as 'an electronic means to link physical ICUs to another location which assists in medical decision making' (Sapirstein, Lone, Latif, Fackler, & Pronovost, 2009, p. 115). Tele-ICU systems usually provide 24/7 care and support to remote areas which are connected to a central ICU to ensure best practise (Hoonakker et al., 2013; Khunlertkit & Carayon, 2013). Tele-ICU implementations include several technologies: audio, video and centralised communication support systems (Khunlertkit & Carayon, 2013; Moeckli, Cram, Cunningham, & Reisinger, 2013).

This research seeks to identify the benefits and limitations of using a telemedicine system in Saudi Arabia, from the user's perspective. Moreover, the research provides

some suggestions for improving such systems in the future. The study examines how the tele-ICU staff assesses the technology.

This chapter will firstly provide some background information on health care in Saudi Arabia, followed by a brief description of the tele-ICU setting in KFSH. Then it will present the motivation that inspired this study. It will then proceed to present the research scope and questions guiding this study and the perceived contributions of the study. Finally it will provide a layout of the study.

1.1 Background of Health Care in Saudi Arabia

Saudi Arabia is one of the largest countries in the Middle East; it covers 2 million square kilometres of land (Khaliq, 2012). The country has most of its tertiary hospitals in three major cities, Riyadh, Jeddah and Dammam. According to the official 2010 census the population of Saudi Arabia has reached 27.1 million and it is estimated to reach 39.8 million by 2025 (Almalki, Fitzgerald, & Clark, 2011). As shown in Figure 1, the country is divided into health regions by the Ministry of Health (MOH) (Aboul-Enein, 2002; Khaliq, 2012).

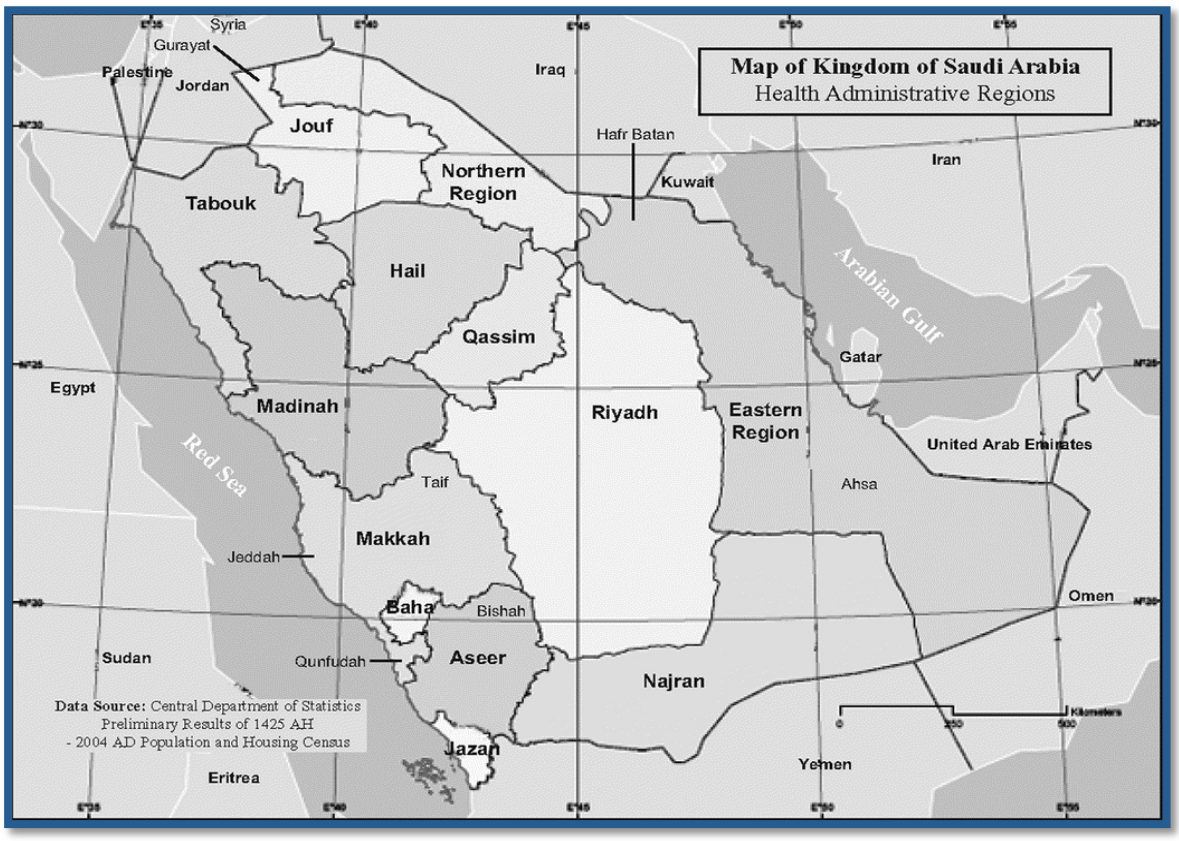


Figure 1. The health regions in the kingdom of Saudi Arabia (Alhamdan, Almazrou, Alswaidi, & Choudhry, 2007, p. 373)

The Saudi government has given health care services a high priority, and they have been improving greatly in the last decades. According to Almalki, Fitzgerald and Clark (2011) the MOH has 244 hospitals (33, 277 beds) and 2037 primary health care centres. Other government organisations (such as the Saudi ARAMCO) also provide health care for their employees and their families and accept referral cases. Thirty-nine hospitals are outside of the government sector and are not under the MOH; these hospitals have 10, 822 beds jointly. KFSH is a government-funded referral hospital with its own funding and administration. Also, there are 125 hospitals (11, 833 beds) in the private sector. This health care system is depicted in Figure 2.

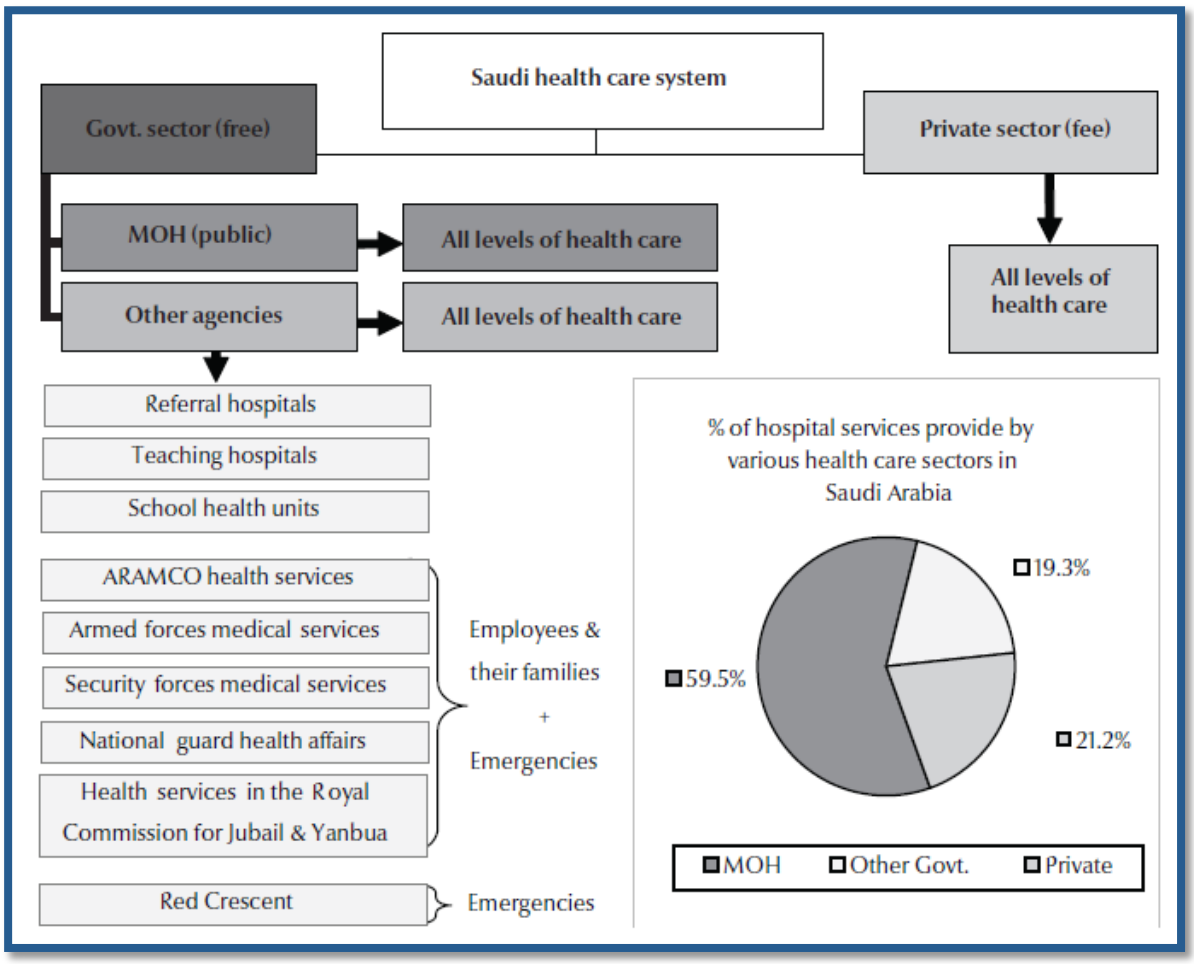


Figure 2. The structure of the health care sectors in Saudi Arabia.(Almalki et al., 2011, p. 786)

Unfortunately, because of its large geographical size, the country has a shortage of medical care in rural areas (Almalki et al., 2011). Further, there are a number of challenges facing the health care systems in Saudi Arabia, such as the high demand for health services, the poor accessibility to some health care facilities, the lack of adopting a national health information system and utilisation of potential electronic health strategies. One of main problems is the long wait and disorganised referral system for patients who have to travel back and forth to the major cities, particularly those living in remote areas (Abou-Shaaban & Niazy, 1991; Mufti, 2000; Rayes, 2013).

Some of the problems that have been identified could be solved by telemedicine systems. Thus, the health care of patients would be improved without the need to travel to any major city. KFSH initiated the telemedicine project to connect to a group of

hospitals around Saudi Arabia. The hospital is located in the capital, Riyadh, and it is recognised as the most advanced and specialised hospital in the country (Mufti, 2000). The tertiary care hospital and research centre has 936 beds (King Faisal Specialist Hospital, 2013). The tele-ICU project is intended to link ICU specialists in KFSH – the central hospital – to patients in other hospitals in Saudi Arabia.

Chiasson, Reddy, Kaplan and Davidson (2007) have stated that there is an increase of government spending on health care in many countries. And Saudi Arabia is no different in increasing spending on health care (Almalki et al., 2011). El-Mahalli, El-Khafif, and Al-Qahtani (2012) have stated that even though the MOH has allocated a significant budget for e-health in general, the adoption rate by health care professionals is low. They pointed to a lack of studies in Saudi Arabia about health care providers' perceptions regarding the benefits and challenges of telemedicine.

Another study by Khalifa, (2013) identified and categorised perceived barriers to adopting a health information system perceived health care professionals in Saudi Arabia. He identified human barriers as one of the major challenges of a successful implementation of health system. He pointed to the importance of examining the beliefs and attitudes of health care professionals in the country in order to understand the real usage of such systems.

1.2 Tele-ICU Setting

The tele-ICU programme was initiated in 2008 by KFSH tertiary care hospital and research centre, which has 936 beds, and is the central hospital in the system. The technology is linked to 26 hospitals in Saudi Arabia. The KFSH health outreach administration has established the programme to facilitate access to ICU specialists working in KFSH by rural hospitals and reduce the number of unnecessary patient

transfers to Riyadh. ICU specialists or *intensivists* are physicians who specialise in the treatment and management of critically ill patients in ICU (Berenson, Grossman, & November, 2009). As there is a shortage of intensivists in the country – only 15 certified intensivists – and with the uneven distribution of health care providers, this telemedicine system would provide support (Rayes, 2013).

The programme provides a teleconferencing facility connecting participating hospitals to KFSH's ICU to conduct consultations. A web-based application is used to request a consultation and provide patient information. In addition, the web portal has a live feed of patients' vital signs from their bedsides in connecting hospitals.

The tele-ICU videoconferencing is a two-way, real-time video and audio link connecting ICUs from secondary hospitals in the country to the tele-ICU central hub in KFSH in Riyadh. Tele-ICU runs on working days only, with scheduled meetings with all the centres. However, it facilitates any emergency consultation, which could be arranged with the tele-ICU coordinator in Riyadh. A designated intensivist is on call to answer any emergency or urgent call to assist the other centres.

There is an allocated room for the project in KFSH as well as in all the other hospitals connecting to tele-ICU; the rooms are equipped with teleconferencing facilities. Only the tele-ICU room in KFSH has the live vital-signs screens of the all the distributed ICUs; other centres display only *their* patients' vital signs. This vital sign information is used by the intensivists to diagnose and manage the health of patients. Figure 3 below provides an overview of the tele-ICU room design. This environment is used to conduct the videoconferencing for both education and peer consultation, and has a high degree of video transition quality.

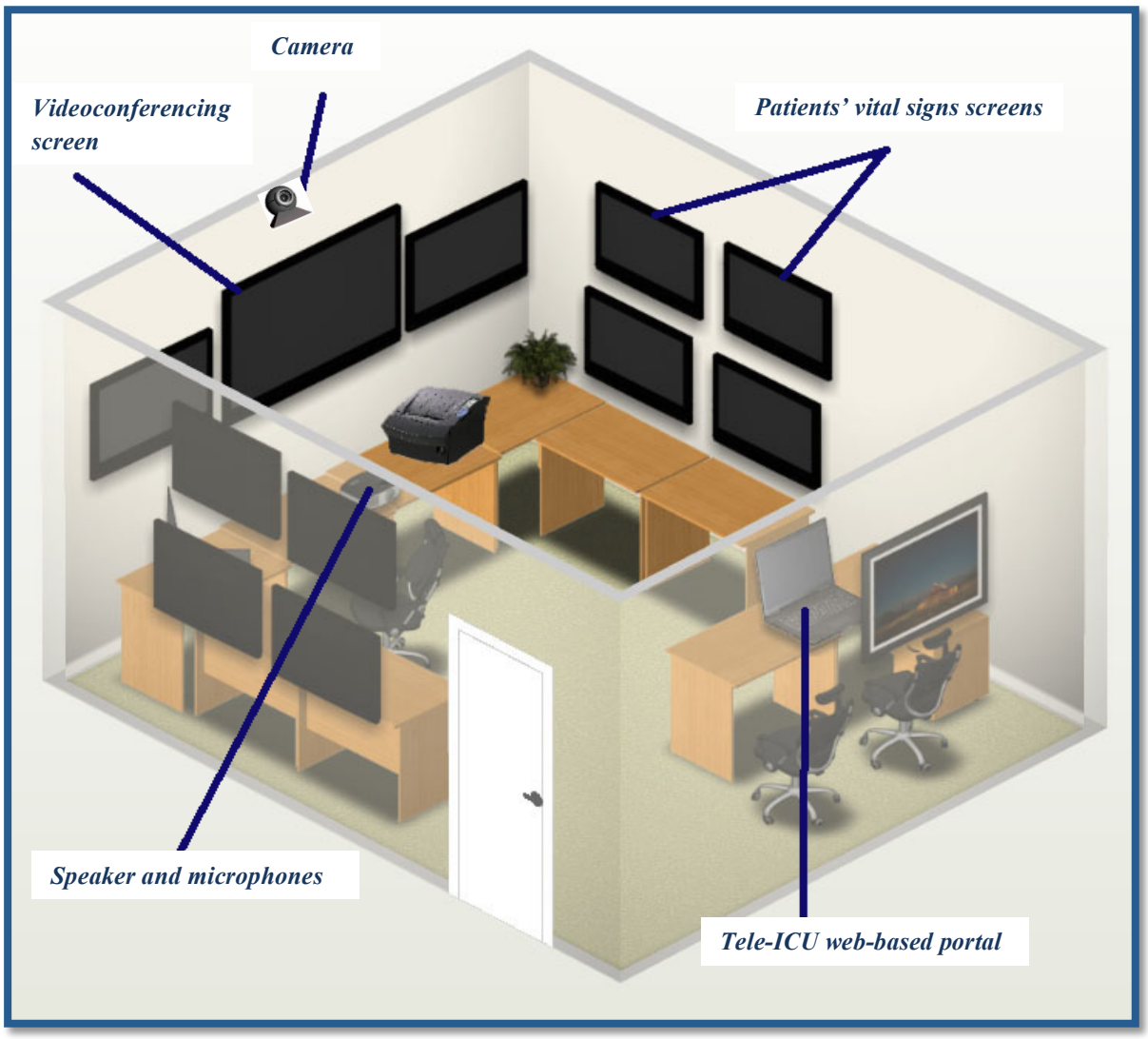


Figure 3. An overview of the tele-ICU room. (Source: author).

The tele-ICU staff located in the central station uses software tools to track care for patients across multiple ICUs through the website portal as a database. The interface for the website is shown in Figure 4 below. The intensivistscan view data about the patient's health like their laboratory results and medical information in order to prepare for the consultation through the website. They can also view live patients' vital signs from bedside monitors. In addition, after the ICU consultation, the recommendations and the result of the meeting are saved in the database and can be sent back to the referring hospital later. Further description of the tele-ICU setting and technology are provided later in the methods chapter under section 3.5.

Figure 4. Tele-ICU webpage interface. (Source: author).

1.3 Motivation

The tele-ICU programme is used to transfer patient health information and consultations between hospitals to improve the health of patients in ICUs in Saudi Arabia. Thus, the primary objective of this study was the health and well-being of patients who would benefit from using the tele-ICU system especially with the shortage of health care in this large country. The main goal of any health information system is the improvement of a patient's clinical care by using the technologies (Chiasson et al., 2007; Kaplan & Maxwell, 2005) .

However, Sapirstein et al. (2009) have pointed out that, even with the increased usage of telemedicine, there is a need to evaluate its impact. Because the field of telemedicine is evolving rapidly there is a need to continue to assess the new knowledge about the technology (Ekeland, Bowes, & Flottorp, 2010).

Although this tele-ICU system has been active since 2008 and the number of participating hospitals is increasing, little is known about the progress of telemedicine in Saudi Arabia in general, so this study explores the issues foreseen by the users of such systems. Thus by exploring the usage of such a project in this country, some awareness of telemedicine usage would be established. This evaluation study will shed some light on the telemedicine experience in Saudi Arabia and provide more opportunities for further research. As Thomas and Hodges (2010) pointed out, research is conducted to contribute to basic knowledge and to develop knowledge leading to action, new services or social change

1.4 Research Scope and Focus

The principal objective of this study was to gain some insight into the opportunities and obstacles facing the users of such systems by evaluating the KFSH tele-ICU project in Saudi Arabia. As suggested previously by El-Mahalli et al. (2012) and Khalifa (2013) an evaluation study on such a system to record the users' experiences and views of the system could reveal key issues that would help the success of similar systems.

This study focuses on the users' perceptions of the tele-ICU system. It identifies constructive indicators and some problems faced by hospital staff who are operating the tele-ICU system in Saudi Arabia. More specifically, the study will examine the motives and barriers facing the users of the tele-ICU in Saudi Arabia.

An additional objective is to identify potential areas of further improvement suggested by the users. The purpose of evaluation research is to examine how well a system works, describe it and develop good practices for the future (Denscombe, 2002). Thus, the study will first provide a detailed description of the system under evaluation. Then, it will identify the users before conducting the evaluation, as suggested by

Ammenwerth, Gräber, Herrmann, Bürkle and König (2003). Then, it will delineate the issues facing the users of the tele-ICU programme found by this study.

1.5 Research Questions

The evaluation of the quality of any telemedicine system is essential for the stability of the system and consequently ensures the safety of patients. Thus, the research questions guided the whole study to gain some understanding of the system. Since, there has not been enough research published on evaluating this kind of project in Saudi Arabia, as shown earlier, this research would be very useful for the improvement of health care. This case study will identify the benefits and limitations of this telemedicine system in Saudi Arabia. Then, it will provide some suggestions to improve the system from the users' point of view. The main research question for this study was as follows,

> What are the perceived motives and barriers the tele-ICU staff in Saudi Arabia identify? Are there any improvements that have to be considered from their perspective?

The underlying questions used to examine the users' experiences with this tele-ICU project are listed below (the first questions was adopted from the study by Pagliari, Gilmour and Sullivan (2004)):

1. How have users in the regional hospitals interpreted and approached the use of tele-ICU?
2. Does the tele-ICU staff working in high-usage centres have different perceptions of the system than staff working in other centres?
3. What are the different perceptions between medical staff and non-medical staff about using the system?

1.6 Contributions of the Study

This research will

- provide a clear view of the current tele-ICU structure and applications,
- recognise constructive indicators and barriers that have been identified by tele-ICU users,
- find possible improvements from the users' perspectives and present some suggestions for the future of such a system,
- provide a good base for understanding the technology for future telemedicine research in Saudi Arabia, and
- provide a paper prepared to be submitted to the *Journal of Telemedicine and Telecare.*

1.7 Study structure

The rest of the thesis has been divided into four chapters, as follows:

- **Chapter 2 – Literature Review:** Provides a review of relevant literature related to evaluating health information and telemedicine systems focusing on tele-ICU.

- **Chapter 3 – Methodology:** Begins by laying out the theoretical background of the research design, and discussing the methodology utilised to address the research question.

- **Chapter 4 – Results:** Presents the results and the analysis that has been used to show different perceptions of tele-ICU staff about the technology.

- **Chapter 5 – Discussion and Conclusion:** first provide an answer to the research questions. Then discusses the findings and their relevance to the current literature. This chapter then provides the conclusion of this research and its limitations, and possible future opportunities for research that could be made use of.

Chapter 2. Literature Review

2.1 Introduction

One of the current discussions in health informatics concerns *telemedicine*. Cummings, Krsek, Vermoch and Matuszewski (2007, page 239) broadly defined telemedicine *'*as the use of electronic information and communications technology to provide and support health care when distance separates the patient and the caregiver.'. The authors delineated the main goal of using telemedicine as the improvement of the availability, timeliness and quality of health care. There are shifts to telemedicine worldwide by health care organisations adopting the new technologies (Breslow, 2007; Currell et al., 2010; Grigsby et al., 2002; Reddy, Purao, & Kelly, 2008; Whitten & Adams, 2003).

Because tele-ICU is a health care system, I first reviewed the literature of health informatics to ascertain the criteria that were examined when evaluating such systems. Then, I narrowed the review to telemedicine evaluation studies in order to understand the main issues facing users in similar contexts. Further, I examined several scientific databases to locate reported studies on tele-ICU to have a more related understanding of users' perceptions. It was challenging to find studies on tele-ICU because of the different terminology used in the literature and lack of standardisation, as pointed out by Young, Chan and Cram (2011).. Many terms have been used in literature such as eICU, virtual ICU, remote ICU and telemedicine in ICU.

In the first section (2.2) of this chapter, an overview of tele-ICU applications reported in the literature is presented. Then a review of the literature is undertaken with respect to the benefits and challenges after examining the evaluation studies literature on health informatics, telemedicine and tele-ICU, which are presented respectively. The second section (2.3) provides a general report of studies evaluating health informatics. Then,

section 2.4 presents telemedicine evaluation studies looking at different theories and models used to evaluate such systems. Finally, a detailed description of the tele-ICU evaluation literature is presented in section 2.5.

2.2 Overview of Tele-ICU

The first description of the application of tele-ICU was in 1982, and a lot of changes have occurred rapidly since then (Breslow, 2007; Kumar, Merchant, & Reynolds, 2013; Sapirstein et al., 2009). Despite increased use in recent times, the need to acquire knowledge of the effectiveness and costs of tele-ICU is very important (Sapirstein et al., 2009).

Sapirstein et al. (2009) revealed an important factor after using tele-ICU, which is the increased compliance with the evidence-based practice of ICU physicians. Chu-Weininger et al. (2010) also agreed with this view. Sapirstein et al. (2009) have recognised that there is no universal acceptance for optimising the use of ICU intensivists that would improve the overall outcome.

Sapirstein et al. (2009) have described three key technological components of tele-ICU. The first component was a system to provide patients' data to the tele-ICU centre including medical records and laboratory results. The second component was the user-interface to access the indexed data about the patients. The third component was a communication network between the bedside health care providers and the intensivists. These authors have acknowledged the difficulties of establishing a new system in a complex patient-care environment. They have stressed the importance of having written communication after the use of the system to track the intervention that was performed. They also pointed to the problem of physicians not being reimbursed for services. This

problem has been acknowledged in other studies as well (Cummings et al., 2007; Rogove, McArthur, Demaerschalk, & Vespa, 2012).

A paper by Cummings et al. (2007) presented a review of literature review studies on the technological background of tele-ICU, its status, clinical literature, and financial and implementation issues. The researchers described different tele-ICU models, where most involve multiple institutions that are not in the same geographical place but are under one corporation. Tele-ICU usually requires a specialist in a central hub providing remote health care to patients in the connecting ICUs, as depicted in Figure 5.

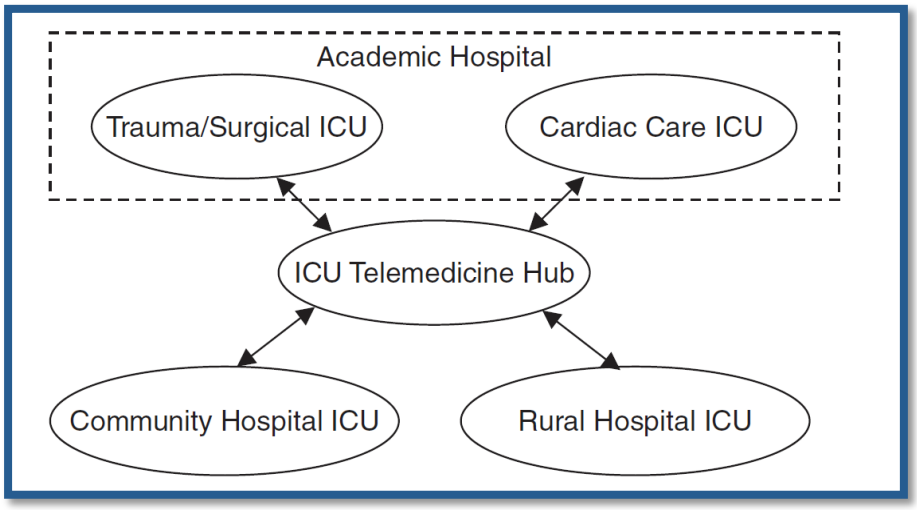


Figure 5. Model of tele-ICU taken from Cummings et al. (2007, p. 240).

Cummings et al. have acknowledged different stakeholders in the central hub: physicians, nurses, pharmacists, respiratory therapists and administrative staff. Further, the coverage of the model differs depending on the implementation of the tele-ICU where some hospitals have 24/7 coverage and some only during business hours. The responsibilities of the intensivist in the central hub can vary, as some have the full responsibility of management, which is called the *closed ICU model.* And some others have an admitting physician who manages the care for the patients' health with only

emergency help from the hub intensivist – called the *open ICU Model.* Breslow et al. (2004) provided a detailed overview of the tele-ICU functionality. The description of the technology required for communication in the tele-ICU environment is depicted in Figure 6.

