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Trust and Trustworthiness: A Framework for Successful Design of Telemedicine

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by

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Dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Computer Information Systems

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An Abstract of a Dissertation Submitted to Nova Southeastern University in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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Trust and its antecedents have been demonstrated as a barrier to the successful adoption of numerous fields of technology, most notably e-commerce, and may be a key factor in the lack of adoption or adaptation in the field of telemedicine. In the medical arena, trust is often formed through the relationships cultivated over time via clinician and patient. Trust and interpersonal relationships may also play a significant role in the adoption of telemedicine. The idea of telemedicine has been explored for nearly 30 years in one form or another. Yet, despite grandiose promises of how it will someday significantly improve the healthcare system, the field continues to lag behind other areas of technology by 10 to 15 years.

The reasons for the lack of adoption may be many given the barriers that have been observed by other researchers with regards to trust and trustworthiness. This study examined the role of trust from various aspects within telemedicine, with particular emphasis on the role that trust plays in the adoption and adaptation of a telemedicine system. Simulators examined the role of trust in the treatment and management of diabetes mellitus (common illness) in order to assess the impact and role of trust components. Surveys of the subjects were conducted to capture the trust dynamics, as well as the development of a framework for successful implementation of telemedicine using trust and trustworthiness as a foundation.

Results indicated that certain attributes do influence the level of trust in the system. The framework developed demonstrated that medical content, disease state management, perceived patient outcomes, and design all had significant impact on trust of the system.

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Chapter 1

Introduction

Problem Statement and Goal

Significant strides in the fields of telecommunications, networking, computer processing, software engineering, and infrastructure have created numerous opportunities for the advancement of telemedicine. Telemedicine's definition encompasses a broad utilization of advanced telecommunications, networking, dissemination of expertise, distribution of information, and the exchange of healthcare information or services through geographically disparate participants (Chau & Hu, 2004). Yet despite the technological advances that have been made, the blending of healthcare and technology through telemedicine has historically remained 10-15 years behind the times (Goldschmidt, 2005). For example, technological treatment advances in organ transplantation, hypercholesterolemia, hypertension, diabetes, cancer, biotechnology, and numerous other procedures have dramatically increased the quality of life (QOL) of millions of people, while the positive effects of telemedicine have reached only a relatively small portion of the medical community and general population to date.

The slow adoption of telemedicine may have numerous causes; however, the availability of advanced technology is not among them. Although a multitude of attempts have been made to establish and expand the adoption of telemedicine, most have been met with limited success. A problem exists that there is significant divergence in the adoption and adaptation of technology within the healthcare and medical community. It is suspected that this divergence, which may be rooted in a lack of trust in the technology being applied, may hinder the advancement and treatment of patients, thus increasing morbidity and mortality.

The idea of trust has been examined in several capacities and applications. Fogg (2003) has demonstrated that credibility and trust are key persuasive aspects of technology. If a user does not find the information or technology credible, they lose trust in the technology and ultimately abandon the innovation. Trust, when examined in the role of the service industry, has been challenging to define or isolate (Chang, Hussain, & Dillon, 2005). Trust may be influenced by several factors such as direct experience and varies greatly between individuals (Falcone & Castelfranchi, 2004). Trust may also influence the adoption or adaptation of technology, particularly in settings such as healthcare or medicine (Geffen, 2002).

Relevance and Significance

The author's goal in conducting this research was to offer a better understanding of the environment of telemedicine, revealing the factors that drive the adoption and adaptation of technology in the field of healthcare and medicine. Research has demonstrated that trust can have a strong bearing on the outcome of user adoption (Gefen, 2002; Fogg, 2003; Chang, Hussain, & Dillon, 2005; Slyke, Belanger, & Comunale, 2004; Van House, 2002). Ultimately, the purpose of telemedicine is to offer a higher quality of life to the patient. To that end, telemedicine functions in numerous ways. In this study, the author has considered the interactions between Patient-to-Clinician, Clinician-to-Patient, and Clinician-to-Clinician. The aging population of today is being confronted with myriad of diseases and conditions that require the collaboration of numerous clinicians and specialists. In order to accomplish the goal of improving the quality of life for patients through telemedicine, there must be a certain level of adoption from all participants.

