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Lessons learned from the usability assessment of home-based telemedicine systems

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ABSTRACT

At-home telemedicine visits are quickly becoming an acceptable alternative for in-person patient visits. However, little work has been done to understand the usability of these home-based telemedicine solutions. It is critical for user acceptance and real-world applicability to evaluate available telemedicine solutions within the context-specific needs of the users of this technology. To address this need, this study evaluated the usability of four home-based telemedicine software platforms: Doxy.me, Vidyo, VSee, and Polycom. Using a within-subjects experimental design, twenty participants were asked to complete a telemedicine session involving several tasks using the four platforms. Upon completion of these tasks for each platform, participants completed the IBM computer system usability questionnaire (CSUQ) and the NASA Task Load Index test. Upon completing the tasks on all four platforms, the participants completed a final post-test subjective questionnaire ranking the platforms based on their preference. Of the twenty participants, 19 completed the study. Statistically significant differences among the telemedicine software platforms were found for task completion time, total workload, mental demand, effort, frustration, preference ranking and computer system usability scores. Usability problems with installation and account creation led to high mental demand and task completion time, suggesting the participants preferred a system without such requirements. Majority of the usability issues were identified at the telemedicine initiation phase. The findings from this study can be used by software developers to develop user-friendly telemedicine systems.

1. Introduction

Telemedicine is the use of telecommunications technology to provide access to healthcare when geographical barriers make conventional consultation impractical (Board on Health Care Services & Institute of Medicine (2012)). Real-time telemedicine entails a healthcare professional interacting with a patient or another care provider synchronously. Real-time telemedicine can be generally classified into clinic- or hospital-based telemedicine, and home-based telemedicine. *Clinic- or hospital-based telemedicine* entails connecting two endpoints that both reside in the clinic or hospital setting. This allows rural or underserved clinics or hospitals to provide their patients access to specialists not available in-person. This is often used in the emergency stroke settings where an expert neurologist takes time-sensitive, life-saving decision, despite the hospital not being staffed a neurologist. Real-time hospital-based telemedicine allows a Neurologist from a large medical center to assess a patient in a rural hospital. *Home-based telemedicine* allows a healthcare professional to remotely connect with and provide care to a patient in the home (or elsewhere). Home-based telemedicine is often used for clinical visits that do not require physical presence such as behavioral health, counseling, follow up, result reporting, and patient education.

Telemedicine has gained significant support in recent years as an acceptable care methodology, with effective utilization in many clinical domains (Bashshur et al., 2011). Telemedicine has been shown to significantly reduce costs (Baker et al., 2011; Rojas and

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Gagnon, 2008) and travel burden (Wootton et al., 2011), while increasing access to health care, particularly to rural and underserved areas (Coelho, 2011; Doolittle and Spaulding, 2006; Kutscher, 2014). Moreover, the results from a study conducted by Agha et al. (2009) to compare telemedicine consultation and inpatient consultation suggests that patients were equally satisfied with telemedicine and in-patient consultation in terms of physician's physical competence and interpersonal skill. In addition, the patients were more satisfied with telemedicine over in-patient in terms of convenience. Another study conducted by Kenney et al. (2016) surveyed 20 patients who received teledermoscopy consultation. All the 20 participants reported it as a convenient means of consultation. A national survey conducted by American Wells revealed that nearly two-thirds of patients would be willing to meet with their doctor by telemedicine (Modahl, 2015). With the precipitous decline in costs of technical capabilities, and its greater availability, telemedicine is quickly establishing itself as an acceptable care delivery model to augment the traditional delivery approaches. However, despite such promise and potential, relatively few patients have ever participated in a telemedicine session (Board on Health Care Services & Institute of Medicine (2012)).