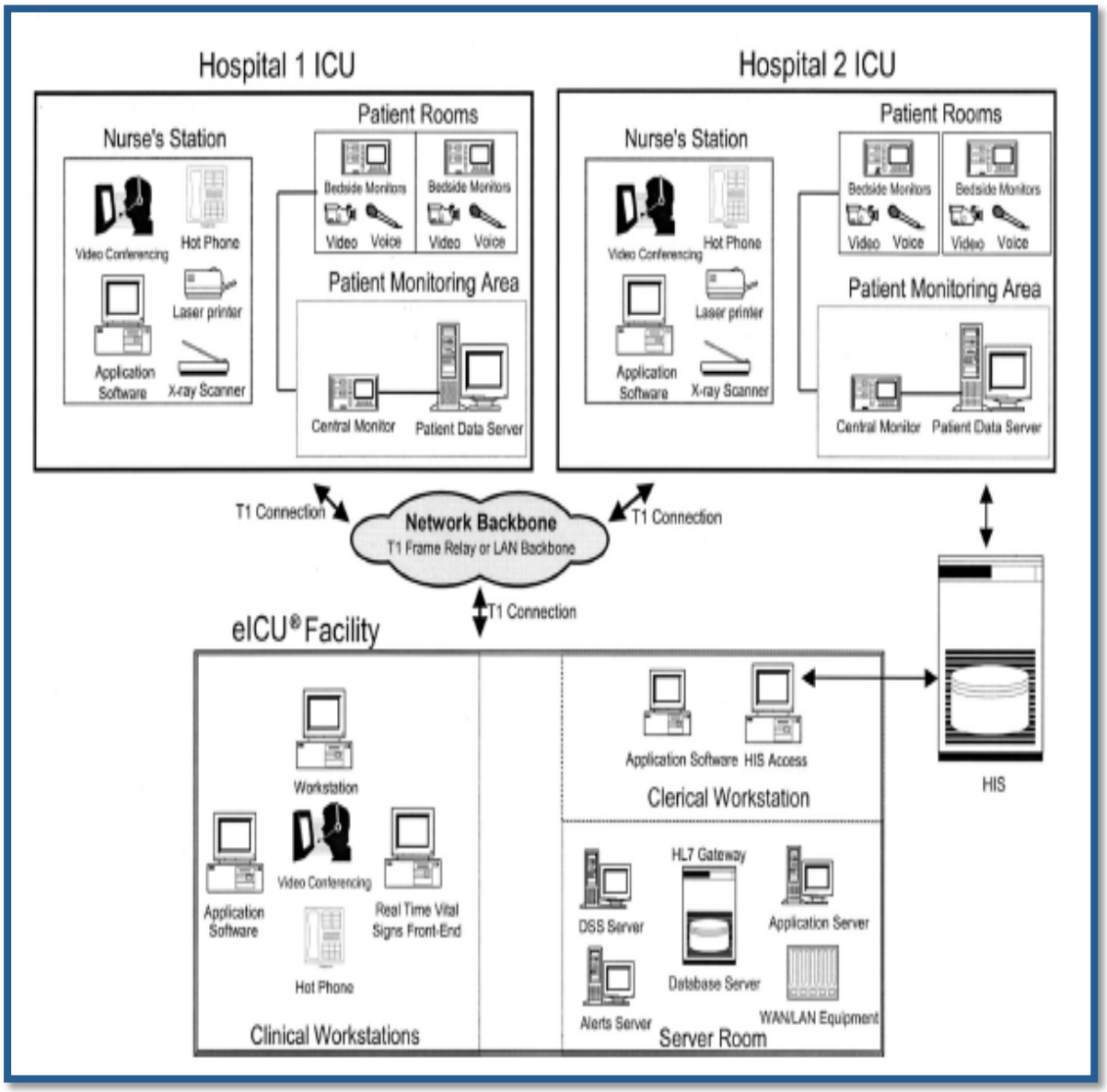


Figure 6. Remote tele-ICU architecture taken from Breslow et al. (2004, p. 33).

LeRouge, Garfield, and Hevner (2002) described some necessary roles for stakeholders when using general videoconferencing systems: system coordinator, administrator, researcher, vendor, technician, educator, and the physicians and nurses responsible for patient care.

Cummings et al. (2007) acknowledged the main advantage of using tele-ICU technology is having an ICU physician always available and with faster access to data to improve patients' health enabling a faster intervention in the case of complications or problems.

Few researchers have stressed the need to use tele-ICU because of the increase in the number of ICU patients as predicted in some studies (Cummings et al., 2007; Young et al., 2011). Cummings et al. stated that the cost of using ICU in the US exceeded US$55 billion in 2000. The cost of an ICU bed per day is around US$2500. The cost of implementing tele-ICU varies depending on the infrastructure upgrade and equipment costs. The cost of tele-ICU implementation in hospitals ranges from $30,000 to $50,000 per bed annually.

Cummings et al. (2007) stressed the need of thorough planning and management of the implementation of a tele-ICU system to make it successful. They argued that physicians are the key players in communicating the needs for the telemedicine system. The key physicians who are going to have a role in the system must be included in the planning, as shown in a case study by Moehr et al. (2006) where it was found that the involvement of the key health providers increases the success of a system. Moehr also showed the importance of training the users *during* the use of the technology as well as before using it. The role of nurses is usually overlooked in the literature, as Hoonakker et al. (2013) pointed out. They also referred to privacy concerns which is an important issue in every telemedicine programme.

The level of intervention by the telemedicine staff has to be clear to all clinical staff and have a defined level of intervention in the of care of their patients. The availability of pre- and post-training for all staff using the intervention is critical.

Breslow (2007) has suggested some success factors that would improve the use of tele-ICU from his experience. For example, getting acceptance from the bedside staff of the new model of care may result in successful implementation. And Breslow mentioned that most health care providers recognise the potential benefit of such intervention but motivating staff is the challenge when trying to increase the use of tele-ICU. Some staff are resistant to changing the model of care or the standard practice plans they used before the intervention. Basically, there is a need to have good leadership to support the use of the technology. Table 1 depicts the key success factors of a remote care programme provided by Breslow (2007).

Table 1

• Organizational commitment to quality excellence
• Active involvement of senior health system leaders (eg, chief executive officer, chief medical officer)
• A systemwide critical care committee charged with practice standardization and quality improvement
• Strong program directors (physician and nurse)
• Accountable ICU medical directors with protected time for unit administration
• Broad clinician buy-in to program vision, with willingness to adopt new processes, master new technologies, and embrace collaboration
• Use of multiprofessional ICU rounds to establish comprehensive daily care plans for all ICU patients
• Adequate technical support at go-live and beyond (timely upgrades, interfaces with other health system applications, etc)
• Staffing the remote care site with respected clinicians
• Adherence of ICU and remote care clinicians to defined clinical processes
• Open communication channels for sharing information and resolving conflicts
• A quality assurance program focused on ensuring accurate clinical documentation (data integrity)
• Regular review of ICU performance metric reports, including adherence to best practices
• Sharing credit for successes
• Using the program infrastructure and technology tools to continually launch new quality initiatives
• Compensation structures tied to quality goals and program performance

Tele-ICU Success Factors

Note. Adapted from Breslow (2007, p. 75)

Cummings et al. (2007) concluded their review with some recommendations for administration, technology, planning and implementation for any tele-ICU. Thomas, Lucke, Wueste, Weavind and Patel (2009) later discussed the effect of three factors that may have influenced the effectiveness of using tele-ICU:

- the way in which the remote intensivists are using the intervention to change the care of patients,
- the acceptance of the physicians in the monitored units, and
- the integration of the information systems used in both locations to ensure consistency.

The use of programme leadership in any health care system is important, where daily responsibility of using the programme by physicians and nurses would increase usage of the system. Breslow (2007) referred to the recent acknowledgment of the importance of practice and the process of standardisation.

Cummings and his colleagues have shown that there are potential disadvantages, like having a technology layer between the patient and the health care provider, and the cost of the new technologies. Physicians are regarded as the main barrier to the implementation of telemedicine, because

- they may perceive it as a threat to their clinical work and known environment,
- they view the lack of direct contact with the patient with disfavour, and
- they are uncomfortable with new technologies.

The American Association of Critical-Care Nurses (AACN) acknowledged that few guidelines have been published about using tele-ICU. Thus, AACN produced a document entitled *Tele-ICU Nursing Practice Guidelines* as a first attempt to define practice guidelines specifically for the emerging technology of tele-ICU (American Association of Critical-Care Nurses, 2013). They claim that the guidelines will bring consistency across new and existing tele-ICU applications. They have acknowledged the growing number of registered nurses who practice within the tele-ICU model of care who could use the guidelines as a benchmark.

2.3 Health Informatics Evaluation

The authors Rahimi and Vimarlund (2007) conducted a literature review focusing on evaluation studies on health care information systems. The authors reported that quantitative research one of the dominated methods used in evaluation studies published between the years of 1982 and 2002. The most common approach was a case study analysis to measure the actual impact of the system. However, in case study evaluation approaches it is difficult to observe all the effects on the system, thus, findings cannot be generalised to a broader context (Bashshur, Shannon, & Sapci, 2005; Borycki & Bartle-Clar, 2011; Kaplan, 2001). On the other hand, understanding of complex evaluations would produce a richer understanding of professional and organisational dynamics (May, Mort, Mair, Ellis, & Gask, 2000).

Kaplan and Harris-Salamone (2009) have provided some suggestions on evaluating health care technologies after the American Medical Informatics Association (AMIA) workshop to improve the outcome for new implementations. The authors expressed concern about the complexity of defining success for the large scale of projects and their clinical environment. On page 294 of their study they provided a simple definition

of success as, 'getting the application or system turned on, getting people to use it , and getting at least grudging acceptance, with the caveat that grudging acceptance can turn to non-acceptance.' The authors explained the need to report failure in order to use the information for future, useful recommendations.

They then defined failure as 'significant budget and timeline overruns, under delivery of value, and the outright termination of a project before completion' (Kaplan & Harris-Salamone, 2009, p. 292). Further, they identified communication and workflow as two of the main issues that would add to project complexity. Finally, they concluded their study with AMIA action recommendations, as shown in Table 2.

Table 2

AMIA Action Recommendations

• Research and Publication Support and publish qualitative and longitudinal studies of all project phases in addition to outcomes for a variety of applications, including for failed projects
• Best Practices Create data bases and an AMIA White Paper translating general principles into practice
• Advocacy Advocate for regulatory changes to facilitate using best practices of health IT
• Education Develop curriculum on project management and organizational issues to maximize success
• Certification Partner with certifying bodies to include guidelines for better health IT development and use
• Databases and Knowledge Integration Develop repositories (data base, blog) for project histories and outcomes and for best practices

Note. Adapted from Kaplan & Harris-Salamone (2009, p. 295)

To identify the success factors of two telehealth project services, an evaluation study by Moehr et al. (2006) used an exploratory approach based on observations and

participant-driven interviews. They found that lack of time in project preparation with no established routine was one of the main issues facing implementation.

With the first service, the central team organised visits to demonstrate the services, but some key health care providers felt left out and some did not attend. This resulted in a failure to accept the services and it was not used. After interviews with some of the participants, Moehr and his team identified some unexpected reasons for the failure: the physicians' lack of familiarity of the new service, the system was replacing a well-established referral system to a closer health centre, inadequate coverage of service needs, privacy concerns of the participants, and different team dynamics.

On the other hand, with the second service, a different team from another department had conducted workshops and design meetings with the participating providers which laid the groundwork for success. After the participants' interviews, the key success factors were reported: focusing on long-term management of known patients, visual information, and patients' perception that the system was beneficial.

2.4 Telemedicine Evaluation

Currell et al. (2010) acknowledged that the term *telemedicine* has been used in recent publications in different forms such as telecommunication, remote consultation, rural health services and videoconferencing. Bashshur et al. (2005) have shown that term telemedicine has been changing and it is becoming known as *telehealth* or *e-health*. There is an increased use of telemedicine nowadays, as anticipated in the literature.

Several researchers have acknowledged the basic benefits of using telemedicine such as reducing hospital costs, reducing travel costs for patients, providing a wider range of health services to more patients, and providing education for health care professionals (Lazakidou, 2006; Yoo & Dudley, 2009).

Although there are several benefits from using telemedicine, there are some issues facing its implementation, such as inadequate planning and legal issues (Lazakidou, 2006). Field (1996) has stressed the importance of evaluating quality, access, cost and acceptance after the implementation of any telemedicine system, and indicating the outcomes, which may vary depending on a particular project. In addition, Currell et al. (2010) conducted a literature review on telemedicine studies and subsequently stressed the importance of the evaluation. These authors were in agreement with other researchers in stating that evaluating the effectiveness, efficiency and safety of any telemedicine system is very important (Bashshur et al., 2005; Hicks et al., 2001; Taylor, 2005).

Evaluating telemedicine systems helps form decisions about safety, practicality and utility (Taylor, 2005). Many researchers have recognised the need for practical and reliable evidence on telemedicine usage (Bashshur et al., 2005; Rahimi & Vimarlund, 2007; Taylor, 2005; van Dijk, Hermens, & Vollenbroek-Hutten, 2007). Taylor (2005) identified the steps undertaken by most studies on telemedicine: the selection of the cases, the interpretation, then a comparison with a gold standard and, finally, statistical analyses. Taylor has suggested that the effect of telemedicine on referral patterns would be an interesting area to explore.

A review of the clinical effectiveness and cost-effectiveness of telemedicine applications, to identify the benefits and drawbacks of telemedicine, was undertaken by Hjelm (2005). The main benefits were found to have been better access to information and services, improved provision of care, improved professional education, and reduced health care costs. The drawbacks included the breakdown in relationships between health care professionals and patients, and between health care professionals themselves. Hjelm also found issues regarding the quality of the system and

organisational matters. Jimison et al. (2008) reported some drivers and barriers when using health care IT by reviewing 563 articles. They concluded that the perceived usefulness of a technology and its convenience facilitated the successful use of a system for chronically ill patients.

Bashshur et al. (2005) have argued that the evaluation must be based on specific evaluation criteria that may vary depending on specific technologies. A wide variety of telemedicine technologies are used in health care, thus there is no single universal criteria to base an evaluation on. Rahimi and Vimarlund (2007) have pointed out that the usual goal in evaluating any telemedicine system is to improve health, contain health care costs, maintain the quality of a system and possibly improve it.

On the other hand Stake (1995) has insisted that the evaluation of information systems could be utilised to establish confidence in generalising the evaluation to similar cases. More specifically there have been several studies that have focussed on building evaluation models for telemedicine systems (Bashshur et al., 2005; Currell et al., 2010; Yoo & Dudley, 2009).

However, the evaluation process is complicated because these systems are employed to improve people's health, and different stakeholders are involved such as patients, health care professionals, policy-makers as well as IT personnel (Bashshur et al., 2005; van Dijk et al., 2007). It is very important to identify the user of a system in a health care context which is usually more complex than other organisations (McLeod & Clark, 2007). Evaluating a complex system must include the different stakeholders because each may have different criteria or have different approaches to using the system (Kaplan, 2001; McLeod & Clark, 2007; Moehr et al., 2006).

Then Currell et al. (2010) have stressed that policy-makers in health care have to evaluate new technologies before investing in them to ensure the well-being of the patients. As Conrath and Sharma (1991) stated, managers and developers of a system are more likely to overvalue the system and be more confident about it. Further, because of the different background and expectations of each stakeholder, it is important to identify each one in an evaluation of a medical information system (Turunen & Talmon, 2000).

Hicks et al. (2001) presented an evaluation model to identify strengths and weaknesses as a framework to identify specific areas. In their model they introduced different levels of analysis, to focus on the individual levels differently, as shown in Figure 7.

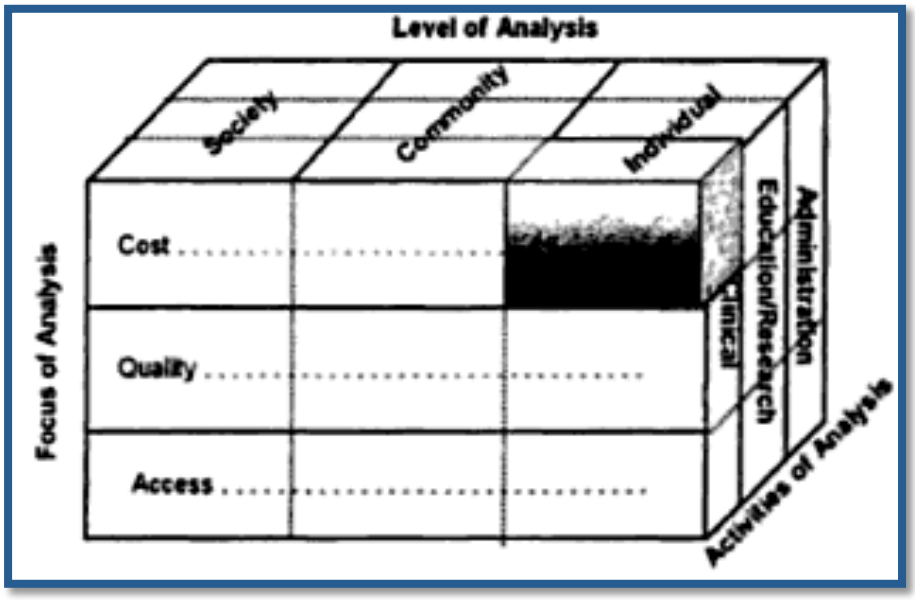


Figure 7. A comprehensive analysis model for evaluating telemedicine systems by Hicks et al. (2001) as cited in Demiris (2004, p. 5).

To assess the impact of telemedicine in health care, Bashshur et al. (2005) proposed the use of theoretical triangulation. The results of both qualitative and quantitative data are combined and the research design would become more rigorous and relevant to clinical practice (Bashshur et al., 2005; Kaplan, 1997, 2001; Ward, Stevens, Brentnall, & Briddon, 2008). While the use of qualitative methods is essential to investigate topics

with subjective importance, quantitative methods produce a more valid and reliable study (Whitten & Richardson, 2002). Thus, the use of multi-method evaluation would help explain the clinical system that is embedded in a social system in a different setting (Heathfield, Pitty, & Hanka, 1998).

Bashshur et al. (2005) have stated that randomised controlled trials are not fully appropriate in evaluating a specific telemedicine project. This view is supported by several other researchers, even though the method is used greatly in the evaluation literature in health informatics (Kaplan, 1997, 2001; Rahimi & Vimarlund, 2007). Further, Kaplan (2001) has argued that randomised controlled clinical trials are good for studying the changes in clinical practice behaviour, but are not best suited for explaining system usage. She added that the need to evaluate social, organisational, cultural, professional and cognitive considerations is important to increase the understanding of the different influencing factors on any health care system.

Further, performing a multi-site study with multiple stakeholders and multi-disciplinary evaluation teams is difficult (Kaplan, 2001). This difficulty illustrates the need for alternative approaches to evaluation depending on the purpose of the evaluation (Bashshur et al., 2005; Kaplan, 2001). Kaplan (2001) suggested several evaluation methods such as the FIT factor – which explains the implementation issues facing a system – or theoretical evaluation based on social and behavioural sciences which would explain the success or failure of a system.

Bashshur et al. (2005) proposed some comprehensive guiding principles for developing practical evaluative steps that included the evaluation design, documentation of the evaluation steps, the evaluation process and, finally, a summary of the outcome. They suggested that having some criteria such as consistency, longevity, coherence, strength and analogy would produce a better evaluation. Their guiding principles are appropriate

for this project. Kaplan (1997) provided some methodological guidelines which included focusing on the concern, using multi-methods, being modifiable, formative and summative. Kaplan's arguments rely too heavily on qualitative analysis and evaluation of any health informatics.

Kaplan stressed that the evaluator needed to be sensitive to the 4 Cs: communication, care, control and context (Kaplan, 1997, 2001). These factors have also been highlighted by other researchers (Van der Meijden, Tange, Troost, & Hasman, 2003). Since telemedicine services could be viewed as an intervention, clinicians using the technology must be involved in the evaluation of health care technology to give detailed information. Thus, some specific evaluation models and theories examined in the telemedicine literature are shown in the next three sections.

2.4.1 Users's Attitudes and Perceptions

Some health care systems have failed from non-technical factors like the lack of user acceptance and adoption (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012; Wu, Wang, & Lin, 2007). So the response of health care professionals to the use of any health care technology could explain the success and failure of any application (Ketikidis et al., 2012). Some studies have used the users' perceptions of a telemedicine system, as an evaluation method (El-Mahalli et al., 2012; Lee, Ramayah, & Zakaria, 2012; McLeod & Clark, 2007).

A study conducted by El-Mahalli et al.(2012) in Saudi Arabia on the perception and the adoption of telemedicine implementation identified the lack of knowledge about telemedicine as the greatest barrier. They established the need for proper training of health care professionals to use telemedicine in the future. This factor has been

identified in the wider literature (Moeckli et al., 2013; Shahpori, Hebert, Kushniruk, & Zuege, 2011).

Whitten and Richardson (2002) pointed out that there is no universal definition of acceptance, and that acceptance is generally thought of in terms of effectiveness, adoption, perception or satisfaction. Further, they suggested additional research to address patterns of utilisation which is an area requiring examination in order to understand acceptance of a telemedicine application.

Ward et al.(2008) have stressed the importance of the attitude of health care staff, which is a significant factor in acceptance and efficacy of use. There are several reported models to measure acceptance and in the next section the TAM acceptance models that have been used in health care will be presented.

2.4.2 Technology Acceptance Model (TAM)

The TAM model was originally built on the grounds of the theory of reasoned action or TRA (Ketikidis et al., 2012). Ward et al. (2008) have agreed that the TAM model would provide a context to study the acceptance of any IT system in health care. Later, Ketikidis et al. (2012) found that the revised TAM model (TAM 2) could be used for better understanding health professional support for a health care technology.

McLeod and Clark (2007, p.2) defined the user as 'a person who causes a decision or information system to act or serve a purpose', or 'a person who brings a decision or information system into service', or 'who avails himself of a decision or information system.' The authors attempted to apply the TAM model to a telemedicine system, to identify the different users and their roles. They suggested that physicians and patients are not identified as users of telemedicine if the physicians are only reading the reports and the patients are passively participating in a teleconferencing setting.

In one study Wu et al. (2007) performed a confirmatory factor analysis to test the reliability and validity of the measurement of the revised TAM model (TAM 2, as shown in Figure 8 below) in a health care setting. They concluded that technical support and training does not affect perceived usefulness and perceived ease of use. Even though most researchers referred to the need of training and technical support, it does not affect the use of the system if the perceived usefulness is negative. On the other hand, they reported a direct positive impact of training and technical support on self-efficiency for the users.

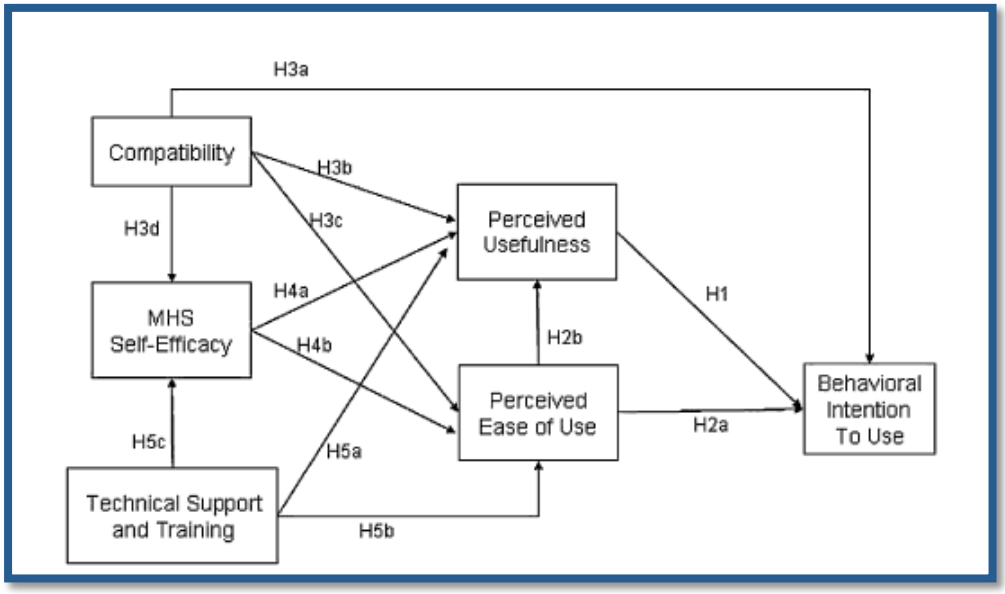


Figure 8. TAM 2 model studied in health care context by Wu et al. (2007, p. 69).

A study by Lee et al. (2012) attempted to compare three behaviour models used in health care systems: TAM, TRA and the theory of planned behaviour (TPB). They discussed the different limitations of each model and stressed the importance of measuring the external factors: technology, organisation and the human context.

2.4.3 Success Model

The DeLone and McLean model of information systems success was frequently referred to in the literature, in more than 1000 publications (DeLone & McLean, 2003; Petter &

McLean, 2009). Researchers used six success factors present in the model: system quality, information quality, usage, user satisfaction, individual impact and organisational impact (van der Meijden et al., 2003). DeLone and McLean have established that success is a multidimensional construct, thus those factors have to be measured (Petter & McLean, 2009; van der Meijden et al., 2003). Further they found that success is a dynamic process, not a static state, where the different dimensions influence the users' behaviour (Kaplan, 2001; van der Meijden et al., 2003). Ten years after the release of the model the authors proposed a new revised model (DeLone & McLean, 2003). The model is depicted in Figure 9.

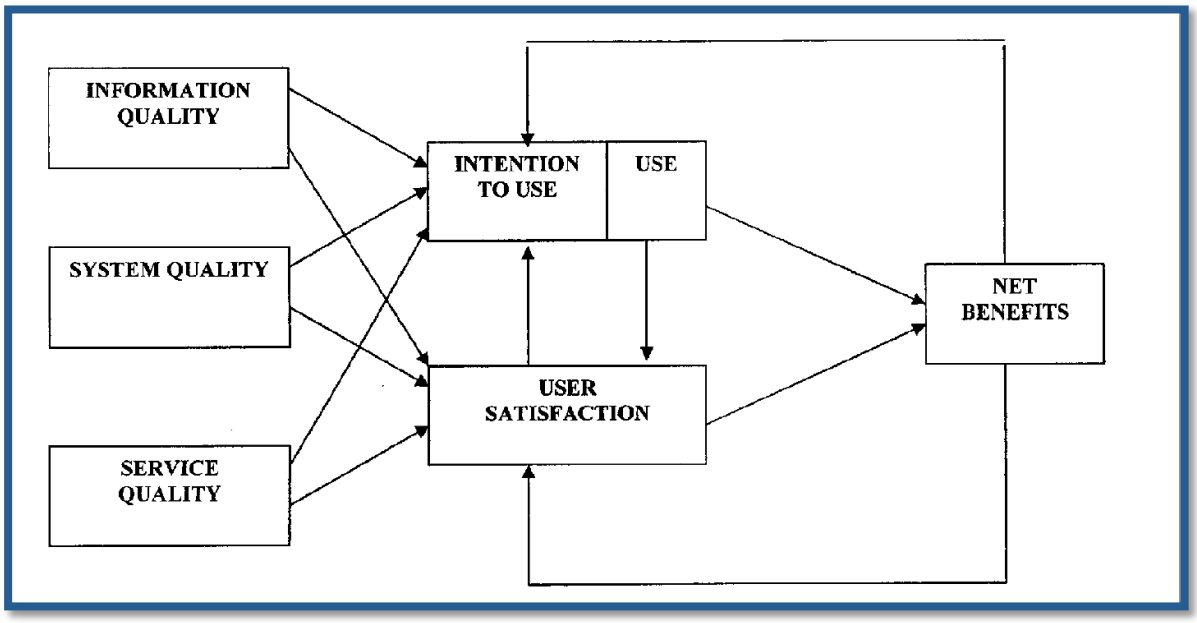


Figure 9. The updated success model by DeLone & McLean (2003, p. 24)

Researchers have stressed that the context and the objective of any investigation is very important in evaluating any information system, especially in the different context of health care (Chatterjee, Chakraborty, Sarker, Sarker, & Lau, 2009; DeLone & McLean, 2003; Hu, 2003; Kaplan, 2001; van der Meijden et al., 2003; Whetton, 2005; Yu, 2010). While a variety of definitions of the term *success of a health care system* have been suggested, Hu (2003) provided a broad definition and saw it referring to the design

selection, implementation, utilisation and adoption of a telemedicine system in health care. Hu indicated that telemedicine is enabled by information systems and dependent on them.

