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Clinicians' Perception of Using Digital Stethoscopes in Telehealth Platform: Queensland Telehealth Preliminary Study

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Clinicians' perception of using digital stethoscopes in telehealth platform: Queensland telehealth preliminary study

Work in Progress

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Abstract

Many developed countries including Australia became aware of the need for establishing telehealth systems in order to provide better services for patients located in remote and ruler areas. An interpretive research approach was adopted for this research as it can help to understand human thought and action in social and organisational contexts in this case the healthcare organisation. This study adopts observation as a qualitative research technique, to explore clinicians' perception of using Digital stethoscope in Queensland telehealth domain. It was aimed to identify the issues that are associated to influence users' perceptions of the system. This research contributes to the existing knowledge of use of the Technology Acceptance Model (TAM). The preliminary findings show that sound quality, usefulness and digital stethoscope's physical features may influence clinicians' usage of Digital stethoscopes in telehealth healthcare environment. Future research will concentrate exploring this aspect further through focus group and interview techniques regarding digital stethoscopes usage.

Keywords:

Telehealth, Digital stethoscope, Telemedicine

INTRODUCTION

Telecommunication technologies are changing ways of thinking, communicating and acting throughout the world. Moreover, they are being used to change the health care industry in unprecedented and irreversible ways, for example using robotics in surgeries (Maheu, Whitten & Allen 2001).

Healthcare organisations use information systems to facilitate diagnose of illnesses, plan medical treatment, track patient records, and bill patients. Information technology, computer science, Information Systems, healthcare services and telecommunication technology can lead to health information systems (Stair and Reynolds 2008).

Telemedicine and telehealth are a progression in an inexorable transformation in health care that promise to bring untold change to the health care industry and radically improve the delivery of care to patients (Darkins & Cary 2000).

Residents in rural and geographically isolated areas have significant problems in accessing health care services. Armstrong (1998) identified physically disabled, poor, prison inmates, and homeless urbane children as examples of groups who frequently lack access to adequate health care services. Telehealth infrastructure could provide some of the healthcare services to some of the remote and rural areas, where there is a lack of regular healthcare services. Access problems could be due to geographical location or physical limitations (Armstrong 1998, p. 187). Elford (2007) stated the benefits of establishing Telehealth for the patient as improved access to medical specialists, decreased patients' stress, reduced travel time and provision of more accurate treatment which leads to improved healthcare services.

The information transmission between two entities involved in telehealth can take many forms such as data and text, audio, still images and video pictures (Craig & Patterson 2005). Traditionally, sound can

be transmitted by the use of a stethoscope in the field of cardiology and other areas of health care. Stethoscope is one of the primary tools used by most of the healthcare professional in the diagnoses process, whereas in the telehealth infrastructure the use of traditional Stethoscope is not possible. Since one aspect of telehealth is capturing sound, some of the recent developments in the domain of digital stethoscopes (DS) provided a hope to fill this gap in the telehealth infrastructure. One aspect of DS is its ability to transmit various sounds that healthcare professionals would like to hear in their diagnosis process over the telehealth infrastructure (MedicineNet 2001).

Generally, a stethoscope is an instrument used to hear and amplify sounds such as the heartbeat, lungs, intestinal, venous, or fetal sounds to the ear of the listener. A stethoscope may consist of two earpieces connected by means of flexible tubing to a diaphragm, which is placed against the skin of the patient at a location appropriate to pick up the sound (MedicineNet 2001). The chest piece consists of two sides that can be placed against the patient for sensing sound. Digital stethoscopes require conversion of acoustic sound waves to electrical signals, which can then be amplified and processed for optimal listening (Stethoscope.com 2008). Digital stethoscopes can be differentiated based on their technical features, quality of sounds, connectivity, functions and price ranges. Some models such as the Littmann, Cardionics and Welch Allyn provide a link to computers and some provide recording capability. 'Several electronic stethoscopes on the market can very easily allow users to record sounds and e-mail them to colleagues for teaching or even consultation' (Stethoscope.com 2008).