A few barriers from a care-receiver perspective that prevent the adoption of telemedicine include the cost, network connectivity issues, and other technological issues while interacting with the system (Board on Health Care Services & Institute of Medicine (2012)). In addition, Waterson (2014) observed that there is a gap between the system design and the healthcare system, while summarizing the results of use of Health Information Technologies (HIT). This gap results in systems being used erroneously and prevents the adoption of technologies by healthcare experts (Carayon et al., 2014). However, telemedicine technologies are becoming widely available in the marketplace and costs of telehealth technologies are dropping (Board on Health Care Services & Institute of Medicine (2012)). Federal agencies such as the United States Department of Agriculture (USDA) are providing funds primarily to assist rural communities to expand network capabilities and acquire telemedical technologies so that medical service providers who serve rural residents can link to other needed expertise located at distances too far to access otherwise.

More recently, care providers are increasingly using home-based video telemedicine systems to manage chronic conditions such as hypertension and diabetes (Levin et al., 2013; Wootton, 2012), age related issues (Brignell et al., 2007), and other health conditions that make it difficult for patients to travel to a hospital from a remote location (Kvedar et al., 2014). Care providers use two-way interactive video chat facilities to converse with patients (Wibbenmeyer et al., 2015), and determine whether the patient needs to be consulted face-to-face or not. Results of a recent study investigating the usability of FaceTime videoconferencing for diabetes care suggests that 65% of 34 participants were satisfied with FaceTime visit (Robinson et al., 2015). A patient living in rural area can be connected to a remote specialist with the help of technology, avoiding travel to the care provider. Widespread application of telemedicine can also be seen in dentistry, ophthalmology, dermatology and mental health care. Because of rapid advancements in technology, the implementation and management of telemedicine is becoming easier and more affordable, as evidenced by recent reduction in hospitalizations, readmissions, duration of stay, and costs for chronic disease management (Broens et al., 2007). The availability of better health-care at lower costs in turn quickens the technological advancement (Klaassen et al., 2016).

A recent study conducted by Gardner et al. (2015) to understand patient perceptions of the feasibility and viability of video-based consultation from home, and their willingness to accept this type of care indicated that most patients were willing to accept video consultation from home. The authors pointed out several barriers that need to be addressed to facilitate a broader adoption of telemedicine technology, which included the usability and reduced cost for usage. The results of this study also suggest the need to evaluate available telemedicine solutions within the context-specific needs of the users of these technologies for user acceptance and real-world applicability.

To foster user acceptance of telemedicine technologies, it is important for healthcare consumers to have a positive attitude toward using such systems (Hu et al., 1999). A key factor that influence user acceptance is the usability of the telemedicine system. It is critical, for real-world applicability to situate telemedicine applications within the context-specific needs of the people benefiting from or otherwise affected by them. Limited research is conducted in evaluating the usability of such tools from a home-based video telemedicine system perspective has been conducted. To address this situation, this study investigates the usability issues associated with four home-based telemedicine software platforms using task performance metrics, and subjective measures.

2. Materials & methods

2.1. Participants

A total of 20 participants (12 males and 8 females) were recruited via local print and online advertising. This sample size was used based on the findings of Bevan et al. and Virzi (Bevan et al., 2003; Chalil Madathil et al., 2013; Chalil Madathil and Greenstein, 2011; Madathil et al., 2010; Virzi, 1992) and Faulkner (Faulkner, 2003) for conducting empirical usability research. These participants ranged in age from 20 to 32 with a mean age of 25.474 (SD = 3.438), thus meeting the study requirement that they need to be 18 or older. None had previous experience with telemedicine systems. They were compensated for their time with a $20 gift card from Amazon.com regardless of their performance. The demographic details of the participants are provided in Table 1.

2.2. Apparatus

This study used two laptop computers with in-built web cameras, one for the participant and one for the researcher who played the role of the doctor. Participants were also provided with a headphone, a microphone and a mouse as well as a printed clinical scenario including blood sugar and pressure levels. Mozilla Firefox browser was installed on both machines. The experimental setup is shown in Fig. 1.

Table 1
Demographic information.

Variable ($N = 19$)	Number	%
Gender		
Male	11	58
Female	8	42
Education		
High School	1	5
Some College	2	11
4-year College Degree	9	47
Master's Degree	6	32
Doctoral Degree	1	5
Use of video chat systems such as Skype and Facetime		
Once a month	2	10
Once a week	10	53
2–3 times a week	4	21
Daily	3	16