Hu (2003) reviewed the literature on the evaluation of telemedicine and found different approaches to evaluate health systems which varied from a very broad evaluation study to evaluation according to theorised models. He then suggested a revised success model to use in the health care context, shown in Figure 10 below.

The three proposed changes by Hu were

- adding an input data quality factor,
- having the service impact before the individual impact, and
- having several feedback loops to reinforce the continuity of the model which affects user satisfaction and system use.

The first and third suggestions are used in the new model, as depicted in Figure 9 above. The author concluded his paper by indicating the need for additional study to validate the model using case studies in a real world telemedicine system.

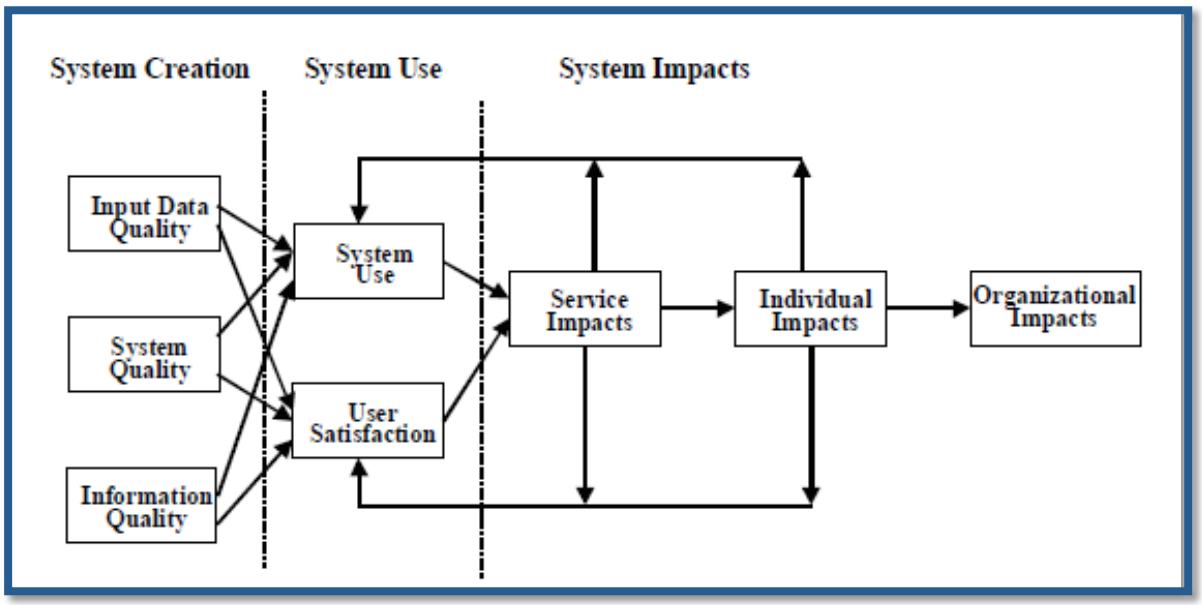


Figure 10. The revised model for telemedicine system success from Hu (2003, p. 4)

In 2009, Petter and McLean (2009) conducted a meta-analysis validating the model using 52 research studies in the literature, to examine the strength and magnitude of the relationships between the model's constructs. All the other relations in the model have been empirically supported, but they considered the relationship between use and user satisfaction was weak. The weak relationship between using a system and user satisfaction is supported by Lau, Hagens, and Muttitt (2007).

Chatterjee et al. (2009) attempted to examine the model in a health care context as well, but confirmed a positive relation between the use and the users' satisfaction. Another study, by van der Meijden et al. (2003), used the original model in a health care context after conducting a review of the evaluation literature; they proposed some additional success factors to the model. They stated that to determine success it has to have regard for the setting, objectives and the stakeholders. The authors found that users' satisfaction was correlated strongly with the ease of use, and dissatisfaction was strongly correlated with the negative perception of the impact on patients.

van der Meijden et al. (2003) explained that the more a system is used does not mean the system is successful and beneficial, thus researchers have to understand the nature, quality and complexity of the system. On the other hand, the less a system is used means that the system is not delivering the anticipated benefits, an issue which has been raised before by Seddon (1997).

One paper explored the purpose of reviewing studies on electronic health records (EHR) using the success dimensions in the DeLone and McLean model and found that information quality was the main success factor used in the literature evaluating EHR that they reviewed (Häyrinen, Saranto, & Nykänen, 2008). Moreover, they had several other goals for evaluation including accuracy, legibility, comprehensiveness, consistency, reliability, relevance and format.

Another study proposed the use of the success model in evaluating a health information system (Lau et al., 2006). They agreed with McLeod and Clark (2007), that patients are not users but are consumers of the system.

LeRouge et al. (2002) introduced a comprehensive quality attribute model for a videoconferencing system, stressing the importance of identifying system quality to measure the effectiveness of a technology system. Later LeRouge, Hevner, and Collins (2007) adopted the new success model and elaborated on it by performing an inductive analysis to produce a better comprehensive model and adding *use quality* as a success factor in the model, as seen in Figure 11.

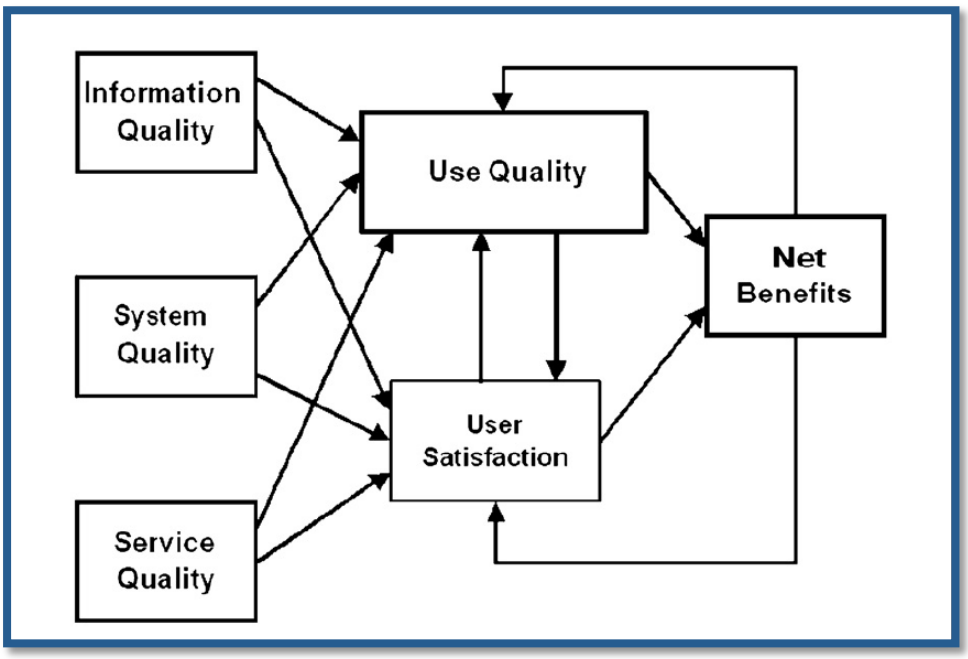


Figure 11. Adding use quality to the success model. Taken from LeRouge et al. (2007, p. 1290).

2.5 Tele-ICU Evaluation

There is no unified conceptual framework in the literature as to what tele-ICU is and how it improves ICU care. Yoo and Dudley (2009) have reported that the most beneficial systems are the ones used in rural areas or centres which do not have an intensivist on site. As the perception of success is complex and changes depending on the context, it is usually dependent on the perspective of the observer. Whetton (2005) emphasised the need for using developed frameworks to find the effectiveness of any health care system.

A study conducted by Rogove et al. (2012) to evaluate the use of tele-ICU found drivers and barriers with respect to utilising the system. The barriers they found were licensing, credentials, costs and billing, and reimbursements. The motivation for usage was immediate access to patient care, overcoming service gaps, improvement in care quality, patient satisfaction and compliance with general practice.

2.5.1 Users Attitudes and Perceptions

Looking at the improvements that may affect the adoption or rejection of health care management is important. A paper by Berenson et al. (2009) studied the efficacy and the work process changes using tele-ICU. They found that the main motivating factor for the users of tele-ICU was their perception of improved patient care with respect to both quality and safety. However, there was no objective data to support the result.

A study conducted by Hoonakker et al. (2013) examined the motivation of ICU nurses to work in tele-ICU. The authors interviewed 50 tele-ICU nurses to find the reasons that enticed them to enter the new field and examined the level of their job satisfaction. They discovered the main motivators were job opportunities, or the need to change from a bedside environment.

Hoonakker and his colleagues indicated that working in ICU is demanding and stressful for the nurses, thus to transfer their skills and knowledge to a different tele-ICU environment is stressful for them. Their study showed that inadequate opportunity for staff development and training was an important reason for nurses to leave their tele-ICU job.

Chu-Weininger et al. (2010) conducted a cross-sectional survey before and after the implementation of a tele-ICU system to measure teamwork and the safety climate in three ICUs. They concluded that the implementation of tele-ICU is associated with improvement in both teamwork and the safety climate. Later they acknowledged that the tele-ICU is used to improve compliance with evidence-based guidelines. This view is supported in the study by Sapirstein et al. (2009).

Shahpori et al. (2011) conducted a survey to assess the pre-implementation of ICU, clinicians' perceptions and knowledge about tele-ICU. More specifically, they

examined the clinicians' perceptions of using tele-ICU to address the challenges of the intensivist shortage and in improving the quality of care. They used both qualitative and quantitative analysis to identify the themes. Overall they found a low level of knowledge about tele-ICU, which was related to the novelty of the technology and its limited implementation. The clinicians were skeptical of the capacity of the technology to address the challenges. Further, the researchers identified that the staff had significantly less positive views concerning patient confidentiality.

Young et al. (2011) conducted a literature review to examine the level of tele-ICU acceptance by staff. They identified four categories of staff evaluation: tele-ICU coverage, impact on patient care, impact on staff and organisational impact. They found that the overall acceptance was high, but suggested more rigorous studies need to be done.

Moeckli et al. (2013) conducted an evaluation study on tele-ICU staff acceptance pre- and post-implementation by conducting semi-structured interviews and site observations. They used a qualitative data analysis to find the themes that influenced the acceptance of the tele-ICU users pre- and post-use. They found that training the staff, their perceived need and organisational factors were the main factors that influenced the acceptance of the tele-ICU system pre-implementation. Understanding the system, its impact on work, its perceived usefulness, and relationships with fellow staff were the main factors in the post-implementation acceptance and utilisations.

The study by Moecki et al. (2013) also described the implementation of tele-ICU as complex because of the time and resources that need to be allocated to support the implementation of the system. However, after implementation, staff acceptance and utilization of the system increased rapidly. These researchers found that even though

there is an association between perceived need and acceptance before implementation, the ICU staff acceptance shifted whether they found it useful or not.

2.5.2 Cost Effects

There is considerable interest in evaluating the success of tele-ICU and the costs associated with its implementation (Breslow et al., 2004; Franzini, Sail, Thomas, & Wueste, 2011; Kumar et al., 2013). One study by Ekeland et al. (2010) conducted an in-depth review of reviews on the impact and cost of telemedicine after 2005. They pointed out the need to find factors to promote the use of telemedicine that could be derived using qualitative research, and to develop robust evidence-based modelling.

Breslow et al. (2004) evaluated the clinical and economic effects of implementing tele-ICU at two adult ICUs in a large tertiary care hospital. They found an association between hospital financial performance and the improvement in health outcomes. Further, they showed a decrease in the hospital mortality rate from 12.9% to 9.4% with a confidence interval between 0.55–0.95.

Then in a critique of Breslow (2004), Leong, Sirio, and Rotondi (2005) concluded that despite the promising use of tele-ICU, there were some limitations that needed to be addressed. The first limitation was that there was no actual basis for the observed changes in the cases. That there would be unmeasured or unanticipated changes was not accounted for in the study. Finally, they revisited physician resistance to adopting the new technology, which may affect staff usage.

A study by Franzini et al. (2011) examined the cost effectiveness of implementing tele-ICU. They found an increased daily cost in the hospital per case. Further, the intervention was not cost effective for patients with simple or acute health issues, but it *was* cost effective for the sickest patients. A more recent literature review by Kumar et

al. (2013) on the efficacy and cost-effectiveness evaluation studies of tele-ICU found a lack of consistency in measurement and reporting. They found that the literature supports the positive efficacy and cost-effectiveness of using tele-ICU.

2.5.3 Impact of Tele-ICU

One study was conducted by Khunlertkit and Carayon (2013) to identify aspects of the contribution of tele-ICU technology to health care processes and outcomes for the patients. They conducted semi-structured interviews with 61 tele-ICU users and used inductive content analysis on their data. Interestingly they found out that the ICU staff that did not accept the use of tele-ICU, sometimes discarded patient-care recommendations provided by the intensivist from the other centre. They asserted that there is no impact on patient-care processes and outcomes when the technology was not accepted by the staff. The researchers stressed the need to understand the influence of such technology on the health care process and patient outcomes.

Another article by Thomas et al. (2009) investigated the association of tele-ICU as a remote monitoring technology with the decrease of mortality, complications and length of stay. No direct association in the improvement of mortality or length of stay was demonstrated.

Thomas et al. (2009) examined the association by conducting an observational study on six ICUs in a large health care system using tele-ICU. They investigated 2034 patients over more than two years before the use of tele-ICU. In addition, they assessed 2108 patients for two years after the use of tele-ICU was introduced. The study showed little evidence to support the usage of tele-ICU. But it did show a small decrease in hospital mortality rate from 12% (95% confidence interval, 10.6% to 13.5%) to 9.9% (95%

confidence interval, 8.6% to 11.2%) which had no significant association after adjusting for the severely ill patients.

Another observational study by Rosenfeld et al. (2000) has produced some evidence that the remote care for ICU patients decreased the ICU mortality rate from 68% to 46% and the severity-adjusted hospital mortality rate from 33% to 30%. Rosenfeld et al. also demonstrated a decrease in the number of complications and patients' length of stay. Finally, Rosenfeld et al. showed a decrease in costs of 33 per cent. The study involved the observation of ten ICU beds in a community hospital over a shorter period, only 16 weeks. Only patients who were admitted and discharged during the observation period were included. This time period was compared with another 16-week period in the same year before tele-ICU was used.

Borycki and Bartle-Clar (2011) described some advantages and disadvantages of using tele-ICU. They have also stressed the need to evaluate the impact of staff shortages, patients' confidentiality and organisational and cost issues. They argued that the available studies that focus on those issues are supported by industry vendors and cannot be generalised because of the different environments and models of care. This viewpoint has support from other researchers (Bashshur et al., 2005; Kaplan, 2001; Rahimi & Vimarlund, 2007).

A study was conducted by Zawada Jr. et al. (2009) on the impact of tele-ICU on rural health care systems which measured mortality rates, length of stay and other scores by using a survey. In this study the tele-ICU was intended to extend the knowledge of the critical care physicians in tertiary hospitals and use it in a delivery model for a region that covered three community hospitals and over 229 rural sites. During the two years of using the tele-ICU intervention, there were 5146 cases of patients who were cared for through the tele-ICU. The staff in the rural hospitals showed high staff acceptance; they

perceived the technology as easy and comfortable to use. The severity-adjusted length of stay was lower in the three rural hospitals during the intervention, as shown in Figure 12.

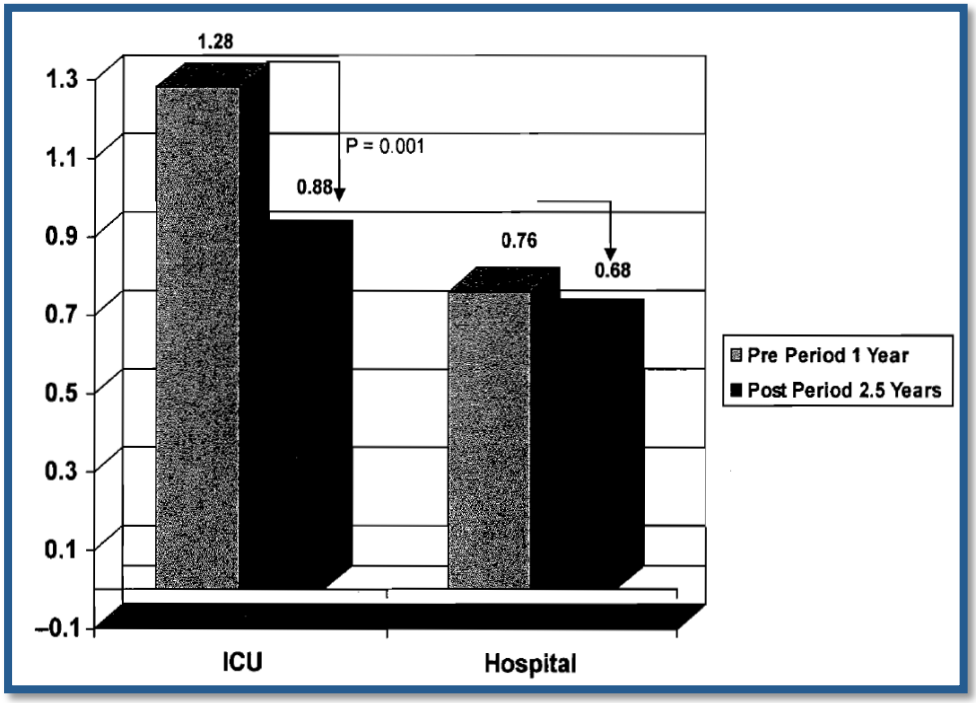


Figure 12. The severity-adjusted ICU and hospital length of stay changes pre- and post-tele-ICU in three community hospitals. Taken from Zawada Jr. et al. (2009, p. 164).

On the other hand, staff in the tertiary hospital reported that they had less physical stress but more mental stress. The new model did not affect their bedside clinical abilities or practice. This study was the first to evaluate a multi-hospital tele-ICU impact on rural health systems.

2.6 Conclusion

After conducting the literature review on the use and impact of tele-ICU in health care, concentrating on users' perception studies. There is an anticipation of continuing usage of the technology in the future. Thus, this study will follow the guidelines presented in the reviewed studies that examine the factors and issues influencing the usage of tele-ICU

However, even with continued reports of a positive relationship between perceived usefulness and increased adoption of new tele-ICU systems, the adoption of this tele-ICU system would not be examined because it is already in use. Thus, it was not appropriate to examine literature about the uptake of such technology.

Moreover, this review shows that qualitative studies are emerging in the field of tele-ICU. Therefore, conducting a qualitative study on this tele-ICU system would provide enriching information, because it is a new technology that has not been fully established in the literature. Having said that, there is a need to standardise evaluation research to examine such systems.

Chapter 3. Methodology

3.1 Introduction

After reviewing the literature on telemedicine and tele-ICU systems in the previous chapter, and with the lack of studies on health care providers' perceptions about using such system in Saudi Arabia – as stated by El-Mahalli et al. (2012) and Khalifa (2013) – this case study was conducted to identify the users' perceptions about utilising the tele-ICU system in KFSH in Saudi Arabia.

This chapter will introduce and discuss the methodological approach (section 3.2) and the research design (section 3.4) devised to answer the research questions (section 1.5). The tele-ICU setting in this project will be presented in section 3.5. Then the data collection will be described in section 3.6, and the analysis used in this study in section 3.7. Finally, I will discuss the ethics approval acquired to conduct this research in section 3.8.

3.2 Methodological Approach

The methodology used in this study was case study research. A case study is a research approach used to contribute to the understanding of individuals, groups, organisations and other phenomena, as defined by Yin (1994). It is a strategy of inquiry, which explores activities or processes with detailed information and uses a variety of data collection methods (Stake, 1995). Case study is a subjective investigation of a phenomena in its natural context, where the boundaries between the phenomena and the environment are not absolutely clear (van der Meijden et al., 2003).

This case study evaluation was conducted using both qualitative and quantitative data. As van der Meijden et al. (2003) have argued, using both data sources improves the outcome of an evaluation instrument on health care systems.

Using both qualitative and quantitative data sources is called *source triangulation* (Yin, 1994). Hence, the use of triangulation enhances the study's reliability and validity, a view which is supported by several researchers (Bashshur et al., 2005; Jick, 1979; Stake, 1995; van der Meijden et al., 2003; Yin, 1994).

Understanding how system users perceive and evaluate the system is one of the reasons qualitative research is used in health informatics (Kaplan & Duchon, 1988; Kaplan & Maxwell, 2005) and explains the actual process that leads to the outcome. Chiasson et al. (2007) put forward other reasons for using qualitative methods in medical informatics, such as understanding how the system is used, investigating its causal process and increasing the utilisation of evaluation results.

Few studies have found that research using qualitative methods in health care information science are commonly used with quantitative methods as well (Chiasson et al., 2007; Kaplan & Duchon, 1988; Kaplan & Maxwell, 2005). Thus together, the results give higher credibility than by using only one type of inquiry (Kaplan & Maxwell, 2005).

However, van der Meijden et al. (2003) concluded their literature review on evaluation studies of health care information systems by pointing to the need for having both quantitative and qualitative approaches in such studies. In this study, it was considered that quantitative measures would usefully supplement and extend the qualitative analysis.

An interview is usually a conversation between two people or more, where the researcher has direct control of the mechanism of the conversation to some degree (Wilkinson & Birmingham, 2003). There are three types of interview used in research: standardised interviews with fixed questions, nonstandard interviews with general questions depending on the conversation, and semi-structured interviews which lie between the two extremes (Berg, 2003).

Interviews – as a data-gathering method – can provide new information about new telemedicine technology (Miller & Salkind, 2002). The purpose of an interview is to understand the experience of another person and what that experience means to them (Seidman, 2005). An interview can put the behaviour of people in context and thus provide an understanding of their action (Seidman, 2005).

3.3 The Underlining Paradigm

There are two main schools of enquiry which are called *positivism* and *interpretivism,* and those philosophical paradigms have various subparadigms with different enquiry assumptions (Creswell, Hanson, Plano, & Morales, 2007; Guba & Lincoln, 1994; Johnson & Onwuegbuzie, 2004). As case studies commonly contain both qualitative and quantitative data, the data could be interpreted according to both a positivist and an interpretivist philosophical paradigm (Creswell et al., 2007; Guba & Lincoln, 1994; Kaplan & Duchon, 1988).

However, the nature of the collected data in this case study may not fit fully into either one of those two main paradigms since my first set of data is quantitative data, which I used to support the analysis of the qualitative data. The analysis technique called *data comparison,* which involves both qualitative and quantitative sources (Johnson & Onwuegbuzie, 2004).

Scott and Briggs (2009) argued that combining both qualitative and quantitative findings into an integrated research design can be fitted under pragmatist philosophy. The authors have pointed that pragmatism methodology is a good base to use in health informatics research. The researchers have pointed out that clinical practice is pragmatist, thus it provides an appropriate base for medical informatics research.

Scott and Briggs (2009) have explained that pragmatism believes that all knowledge is empirical and not foundational. And, data are being necessarily selected and interpreted. Further, the validity of ideas can be assessed by their consistency with established knowledge. The view of providing a framework utilising quantitative and qualitative techniques based on a pragmatist rationale, is supported by Johnson and Onwuegbuzie (2004).

LeRouge et al. (2007) have acknowledged that a new research paradigm is moving to context-specific theories, rather than studies intended to be suitable for everyone. They argue that there is a need for more qualitative studies in telemedicine literature to describe its benefits with a richer understanding of the telemedicine process. Thus, the philosophy of pragmatism was used to build this case study.

3.4 Study Design

A research project is a strategy to learn more about a selected subject or problem, and is time-limited (Thomas & Hodges, 2010). In this case study, a series of enquiries was conducted to explore tele-ICU usage in Saudi Arabia. First, I obtained the usage statistics from the tele-ICU records, which are the number of cases treated via the tele-ICU intervention through KFSH. The usage statistics were obtained to distinguish between high-usage centres and low-usage centres connecting to the tele-ICU system.

Then I used interviews, which are suitable to answer the main research question regarding the issues facing tele-ICU users. The interviews were developed to assess the staff perception and expectations related to tele-ICU. A pilot interview was conducted informally to test the interview protocol first. Then interview data were collected between July and September 2013.

Email invitations were sent to all 26 connected tele-ICU hospitals. They were followed by phone calls to schedule interview appointments with potential participants. Then, I conducted 20 individual semi-structured interviews with tele-ICU staff from 13 connecting hospitals.

For analysing the data, a mixed qualitative and quantitative data analysis approach was used. First, the interview data was transcribed. Then the transcriptions were transferred to a data management software, *QSR NVivo 10©.*

Then the transcripts were analysed to identify key themes, which are the users' motives, barriers and suggestions after using tele-ICU. The main themes were adopted from Rogove et al. (2012) and van der Meijden et al. (2003). Then the participants' responses were separated to conduct a data comparison analysis to identify similar patterns of themes. An overview of the steps involved in conducting in this study is represented in Figure 13 below.

In the following two sections, the tele-ICU setting will be described first to have a better understanding of the context of the study. Then each data collection method is described and discussed in the data collection section 3.6.