Abbruscato (1998) highlights the need to maintain a doctor-patient interaction as one of the basic requirements of a stethoscope examination procedure. Normally, the patient needs to be physically present to facilitate the doctor's examination. Consequently, patients who need frequent stethoscope examinations are faced with the difficult prospect of frequently visiting their doctor at a health centre. These difficulties are particularly hard for patients who live in remote areas and who need to see a doctor on a regular basis. Therefore, Abbruscato (1998) states there is an urgent need for a system by which a doctor can perform medical examinations on a remotely located patient. Spooner and Gotlieb (2004) state that the health industry, particularly cardiology, has already embraced telehealth. Electronic stethoscopes can facilitate the transmission of heart sounds with excellent fidelity.

Digital stethoscopes have the ability to facilitate the transmission of heart sounds with excellent reliability, but their ability to transmit sounds of high quality is quite limited on a telehealth infrastructure. Leading DS available in the market (for example 3M Littman) has been trialled in Australian telemedicine but clinicians have found it difficult to get an accurate recording of the sound from available products (Gururajan 2007).

"Currently in Queensland Health, digital stethoscopes are in use by a number of physicians including Cardiologists, Cardiac Surgeons and Respiratory Specialists. However, the use is restricted to patients who present in person. There are no physicians in Queensland using the digital stethoscope technology for remote assessment of patients because current instruments are found to be inadequate in meeting physicians'requirements to use this instrument on a telehealth infrastructure" (Hafeez-Baig et al 2007 p.2).

User acceptance is a critical success criterion for IT adoption and can be sufficiently explained, accurately predicted, and effectively managed by means of a host of relevant factors (Hu et al. 1999). The relevant factors can contain three important dimensions such as: characteristics of the individual, characteristics of the technology, and characteristics of the organisational context. As technology continues to be implemented extensively with innovative technology applications that target specialised individual professionals such as physicians, it is important to study the extent to which existing theories can explain or predict their technology acceptance (Chau & Hu 2001).

Lewin group Inc (2000, p21) mentions 'if clinicians are not comfortable with the technology, or judge that the technology decreases their control over patient care, they may avoid using it, thereby precluding other benefits of telemedicine'. Moreover it is suggested "clinical acceptance of a telehealth application may depend on the degree of confidence the clinicians have in his or her clinical findings from using the system as well as the clinician's satisfaction with the encounter in the absence of face to face interaction with the patient" (Lewin group Inc 2000).

The Technology Acceptance Model (TAM) by Davis (1989) is in the domain of Information Systems (IS) that theorise adoption phenomena that an individual behavioural intention to use technology is determined by two fundamental concepts as followed:

Perceived usefulness (PU): the extent to which a person believes that using the system will increase the job performance; and

Perceived ease-of-use (PEOU): the degree to which a person believes that using the system can be free from effort (Davis, 1989, p320)

It is realised that usefulness and ease of use of a new technology, adapted from the TAM model, could have an impact on the acceptance of the digital stethoscope by users. In this case TAM is used as a guide to explain the ease of use and usefulness of new technology for the clinicians in telehealth. Furthermore, TAM can also be used to explain clinicians' satisfaction of using the digital stethoscope in a telehealth system context.