Barriers, Issues, Limitations, and Delimitations

Historically, telemedicine has not evolved as quickly as other forms of technology or even medical advances (Goldschmidt, 2005); there are certain barriers that delay the process. Perhaps the climate of healthcare and medicine has not afforded the opportunities for technology to survive or flourish. Yet, despite the lack of major advances in telemedicine, it does continue to move forward, albeit slowly (Goldschmidt). Programs funded and promoted by governments have offered the greatest financial foundation for telemedicine (Raghupathi & Tan, 2002). These programs have poured millions of dollars into the research and development of telemedicine projects.

However, despite the funding and promotion of telemedicine programs, there appear to be other, perhaps less recognized barriers to the adoption by healthcare professionals overall. Adoption and adaptation have taken place on a micro level but have not expanded into the macro arena (Goldschmidt, 2005). It is hypothesized by the researcher that trust may have a bearing on this lack of macro adoption; thus a focused approach may elucidate and enhance the key aspects impacting the adoption on a macro level.

In terms of persuasive computing, trust, and deception, researchers Bradner and Mark (2002) found that geographic distance might lead to a reduction in cooperation and persuasion when perceived distance is greater. Moreover, there may be an increased risk for deception and lack of success with an extensive perceived distance, ultimately creating another barrier to the successful adoption of telemedicine.

Another realm that may present limitations is the barrier of bias, which can surface from numerous sources. One such source is the author and researcher of this work. The author acknowledges a certain degree of bias in terms of selection criteria for this research. Other methodologies or examinations may serve to validate the final analysis of the data. In part, the author has selected a variety of literature from a trust and persuasive technologies perspective, as well as telemedicine collections. Examination focused on various contexts of innovation in both fields.

Certainly there are numerous other barriers to overcome in order to succeed in telemedicine. This research does not purport to hold the key to success with telemedicine by solely examining trust, but also by identifying the trust factors involved such as quality and type of medical data, formatting and presentation of the information, and interpersonal dynamics. In this way, the line of thinking and general knowledge in the area of telemedicine will be advanced. Through this advancement in knowledge, it is hoped that an improvement is realized in the quality of life for patients. Future research may thus validate the results of these current findings, as well as facilitate their application and generalization to other areas.

Elements, Hypotheses, Theories, and Research Questions

The rapid expansion and development of the Internet over the past decade has changed the face of business. Businesses have been forced to deal with issues related to trust in order to establish customer relations comparable to the face-to-face business model (Slyke, Belanger, & Comunale, 2004). Trust dynamics have been explored and described in numerous e-commerce, health portal, and other web endeavors in an attempt to determine the role of trust in the adoption of these services (Chang, Hussain, & Dillon, 2005; Falcone & Castelfranchi, 2004; Fogg, Marable, Soohoo, Standford, Danielson, & Tauber, 2003; Gefen, 2002; Luo & Najdawi, 2004; Sillence, Briggs, Fishwick, & Harris, 2004; Slyke, Belanger, & Comunale). Trust has emerged as a key component in the adoption rates of these technologies; a higher level of trust generally translates into a greater likelihood of adoption (Bryant & Colledge, 2002; Eastin, 2006; Kehoe & Ponting, 2003; Lee, 2005). However, this philosophy may not easily transfer into a telemedicine model. This may be due to the fact that the risks associated with the use of a telemedicine model are quite distinct from those associated with other online models such as e-commerce or health portals. The risks associated with e-commerce and health portals are perhaps a loss of privacy or money, while those associated with telemedicine are translated into undesired outcomes should the telemedicine model fail. Risks are also distinct and pronounced on both ends of the telemedicine spectrum. Patients may risk privacy issues, misdiagnosis, inadequate treatment, or unrecognized adverse events associated with medication, treatment, or patient compliance issues; all of which may lead to negative health related outcomes resulting in increases in morbidity or mortality. Clinicians in turn may not only experience the failed outcomes of the patient, but also risk liability for improper care or treatment. Consultative clinicians risk increased liability and loss of credibility, thus reducing new patient referrals or consultative opportunities. These risks represent a unique profile for the telemedicine community and may require an equally unique framework for the successful design of a telemedicine system.