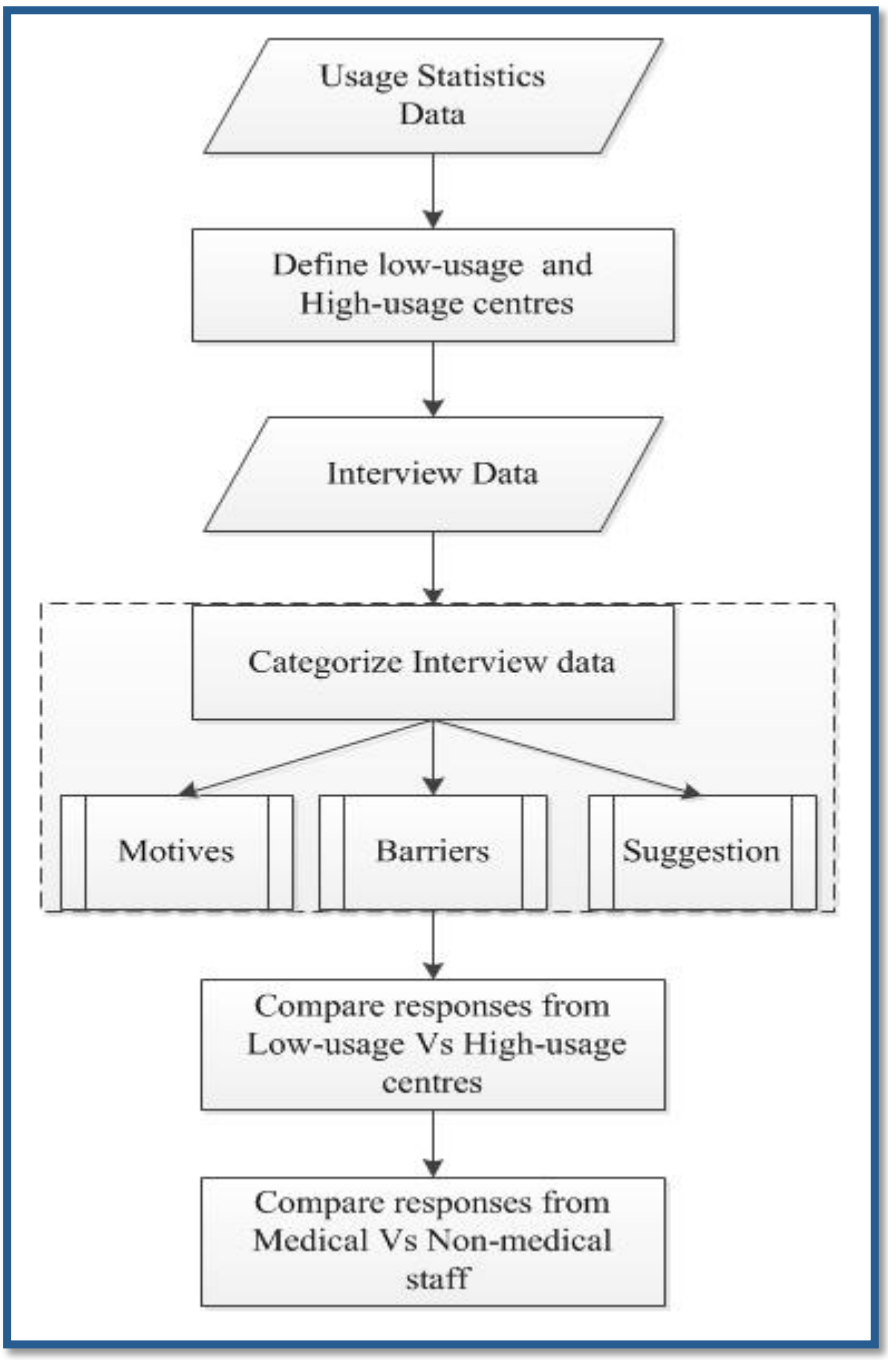


Figure 13. The steps involved in conducting this study. (Source: author)

3.5 Tele-ICU Settings

The tele-ICU technology links bedside staff in 26 different ICUs to the critical care specialist in the intensive care unit located at KFSH, the tele-ICU central hub. KFSH is a tertiary care hospital and research centre which has 936 beds. The tele-ICU program started in 2008 and all the implementation of the programme was executed by the health

outreach team in KFSH. There are 26 hospitals that are connected to KFSH; they differ by regional location, size and experience of tele-ICU. Some hospitals are in urban areas and some are in rural areas. Figure 14 shows an overview of the components involved in tele-ICU.

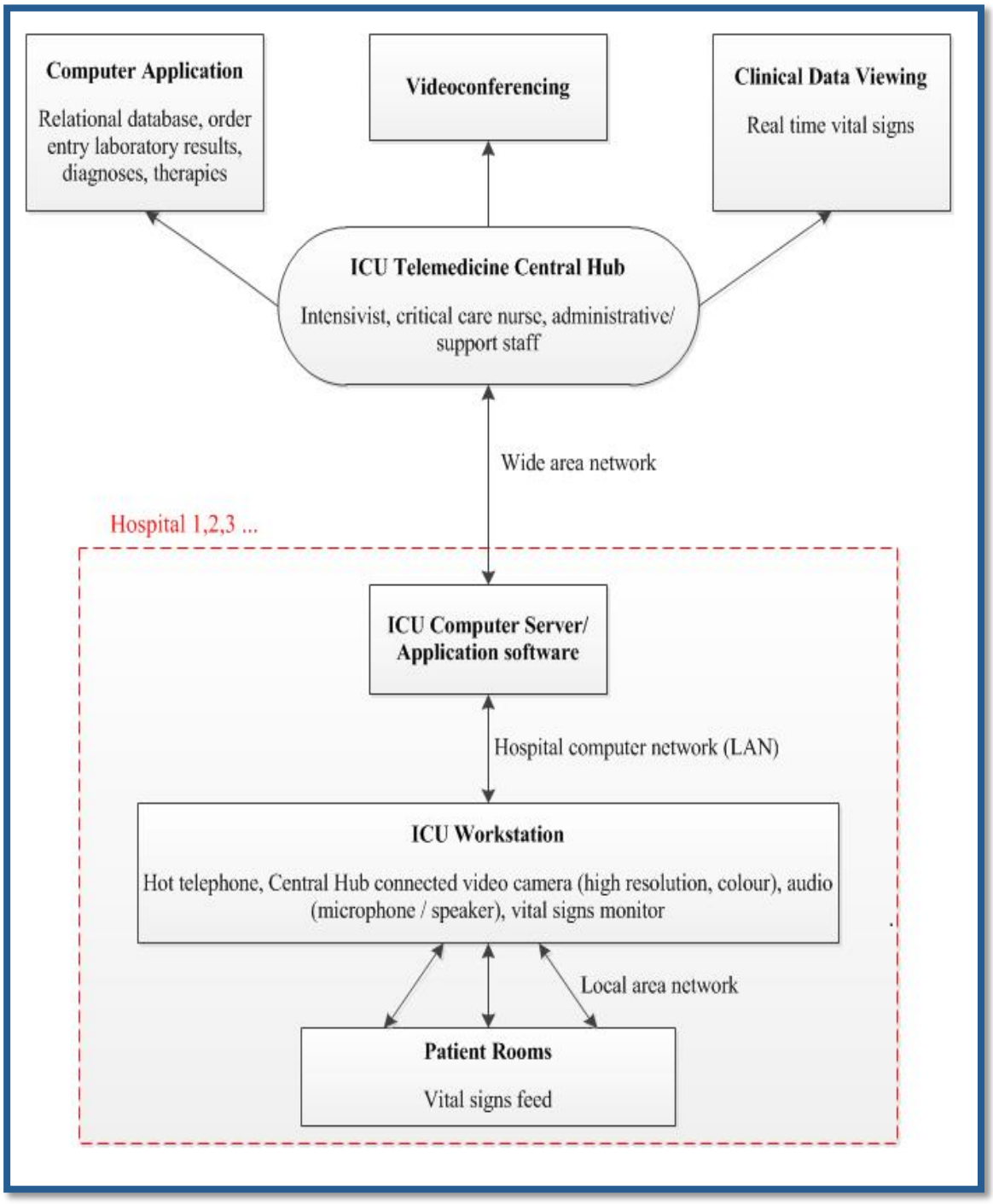


Figure 14. An overview of the components involved in tele-ICU, adopted from Cummings et al. (2007).

Each centre has a designated room with the equipment needed for tele-ICU videoconferencing and computer facilities. Figure 3 above, shows an overview of the tele-ICU room examined in this study. This environment is used to conduct the videoconferencing for peer consultation and education; it has high quality video transition capabilities. Figure 15 below depicts the centre of the room, showing the videoconferencing screen of the in the middle of the room to conduct the communications. The next three sections will provide a description of the tele-ICU staff, programme overview and technology.

Figure 15. The tele-ICU room in KFSH, taken in September 2013. (Source: author)

3.5.1 Staff

The descriptions of the staff roles in the tele-ICU environment are,

- the tele-ICU coordinator, responsible for scheduling encounters and the operations of the system,

- the tele-ICU administrator, responsible for designing the policy and the procedure,
- tele-ICU researcher, responsible for collecting the data and analysing the system usage,
- the tele-ICU vendor (which is KFSH), responsible for the technical aspects of the system selection, implementation, maintenance, support and coordination,
- the tele-ICU technician, responsible for the operation and maintenance of the system,
- the tele-ICU educator (only at KFSH), who is responsible for training users of the system, and
- the tele-ICU users, i.e. the physicians and nurses responsible for patient care.

In the central hub, the coordinator fills multiple roles, as the researcher and educator as well as the coordinator. The coordinator is responsible to coordinate weekly videoconferences with the other centres. KFSH functions as the vendor for all the connecting centres.

In the other 26 hospitals, there are few main roles for the tele-ICU staff. First, there are coordinators in each hospital to arrange the connection with tele-ICU central hub. They are responsible for sending patients' medical information as well. Then there are the tele ICU users, including physicians and attendant nurses, who consult with each other. The final category is the IT technicians, who set up the videoconferencing equipment.

3.5.2 Programme Overview

The physicians in the central hub are board-certified intensivists and critical-care nurses who provide scheduled tele-consultations and lectures. The intensivists located in the central hub use software tools to access a database containing medical information

about patients across multiple ICUs in different hospitals. They also use the software to track live vital signs for those patients. The central hub staff can communicate with the other centres via video conferencing facilities. The full description of the technology is provided in the next section, 3.5.3.

The remote care programme is being implemented with no change to the existing health care delivery in the connected hospitals. The tele-ICU consultations and lectures run during usual working hours with a specific schedule for each centre. Moreover, there is emergency phone coverage from the assigned intensivist.

There are occasional scheduled lectures for continuing medical education purposes. The lectures target the staff in the connecting hospitals, specifically the ICU nurses. This programme is managed by the central hub coordinators, and is presented by ICU staff at KFSH. The sessions are transmitted by the teleconferencing facility to all connecting centres. In addition, the project management is promoting awareness of this project by launching social network accounts (Twitter, Facebook and Instagram) to explain the purpose and the use of the project. Through their accounts, they are inviting the public to access the tele-ICU's consultants and to get a second opinion about their condition from anywhere in the country.

3.5.3 Technology

The tele-ICU technology implemented by KFSH has three components:

- *The Tele-ICU videoconferencing:* This is the communication network between the intensivists in KFSH and the bedside health care providers. This includes camera, speaker, microphones and a high-resolution screen to conduct the videoconferencing. The equipment is installed in each tele-ICU room in each participating hospital. Most hospitals are connected through a local network to

KFSH and some use the internet connection. The videoconferencing transmission is accessible through secure internet protocols and only used in the designated hospitals.

- *The tele-ICU website:* This is the user-interface website which is used to access the indexed data about the patients requesting consultation. This is a web-based information system used as a database for patients requiring consultation, as well as to transfer medical information including medications, lab results and diagnoses. There is also a web-based application to request a session and give the patient's information which is sent to the tele-ICU coordinator at KFSH, and visible to KFSH tele-ICU physicians. This form is shown in Figure 16 and Figure *17* below. With this application, the coordinators in KFSH could send back recommendations from the ICU consultation and the results of the meeting. And they can follow up later, if the requesting physician provides updated patient's information.

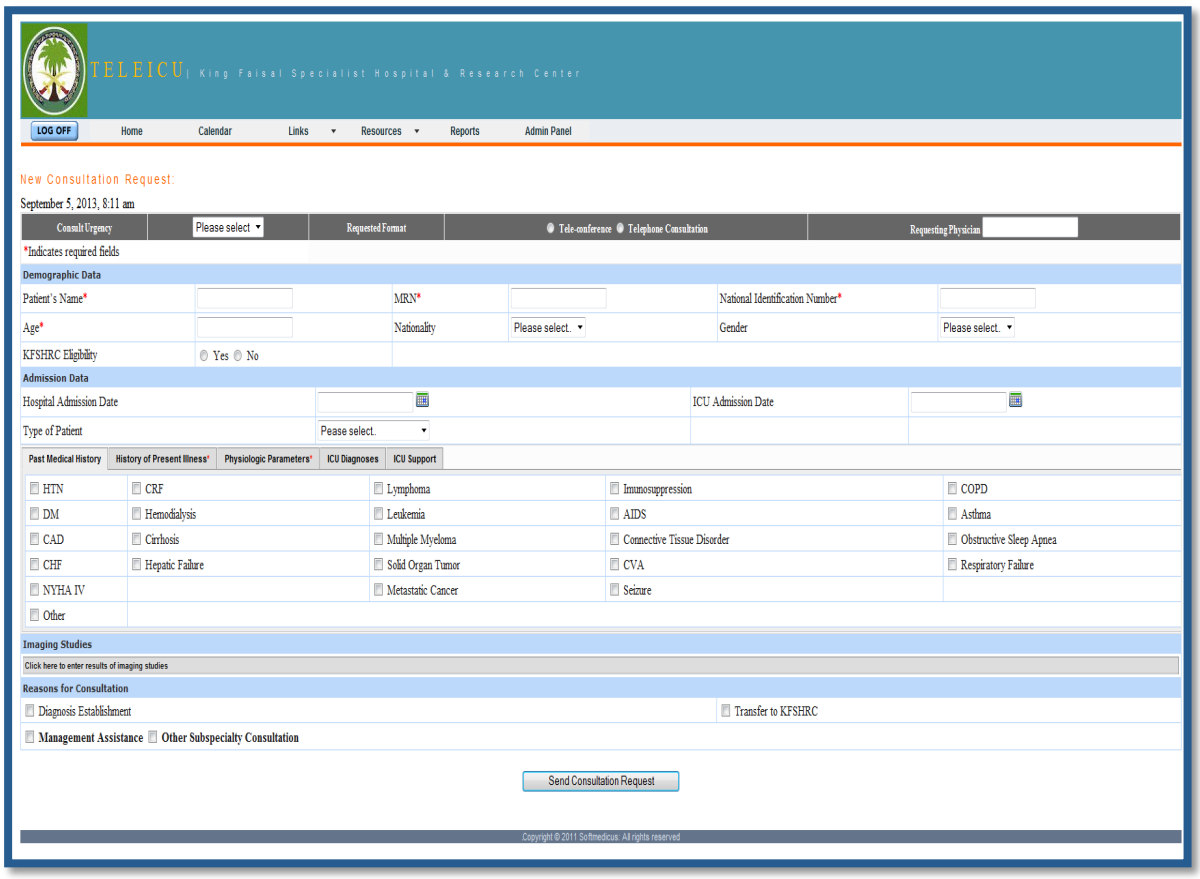


Figure 16. A caption of the tele-ICU web-based form for patient's information. Source: A. Almashary (personal communication, 5 September 2013)

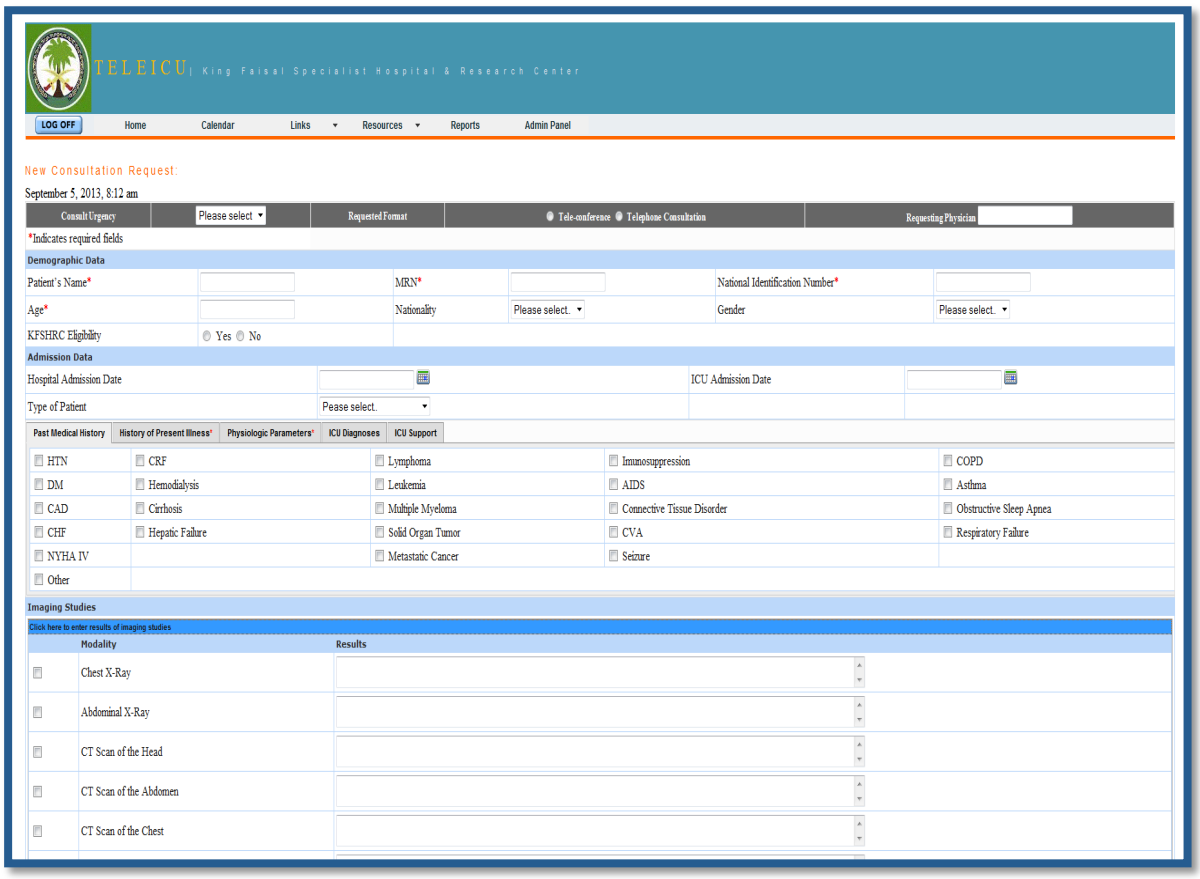


Figure 17. A second caption of the tele-ICU web-based form for patient's information. Source: A. Almashary (personal communication, 5 September 2013).

- *The vital signs:* This system provides a live feed of the vital signs data that are connected to the bedside of the patient. The vital signs for each hospital are shown in their own tele-ICU room and displayed in the central hub room as shown in Figure 18. The vital signs are accessible through the website interface by the central hub staff only. The intensivists use the information for diagnostics or health management.

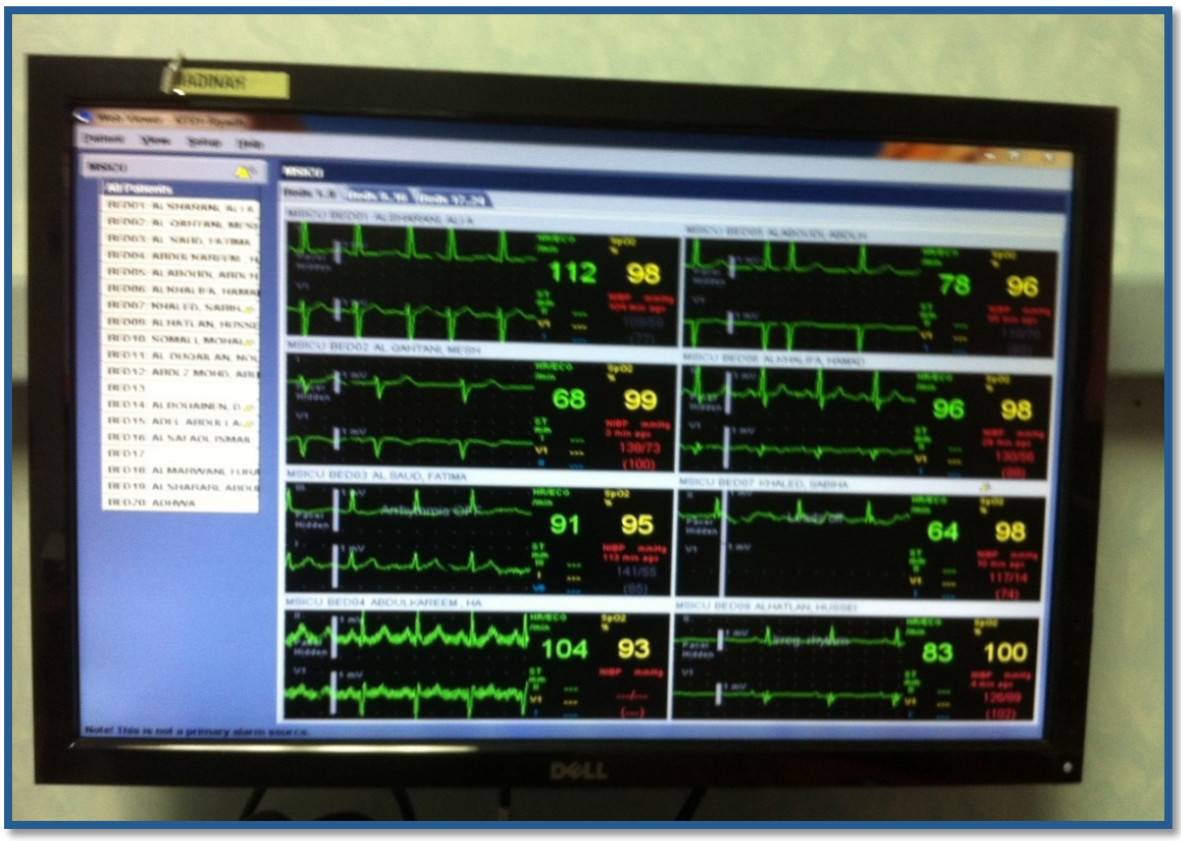


Figure 18. One of the vital signs monitors in the tele-ICU room in KFSH, taken in September 2013. (Source: author)

3.6 Data Collection

A data gathering methodology is the set of procedures and techniques used to collect the study's evidence (Thomas & Hodges, 2010). In this study the data collection was conducted in a sequence of steps as explained in the Study Design section (section 3.4). Further details are described in the following sub sections.

3.6.1 Usage Statistics

The KFSH tele-ICU kept a log of all cases discussed through their system. The total number of cases since beginning in 2008 has been entered in this log. In addition, the monthly breakdown of cases from January 2009 until July 2013 was available for review. The records documented the number of cases treated using the tele-ICU intervention during weekly scheduled calls and included urgent calls as well.

Later, the usage statistics were ranked for all centres each month between January 2012 and August 2013. I have compiled only this period because the records of the tele-ICU did not document the centres of the treated cases before 2012. If a centre was the highest one ranked in any particular month, this centre was included in a higher usage group.

Then the centres were divided into high-usage centres and low-usage centres to differentiate the participants' responses in the analysis of the interview data to find any differences between the two groups.

3.6.2 Interviews

The goal of the interview was for the interviewees to provide a description of the tele-ICU system from their own experience and understanding. These interviews captured users' perspectives on using the technology.

The data collection instrument constituted 20 separate interviews with tele-ICU staff. The interviews were arranged between the researcher and every participant. All but two interviews (central hub staff) were conducted by phone. The interviews I used in this study were semi-structured. Semi-structured interviews are usually used when there are different interpretations covering the same areas of inquiry (Noor, 2008). Each semi-structured interview was up to 30 minutes in duration and focussed on the user's experience of the tele-ICU project. All the interviews were recorded using a smart phone application and were conducted in English.

Telephone interviews were conducted rather than face-to-face interviews because of the inflexible and difficult travel times required to reach all the hospitals, which are distributed throughout the country. The participants were made aware of the researcher's background as suggested by Kaplan and Maxwell (2005). Thus, as a

researcher in a health care context, I explained to the interviewee that I do not have a medical background.

The interview protocol, shown in the following section, 3.6.2.4, was developed to answer the main research question and the first sub-question stated in section 1.5. Building the list of questions depended on what was important in the study, thus the key issues were covered as suggested by Seale, Gobo, Gubrium and Silverman (2004). Thus, it was used to gather some information about the tele-ICU users' understanding of the technology, workflow, and their perceptions. The interviewees were prompted about the impact of tele-ICU on the hospital, patients and staff to ensure that all those aspects would be covered. Finally, their suggestions for the future use of telemedicine in general were recorded.

3.6.2.1 Selection Criteria

There were two criteria to select participants for this study. First, the participant had to be tele-ICU staff member who had used the videoconferencing system at least once before, and who was willing to participate in the study. Second, only participants who spoke English were invited.

3.6.2.2 Selection Process

The director of the tele-ICU at KFSH provided a contact list of the participating centres. He sent the study information sheet to all the tele-ICU connecting centres to invite potential participants.

I conducted follow-up phone calls to all the centres to invite participants to join the study using the KFSH-designated phone extensions. Interviews were scheduled with possible interviewees and the invitation email was re-sent including both the participant information and consent sheets.

Making individual contact with each potential participant was time consuming but it was more effective. The procedure was used as it been shown to be more powerful than sending an email, because potential participants can easily discard an email from an unknown person (Seidman, 2005).

The next step was to ask the participants to read and sign the consent sheet. Nevertheless, some asked to do the interview on the initial phone call because of their busy schedule and agreed to sign the consent later. Other participants preferred to arrange a specific time in order to concentrate better. Lastly, I reassured all the participants that they could withdraw from participation at any time.

3.6.2.3 Pilot Interview

A pilot interview was conducted informally by interviewing an expert in the field of health informatics. The purpose for the pilot interview was to test the interview protocol before using it in the study. The list of questions was compiled from the relevant literature, including non-academic literature, as shown in the next section.

3.6.2.4 Interview Protocol

The key themes focused on were usage issues, motives and suggestions for the future of tele-ICU and telemedicine. The interview guide for this study had three steps.

- The first step involved giving a brief introduction about the study and its purpose. The participant was asked if they understood the information they had received, and if they had any questions. The participants were reassured about their privacy, and that they would remain anonymous. They were asked to send back their signed consent sheet when possible. Permission to record the interview was obtained in the form of verbal consent.

- The second step was the interview itself. The guiding questions, which were asked – adapted from Taylor (2005), Kaplan & Maxwell (2005) and Gomez (2010) – were as follows:

  Introductory Questions

  - How long have you worked on the tele-ICU project with KFSH?
  - Who are the main users of the tele-ICU project?
  - What steps are taken to coordinate the connection with other hospital?

  To Examine Usage Issues

  - Do you know how to use the tele-ICU website to enter a patient's information and medical history?
  - If you are not using the website, why?
  - How can the website be strengthened?
  - Why do think some users do not use tele-ICU conferencing?
  - Based on your experience, what is the best way to ensure the reliability of the telemedicine system? (How do you ensure that the information is delivered to KFSH?)
  - What are your recommendations and suggestions for using the system in the future?

  To Examine Usage Motives

  - What are the main strengths and opportunities of this telemedicine project? (How can it improve the hospital, patient care and medical professionals?)
  - How does such a system contribute to health care delivery and development in Saudi Arabia?

  Future of Telemedicine

- ❖ What is the future of telemedicine around the world?

- During the interview I was trying to be as neutral about the topic as I could. I tried to establish a relaxed and an encouraging relationship with the interviewee, as suggested by Seale et al. (2004).
- At the end of the interviews, I thanked the interviewees for their participation and asked if they had any further points they would like to add.

3.7 Analysis

In case studies, analysis is considered the heart of theory building, hence the importance of the data analysis within the case study context (Eisenhardt, 1989). A case study is frequently built on several analytical strategies and the major ones are testing rival theories and developing a descriptive framework of the organisation of the case study (Yin, 1994).