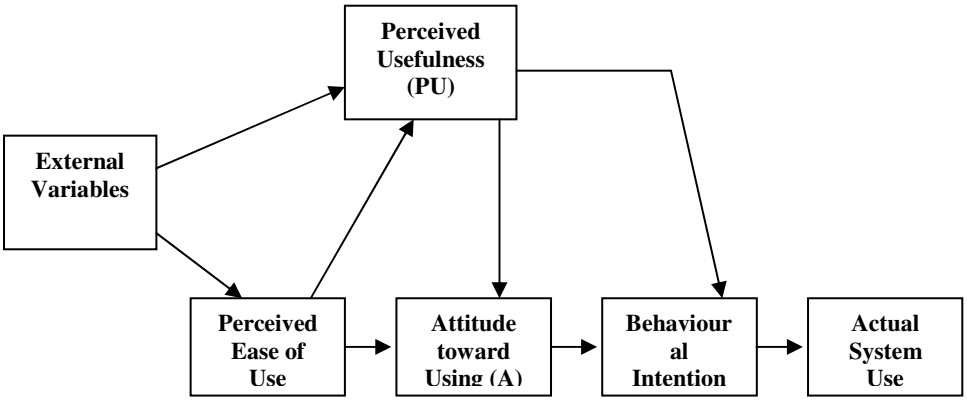

Figure 1: Technology Acceptance Model (*Source:* Davis et al. 1989, p.985)

Davis (1989) explains that perceived usefulness is the degree to which a person believes that using a particular system would enhance his or her job performance (See figure 1). This concept could apply in the telehealth context and might explain the extent to which clinicians believe that the usage of a digital stethoscope will increase their job performance in the telehealth system. Davis (1989) suggests that this follows from the definition of the word "useful" that is capable of being used advantageously. Additionally perceived ease of use refers to the degree to which a person believes that using a particular system would be free of effort, following from the definition of "ease" which means freedom from difficulty or great effort (Davis 1989). In this study the concept might be the degree to which clinicians believe that using a digital stethoscope is useful. Studies have identified the relationship, importance and influence of the TAM model (Davis, 1989) variables to each other and especially to the adoption of technology by users (Croteau and Vieru 2002; Hu et al. 1999; Han et al. 2006; Phillips et al. 1994).

Croteau and Vieru (2002) found that perceived effort and persistence have a significant impact on perceived ease of use in the case of physicians from the teaching and academic areas. Croteau and Vieru (2002) also found that Perceived usefulness (PU) was the most significant factor affecting behavioural intention to adopt. So based on this statement, the concern of the suggested evaluation model will be more on usefulness of the digital stethoscope for clinicians rather than ease of use, because clinicians are well-educated professional users who may learn to work with new technology better than other users. Hu et al. (1999) have identified a significant point, suggesting that ease of use has no effect on attitude and perceived usefulness because the physicians as the users can understand the new technology quickly (Hu et al. 1999). The research study by Hu et al. (1999) suggests that if the telehealth systems fulfil the physicians' needs, then the telehealth technology may be accepted, additionally, physicians need to be sure that the utility of the system is what they require for their practices (Hu et al. 1999).

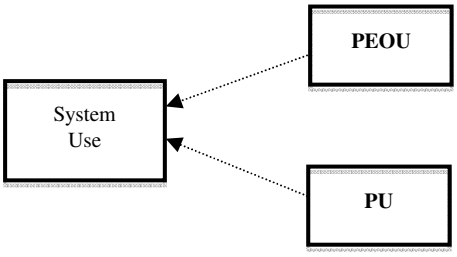

Figure 2: Conceptual model for this study (*Source*: Adapted from Davis et al 1989)

TAM is developed by Davis (1989) to explain the user acceptance of Information technology. Since Telehealth is an IS based innovation, therefore TAM appeared to be a suitable theoretical basis for this study.

Technology acceptance model have been used as a guide for this study, so a conceptual model was derived from original TAM to focus on ease of use and usefulness of system and importance of those two components on system use by clinicians (See figure 2).

It is realised that usefulness and ease of use of a new technology, adapted from the TAM model, could have an impact on the acceptance of the digital stethoscope by users. In this case TAM is used as a guide to explain the ease of use and usefulness of new technology in telehealth. Furthermore, TAM can also be used to explain clinicians' perception of using the digital stethoscope in telehealth system. User satisfaction has been used as a surrogate measure of system effectiveness (Ong & Lai 2004). Therefore, research question addressed in this paper can be formulated as follow:

"*What is the clinicians' perception of using digital stethoscopes in a telehealth context?*

This question seeks to explore whether clinicians' intention to use digital stethoscopes through telehealth context for their routine practice in the future could be influenced by two fundamental constructs of TAM model.

METHODOLOGY

This research will be conducted using an interpretivist viewpoint which can help an IS researcher to understand human thoughts and actions in a social and organisational environment (Klein & Myers1999 p.67); it has the potential to produce deep insights into information system phenomena.

For this study, significant preliminary work is essential to be conducted so the researcher can understand and familiarize with the situation. It could also help the researcher to understand and gain knowledge about the phenomenon. The researcher seeks to understand the usage phenomena and user reaction to new technology in a telehealth system in Queensland.

As the study aims to answer the question "*What is the clinicians' perception of using digital stethoscopes in telehealth context?* A qualitative approach may be helpful to study and learn about the group of clinicians who work with the DS as a new technology in a health organisation. Silverman (2006) mentions four major methods used by qualitative researchers as: Observation, Analysing text and documents, Interviews and focus groups, Audio and video recording; whereas Jarvinen (2004) suggests the most typical data gathering techniques are interview, observation, questionnaire and written material. Oliver-Hoyo and Allen (2006) state that data collection methods of qualitative research commonly include field notes, student journals or documents, surveys and interviews. Additionally, Marshall and Rossman (2006) mention that qualitative research typically rely on four methods for gathering information which are: participating in the setting, observing directly, interviewing in depth and analysing documents and material culture.

This paper has been developed while the research project was in progress, and findings presented here are only preliminary. The research methodology for this project is consisting of two key stages. For the first stage observation was used and for the second stage, focus groups was conducted.

Krueger (1994, p6) explains focus group as a well planned discussion that will gain perceptions on a specific topic in a liberal environment. Likewise, a part of this research will explore clinicians' perception of using digital stethoscopes in telehealth platform. Based on Krueger's definition, the focus group seems an appropriate procedure to use while the goal of this research is to explain people's views regarding their experiences of using the digital stethoscope in the telehealth context. This paper is concerned with the first stage of the methodology specifically the observations that was conducted by the researcher. An additional paper for the second stage that involves focus groups will be published later.

Observation is suggested by Marshall and Rossman (2006) as a highly important method in all qualitative inquiry. Observation is used to realise complex interactions in natural social settings. Observation in research is more than simply seeing; it may involve hearing and touching the environment. Researchers have an active role in the observation process (Silverman 2006).

By using the observation along with other qualitative methods, the researchers can look at other persons' behaviours. It means that the observer can understand what participants mean when they say something. Jarvinen (2004) states that direct observation may be more reliable than what people say in

many instances. Conducting observation can help the researcher to discover whether people do what they say they do or behave in the way they claim to behave.

Direct observation, which is distinguished from participant observation, was a method used for this study. It was aimed to observe certain sampled situations or people rather than trying to become immersed in the entire context (Trochim 2006).

By conducting an observation, the users were observed and investigation was done regarding the research questions. During this stage, users have been given stethoscopes to work with in the teleheath context. One of the objectives of conducting observation was to understand users' perceptions of using a digital stethoscope in telehealth. In next section participants' recruitment method for this study will be discussed.

Researcher's external supervisor from Queensland Health has agreed to recommend suitable participants for participation in the observations and assisted in the recruitment of the participants, with initial contact being made through telephone or email. Through conducting this research it was considered that the overall design of digital stethoscopes to be used in telehealth environment could be improved.

The Digital stethoscope project research team has contacted Queensland health via email prior conducting Observation and the focus groups. It was explained about the research aim and researchers'' activities and seeking their help and participation. Three positive responses were received from hospitals in Queensland and since the confirmation emails were obtained, the research team organised their data collection stage at those hospitals.

The participants have been chosen from clinical staffs, doctors, nurses and practitioners from the healthcare setting. The user group is defined as clinicians for this study. In order to scope this research project to PhD program, a choice has been made to restrict of the study of the clinicians as the user group and exclude patients from this research.