Coding is a key step in qualitative analysis, and involves sorting the data into categories by marking codes on the transcripts (Henry, 1999). The term *coding* refers to the routine process for organising the text of the transcripts and discovering patterns within its structure (Auerbach & Silverstein, 2003; Gibbs, 2008). That process helps to visualise the categories which represent each segment (Henry, 1999).

In this study, the codes are derived from the relevant literature, and from the themes raised by the participants. Thus the construction of a codebook to be used in the analysis process can be data-driven or concept-driven (Gibbs, 2008).

The analysis process was conducted as follows: First, the interviews were transcribed then imported to qualitative data management software. A coding process was conducted to identify the key themes. The coding processes of Auerbach and Silverstein (2003) and Gibbs (2008) were used as guiding principles for this study. Then a data

comparison analysis was conducted. That process is described in the following subsection.

3.7.1 Data Preparation

The interviews were transcribed keeping the names anonymous to protect the confidentiality of the participants. Also, the names of centres were omitted from the transcriptions to protect the participants.

Then the data were transferred to a data management software QSR NVivo 10 ©. The introduction of computer-aided programmes has influenced established practices in qualitative research, and helped clarify the analysis process but it *is* time-consuming as well (Creswell, 2009; Gibbs, 2008). Nvivo can be used for both deductive and inductive coding approaches (Creswell, 2009).

The advantages for using such software were described by Gibbs (2008) as following:

- to carry out analysis on large amounts of data,
- to have consistent and systematic data management,
- to manage both coding and retrieval of the text, without taking the text out of context , and
- to provide assurance by searching the entire data to ensure the data were fully covered.

English is the second language for all the interviewees, thus the poor grammar content of the interviews had to be altered throughout the study. As Gibbs (2008) explained that sometimes there may be parts of the interview that require interpretation in order to present the understanding of the original content

3.7.2 Theme Analysis

The coding process was conducted to identify key themes in the following sequence:

1. going through the transcripts to code all the relevant motives and barriers recognised by previous literature;
2. coding all the suggestions in one category and grouping the reoccurring suggestions into specific codes; then
3. revising the transcripts for extra new themes under the 'motives' and 'barriers' types, but few themes emerged.

This process categorised the interview transcripts into three main categories: Motives, Barriers, and Suggestions. Only themes mentioned by at least two users were coded.

Then, a data comparison analysis to find differences between groups of users was undertaken. The process was adopted from a similar study by Hoonakker et al. (2013). First, the respondents were separated into two groups depending on where they worked (high-usage vs low-usage centres). Then the respondents were separated into two groups depending on their medical background (medical vs non-medical).

From each user, if a certain topic was mentioned any number of times, it was counted as one occurrence for the whole group. This procedure presented a count of how many users mentioned a certain theme. Then a comparison was made between the groups to identify patterns or themes.

3.8 Ethics

The Auckland University of Technology Ethics Committee (AUTEC) approved this study on 3 July 2013 (AUTEC reference number 13/81). In addition, the health outreach department in KFSH approved the study. The research needed ethics approval because

there was the possibility that, by using a case study, some discomfort might arise for the participants during the interviews (Yin, 1993). It was necessary to get the approval from the organisation before conducting the study to ensure their authorisation to invite participants. Then, I obtained AUT's standard ethics approval to ensure the privacy and confidentiality of the participants. All participants gave their verbal consent before conducting each interview. Even though, they agreed to sign their consent sheet, not all the participants returned their signed consent sheet following the interview. I assume this is because of their busy, demanding jobs.

Because there was a limited group of participants, the report has avoided displaying any data which could identify the participants as Berg (2003) suggested. Providing confidentiality lays an obligation on the researcher to protect every participant's identity and location (Kaplan & Maxwell, 2005; Seale et al., 2004). In terms of any risk arising from being seen to criticise government initiatives, which did not occur, the participants were assured that their identities would be kept confidential.

Moreover, participant information is available only to the researcher and the academic supervisor. The participants' information was not shared with KFSH or any other party. All the participants were informed that if they experienced any discomfort, they could decline a particular question or withdraw from the interview at any time as suggested by Seale et al. (2004).

Chapter 4. Results

There were 26 different hospitals connected to the tele-ICU in KFSH at the time of the study. Usage statistics were examined to provide an insight into the utilisation of the tele-ICU system. Further, these statistics were used to identify key differences between centres connected to the tele-ICU system. After that, 20 users from 13 tele-ICU centres were interviewed regarding their experience using the tele-ICU facilities.

The analysis of the interview transcripts was undertaken to identify motives and barriers influencing tele-ICU usage as well as categorising the suggestions provided by users as a theme.

Further, a data comparison analysis technique was undertaken to compare different patterns of themes between users from high-usage centres and low-usage centres and between medical and non-medical users to identify different perceptions.

In this chapter, the results obtained from the data collection methods will be presented. First, the preliminary findings from usage statistics and interviews will be described in section 4.1. Then, the key themes resulting from the interview analysis will be demonstrated (section 4.2). Later, the results of the data comparison analysis of the research outcome will be discussed (section 0).

4.1 Preliminary Findings

In this section, the data obtained from usage statistics are presented first (section 4.1.1). From the statistics, the hospitals were divided into high-usage vs low usage centres in the study, which would be used for separating the interview data later in the analysis.

The next finding demonstrated in this section is the interview data (section 4.1.2), which will be categorised into the issues and suggestions. Thus, users' perspectives and responses will be used for comparing different groups at the end of this chapter.

4.1.1 Findings from Usage Statistics

The central hub of the tele-ICU in KFSH has a log of all cases (patient encounters) which presented through the tele-ICU system. The records represent the number of cases treated within the weekly scheduled meetings plus any urgent calls.

First, I obtained the number of cases treated via tele-ICU consultation each year, which is depicted in Figure 19. The total number of consulted cases from January 2008 until the end of the study on August 2013 was 1089 cases. A graph of the number of cases each year shows a steady increase in the accumulated number of patients until 2012, as shown in Figure 20 below. The number of cases consulted via tele-ICU was increasing except for 2013 as only a 9-month period of data was collected.

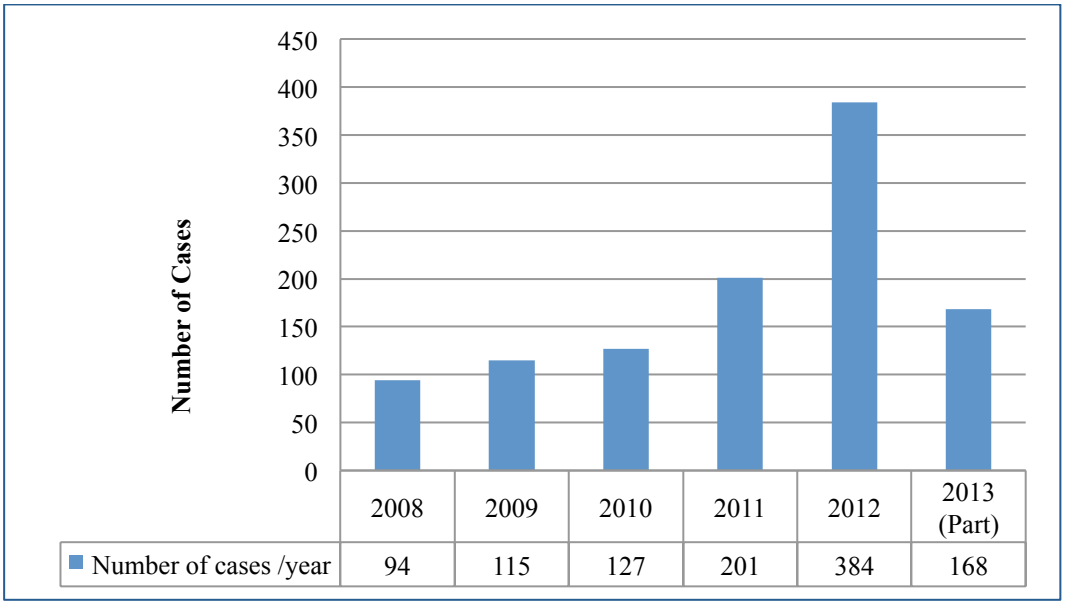


Figure 19. Number of consultations with ICU staff at KFSH via tele-ICU.

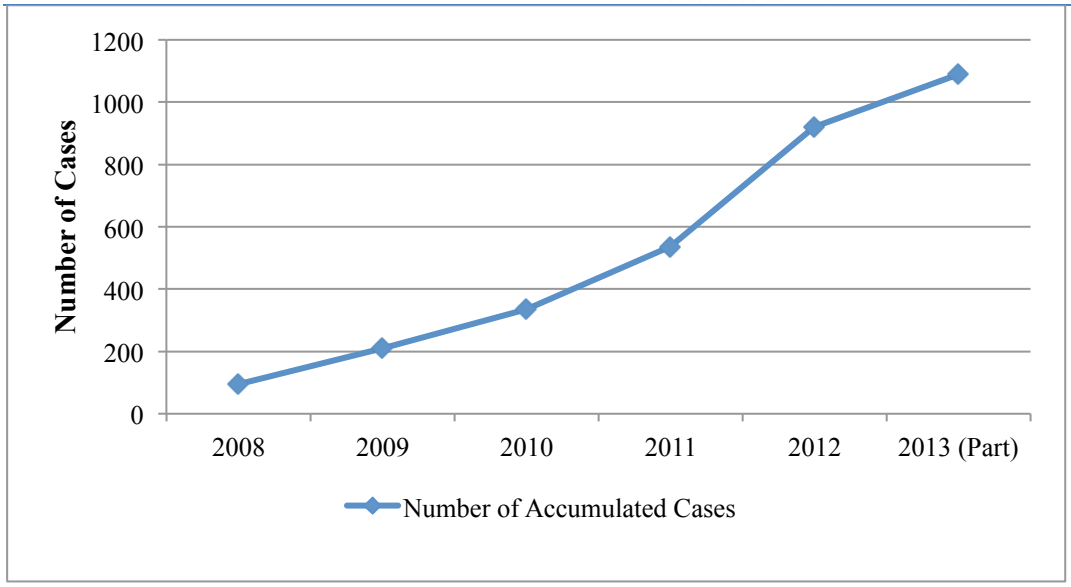


Figure 20. Accumulated number of cases from the start of tele-ICU.

In addition, I calculated the total number of cases each month from January 2009 until August 2013, this period was chosen based on the available data; this is depicted in Figure 21 below. As shown there is less utilisation of the tele-ICU system during some of the months (August, September and October). This might be related to less staffing during the end of the summer holiday in Saudi Arabia and the beginning of residency training programmes in October. .

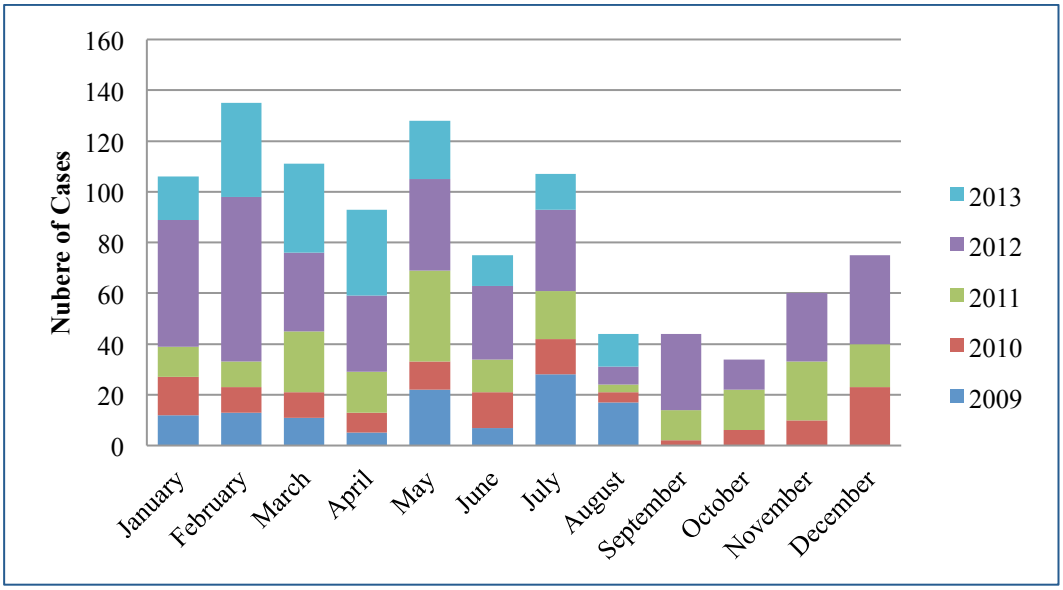


Figure 21. The total number of cases each month, January 2009–August 2013.

4.1.1.1 Centre Usage

There were 26 different hospitals connected to KFSH at the time of the study; they differed in regional location, size, and experience with tele-ICU. The usage data indicated an increased utilisation of the tele-ICU system by some centres. For each month in the 2012-2013 period, the usage statistics were ranked for all centres. If a centre was the highest one ranked for a particular month, this centre was included in a higher-usage group. This resulted in a list of nine centres and their highest number of consulted cases is shown in Table 3.

The centres presented in Table 3 are identified as high-usage centres in the study. Thus, the hospitals were divided into high-usage and low-usage centres, where the low-usage centres are the remaining centres. The compiled ranking presented is from only the last two years because the tele-ICU records before 2012 did not include the centres of the treated cases.

Table 3

The hospitals with the highest number of cases in any particular month from January 2012 until August 2013

Hospital	Highest number of cases
A	4
B	6
C	12
D	6
E	4
F	6
G	5
H	9
I	6

4.1.2 Findings from Interviews

All the 26 secondary hospitals connected to the KFSH tele-ICU system were contacted by phone or email. Of the 26 hospitals participating in the project, staff from 13 centres responded and agreed to participate in the study. The response rate was 50 per cent.

The interviewees included 13 coordinators – five of whom were nurses – 4 physicians, 1 respiratory therapist, 1 IT technician and 1 nurse. Table 4 shows the characteristics of the tele-ICU users who participated in the interviews. Seventy-five per cent of the participants were male. On average, their experience of using tele-ICU was three years, which ranged from two months up to five years. Participants had different duties with respect to the tele-ICU project.

There are approximately seven hours of interview data following the 20 interviews. The duration of each interview varied between 8–25 minutes. Moreover, 11/20 (55%) participants came from centres with a higher usage of the tele-ICU intervention. On the other hand, 9/20 (45%) participants represented the low-usage centres.

Table 4

The characteristics of the interviewees

Interviewee	Job	Gender	Length of tele-ICU Experience
1	Coordinator	Male	2 years
2	Coordinator & nurse	Male	2 years
3	Coordinator & nurse	Female	1 year
4	Coordinator	Male	3 years
5	Respiratory therapist	Male	3 years
6	Physician	Male	3 years
7	Nurse	Female	3 years
8	Coordinator & nurse	Female	5 years
9	Coordinator	Male	2 years
10	Coordinator & nurse	Female	7 months
11	Coordinator	Male	1 year
12	Physician	Male	2 years
13	Coordinator	Male	2 years
14	Physician	Female	6 months
15	Coordinator & nurse	Male	1 month
16	IT technician	Male	1 year & 2 months
17	Physician	Male	2 years
18	Coordinator	Male	4 years
19	Coordinator	Male	3 years
20	Coordinator	Male	3 years

4.1.2.1 System Usage

The participants have voluntarily shared their thoughts and input about the usage of tele-ICU facilities for this study. The tele-ICU system has both a website and video teleconferencing facilities. The participating centres are provided with an access to the secure website. They are expected to fill in a form, which has the patient's demographic

and clinical data, to organise a consultation session. Later on, video conferencing is arranged between the ICU team in KFSH and the other centre.

Most of the users were satisfied about using tele-ICU conferencing. Slightly over 45% reported that they utilise the tele-ICU website to enter patients' medical information. On the other hand, 30% of the participants reported that they knew about the website, but did not use it. As one coordinator mentioned, 'We can … use it. But it's not our responsibility.' Almost 50% of the website users were nurses. Nevertheless, the group of users who skip the use of the website to organise a session have used the phone directly to contact the central hub.

The description of the videoconferencing connection process was consistent through most of the users, and the description was as follows. First, the tele-ICU staff from the consulting canter request a meeting session with KFSH. After the time is arranged between the coordinators, an IP address to connect the videoconferencing facility is obtained. Then the consulting centre uses the IP address to start the connection for the tele-ICU videoconferencing to conduct the patients' consultation.

4.1.2.2 Usefulness

The users have shown their support and enthusiasm for the system because of its usefulness for improving the delivery of care to their patients. As one participant said, 'It's excellent … easy and it's supporting the patient and servicing the patient'. Some interviewees have shared stories about specific examples of how the system was useful to some patients.

Most of the interviewees (85%) agreed that the project is helping in their continuing education. Moreover, interviewees suggested that tele-ICU consultation might facilitate faster acceptance for patients who need a transfer to KFSH.

Different views from physicians and nurses have shown that, by using the tele-ICU facilities, physicians primarily sought advice regarding a patient's care while that patients remained under their care without being transferred to another hospital. On the other hand, nurses were primarily interested in the continuing education aspect of the system. One nurse, though it would be a great help if the bedside nurses (who provide direct patient care) for the presented case, could attend the session.

4.1.2.3 Future of Telemedicine

Most users were very optimistic of the future of telemedicine in general. As one participant said, 'I think in the near future all the health administration will be using this technology.' Participants have agreed that connecting more hospitals would enrich overall health care in the country and perhaps around the world.

Some interviewees thought that the connection of health care organisations is ongoing and they would be pleased to be part of the new changing world. One participant indicated that, 'When we want to ask about a second opinion, not just King Faisal [hospital, we] want [to connect] directly to any hospital in the world.'

4.2 Key Themes

The users have different perceptions of tele-ICU usage and they have mentioned 27 identified themes. The total number of tele-ICU user respondents was 20. When a user mentioned a certain topic during the interview - any number of times - it was counted as one occurrence. This procedure presented a count of how many users mentioned a certain theme. The different themes were placed under three main categories: Motives, Barriers, and Suggestions, as shown in Table 5 below. A description of each category, with an example of a representative quote, is presented in the next section.

Table 5

The key themes derived from the interview data

Category	Topic	Number of Occurrences *
Motives	Communication & Collaboration	16
	Continuing Medical Education	17
	Filling Gaps in Service	4
	Immediacy of Patient Access	7
	Addressing Patient Satisfaction	8
	Impact on Patient Care	17
	Providing Clinical Support	17
	Providing Quality Care	17
	Quality Improvement	16
	Reducing Referrals	7
	Ease of Use	12
Barriers	Administrative Culture	10
	Physicians' Culture	8
	Maintaining the Programme	2
	Lack of Exposure	10
	Lack of Understanding	8
	Medical Resources Availability	2
	Language	3
	Documentation	3
	Internet Connectivity	5
	Remote Accessibility	3
	Technical Support	2
	Usability	6
Suggestions	Connecting to Other Centres	15
	Continuing Medical Education Sessions	6
	Tele-ICU Training	10
	Include Nurses	2

Note: * The number of people who mentioned this issue. The total number of respondents was 20, all users of tele-ICU.

4.2.1 Motives

The respondents mentioned 11 issues under Motives, which were perceived as drivers to use the tele-ICU facilities. The most mentioned topics were Providing Clinical Support (17/20), Providing Quality Care (17/20) and opportunity for Continuing Medical Education (17/20). The second tier of important issues were improvement of Communication and Collaboration (16/20) and Quality Improvement (16/20). Table 6 below contains some respondents' quotes for each topic under the Motives category.

4.2.2 Barriers

The participants mentioned 12 perceived issues categorised under the Barriers category. The issues of Administrative Culture (10/20) and Lack of Exposure (10/20) were nominated as barriers, which users perceived as the greatest concerns for utilising the tele-ICU. The new themes that emerged from the transcripts were Medical Resources Availability and Language issues. Table 7 below contains some respondents' quotes for each topic under the Barriers category.

Table 6

Motives mentioned by the users with quotes from the transcripts

Theme	Topic	Representative Quotes from Respondents
Communication & Collaboration	Learn from each other and work with other teams	'Sometimes we feel … we are working in big hospital.' (another said) 'Communication is the best now. Through audio and video it is a very effective way'
Ease of Use	Easy use of the system	'Is so very easy. Anybody can use it.'
Continuing Medical Education	Learn from each other	'After a consultation, they are learning a lot. I know, it improve, because my observation'
Filling Gaps in Service	Overcome the lack of medical services that help health care providers	'There is a shortage of doctors … in the Kingdom of Saudi Arabia, especially consultants … With this service, we can … assure that one doctor can give the consultation'
Immediacy of Patient Access	Provided immediate access to specialist in KFSH	'For urgent critical case … only just paging the consultant at King Faisal Specialist Hospital' (another said) 'Before the patients go by themselves to another city, to doctors from higher centres, they make it easier for the patients.'
Addressing Patient Satisfaction	Patient more satisfied after the tele-ICU consultation	'We saw … patient and families happy throughout our services.'
Impact on Patient Care	Direct improvement of patient care	'Help … the patient … [so] he can go outside from the hospital and he's feeling okay.'
Providing Clinical Support	Providing second opinion to support the clinical decision care	'We have support for us in the clinical management.'
Providing Quality Care	Ensuring a high quality of care is	'The best opportunity to provide the best way managed for the patient.'
Quality Improvement	Improving the overall quality of health care provided in connecting hospitals	'[we learn] how to care about critical patients, so by dealing with that'
Reducing Referrals	Reduce the number of referring patients to KFSH	'Referring the patient to higher centre … it will take days … while the consultation through the video conference … the answer will be there [immediately]'

Table 7

Barriers mentioned by the users with quotes from the transcripts

Themes	Topic	Representative Quotes from Respondents
Administrative Culture	There is no clear plan to use the tele-ICU utilities	'As long as there is support with each [party] in administration. I mean, the support must be there, there must be a backup.'
Physicians' Culture	Negative beliefs and impressions of physicians about tele-ICU, add more responsibility	'Maybe for some doctors … they don't want to improve problem with themselves … I mean … they are thinking until this time "they are the best."'
Maintaining the Programme	Lack of motivation from users	'Dedication of the person also should be better'
Lack of Exposure	Lack of knowledge about the existence of the system	'Really, I don't know if there is a website or not.'
Lack of Understanding	Lack of awareness of benefits using of tele-ICU	'Maybe they don't use this way of communication because they ignore it. They don't [understand] it'
Medical Resources Availability	Lack of medical care resources suggested to the health care providers in the secondary hospitals like certain medications or tests	'Usually most of the time the recommendation has no available resources back in their units … or in their hospitals … So, why to consult someone, to recommend something, that I don't or I cannot do.'
Language	Difficulties with the English language	'Language barrier because it's in English, so this is one of the [barriers]'
Documentation	Difficulties with and lengthiness of data entry	'It's seems … a bit long, you know, to fill in so much information. Some information is unneeded, but unfortunately it's recorded in this form.'
Internet Connectivity	Loss of internet connection stopping the use of the system	'We prepare the patient, we prepare the file, but sometimes the connection not good.'
Remote Accessibility	Difficulty to access the system from other computer terminals	'It's not accessible for them as only in our office.'
Technical Support	Lack of support from the technical teams	'We have one technician [but] actually we are doing everything.'
Usability	Does not satisfy users' needs, or not clear to use, or the design was not user-friendly	'There is one website but [it is] not clear and sometimes not working'

4.2.3 Suggestions

There were four suggestions that participants mentioned frequently. The next two themes were the suggestions that were mentioned the most by respondents:

- Connecting to Other Centres (15/20) by having a network of connections rather than one hospital acting as a hub and connecting to all, and
- Tele-ICU Training (10/20), which would involve teaching users how to use the tele-ICU website and utilising the videoconferencing for better education for a wider range of staff including physicians and bedside nurses.

Table 8 contains some respondents' quotes for each topic under the Suggestions category.

Table 8

Suggestions mentioned by the users with quotes from the transcripts

Themes	Topic	Representative Quotes from Respondents
Connecting to Other Centres	To connect with more centres around the country to improve the overall health care system	'[connect to] all other hospitals around … in all [the] kingdom' (another said) 'Our suggestions: if possible to be [connected] with other [hospitals,] but I don't think it's easy'
Continuing Medical Education Sessions	To provide medical teaching sessions to staff to improve their knowledge	'Training, more education. Continuing education for not only technical … [continuing] education doesn't stop.'
Tele-ICU Training	To have training how to use the tele-ICU facilities	'The managers of this programme can come from their other hospital and present … a lecture for all doctors … the way tele-ICU [work].'
Include Nurses	To add more professional responsibility	'We have to include nurses because nurses have the big role in ICU.'

4.3 Data Comparison

The respondents were separated to find and compare different patterns of themes, concerning the issues they face and the suggestions they provided. The first comparison was between the staff from high- and low-usage centres (section 4.3.1). The tele-ICU centres were identified in regards to the usage statistics earlier in this chapter.

The additional comparison is between the respondents with medical responsibilities and the remaining administrative staff who did not have direct patient-care responsibilities. Thus, I grouped physicians and nurses into the Medical Staff group and separated their responses from the Non-Medical Staff (section 4.3.2).

4.3.1 High-usage Centres vs Low-usage Centres

There were 11 interview participants from high-usage centres and nine from the low-usage centres. Although both groups of users were optimistic about the usage of the system, there were some differences in the number of issues mentioned by each group. Overall, the users working in the high-usage centres mentioned more issues and had more suggestions than those in the other centres using tele-ICU less frequently.

First, the users working in high-usage centres described more Motives of the two groups, as shown in Figure 22. The Motives they mentioned more frequently were Continuing Medical Education, Impact on Patient Care, Providing Clinical Support and Providing Quality Care. Overall, the Motives they mentioned were more insightful and tangible because they were using the system more frequently.

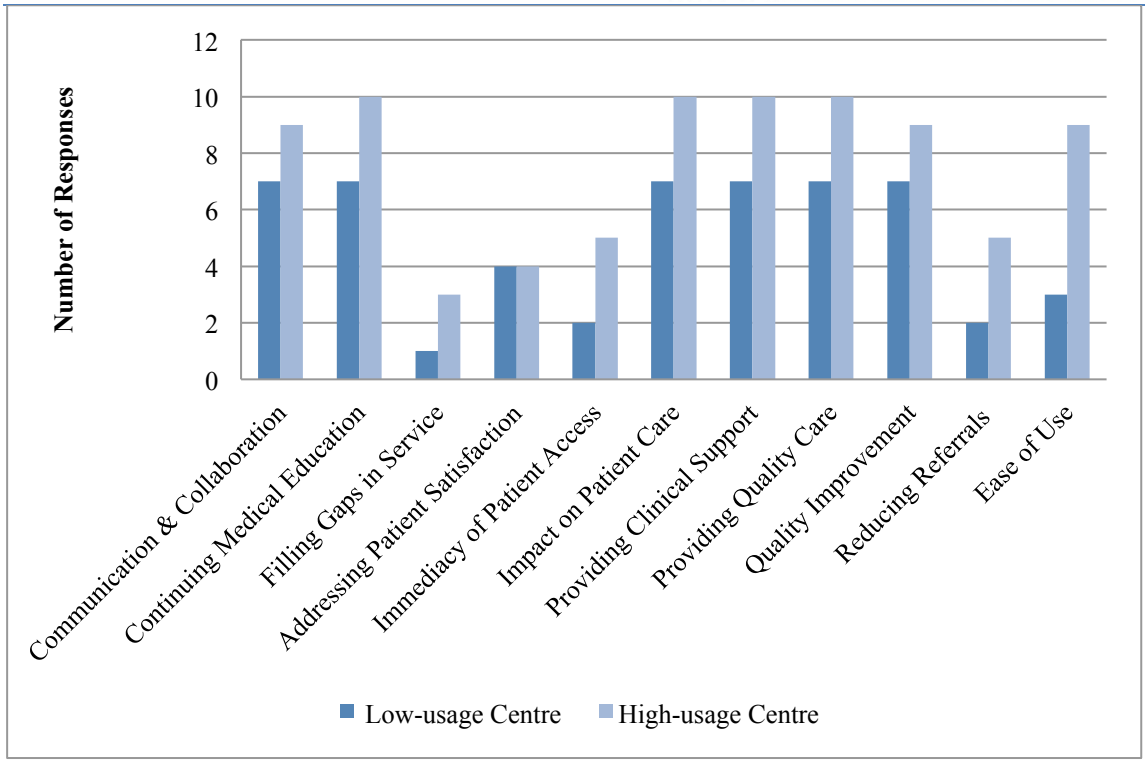


Figure 22. The number of participants from two different groups (Low-usage vs High-usage Centres) identify themes under the 'Motives' category.