DATA COLLECTION AND ANALYSIS

The following table demonstrates summary of the hospitals' background and facility services.

All three hospitals are located in Queensland. One is in metropolitan area; the other one is a regional hospital and the last one is located in remote area.

Table 1: Hospitals' summary of services (*Source: http://www.health.qld.gov.au/)*

Hospital name	Specialist services	Other services
Hospital A	Acute medical services including general medicine, mental health, emergency medicine, endocrinology; gastroenterology; obstetrics and gynaecology; oncology, paediatrics; respiratory medicine; renal medicine; haemodialysis, home dialysis peritoneal dialysis, renal replacement therapy. Surgical services including day of admission and day surgery services; endoscopy services; ENT head; faciomaxillary surgery; gynaecology; major orthopaedic pre-admission service; orthopaedic surgery; preoperative services. Specialty services including stomal therapy and wound management. Anaesthetic services including acute pain service.	**Medical support:** Clinical measurement including ECG; EEG; stress testing; Health Information Service; Infection Control; Medical imaging - 24 hour emergency imaging, CT, General X-ray, Angiography, Ultrasound (+ sourcing of MRI and Echocardiography), Pathology including biochemistry; cytology; haematology; histology; microbiology; Pharmacy; Red Cross Blood bank. **Allied Health Services:** Dietetics; Occupational therapy; Physiotherapy; Podiatry; Psychology; Rural Allied health services; Speech pathology; Social work. **Other:** Health Promotion; Outreach Support; Pastoral Care; SNAP Project
Hospital B	**Visiting specialist services:** Physician, Dermatology, Flying Obstetrics and Gynaecology, Ophthalmology, Psychiatry, Flying Surgeon, Paediatrician	**Allied Health Services:** Occupational Therapy, Pathology, Radiography, Speech Pathology, Physiotherapy, Social Worker

Hospital C	**None**	**Allied Health Services:** Physiotherapy; Rural Mental Health Service; Social Worker; Oral Health; Occupational Therapist

DATA COLLECTION

Three different types of stethoscopes were given to the users. Digital Stethoscopes have been given to them for durations of 10 minutes, on a telehealth platform. It was planned to have one entity in a remote area and the other in the main centre. Therefore, two separate rooms have been organised for the research team at each hospital to be able to set up the telehealth platform. The research set up was consisting of two laptops, an external modem, two webcams, two sound recorders, a video recorder and special software. Participants' observation was fully documented by the main researcher. Also a video camera has recorded all the sessions and participant's behaviour regard using the three DS.

Hospital A is located in a city with large number of patients seeking health services daily. Since the research team were not able to access all the doctors at the same time for the study, so doctors' participation was based on their own convenience time. Total number of participants included nine doctors and three nurses for hospital A.

First participant from hospital A, a doctor, gave us some feedback about the usefulness of telehealth system for clinicians especially at preadmission sector of anaesthetics. He stated that "although nurses may not use digital stethoscopes through telehealth system but clinicians at emergency department will use DS to contact and monitor patients at emergency department". The rest of the doctors and nurses attended our study later in the morning and have been observed regarding use of DS and their comments about digital stethoscopes' usage were documented.

The participants from hospital B tested the stethoscopes for about half an hour in separate rooms and gave us their feedback individually and later during a group interaction. The participants were three medical doctors and one medical student from Queensland health. They made their comments considering the device to be used in remote access areas, so their feedback was slightly different to the ones we received from hospital A.

A group of 5 nurses and one doctor from hospital C were participated in this project. Each participant tested three different digital stethoscopes on a patient (one of the research team member) and then moved to the next room to assess the sound received from same digital stethoscopes through our computer-to-computer network. As participants for this study are clinicians, mainly doctors, it was very difficult to have the doctors at the same time in same room to test DS. Doctors have been called out for urgent visits regularly and had to leave the researchers for up to two hours until their return.

PRELIMINARY FINDINGS AND DISCUSSION

Observation and focus group have been used as the main data collection method. Since the focus group result will be present in a separate paper, this paper will discuss the observation results that would develop preliminary findings for this research. The first step in qualitative analysis for this study was reading observational notes and watching the video records. The observational notes were scanned through and keywords were highlighted manually. After reviewing notes for several times, the researcher was able to identify the themes out of the notes based on frequency of occurrence. Initial analysis of collected data at preliminary stage of research indentified the following themes:

Sound Quality: Almost all the participants were concerned about the quality of sound that they were receiving. Since some of the participants were receiving sound with low quality and crackling for many times, therefore the participants were struggling to receive high quality of sound by moving the DS diaphragm on patient's chest.

Number of participants from hospital A were complaining about crackling of sound while they were listening to heartbeat through the telecommunication system that was set up for this study. It was not clear for researcher whether the crackling is due to the telecommunication and wireless modem quality, or was it earphone' quality. This problem may get clarified if the DS will be tested via real telehealth system in Queensland. If crackling of sound could be eliminated, the participants may be able to make satisfactory statements regards DS usage and their expectations of the system.

Majority of the participants from Hospital B mentioned that they were happy with the sound quality they received from one of the DS and they were able to make diagnosis by using that specific DS. Most of them were happy with specific DS quality and design while using on patients. None of them were happy by the sound they received from the stethoscopes through the telehealth system. They found the quality received from the system too low and unable to make diagnosis. They found differences in quality of sound when tested the DS individually and when tested through the telehealth system.

The sound they have received through the network appeared to have very low quality and frequently crackled. Participants were complaining about crackle and broken sound which was different to background noise they were receiving. This became an unknown issue to the researchers that they could not understand if the problem was a normal feedback about the sound quality or the network set up had a problem that caused the sound transmission breaking repeatedly.

Participants from hospital C complained about one of the DS in regard to unsatisfactory sound quality in comparison with other stethoscopes. At least one participant stated that the sound she was receiving is muffled. Another participant was complaining about breaking in sound transmission that could not let her to make diagnosis. All of the participants were complaining about a weird background noise/ buzz while listening to the patient's heart from next room. Later, the researchers realised that hairy chest would have caused this problem and as soon as a female team member played the patient role, the participants became happy about the noise elimination.

Usefulness: At least half of the participants from all hospitals addressed that DS would be a useful device for education purpose. Some of the participants tried to compare each DS with their own traditional stethoscope to find out which one works better for them and will be useful for their routine job. Participants have been happy with user friendliness and features of a DS and found it straightforward.

DS physical features: Volume control was another important factor that participants found necessary for a DS to be used in telehealth systems. Some of the participants were complaining about DS earpiece shapes. Participants compared all DS to find the best earpiece quality and design among three DS.

Since, majority of participants have been able to work with all DS easily, ease of use did not emerge to be an important issue in usage of DS. This may be due to high level of education among clinicians specially the doctors. Similarly, Hu et al. (1999) suggest that there is no significant influence of perceived ease of use on perceived usefulness because the physicians as the users can understand the new technology quickly.

CONCLUSION

By conducting an observation, clinicians were observed and investigation was done regarding the research question. This paper is presenting the preliminary findings only. More qualitative data collection and analysis is required to be able to have better explanation of clinicians' perception of using DS so the researcher is still collecting and analysing data and the results will be address in future publications.

Future research will concentrate on focus groups technique to explore the finding of this research further. The focus group protocol would be designed based on four different themes identified. Data gathered through the focus group technique will be analysed using Nvivo 8 and the finding of this phase of research will be published in separate paper. The research model will also be revised and modified to incorporate the findings of data collected through focus group technique.

This research contributes to the existing knowledge of use of the Technology Acceptance Model (TAM). The outcome of this research attempts to provide practical usage. In order to have effective information systems, it requires an understanding of the organisation, and information technology shaping the systems. As Telehealth systems are a form of information system, to understand the organisation may help to increase the efficiency of the system.

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