Second, once more users from the high-usage centres described more Barriers than the the low-usage centres. The high-usage centre users mentioned more concerns regarding Physicians' Culture, Lack of Exposure, Lack of Understanding, Language and Medical Resources Availability compared to the low-usage centres, as shown in Figure 23. There was no difference with respect to barrier issues between the two groups regarding the issues of Administrative Culture, Technical Support, and Usability.

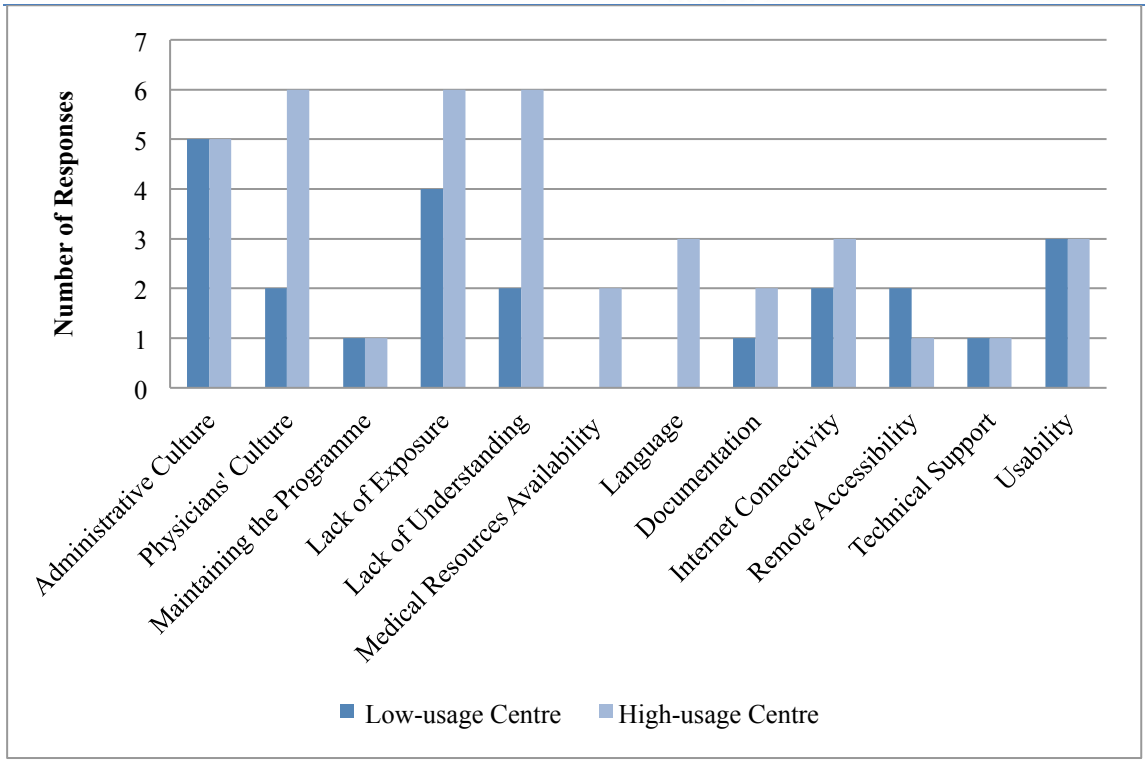


Figure 23. The number of participants from two different groups (Low-Usage vs High-usage Centre) identify themes under the 'Barriers' category.

Third, the responses from the high-usage centres have slightly more responses when providing suggestions. The most mentioned suggestion from the higher-usage centres about the future of tele-ICU and telemedicine in general, was Connecting to Other Centres and to have more Tele-ICU Training, as shown in Figure 24. Seventy-eight per cent of the Continuing Medical Education Sessions suggestions were coded from respondents in the low-usage centres, which is shown in Appendix E.

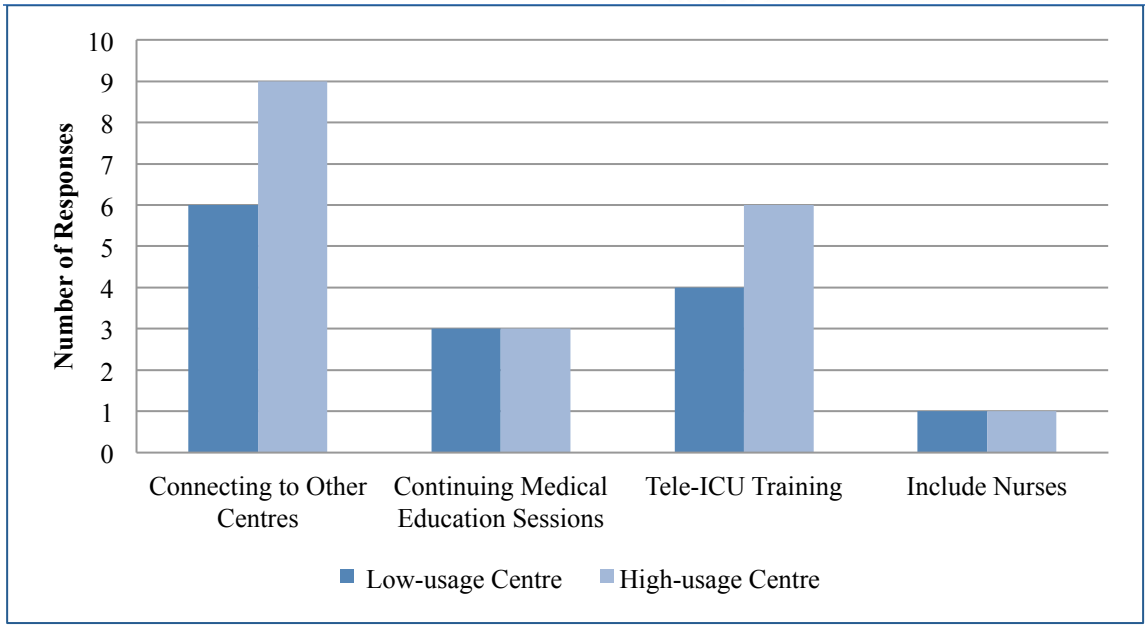


Figure 24. The number of participants from two different groups (Low-usage vs High-usage Centres) identify themes under the 'Suggestions' category.

4.3.2 Medical Staff vs Non-medical Staff

As an extra step in analysis the responses were separated with regards to the users' medical backgrounds. There were 11 medical staff amongst the 20 participants. Five of the medical staff were from high-usage centres as well. The medical staff mentioned more issues and had more suggestions.

All of the medical-staff respondents talked about the motives of Continuing Medical Education, and Providing Quality Care and all except for one (10/11) talked about the issues regarding Providing Clinical Support, Impact of Patient Care and Quality Improvement, as shown in Figure 25.

On the other hand, the non-medical Staff mentioned fewer issues around clinical care and medical education, but mentioned motives of Addressing Patient Satisfaction and the Immediacy of Patient access more frequently than the medical staff.

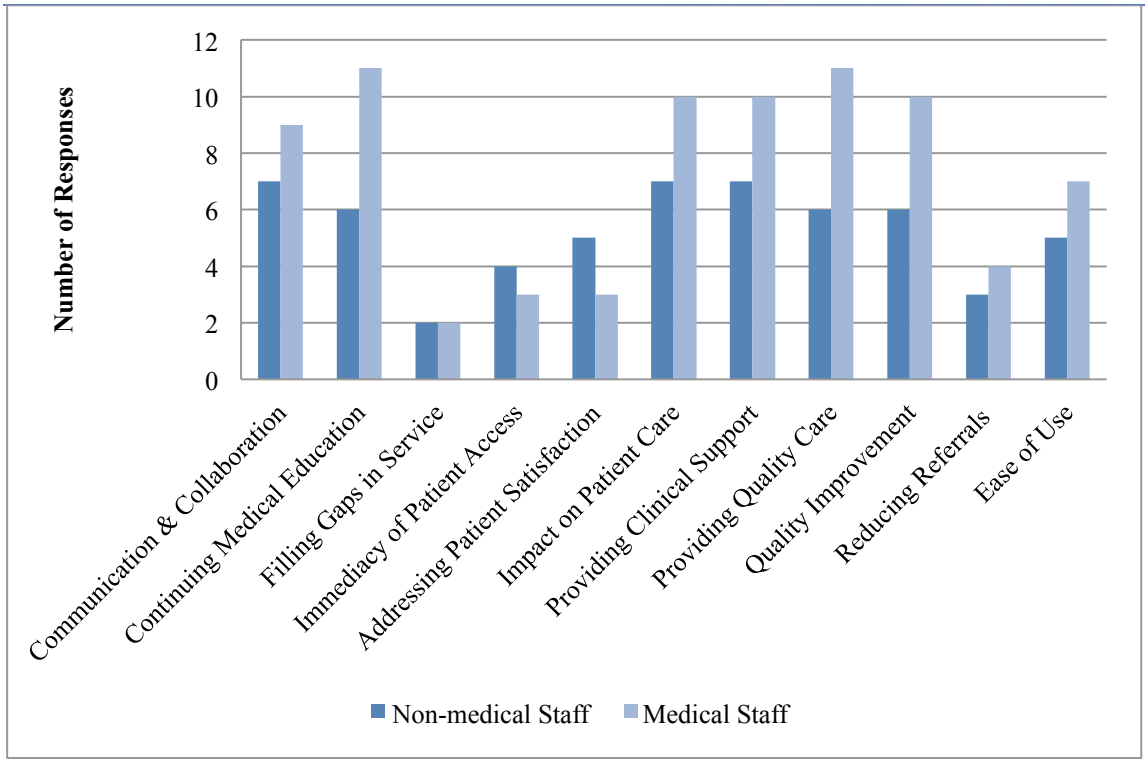


Figure 25. The number of participants from two different groups (Non-medical vs Medical Staff) identify themes under the 'Motives' category.

More medical staff respondents mentioned barriers such as Administrative Culture and Lack of Understanding than non-medical staff, as shown in Figure 26. On the other hand, more non-medical staff were concerned about Physicians' Culture and Internet Connectivity issues.

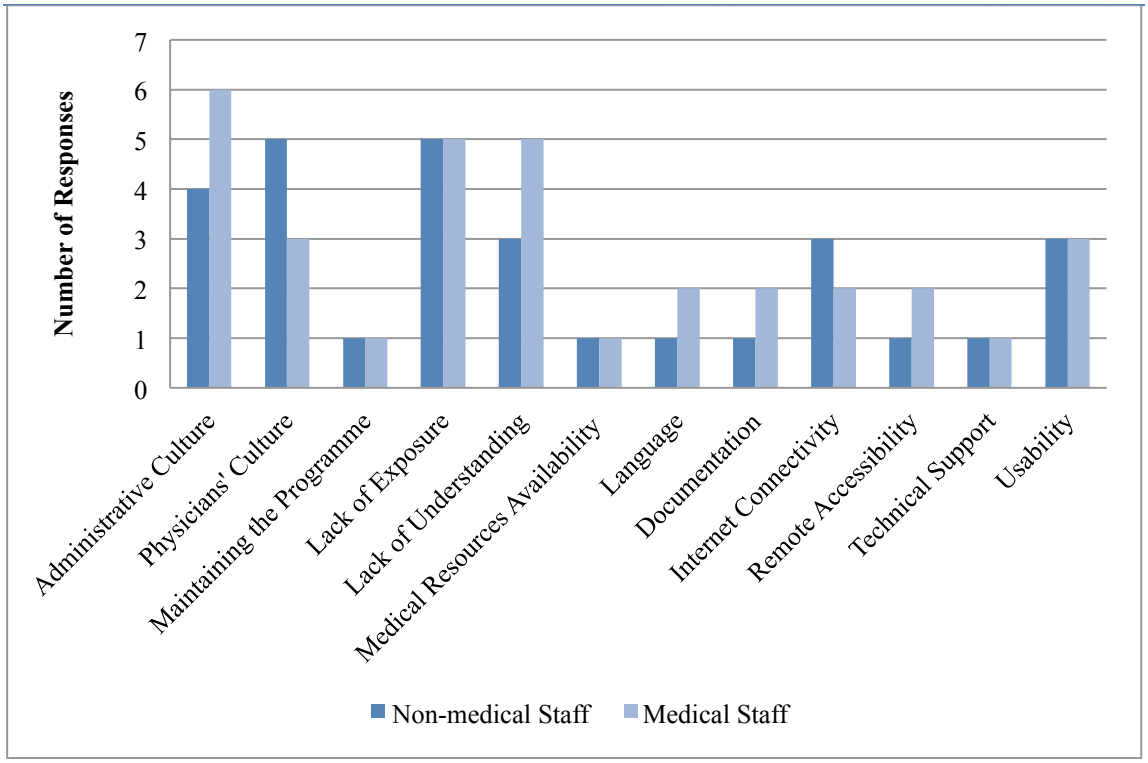


Figure 26. The number of participants from two different groups (Non-medical vs Medical Staff) identify themes under the 'Barriers' category.

Medical staff referred more often to the suggestion of Continuing Medical Education Sessions and Include Nurses (in the tele-ICU conferencing), as shown in Figure 27.

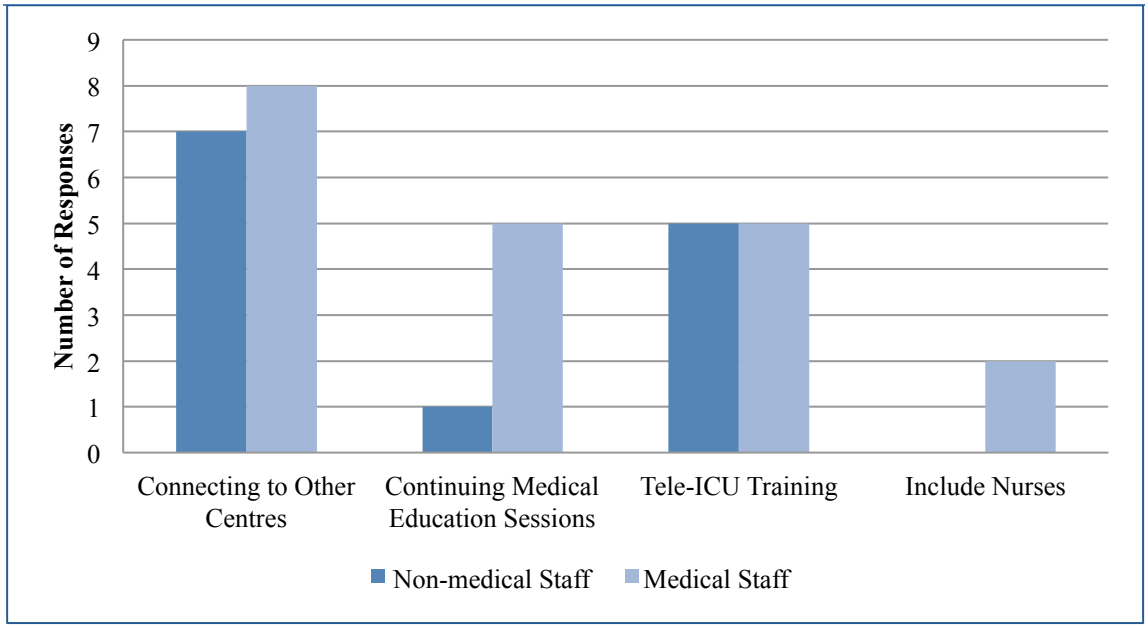


Figure 27. The number of participants from two different groups (Non-medical vs Medical Staff) identify themes under the 'Suggestions' category.

4.4 Conclusion

The data presented in this chapter were collected to provide more insight about the motives and barriers facing the tele-ICU users using the KFSH tele-ICU centre as a research model. The results of the data collection show a high level of acceptance by the users.

Using both quantitative and qualitative data analysis has yielded a more comprehensive understanding of the tele-ICU context. The users have mentioned 27 identified themes under three main categories: Motives, Barriers, and Suggestions. The most mentioned topics under Motives were Providing Clinical Support, Providing Quality Care and opportunity for Continuing Medical Education. The issues of Administrative Culture and Lack of Exposure issues were nominated as barriers. The suggestions that were made were regarding Connecting to Other Centres and Tele-ICU Training as a means of improving the usage of tele-ICU.

The data showed different perceptions of the users who are working in centres utilising the tele-ICU services more frequently. The Motives they mentioned more often were Continuing Medical Education, Impact on Patient Care, Providing Clinical Support and Providing Quality Care. The data showed different patterns of users' perceptions working in different roles, such as medical and administrative staff. The members of the medical staff were motivated to use the system more for Continuing Medical Education, and Providing Quality Care. In the next chapter, I will discuss the findings with respect to the earlier literature.

Chapter 5. Discussion and Conclusion

5.1 Introduction

In this chapter, I will first answer the research questions based on the findings in section 5.2. Then, I will discuss the study results and relate them to the previous literature, from both the usage statistics (section 5.3) and the interview data (section 5.4). I will then discuss the methodology chosen for this study along with the reason for choosing those particular methods in section 5.5. The conclusion of the study is in section 5.6, including suggestions that are applicable to the system. This chapter will conclude with an overview of the study's limitations (section 5.8) and the possibilities for future research (section 5.9).

5.2 Answering the Research Question

I have conducted a case study evaluation of a tele-ICU project in Saudi Arabia from the perspective of staff in order to answer the main research question which was stated in chapter one (section 1.5):

> What are the perceived motives and barriers the tele-ICU staff in Saudi Arabia identify? Are there any improvements that have to be considered from their perspective?

The tele-ICU users have expressed many motives for using the system; they have also presented issues that have been identified in the results. The most important factors in the motives category as identified by the users were Providing Clinical Support, Providing Quality Care, and Continuing Education. The barriers that were identified most frequently occurred in the categories of Administrative Culture and Lack of Exposure.

The statistical data showed a progressive increase in the number of patients who were cared for through the tele-ICU service. Finally suggestions to improve the tele-ICU

project have been presented. The most frequent suggestions were Connecting to Other Centres and Tele-ICU Education.

And to answer the sub-questions …

1. How have users in the regional hospitals interpreted and approached the use of tele-ICU?

   The users understand the usage of the teleconferencing aspect of the system but not all the staff uses the website. Some staff members have reported that they did not know it existed.

2. Does the tele-ICU staff working in high-usage centres have different perceptions of the system than staff working in other centres?

   Users from the high-usage centres have a clearer idea about the issues they are facing, thus they are more articulate about their issues.

3. What are the different perceptions between medical staff and non-medical staff about using the system?

   Members of the medical staff were more concerned about patient health.

5.3 Usage Statistics

The total number of consulted cases from January 2008 until the end of the study on August 2013 was 1089 cases. That is an average of 189 cases per year with a progressive increase in the number of cases from 2008 to 2012. There was an apparent drop in the number of cases consulted through tele-ICU in 2013 (shown in Figure 20) as only nine months of that year are included.

The number of cases was obtained as a reference for tele-ICU usage which has been shown to have a positive correlation with users' satisfaction, as confirmed by Chatterjee et al. (2009). The progressive utilisation of the system over the years suggests that users

of the system viewed it as successful and as a useful tool, as shown from the interviews. On the other hand Petter and McLean (2009) and Lau et al. (2007) considered the relationship between usage and user satisfaction to be weak.. Moreover, van der Meijden et al. (2003) have argued that more usage does not mean the system is successful.

Cummings et al. (2007) have provided a distinction between open and closed ICU models. Most tele-ICUs described in the literature are using the closed ICU model, where the intensivist has full responsibility for the remote patients. Most tele-ICUs described in the literature (see Hoonakker et al., 2013; Moeckli et al., 2013; Shahpori et al., 2011) are using the closed ICU model, where the intensivist has full responsibility for the remote patients. The open ICU model was adopted by KFSH in Saudi Arabia. The patient management is administered by KFSH staff members, who do not have treatment privileges in the connecting hospitals, and have responsibilities in their own ICU as well. In addition using the closed ICU model requires much more in the way of human and financial resources. The closed ICU system can be used for a smaller number of connecting hospitals, on the condition there is a dedicated staff just for tele-ICU services.

In terms of the number of cases, a study by Zawada Jr. et al. (2009) reported on a tele-ICU intervention which utilised the open ICU model, covering three community hospitals and over 229 rural sites, and which treated 5146 cases over two years. On average there were 11 cases per year per centre. Another study – by Thomas et al. (2009) – reported that the tele-ICU intervention in 6 ICUs treated 2108 cases over 2 years. That made an average of 176 cases per year per centre. The variation in numbers could be related to the model of ICU they adopted. The open model used in the tele-ICU in the study by Zawada Jr. et al. (2009) might have treated fewer patients because the

bedside staff are responsible for their patients' health, thus there is no need to consult about all patients. However, the study by Thomas et al. (2009), which used a closed ICU model in the tele-ICU, did have to consult about all patients. Thus, KFSH adopted the open model and have an average of eight cases per year per centre.

DeLone and McLean (2003) have argued that no system usage is entirely mandatory because, at some level of the organisation when a higher management has chosen to implement a system, the actual use of the employees will be variable depending on acceptance of the system. In this study, because it was not mandatory for all the tele-ICU staff members to use the website, some did not know it existed. There was variable utilisation of the system by different hospitals; this might be because of variable needs or their perceived usefulness. There has been a steady increase in the number of cases per year which might be secondary to the realisation of the benefits of the system and adoption of this new technology.

5.4 Interviews

As has been mentioned many times in recent publications, the research on tele-ICU is limited and needs to be enriched in order to understand the issues facing the users. Such issues could be a predicting tool used to measure the future of this technology. The data gathered by this study gave a comprehensive picture of what tele-ICU users are experiencing, and it appears from the data gathered that most of them are satisfied about it. As one participant said, 'It's excellent and it's easy and it's supporting the patient and servicing the patient, and it's useful.'

The tele-ICU in this study has three components: the first component is the tele-ICU designated database in the KFSH servers. The second is the access to the database within the website portal that provides the list of patients. The third is the videoconferencing facilities used in secure channels designated within the network

between participating hospitals and KFSH. This is similar to the tele-ICU setting described by Sapirstein et al. (2009) which had three key technological components: the tele-ICU information system for patient data including medical records and laboratory results, the user-interface to access indexed patient records, and the communication network between the hubs. The Saudi system is characterised by flexibility in connection to different networks. As one staff member explained, 'If we are on a different network, we can still connect you. If you are [on] the same network, if we are connecting through VPN or VPM, we can still connect.' And with respect to security concerns one participant explained, 'If you update something, it will show that logs, that time, that case, it's been updated.'

In the beginning of the data analysis it was rather difficult to include the motives and barriers that have been mentioned in the large amount of telemedicine literature. Thus only a few papers were considered to build the code book analysis of the interview findings: they were Rogove et al. (2012) and van der Meijden et al. (2003). This was to ensure that the findings were relevant, coherent and able to be used.

5.4.1 Motives

5.4.1.1 Ease of Use

The website was initially designed and implemented by an ICU physician who felt the need for such a system, and it was then adopted by the health outreach in KFSH who added the videoconferencing facilities to all the hospitals. Thus, KFSH was established as the central hub connecting with the other centres. Further, the health outreach enhanced the original website by adding vital signs and reallocating the internet portal through the KFSH website, and used it as the main database centre. One participant explained that the website has helpful features. He said, 'The website contains all the

information about the patient, like his radiology report, his laboratory results, medical report that the doctor can write it in the video, how old, contact number of the relative, everything is mentioned in the website.'

5.4.1.2 Impact on Patient Care

In this study, all the medical staff reported that using the tele-ICU provided quality care for their patients. Thus, the main objective of users is to improve the health of their patients, which is the main objective of any telemedicine programme. However, the effect of tele-ICU on patient health cannot be measured directly in this study design. It would have been difficult to gather and calculate the mortality rates for all 26 hospitals covered in the study, especially given all the factors that might also alter the outcome. Also there was no follow-up information on the patients' health that had been saved in the system.

There are few studies which showed a decrease in the mortality rate after the implementation of tele-ICU (Breslow et al., 2004; Rosenfeld et al., 2000; Thomas et al., 2009). Breslow et al. (2004) showed a decrease in the hospital mortality rate from 12.9% to 9.4% with a confidence interval between 0.55–0.95 after implementing tele-ICU. However, that result has been criticised and it may be that another intervention used in the hospital changed the outcome and was not measured. Thus, more research on hospital mortality rates would clarify the impact of a tele-ICU system.

The results gathered in this study support the positive impact on patient care, based on the interviews. Seventeen of the 20 participants referred to the positive impact on patient care and providing quality care as well. Some researchers have identified the positive impact on patient care after utilising telemedicine, like Cummings et al. (2007), van der Meijden et al. (2003), and Young et al. (2011). Further, Berenson et al. (2009)

found that the impact on patient health is one of the main motivations for staff as well. Moreover, utilising tele-ICU would increase the compliance of the evidence-based practice by bedside staff in the connecting hospitals which would likely affect the patient outcome as suggested by Sapirstein et al. (2009) and Chu-Weininger et al. (2010).

5.4.1.3 Clinical Support

In this study, almost all of the medical staff reported their motive in using the system is to get clinical support. However, Khunlertkit and Carayon (2013) have shown that tele-ICU has no impact on patient care processes and clinical practices. But, the technology was not accepted by their study participants, which suggests that user acceptance is an important factor before the utilisation of the system. Thomas et al. (2009) have raised the issue of the importance of the acceptance of the bedside caregivers that would influence patients' care.

5.4.1.4 Continuing Medical Education

In this study, most participants mentioned continuing medical education as one of the main motives of using tele-ICU. One of the main objectives of telemedicine is providing education for health care professionals, as stated by Lazakidou (2006), Yoo and Dudley (2009) and Hjelm (2005).

5.4.1.5 Written Communication

The tele-ICU utilities allows an exchange of information between the consulting hospital and the main hub in KFSH ICU by written and verbal tools in order to get advice regarding patient care. The connecting hospital starts the process by completing an electronic form which includes all the patient's medical information. Then, a videoconferencing session is scheduled which results in advice being given regarding

the patient's treatment. However, the findings have shown that many centres did not use the website and therefore skipped the written communication completely and went directly to ask for the videoconferencing which was an easier step.

One participant mentioned the importance of the documentation and was very happy about the feedback from KFSH through the tele-ICU website. He said, 'after discussion, they send …[the] feedback to us [in writing] using the tele-ICU website and this makes communication 100% [better].' Mutual understanding is very important in the communication of common goals for patient care. Sapirstein et al. (2009) have stressed the importance of having written communication after the use of the intervention to ensure the conciseness of the understanding between the clinicians. One research paper studied the correlation between the agreement of common goals documented in the ICU and confirmed such agreement increases collaboration and decreases a patient's length of stay (Collins, Bakken, Vawdrey, Coiera, & Currie, 2011).

5.4.1.6 Other Motives

One of the main motives for using telemedicine referred to in the literature is the reduction in patients' travel. Since this case study is focused on critical patients who are admitted to the intensive care units, the patients are not fit to travel by themselves. The programme will provide a consultation to the bedside health care provider in the local hospital and therefore will ideally reduce patient transfer to a tertiary hospital with its associated costs. One participant indicated that the tele-ICU system 'saves a lot of time … [because] patients suffer from travelling from here to King Faisal Specialist Hospital.'

In this study, participants did not mention the reduction of costs as a motive to use the tele-ICU services, although this has been referred to in the literature several times, for

example Zawada Jr. et al. (2009) and Kumar et al. (2013). I speculate that the reason is that all the hospitals associated with KFSH provide free services to patients. Moreover, the KFSH management is responsible for the set-up and the running costs of the programme, thus it did not affect the users' perceptions.

5.4.2 Barriers

5.4.2.1 Lack of Understanding

After conducting the first few interviews, I came to the understanding that not all the centres are utilising the website. The results showed that all the participants have experienced using the tele-ICU utilities, but had different understandings of the system and how it works. Most participating staff knew exactly the process of connecting the videoconferencing facility. On the other hand, some users did not have a full understanding of how to use the website. Some do not use it and others did not know of its existence. A study by Moeckli et al. (2013) found that the tele-ICU staff's understanding of the technology and their expectations were assumed to be significant barriers to the increased utilisation of the system.

5.4.2.2 Lack of Exposure

Even though I have interviewed users of the tele-ICU, 10 participants perceived the lack of exposure as one of the main barriers to using the system. In addition the lack of knowledge could be a barrier as suggested by the findings of El-Mahalli et al. (2013), who have mentioned that the lack of knowledge about telemedicine technology among health care professionals is one of the main barriers in Saudi Arabia.

5.4.2.3 Physicians and Administration Culture

Breslow et al. (2004) stated that most health care providers recognise the potential benefit of tele-ICU intervention but it remains a challenge to increase the usage. In this

study a few participants reported that some of the caregivers were resistant to changing their model of care and the standard practice plans that they were using before the intervention. (This was coded under 'Physicians' Culture' barrier). Cummings et al. (2007) have acknowledged that physicians can be one of the key barriers of implementing telemedicine since they might perceive it as a threat to their known work environment and some are not comfortable with new technologies.

Therefore good leadership which supports the use of the technology is very important. Although the health outreach programme gives their support to all centres, there might be less local support or motivation from all the connected centres. And this links to the Adminstration Culture barrier as well. Thus if there is a clear plan to utilise the tele-ICU intervention, the caregivers would change their model of care to incorporate the use of the new system.

One of the participants mentioned that the change from everyday routine, which is already hectic, by adding yet another task is usually hard for staff to adopt. This factor is agreed by Moeckli et al. (2013) who indicated that the implementation of tele-ICU on existing ICUs could disturb the usual workflow, workload and usual-practice culture of the system. Thus in this study, although the centre management may support the system, they may need to provide motivation to their staff. This brings the discussion back to the adoption of the new technology and how to expedite it.

In this study ten of the participants mentioned administrative barriers that can affect the tele-ICU use. This finding contradicts the opinion of Rogove et al. (2012) who indicated that hospital management is not a barrier to tele-ICU implementation. However, in this study management may not be the direct barrier but there might have been additional issues that were directly related to management that were not revealed by the findings.

Or, perhaps there are differences in management cultures in the two tele-ICU contexts between the two studies.

5.4.2.4 Confidentiality

Shahpori et al. (2011) reported on a telemedicine system that was less utilised by health care staff and identified that staff had significantly less positive views about patient confidentiality. In this study, only one participant indicated confidentiality was an issue he was concerned about.

5.4.2.5 Other Barriers

Most of the technology that was reported in the literature review has 24/7 support of tele-ICU nurses or physicians, monitoring patients by cameras in the patients' rooms. However, this does not apply in the tele-ICU setting in this study, because I think it would be unconventional for the staff in the other hospitals who may feel that KFSH are watching their moves, as explained by Hoonakker et al. (2013). Some bedside users reported that they believe the main centre was watching them and felt that they may take over, a barrier which has also been reported by Kumar et al. (2013).

5.4.3 Suggestions

5.4.3.1 Connecting to Other Hospitals

The most frequent suggestion by 15 participants was connecting telemedicine facilities to other hospitals. However, there was no literature that explicitly raised the issue of connecting more hospitals; it was rather a future vision from most researchers. Probably because most participants were enthusiastic about the future of the system they think the system has to expand to more centres.

5.4.3.2 Tele-ICU Training

In this study, 10 participants mentioned that they needed more education and training on tele-ICU usage. Several studies agreed on the importance of continuing education and training in the health care system which is vital for effective implementation (see Rogove et al., 2012; Ward et al., 2008). Cummings et al. (2007) have stressed the need to have a defined level of intervention in patient care by the central hub staff that has to be clear to all clinical staff. Thus, providing training for all staff who are using the intervention is critical so that all staff members know what is expected from the intervention.

The tele-ICU management in KFSH that is responsible for programme implementation conducts site visits and meetings, as mentioned by some participants, to ensure that the system is running efficiently. The tele-ICU central hub schedules occasional lectures to provide continuing education through the teleconferencing facility in the tele-ICU system.

Therefore, the reason behind the large number of suggestions may be because some of the participants did not know about the lectures or were too busy to attend. In my opinion, if webcasting could be used to convey the lectures on the tele-ICU website, this might allow easier access for different users from different places in the connecting hospitals.

Moreover, one participant suggested the technology should be mobile to make it accessible for users at the bedside. He said, 'If the doctor really needed ... [a] consultation, maybe they will bring only their iPads and … [go to] the patient now.' The issue arising from using portable computers would be the confidentiality of patients' information.

5.4.3.3 Campaigning

The tele-ICU management have been campaigning through social media about their services. However, one participant mentioned the need for increased awareness of the existence of the system and its services. She said, 'We actually need good advertisement, promotion, they should promote this.' Therefore it might need more aggressive campaigning especially within the medical field.

4.3.1 High-usage Centres vs Low-usage Centres

In this study, the staff in high-usage centres have similar perceptions of the tele-ICU motives and barriers when compared to the staff working in low-usage centres. However, more barriers and motives were mentioned by high-usage centre staff as they are more experienced with the system and thus have more insight.

5.4.4 Medical Staff vs Non-medical Staff

The motives of the medical staff, including physicians and nurses, were focused on continuing medical education, and providing clinical support and quality care which were mentioned more frequently by this group than by non-medical staff. I also noted that nurses were more interested to use the tele-ICU system for continuing medical education as compared to physicians who want to use it mainly for clinical support.

Ward et al. (2008)) found different levels of enthusiasm among nurses and doctors about using the new technology. In their study, physicians attached more importance to patient care improvements. On the other hand, the nurses were more interested in the continuing education aspect of using the new technology. In this study, I have found the same differences in the interests of nurses and doctors. Both agreed that continuing education is one of the main motives of utilising tele-ICU. As Zawada Jr. et al. (2009)

affirmed, the tele-ICU was intended to extend the knowledge of the critical care clinicians.

5.5 Methodology

In this section, I will discuss the evaluation models found in the literature and the reasons for not utilising them in this study. Then I will discuss the case study methodology used for this study.

5.5.1 Evaluation Models

There is a need for an evaluation framework to evaluate the effectiveness of a health care system, as emphasised by Whetton (2005). Based on the literature review, I found a few models that could have been used to implement an evaluation study, but they did not fit the tele-ICU context or could not answer the research questions.

I first examined the use of the success model, which was built by DeLone and McLean (2003) – as discussed in Chapter 2, Figure 9 – to carry out the evaluation of the tele-ICU project. However, the model was originally designed for informational systems, whereas the setting of the tele-ICU is different. Also, the factors which were examined have different criteria to the ones that were used for evaluating tele-ICU in the literature. Tele-ICU is considered a second opinion technology which is not an information system. As a study by Häyrinen et al. (2008) applied the success model to explore the purpose of reviewed studies on evaluating electronic health records (EHR), which is an information system.

And I did not use behaviour models as evaluation models because their focus is on users' behaviour only rather than exploring the general context of the tele-ICU. Lee et al. (2012) compared three behaviour models used in health care systems, TAM, TRA

and the theory of planned behaviour. Lee and his colleagues suggested that external factors may not be visible to the behaviour models they investigated.

5.5.2 Case Study

The chosen methodology for this study was a case study, using qualitative and quantitative data to have a better understanding of the staff perception of the tele-ICU. The design of the method was clear in the early stages of the research, which was important in order to address some concerns about the use of a case study methodology. The issues that had been identified by researchers were the lack of rigour, the limited basis for scientific generalisation, and the lengthy duration of conducting such studies resulting in massive documentation (Yin, 1994).

First, to overcome the possibility of a lack of rigour in *this* study, I followed specific principles as discussed by Yin (1993) and Bashshur et al. (2005), to obtain the data and analyse it. A case study can investigate an empirical topic by following a set of pre-specified procedures (Eisenhardt, 1989; Yin, 1994). In a further step to ensure the rigour of the findings I used source triangulation to accommodate both subjective and objective understandings. Triangulation is used in case study research to increase the validity of the case study (Bashshur et al., 2005; Stake, 1995).

Second, to address the issue of a limited basis from which to generalise the findings, the findings of this study could be generalised to situations *with a similar context* (Turunen & Talmon, 2000). Thus, I think the results of the evaluation of this tele-ICU project could be useful for other hospitals with similar settings and users of similar backgrounds. As Yin (1993) has pointed, case study evaluation produces explicit theory about the context from which the case has been developed. New tele-ICU systems can

improve their designs after the evaluation. Seale et al. (2004) explained that context-dependent knowledge develops a base for experts to build new knowledge.

Finally, it was important to gather a reasonable number of interviews and documentation, but without excess, as few hospitals are implementing the same system. Data were also collected from a secondary source, which was the number of consulted cases for those hospitals. And interviews were conducted with a representative number of the different users.

5.5.3 Qualitative Methods

The ethics consent and anonymity of the participants were very important and discussed with each participant, which added to the quality of the analysis and, accordingly, the findings could be extended to benefit society, as argued by Gibbs (2008). The key for analytical work in evaluation studies is to have a clear definition of what the system is and take into account the differences in settings (Rahimi & Vimarlund, 2007). Some issues were reported in the literature concerning the use of interviews as a data collection method. Hamilton (2005) argues that verbal self-reporting can be accurate and inaccurate at the same time depending on influencing factors.

The transcripts were reviewed against the original recordings to ensure the content was fully accurate. Checking the transcriptions was a time-consuming process but provided a greater reliability of the data. The search results depend on the underlining coding quality, thus consistency of coding was important or else the results may have been affected (Gibbs, 2008).

I have attempted to provide as much description possible to provide complete information about the results, as one of the main concerns with respect to quantitative data is to provide rich description. Moreover, reducing the number of codes and keeping

the hierarchy shallow so as to keep most lists to two levels is very important, as suggested by Gibbs (2008).

LeRouge et al. (2007) have pointed out that qualitative studies are subjective and may be biased, but can be validated by rigorous methods. Thus, I have thoroughly followed the approaches of Auerbach and Silverstein (2003) and Gibbs (2008) in the coding analysis phase to ensure the results are reliable.

Auerbach and Silverstein (2003) proposed three criteria to justify the subjectivity of interpreting that data: transparency, communicability and coherence. Transparency means another investigator can know about and check what was done; communicability means that the categories made sense to both participants and investigator; and coherence means that the categories were both internally consistent and reflective.

Moreover, Gibbs (2008) discussed the importance of the validity, reliability and generalisability of the results to ensure a study is of high quality. Examining different experiences, ages, attitudes, or social backgrounds in order to produce validity when dealing with negative cases, increases the richness of the coding.

5.6 Conclusion

The rapid pattern of change in health care recently has to be considered in any study of telemedicine (Currell et al., 2010). Hence, the results of this study on health care systems could vary depending on what changes occur in health care structures and values. Thus there is an opportunity to conduct studies in the context of health care systems to construct further theoretical insights that may guide the future of health care (Doolin, 2004). Evaluating existing systems, such as the tele-ICU system, to discover the effects of such a system and explore any improvements that could be made is a good

step. Field (1996) has stressed the need for telemedicine evaluation after implementation to assess users' acceptance.

There is an increased need to employ systems reaching the vast rural areas in the kingdom of Saudi Arabia by connecting them with larger tertiary hospitals. An evaluation of an active and successful system would provide an insight into their practices. In addition, an evaluation may improve outcomes in the future and enable the expansion of the system.

In this study, the focus was on the users and their views of the tele-ICU intervention to enrich the quality of their patient care. As one physician said, 'Every case is a knowledge. Every case is like a mathematic equation.' Then she said, 'To provide for my patients the best – especially critical, very critical patients – that they cannot be moved from a place to another.' The aim of this study is to address the issues facing the real users of the tele-ICU project in Saudi Arabia and, more specifically, to underline the benefits and the problems facing them by using the system. Moreover, the study explored the suggestions that may improve the experience of the users and potentially expand the system.

Based on the results, the chief barriers which were identified were issues under the categories of Administrative Culture and Lack of Exposure. The chief motives identified by the users were Providing Clinical Support, Providing Quality Care, and Continuing Medical Education. The main suggestions were Connecting to Other Centres and Tele-ICU Training. The users working in the high-usage centres mentioned more issues and suggestions than the other centres using the intervention less frequently. Furthermore, medical staff referred more often to the suggestion of having Continuing Medical Education sessions.

All participants were excited about the future of telemedicine and what it may bring. As one participant imagined, the future of telemedicine would be like a social network that connects every health care provider. She said, '[It] will like you talk on Facebook.' But everyone would have to work hard every step of the way to ensure its bright future. As one participant explained, 'We start crawling, and after that, we will walk.' This shows that it may be difficult in the beginning but later the patients would receive greater benefit.

5.7 Contributions of the Study

This study made a contribution by describing the users' perspectives of the tele-ICU in Saudi Arabia, which is lacking in the current literature. Furthermore, there is a lack of studies on users' perceptions on health care systems in Saudi Arabia, as mentioned by El-Mahalli et al. (2012) and Khalifa (2013).

This study has provided a rich description of the tele-ICU setting and processes that have been adopted in Saudi Arabia and, as far as I know, it is the only research discussed from Saudi Arabia. The results have shown the tele-ICU users' positive experiences and identified the contribution of the systems to patient care.

More importantly, this study has revealed the real motives that encourage the users of this technology to continue their usage. The results show some barriers as well that have been mentioned by the users which could be considered in future implementation. This study has provided some suggestions mentioned by the users for this tele-ICU project that could be generalised to similar telemedicine systems and that could be implemented in similar setting. The suggestions derived from the users are presented in Table 9Table 9.

Table 9

Suggestions derived from users' responses

General Suggestions	Representative Quotes from Respondents
○ More meetings with other centres to promote evidence-based practice.	'Meet with us … all the hospital [staff knowledge] will be increased'
○ More involvement by other health organisations in utilising this technology.	'All ... health [care] administration …[should] be using this technology'
○ Frequent connection and the sharing of cases from KFSH for educational purposes.	'If it connected more frequent. Whatever the cases we can discuss it at the higher centre that will be more benefit, and if they will have critical care symposium once or twice'
○ A presentation by the doctors of one case at least every week to KFSH in order to share their knowledge and receive some evaluation and feedback.	'cases we can discuss it at the higher centre that will be more benefit, and if they will have critical care symposium once or twice [a week]'
○ Involvement of more staff members in the processes and training.	'[staff] involvement [from] our administration [to be] involved'
○ Service availability to all departments and specialities (not only ICU), in order to allow more people to utilise it.	'[To make the service] available to all this centre department it will be more easier and more people will take part'
○ An advertising campaign to alert people to the system and its value.	'I think it needs campaigning for this one ... We actually need good advertisement, promotion.'
○ A shortened, more user-friendly form,	'To shorten it a little bit, just to include only the [important] information'
○ A bilingual form and feedback in both Arabic and English to make it easier for everyone to use.	'If we can have a bilingual form, Arabic and English'.
○ Enhancement of the interface to allow bedside clinicians to enter the data themselves, which would make it easier and more motivating for them.	'[If] ICU doctors or sisters are interested in enter[ing] the data themselves, then it will be easier and more interesting to them.'
○ Revision of the development of the website every few months.	'[Maybe if] they develop it every three to four months.'
○ More accessibility through portable devices for mobile users like physicians and caregivers.	'They will bring only their pads … [at] the patient [side] now … and right away … they will [use] the technology.'
○ To have a direct connection between the patients' health records in the hospitals' databases and the tele-ICU databases.	'connect to our system, to this office. They can't directly the explain an investigation.'

I reviewed the telemedicine literature about systems training and educational plans, since education was one of the main suggestions of the participants. A number of papers have emphasised the importance of staff training to execute an effective system. Thus, some suggestions for the training plans have been compiled, as shown in Table 10, to help design the training plan in future telemedicine systems.

Table 10

Suggestions for education derived from the literature

Suggestion	Adopted From
○ Having a robust training and a clear educational plan before considering the new technology and an assessment of the organisational readiness is key for a successful outcome	Shahpori et al.(2011) and Ward et al. (2008)
○ Having an ongoing training and educational plan for the entire tele-ICU staff to first introduce the new technology and later to provide consistent explanation of the workings of the system and its possible outcomes	Rogove et al. (2012) and Young et al.(2011)
○ Allocating resources for the education and training of the tele-ICU staff and for continuing evaluation would result in the rapid, successful adoption and use by the staff	Moeckli et al. (2013) and Shahpori et al. (2011)
○ Including key staff and clinicians in the planning of the system, with proper training and education about the system, would ensure the success of the system	Moehr et al.(2006)

5.8 Limitations

As mentioned in several evaluation studies, the results of user's perceptions could not be generalised to all tele-ICU users. Thus the attitudes and the perceptions of the tele-ICU staff in Saudi Arabia could not be generalised to other projects, unless there was a similarity of culture and systems organisation. However, in comparing the issues expressed by these users with users in other centres with similar experience, the results could be linked (Hoonakker et al., 2013).

This study focused on the current users of the system, but not on all the potential users who are working in the connected tele-ICU centres, who do not partake in the intervention. Initially, I wanted to enquire about the lack of use, to find out the reason behind their lack of use and the problems are they facing. I have specifically contacted the centres who did not use the tele-ICU equipment which is already set up in their hospitals, but there was no interest in participating in the study.

The interview questions used in this study were somewhat broad and thus the participants did not express all the issues that had been mentioned in the literature as shown in the discussion. However, the purpose of having general and broad questions was to obtain better understanding of the participants' views without imposing any pre-existing ideas from the researcher.

An alternative approach would be to collect observational data about the real usage of the system to validate the interview findings. However, it was considered too inflexible to be approved as the tele-ICU management were concerned about the privacy of the patients' information and its protection. Moreover, obtaining ethics approval would have required more time as there would have been a delay while waiting for the application to be processed.

5.9 Future Work

A subsequent step after this study would be to collect questioner data to validate the findings of the interviews which could be distributed to all tele-ICU users. A future observational study attending tele-ICU sessions would confirm the strengths that keep the programme running and may reveal any potential complications in the system.

Another interesting project could enquire about the lack of use from staff working in centres which has the tele-ICU equipment and have low utilization of the tele-ICU facilities. It would be valuable to find the reasons behind their lack of use or perhaps the problems are they facing.

It would also be beneficial to carry out a study measuring the impact of the tele-ICU on patients' health. Khunlertkit and Carayon (2013) have stressed the importance of understanding the impact of such a system on patient outcomes.

Another aspect to study would be to find the patients' perspectives about the outcomes of the system, and their assessment of the implemented system, as previously suggested by Ekeland et al. (2010). I did not have the privilege of getting patients' and families' input about the usage of the system, which would have enriched my findings, but this could be done in a future study.

A future study could investigate the success factors in the DeLone and McLean (2003) success model, and use it as an evaluation tool. Another study could review the literature to develop a comprehensive framework, which could be used to evaluate the effectiveness of telemedicine systems, as raised by Whetton (2005).

References

Abou-Shaaban, R. A. R., & Niazy, E. M. (1991). Telemedicine and telepharmaceutical services: A model to improve maldistribution of medical resources between regions & urban/rural sectors in the kingdom of Saudi Arabia. *GeoJournal, 25*(4), 401-412. doi:10.1007/BF02439492

Aboul-Enein, F. H. (2002). Personal contemporary observations of nursing care in Saudi Arabia. *International Journal of Nursing Practice, 8*(4), 228-230. doi:10.1046/j.1440-172X.2002.00370.x

Alhamdan, N. A., Almazrou, Y. Y., Alswaidi, F. M., & Choudhry, A. J. (2007). Premarital screening for thalassemia and sickle cell disease in Saudi Arabia. *Genetics in Medicine, 9*(6), 372-377. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/17575503

Almalki, M., Fitzgerald, G., & Clark, M. (2011). Health care system in Saudi Arabia: An overview. Eastern Mediterranean Health Journal *17*(10) 1-793. Retrieved from http://applications.emro.who.int/emhj/V17/10/17_10_2011_0784_0793.pdf

American Association of Critical-Care Nurses (2013). *Tele-ICU nursing practice guidelines*. Retrieved from http://www.aacn.org/wd/practice/content/tele-icu-guidelines.content

Ammenwerth, E., Gräber, S., Herrmann, G., Bürkle, T., & König, J. (2003). Evaluation of health information systems—problems and challenges. *International Journal of Medical Informatics, 71*(2–3), 125-135. doi:10.1016/S1386-5056(03)00131-X

Auerbach, C. F., & Silverstein, L. B. (2003). *Qualitative data: An introduction to coding and analysis*. New York, NY: NYU Press.

Bashshur, R., Shannon, G., & Sapci, H. (2005). Telemedicine evaluation. *Telemedicine Journal and e-Health, 11*(3), 296-316. Retrieved from http://deepblue.lib.umich.edu/bitstream/handle/2027.42/63176/tmj.2005.11.296.pdf?sequence=1

Berenson, R. A., Grossman, J. M., & November, E. A. (2009). Does telemonitoring of patients—the eICU—improve intensive care? *Health Affairs, 28*(5), w937-w947. doi:10.1377/hlthaff.28.5.w937

Berg, B. L. (2003). *Qualitative research methods for the social sciences* (5th ed.). Boston MA: Pearson.

Borycki, E. M., & Bartle-Clar, J. A. (2011). Tele-ICU - A Canadian Review. In R. Shahpori, A. Kushniruk, M. Hebert, & D. Zuege (Eds.), *International Perspectives in Health Informatics*. Amsterdam, The Netherlands: IOS Press.

Breslow, M. J. (2007). Remote ICU care programs: Current status. *Journal of Critical Care, 22*(1), 66-76. doi:10.1016/j.jcrc.2007.01.006

Breslow, M. J., Rosenfeld, B. A., Doerfler, M., Burke, G., Yates, G., Stone, D. J., ... Plocher, D. W. (2004). Effect of a multiple-site intensive care unit telemedicine program on clinical and economic outcomes: An alternative paradigm for intensivist staffing. *Critical Care Medicine, 32*(1), 31-38. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/14707557

Chatterjee, S., Chakraborty, S., Sarker, S., Sarker, S., & Lau, F. Y. (2009). Examining the success factors for mobile work in healthcare: A deductive study. *Decision Support Systems, 46*(3), 620-633. doi:10.1016/j.dss.2008.11.003

Chiasson, M., Reddy, M., Kaplan, B., & Davidson, E. (2007). Expanding multi-disciplinary approaches to healthcare information technologies: What does information systems offer medical informatics? *International Journal of Medical Informatics, 76*(Sppl. 1), 89-97. doi:10.1016/j.ijmedinf.2006.05.010

Chu-Weininger, M. Y., Wueste, L., Lucke, J. F., Weavind, L., Mazabob, J., & Thomas, E. J. (2010). The impact of a tele-ICU on provider attitudes about teamwork and safety climate. *Quality and Safety in Health Care, 19*(6), e39. doi:10.1136/qshc.2007.024992

Collins, S. A., Bakken, S., Vawdrey, D. K., Coiera, E., & Currie, L. M. (2011). Agreement between common goals discussed and documented in the ICU. *Journal of the American Medical Informatics Association, 18*(1), 45-50. doi:10.1136/jamia.2010.006437

Conrath, D. W., & Sharma, R. S. (1991). Evaluating expert systems using a multiple-criteria, multiple-stakeholder approach. Proceedings of the IEEE/ACM International Conference on Developing and Managing Expert System Programmes, USA, 139-148. doi:10.1109/dmesp.1991.171731

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Creswell, J. W., Hanson, W. E., Plano, V. L. C., & Morales, A. (2007). Qualitative research designs: Selection and implementation. *The Counseling Psychologist, 35*(2), 236-264. doi:10.1177/0011000006287390

Cummings, J., Krsek, C., Vermoch, K., & Matuszewski, K. (2007). Intensive care unit telemedicine: Review and consensus recommendations. *American Journal of Medical Quality, 22*(4), 239-250. doi:10.1177/1062860607302777

Currell, R., Urquhart, C., Wainwright, P., & Lewis, R. (2000). Telemedicine versus face to face patient care: Effects on professional practice and health care outcomes. *Cochrane Database of Systematic Reviews*(2), 1-22. doi:10.1002/14651858.CD002098

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems, 19*(4), 9-30. Retrieved from http://dl.acm.org/citation.cfm?id=1289767

Demiris, G. (2004). *E-Health: Current status and future trends* (Vol. 106). Amsterdam, The Netherlands: IOS Press.

Denscombe, M. (2002). Ground rules for good research: A 10 point guide for social researchers. Buckingham, UK: Open University Press.

Doolin, B. (2004). Power and resistance in the implementation of a medical management information system. *Information Systems Journal, 14*(4), 343-362. doi:10.1111/j.1365-2575.2004.00176.x

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review, 14*(4), 532–550. Retrieved from http://www.jstor.org/stable/258557

Ekeland, A. G., Bowes, A., & Flottorp, S. (2010). Effectiveness of telemedicine: A systematic review of reviews. *International Journal of Medical Informatics, 79*(11), 736-771. doi:http://dx.doi.org/10.1016/j.ijmedinf.2010.08.006

El-Mahalli, A. A., El-khafif, S. H., & Al-Qahtani, M. F. (2012). Successes and Challenges in the implementation and application of telemedicine in the Eastern Province of Saudi Arabia. *Perspectives in Health Information Management, , American Health Information Management Association,* (9), 1-27. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3510649/

Field, M. J. (1996). Telemedicine: A guide to assessing telecommunications in health care. Washington DC, US: National Academy Press.

Franzini, L., Sail, K. R., Thomas, E. J., & Wueste, L. (2011). Costs and cost-effectiveness of a telemedicine intensive care unit program in 6 intensive care units in a large health care system. *Journal of Critical Care, 26*(3), 1-6. doi:10.1016/j.jcrc.2010.12.004

Gibbs, G. R. (2008). *Analysing qualitative data*. London, UK: Sage Publications.

Gomez, R. (2010). Public access computing ecosystem: Data collection instruments. Retrieved from http://faculty.washington.edu/rgomez/projects/Data%20collection%20instruments%20for%20Info%20Ecology%20study.pdf

Grigsby, J., Rigby, M., Hiemstra, A., House, M., Olsson, S., & Whitten, P. (2002). The diffusion of telemedicine. *Telemedicine Journal and e-Health, 8*(1), 79-94.. doi:10.1089/15305620252933428

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105-117). London, UK: Sage.

Häyrinen, K., Saranto, K., & Nykänen, P. (2008). Definition, structure, content, use and impacts of electronic health records: A review of the research literature. *International Journal of Medical Informatics, 77*(5), 291-304. doi:http://dx.doi.org/10.1016/j.ijmedinf.2007.09.001

Heathfield, H., Pitty, D., & Hanka, R. (1998). Evaluating information technology in health care: Barriers and challenges. *British Medical Journal, 316*(7149), 1959-61. doi: 10.1136/bmj.316.7149.1959

Henry, M. (Ed.). (1999). *IT in the social sciences: A student's guide to the information and communication technologies*. Oxford, UK: Blackwell Publishers.

Hicks, L., Boles, K., Hudson, S., Kling, B., Tracy, J., Mitchell, J., & Webb, W. (2001). Development of a telemedicine evaluation model. Retrieved from http://collab.nlm.nih.gov/tutorialspublicationsandmaterials/telesymposiumcd/6A-1.pdf

Hjelm, N. M. (2005). Benefits and drawbacks of telemedicine. *Journal of Telemedicine and Telecare, 11*(2), 60-70. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15829049

Hoonakker, P. L. T., Carayon, P., McGuire, K., Khunlertkit, A., Wiegmann, D. A., Alyousef, B., ... Wood, K. E. (2013). Motivation and job satisfaction of tele-ICU nurses. *Journal of Critical Care, 28*(3), 315.e13-21. doi:10.1016/j.jcrc.2012.10.001

Hu, P.-J. (2003). Evaluating telemedicine systems success: A revised model. *Proceedings of the 36th Annual Hawaii International Conference on System Sciences (HICSS'03), 6,* 6–9. doi:10.1109/HICSS.2003.1174379

Huis in't Veld, M. H. A., Hermens, H., & Vollenbroek-Hutten, M. (2007). A systematic review of the methodology of telemedicine evaluation in patients with postural and movement disorders. *Journal of Medecine and Telecare, 12*, 289-297. doi:10.1258/135763306778558178

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly, 24*(4), 602-11. doi:10.2307/2392366

Jimison, H., Gorman, P., Woods, S., Nygren, P., Walker, M., Norris, S., & Hersh, W. (2008). *Barriers and drivers of health information technology use for the elderly, chronically ill, and underserved*. (Report No. 09-E004). Retrieved from http://www.ncbi.nlm.nih.gov/books/NBK38653/

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26. doi:10.3102/0013189X033007014

Kaplan, B. (1997). Addressing organizational issues into the evaluation of medical systems. *Journal of the American Medical Informatics Association, 4*(2), 94-101. doi:10.1136/jamia.1997.0040094

Kaplan, B. (2001). Evaluating informatics applications—some alternative approaches: Theory, social interactionism, and call for methodological pluralism. *International Journal of Medical Informatics, 64*(1), 39-56. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11673101

Kaplan, B., & Duchon, D. (1988). Combining qualitative and quantitative methods in information systems research: A case study. *MIS Quarterly, 12*(4), 571-586. Retrieved from http://www.jstor.org/stable/249133

Kaplan, B., & Harris-Salamone, K. D. (2009). Health IT success and failure: Recommendations from literature and an AMIA workshop. *Journal of the American Medical Informatics Association, 16*(3), 291-299. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2732244/

Kaplan, B., & Maxwell, J. A. (2005). Qualitative research methods for evaluating computer information systems. In J. Anderson & C. Aydin (Eds.), *Evaluating the organizational impact of healthcare information systems* (pp. 30–55). New York,NY: Springer.

Ketikidis, P., Dimitrovski, T., Lazuras, L., & Bath, P. A. (2012). Acceptance of health information technology in health professionals: An application of the revised technology acceptance model. *Health Informatics Journal, 18*(2), 124-134. doi:10.1177/1460458211435425

Khalifa, M. (2013). Barriers to health information systems and electronic medical records implementation. A field study of Saudi Arabian hospitals. *Procedia Computer Science, 21*(0), 335-342. doi:10.1016/j.procs.2013.09.044

Khaliq, A. A. (2012). The Saudi healthcare system: A view from the minaret. *World Health & Population, 13*(3), 52-64. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/22555119

Khunlertkit, A., & Carayon, P. (2013). Contributions of tele–intensive care unit (Tele-ICU) technology to quality of care and patient safety. *Journal of Critical Care, 28*(3), 315.e1-315.e12. doi:10.1016/j.jcrc.2012.10.005

King Faisal Specialist Hospital and Research Centre. (2013) Retrieved from http://www.kfshrc.edu.sa

Kumar, S., Merchant, S., & Reynolds, R. (2013). Tele-ICU: Efficacy and Cost-effectiveness of remotely managing critical care. *Perspectives in Health Information Management, 10*(Spr.), 1-13. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3692325/pdf/phim0010-0001f.pdf

Lau, F., Hagens, S., & Muttitt, S. (2007). A proposed benefits evaluation framework for health information systems in Canada. *Healthcare Quarterly, 10*(1), 112-16, 118. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/17326376

Lazakidou, A. A. (2006). *Handbook of research on informatics in healthcare and biomedicine*. London, UK: Idea Group reference.

Lee, H. W., Ramayah, T., & Zakaria, N. (2012). External factors in hospital information system (HIS) adoption model: A case on Malaysia. *Journal of Medical Systems, 36*(4), 2129-2140. doi:10.1007/s10916-011-9675-4

Leong, J. R., Sirio, C. A., & Rotondi, A. J. (2005). eICU program favorably affects clinical and economic outcomes. *Critical Care, 9*(5), E22. doi:10.1186/cc3814

LeRouge, C., Garfield, M. J., & Hevner, A. R. (2002). Quality attributes in telemedicine video conferencing. Proceedings of the 35th Hawaii International Conference on System Sciences (HICSS-35'02). doi:10.1109/hicss.2002.994132

LeRouge, C., Hevner, A. R., & Collins, R. W. (2007). It's more than just use: An exploration of telemedicine use quality. *Decision Support Systems, 43*(4), 1287-1304. Retrieved from http://www.sciencedirect.com/science/article/pii/S0167923606000297

May, C., Mort, M., Mair, F., Ellis, N. T., & Gask, L. (2000). Evaluation of new technologies in health-care systems: What's the context? *Health Informatics Journal, 6*(2), 67-70. doi:10.1177/146045820000600203

McLeod, A. J., & Clark, J. G. (2007). Identifying the user in healthcare information systems research. *Proceedings of the 40th Hawaii International Conference on System Sciences*. doi:10.1109/HICSS.2007.258

Miller, D. C., & Salkind, N. J. (Eds.). (2002). *Handbook of research design and social measurement*. Thousand Oaks, CA: Sage.

Moeckli, J., Cram, P., Cunningham, C., & Reisinger, H. S. (2013). Staff acceptance of a telemedicine intensive care unit program: A qualitative study. *Journal of Critical Care 28*(6), 890–901. doi:10.1016/j.jcrc.2013.05.008

Moehr, J. R., Schaafsma, J., Anglin, C., Pantazi, S. V., Grimm, N. A., & Anglin, S. (2006). Success factors for telehealth—A case study. *International Journal of Medical Informatics, 75*(10–11), 755-763. doi:10.1016/j.ijmedinf.2005.11.001

Mufti, M. H. (2000). *Healthcare development strategies in the Kingdom of Saudi Arabia*. New York, NY: Springer.

Noor, K. B. M. (2008). Case study: A strategic research methodology. *American Journal of Applied Science*s, *5*(11), 1602-1604. doi:10.3844/ajassp.2008.1602.1604

Pagliari, C., Gilmour, M., & Sullivan, F. (2004). Electronic clinical communications implementation (ECCI) in Scotland: A mixed-methods programme evaluation. *Journal of Evaluation in Clinical Practice, 10*(1), 11-20. doi:10.1111/j.1365-2753.2004.00475.x

Petter, S., & McLean, E. R. (2009). A meta-analytic assessment of the DeLone and McLean IS success model: An examination of IS success at the individual level. *Information & Management, 46*(3), 159-166.

Rahimi, B., & Vimarlund, V. (2007). Methods to Evaluate Health information Systems in Healthcare Settings: A Literature Review. *Journal of Medical Systems, 31*(5), 397–432. doi:10.1007/s10916-007-9082-z

Rayes, A. A. (2013). *Tele-ICU Recognition Day 15-Jan 2013 (Day Two Part 2)* Retrieved from http://www.youtube.com/watch?v=xzV0BRX0zK8

Reddy, M. C., Purao, S., & Kelly, M. (2008). Developing IT infrastructure for rural Hospitals: A case study of benefits and challenges of hospital-to-hospital partnerships. *Journal of the American Medical Informatics Association, 15*(4), 554-558.

Rogove, H. J., McArthur, D., Demaerschalk, B. M., & Vespa, P. M. (2012). Barriers to telemedicine: Survey of current users in acute care units. *Telemedicine and e-Health, 18*(1), 48-53.

Rosenfeld, B. A., Dorman, T., Breslow, M. J., Pronovost, P., Jenckes, M., Zhang, N., ... Rubin, H. (2000). Intensive care unit telemedicine: Alternate paradigm for providing continuous intensivist care. *Critical Care Medicine, 28*(12), 3925-3931. Retrieved from http://www.safetyleaders.org/Safe_Practice_Articles_NQF2006/Intensive_care_unit_telemedicine_-_alternate_paradigm_for_providing_continuous_intensivist_care_7_Rosenfeld_CCM_2000.pdf

Sapirstein, A., Lone, N., Latif, A., Fackler, J., & Pronovost, P. J. (2009). Tele ICU: Paradox or panacea? *Best Practice & Research Clinical Anaesthesiology, 23*(1), 115-126. doi:10.1016/j.bpa.2009.02.001

Scott, P. J., & Briggs, J. S. (2009). A pragmatist argument for mixed methodology in medical informatics. *Journal of Mixed Methods Research, 3*(3), 223-241. doi:10.1177/1558689809334209

Seale, C., Gobo, G., Gubrium, J. F., & Silverman, D. (Eds.). (2004). *Qualitative research practice*. London, UK: Sage.

Seddon, P. B. (1997). A respecification and extension of the DeLone and McLean model of IS success. *Information Systems Research, 8*(3), 240-253. doi:10.1287/isre.8.3.240

Seidman, I. (2005). *Interviewing as qualitative research: A guide for researchers in education and the social sciences* (3rd ed.). New York, NY: Teachers College Press.

Shahpori, R., Hebert, M., Kushniruk, A., & Zuege, D. (2011). Telemedicine in the intensive care unit environment—A survey of the attitudes and perspectives of critical care clinicians. *Journal of Critical Care, 26*(3), 328.e9-15. doi:10.1016/j.jcrc.2010.07.013

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage Publications.

Taylor, P. (2005). Evaluating telemedicine systems and services. *Journal of Telemedicine and Telecare, 11*(4), 167-177. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15969791

Thomas, D. R. & Hodges, I. D. (2010). *Designing and managing your research project: Core skills for social and health research.* London, UK: Sage Publications.

Thomas, E. J., Lucke, J. F., Wueste, L., Weavind, L., & Patel, B. (2009). Association of telemedicine for remote monitoring of intensive care patients with mortality, complications, and length of stay. *The journal of the American Medical Association, 302*(24), 2671-2678. doi: 10.1001/jama.2009.1902

Turunen, P. A., & Talmon, J. B. (2000). Stakeholder groups in the evaluation of medical information systems. Proceedings of the 7th European Conference on the Evaluation of Information Technology. Retrieved from http://scholar.google.co.nz/scholar?q=Stakeholder+groups+in+the+evaluation+of+medical+information+systems&hl=en&as_sdt=0&as_vis=1&oi=scholart&sa=X&ei=xPdoUNWmEsLvmAWszoG4Dg&sqi=2&ved=0CBkQgQMwAA

Van der Meijden, M. J., Tange, H. J., Troost, J., & Hasman, A. (2003). Determinants of success of inpatient clinical information systems: A literature review. *Journal of the American Medical Informatics Association, 10*(3), 235-243. doi:10.1197/jamia.M1094

Ward, R., Stevens, C., Brentnall, P., & Briddon, J. (2008). The attitudes of health care staff to information technology: A comprehensive review of the research literature. *Health Information & Libraries Journal, 25*(2), 81-97. doi:10.1111/j.1471-1842.2008.00777.x

Whetton, S. (2005). Successes and failures: What are we measuring? *Journal of Telemedicine and Telecare, 11*(Suppl. 2), 98-100. doi:10.1258/135763305775124678

Whitten, P., & Adams, I. (2003). Success and failure: A case study of two rural telemedicine projects. *Journal of Telemedicine and Telecare, 9*(3), 125-129. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12877772

Whitten, P. S., & Richardson, J. D. (2002). A scientific approach to the assessment of telemedicine acceptance. *Journal of Telemedicine and Telecare, 8*(4), 246-248. doi: 10.1258/135763302320272257

Wilkinson, D., & Birmingham, P. (2003). *Using research instruments: A guide for researchers*. London, UK: Routledge Falner.

Wootton, R. (2001). Telemedicine. *BMJ, 323*(7312), 557-560. doi:10.1136/bmj.323.7312.557

Wu, J.-H., Wang, S.-C., & Lin, L.-M. (2007). Mobile computing acceptance factors in the healthcare industry: A structural equation model. *International Journal of Medical Informatics, 76*(1), 66-77. doi:10.1016/j.ijmedinf.2006.06.006

Yin, R. K. (1993). *Applications of case study research* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Yin, R. K. (1994). *Case study research: Design and methods* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Yoo, E. J., & Dudley, R. A. (2009). Evaluating telemedicine in the ICU. *The Journal of the American Medical Association, 302*(24), 2705-2706. doi:10.1001/jama.2009.1924

Young, L. B., Chan, P. S., & Cram, P. (2011). Staff acceptance of tele-icu coverage: A systematic review. *CHEST Journal, 139*(2), 279-288. doi:10.1378/chest.10-1795

Yu, P. (2010). A multi-method approach to evaluate health information systems. Retrieved from http://ro.uow.edu.au/cgi/viewcontent.cgi?article=9584&context=infopapers

Zawada Jr., E. T., Herr, P., Larson, D., Fromm, R., Kapaska, D., & Erickson, D. (2009). Impact of an intensive care unit telemedicine program on a rural health care system. *Postgraduate Medicine, 121*(3), 160-170. doi: 10.3810/pgm.2009.05.2016

Glossary

Barriers: The perceived barriers to use the tele-ICU system in this study.

Case study: A strategy of inquiry, which explores activities or processes with detailed information and uses a variety of data collection methods.

Closed ICU model: In this model the intensivist in the central hub can have the full responsibility of patient care management.

Coding: The routine process for organising the text of the transcripts and discovering patterns within its structure in the analysis.

Data comparison: An analysis technique which involves comparing data using both qualitative and quantitative sources

Deductive Analysis: This refers to building the analysis on previous theories, and looking for similar patterns

Failure of a health care system: Failure occurs when budget and time constraints are exceeded, there is an under-delivery of value, or a project is terminated before completion.

High-usage centre: The centres that had the highest degree of usage in a particular month in the study period (as shown in Table 3).

Inductive Analysis: This refers to performing the data analysis in order to build new theory, then examining the new theory with existing theories after the analysis is complete.

Intensivists: Physicians who specialise in the treatment and management of critically ill patients in ICU.

Low-usage centre: The other centres that were not identified as high-usage centres.

Medical staff: Physicians and nurses

Mortality rate: The ratio of total deaths to total population in a specified community or area over a defined period of time.

Motives: The perceived drivers to use the tele-ICU system in this study.

Non-medical staff: All tele-ICU staff other than physicians or nurses

Open ICU Model: In this model the bedside physician manages the care of the patients, and the intensivist in the central hub has responsibility only for emergency cases.

Source triangulation: Using both qualitative and quantitative data sources.

Success Model: The DeLone and McLean model of information systems success.

Success of a health care system: A system is successful when it is working, people are using it, and it is getting at least grudging acceptance (with the caveat that the grudging acceptance can turn to non-acceptance).

Telemedicine: An alternative term for telehealth or e-health. It is defined as an electronic information and communications technology used to provide and support health care when distance separates the patient and the caregiver.

Telemedicine Hub: A tele-ICU centre inside a hospital.

Tele-ICU: An electronic connection between physical ICUs to another location which assists in medical decision-making.

Tele-ICU conferencing: The communication network between the bedside health care providers and the intensivists.

Tele-ICU website: The user-interface to access the indexed data about the patients and the system which provides vital signs.

Appendices

Appendix A KFSH Approval Letter

مستشفى الملك فيصل التخصصي ومركز الأبحاث
King Faisal Specialist Hospital & Research Centre
Gen. Org. مؤسسة عامة

16 June 2013

Auckland University of Technology
New Zealand

To whom it may concern,

This letter serves as an authorization for **Ms. AlJuhara Nasser AlSubaily**, Master's student in the School of Computing and Mathematical Sciences at AUT, to conduct a research on Tele-ICU Services of Health Outreach Services Department, King Faisal Specialist Hospital, Riyadh.

In view of this, we are pleased to provide necessary information that might be useful for Ms. AlSubaily's study of our project.

Thank you and best regards.

Sincerely yours,

Khalid Al Joudi
Acting Director
Health Outreach Services Department
King Faisal Specialist Hospital
Riyadh, KSA

KAJ/AAM/crnp

ص.ب: ٣٣٥٤ الرياض ١١٢١١ المملكة العربية السعودية . هاتف: ٤٦٤٧٢٧٢ ٩٦٦١+ . فاكس: ٤٤١٤٨٣٩ ٩٦٦١+
P.O.Box: 3354 Riyadh 11211,Kingdom of Saudi Arabia . Tel: +9661 4647272 . Fax:+9661 4414839 . www.kfshrc.edu.sa

Form 11100-02 (Rev. 09-27) I.C. 202040 Printed by Reprographics KFSH&RC

Appendix B AUTEC Approval Letter

AUT UNIVERSITY | AUTEC SECRETARIAT

3 July 2013

Dave Parry
Faculty of Design and Creative Technologies

Dear Dave

Re Ethics Application: **13/81 A case study evaluation of the telemedicine project in Saudi Arabia.**

Thank you for providing evidence as requested, which satisfies the points raised by the AUT University Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 3 July 2016.

As part of the ethics approval process, you are required to submit the following to AUTEC:

- A brief annual progress report using form EA2, which is available online throughhttp://www.aut.ac.nz/researchethics. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 3 July 2016;
- A brief report on the status of the project using form EA3, which is available online through http://www.aut.ac.nz/researchethics. This report is to be submitted either when the approval expires on 3 July 2016 or on completion of the project.

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to obtain this. If your research is undertaken within a jurisdiction outside New Zealand, you will need to make the arrangements necessary to meet the legal and ethical requirements that apply there.

To enable us to provide you with efficient service, please use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

All the very best with your research,

Kate O'Connor
Executive Secretary
Auckland University of Technology Ethics Committee

Cc: Aljuhara Alshubaily Aljuhara_n@yahoo.com

Participant Information Sheet

Date Information Sheet Produced:

9 April 2013

Project Title

A Case Study Evaluation of the Telemedicine Project in Saudi Arabia.

An Invitation

My name is Aljuhara Alshubaily. I am a master's student in the School of Computing and Mathematical Sciences at Auckland University of Technology.

I am interested in evaluating telemedicine projects in Saudi Arabia. I would like to gain some insight into the opportunities and obstacles facing such systems by evaluating the King Faisal Specialist Hospital (KFSH) telemedicine project (tele-ICU) in Saudi Arabia.

The tele-ICU system has been employed to transfer health information between hospitals in order to improve the health of patients in intensive care units (ICU) in rural hospitals in Saudi Arabia.

This research will allow me to obtain the degree of Masters in Computer and Information Sciences (MCIS) from AUT University. I invite you to participate in this research via a phone interview on the evaluation of a telemedicine project in Saudi Arabia.

Your participation would be appreciated but is entirely voluntary and you may withdraw at any time during the research.

What is the purpose of this research?

The goal of evaluating any system is to determine the success or failure of the programme in reaching its goals. This research would identify constructive indicators and may demonstrate some problems for similar telemedicine systems in Saudi Arabia. Moreover, the research may provide some suggestions for improving such systems in the future.

How will my privacy be protected?

All the information provided by the participants will be securely stored. Only the researcher and the academic supervisor will have access to the information. No names or identification that could be linked to a participant will be mentioned in the research or any subsequent publications.

A transcript of the interview could be sent to participants if required. You will then have the opportunity to ensure that any quotes are accurate before final publication.

The interview recording will not be retained after the completion of the study.

What are the costs of participating in this research?

30 minutes of your time for the interview.

What opportunity do I have to consider this invitation?

You can reply to the email, and make an appointment with the researcher for the phone interview.

How do I agree to participate in this research?

Before starting the interview, you will be asked for signed consent, to participate in the research. You can stop the interview at any time, and withdraw consent as well.

Will I receive feedback on the results of this research?

Yes, you can obtain the report that will be available at the end of the research. If you indicate that you want to receive the report, it will be sent to your email address.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Dr Dave Parry, dparry@aut.ac.nz, +64 9 921 9999 ext 8918

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , +64 9 921 9999 ext 6038.

Whom do I contact for further information about this research?

Researcher Contact Details:

Aljuhara Alshubaily, aljuhara_n@yahoo.com

Project Supervisor Contact Details:

Dr Dave Parry, dparry@aut.ac.nz, +64 9 921 9999 ext 8918

Approved by the Auckland University of Technology Ethics Committee on 3rd July 2013

AUTEC Reference number 13/81.

Little has been published about the evaluation of telemedicine projects in Saudi Arabia. I would like to explore the usage of such projects in this country. The interview questions would not be about your direct usage of the system; it would be about your general experience and knowledge.

This research will form part of a master's thesis as part of the requirements for obtaining an MCIS degree. Hopefully, a journal or conference publication will also be produced.

How was I identified and why am I being invited to participate in this research?

The tele-ICU manager in KFSH provided a list of people who are using the system. Although KFSH supports this research, participation is entirely voluntary. And names of those who do or do not participate will not be passed on to the management.

What will happen in this research?

There will be separate phone interviews with each participant. The interview will be arranged between the researcher and the participant. An interview may take up to 30 minutes where we will your experience with the tele-ICU project. All the information will be audio recorded and then transcribed. The transcripts will be analysed by the researcher and the supervisor only.

What are the discomforts and risks?

You may perceive the study as criticising government initiatives but the identity of individual participants will not be published in any report. Because there is a limited pool of participants I will be careful to avoid publishing material which could identify you.

How will these discomforts and risks be alleviated?

If any participant experiences a measure of discomfort they can decline a particular question or withdraw from the interview at any time.

In terms of any risk of criticising government initiatives, the opinions of the participants and their identity will be kept confidential, and their information is available only to the researcher and the academic supervisor at AUT. Furthermore, the research has been approved by KFSH. You will have the opportunity to review the transcript before final analysis if you wish.

What are the benefits?

This research will give participants a clearer view of the current tele-ICU application. Moreover, it would give a better understanding of good practice and perhaps highlight any required changes as well. Hopefully you will find the discussion interesting and beneficial.

Consent Form

AUT UNIVERSITY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

Project title: A Case Study Evaluation of the Telemedicine Project in Saudi Arabia

Project Supervisor: ***Dave Parry***

Researcher: ***Aljuhara Alshubaily***

- O I have read and understood the information provided about this research project in the Information Sheet dated 9th April 2013.
- O I have had an opportunity to ask questions and to have them answered.
- O I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.
- O I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- O If I withdraw, I understand that all relevant information including tapes and transcripts, or parts thereof, will be destroyed.
- O I agree to take part in this research.
- O I wish to receive a copy of the report from the research (please tick one): YesO NoO

Participant's signature: .....

Participant's name: .....

Participant's Contact Details (if appropriate):

.....

.....

.....

.....

Date: .....

Approved by the Auckland University of Technology Ethics Committee on 3rd July 2013

AUTEC Reference number 13/81.

Appendix E The Distribution of Themes Between Groups of Users Working In Each Type of Centre

Category	Topic	Low Usage Centre	High Usage Centre
Motivation	Communication & Collaboration	27.61%	72.39%
	Continuing Medical Education	21.74%	78.26%
	Filling Gapes in Service	5.83%	94.17%
	Addressing Patient Satisfaction	14.35%	85.65%
	Immediacy of Patient Access	24.25%	75.75%
	Impact on Patient Care	18.47%	81.53%
	Providing Clinical Support	25.54%	74.46%
	Providing Quality Care	17.43%	82.57%
	Quality Improvement	23.78%	76.22%
	Reducing Referrals	7.09%	92.91%
	Ease of Use	15.12%	84.88%
Barriers	Administrative' Culture	20.86%	79.14%
	Physicians' Culture	27.70%	72.30%
	Maintaining the Program	62.50%	37.50%
	Lack of Exposure	50.42%	49.58%
	Lack of Understanding	17.92%	82.08%
	Medical Resources Availability	0%	100%
	Language	0%	100%
	Documentation	15.15%	84.85%
	Internet Connectivity	23.87%	76.13%
	Remote Accessibility	87.04%	12.96%
	Technical Support	16.67%	83.33%
	Usability	45.83%	54.17%
Suggestions	Connecting to Other Centres	24.47%	75.53%
	Medical Continuing Education Sessions	78.85%	21.15%
	Tele-ICU Training	44.39%	55.61%
	Include Nurses	14.91%	85.09%

Appendix F The Distribution of Themes Between Groups of Users Who Are Medical Staff or Not

Category	Topic	Non Medical staff	Medical staff
Motivation	Communication & Collaboration	23.76%	76.24%
	Continuing Medical Education	20.87%	79.13%
	Filling Gapes in Service	29.17%	70.83%
	Immediacy of Patient Access	46.27%	53.73%
	Addressing Patient Satisfaction	38.19%	61.81%
	Impact on Patient Care	24.73%	75.27%
	Providing Clinical Support	22.46%	77.54%
	Providing Quality Care	24.17%	75.83%
	Quality Improvement	26.47%	73.53%
	Reducing Referrals	39.12%	60.88%
	Ease of Use	23.08%	76.92%
Barriers	Administrative' Culture	20.86%	79.14%
	Physicians Culture	51.45%	48.55%
	Maintaining the Program	62.50%	37.50%
	Lack of Exposure	51.69%	48.31%
	Lack of Understanding	33.53%	66.47%
	Medical Resources Availability	31.76%	68.24%
	Language	5.88%	94.12%
	Documentation	28.28%	71.72%
	Internet Connectivity	21.94%	78.06%
	Remote Accessibility	34.57%	65.43%
	Technical Support	16.67%	83.33%
	Usability	40%	60%
Suggestions	Connecting to Other Centres	37.83%	62.17%
	Medical Continuing Education Sessions	7.69%	92.31%
	Tele-ICU Training	35.29%	64.71%
	Include Nurses	0%	100%