Considering the dynamic and distinct risks that may be associated with telemedicine, the adage of "increased trust equates to increased adoption" may not follow the same dynamics that are recognized in other online environments (Slyke, Belanger, &

Comunale, 2004; Sillence, Briggs, Fishwick, & Harris, 2004; Luo & Najdawi, 2004; Gefen, 2002). These are the questions that have been addressed by this research. What are the trust dynamics that may impede or support telemedicine? Are they distinct from other online services? Does the fact that trust has been shown to have an impact in the adoption rates in an e-commerce (Gefen) environment translate equally into telemedicine, since telemedicine reflects very distinct risks that may not be present in e-commerce?

The hypotheses of this research were that trust and its antecedents have a strong bearing on the adoption and adaptation of telemedicine. Does trust impact telemedicine as it does other areas such as e-commerce (Gefen, 2002), health information web sites (Sillence, Briggs, Fishwick, & Harris, 2004; Slyke, Belanger, & Comunale, 2004), and other tenets of human computer interaction (HCI)? If so, what type of framework in telemedicine would need to be followed to maximize trust? Could a user form a different interpretation of telemedicine if trust concerns were addressed and eliminated?

The primary endpoint of this study was to examine the impact of specific trust dynamics on the field of telemedicine. This was achieved by focusing upon the disease state of diabetes mellitus. Not because diabetes mellitus has some unique issues with regards to trust, but rather diabetes was selected by the researcher due to its emergence as a global healthcare pandemic (International Diabetes Federation, 2006). The secondary endpoint of this study was to examine the impact of trust and telemedicine on various aspects of healthcare; specifically, perceptions and expectations between patients, their doctors, and other clinicians. Are patients' perceptions unique from those of their clinicians? Are clinicians' expectations altered when communicating with patients versus other clinicians? In order to effectively answer these questions, the researcher evaluated the role of various communication pathways, attempting to discover specific nuances that may exist between them that are related to trust. Ultimately, it was anticipated that these discoveries would elucidate the lack of diffusion within telemedicine (Goldschmidt, 2005; Tanriverdi & Iacono, 1998; Paré & Trudel, 2007; Greenhalgh, Robert, Bate, Macfarlane, & Kyriakidou, 2005; Robinson, Savage, & Campbell, 2003).

The hypotheses of this research were based on examining trust dynamics within the health care community by examining the role of a telemedicine application. This was based on the communication links between members of the medical community, the patient and the clinician.

Hypothesis: There is a significant impact on the trustworthiness of disease state management of diabetes based on the content and technical design elements of a telemedicine system, as well as the interpersonal relationships between the subjects. This hypothesis can be broken down into six sub-hypotheses.

H1: The perceived content of medical information (i.e. lab results, kidney function, wound care, etc.) presented to the patient from the clinician will have a significant impact on the trustworthiness of the telemedicine application.

H2: The perceived content of the medical information (i.e., diet, exercise, daily glucose logs) presented to the clinician from the patient will have a significant impact on the trustworthiness of the telemedicine application.

H3: The perceived content of the medical information (i.e., diagnosis, medical therapy, disease state management and treatment options) presented to the clinician from the clinician will have a significant impact on the trustworthiness of the telemedicine application.

H4: The design elements (i.e., how the site is displayed or represented to the user) of the telemedicine system will have a significant impact on the perceived trustworthiness of the telemedicine application, measured across all stratified groups.

H5: The measure of perceived relationship between patient and clinician (bi-directional) will have a significant impact on the trustworthiness of the telemedicine application.

H6: Perceived patient outcome (bi-directional for patient and clinician) will have a significant impact on the trustworthiness of the telemedicine application.

In order to evaluate the hypotheses, the researcher utilized surveys designed to incorporate and capture subject feedback data in relation to trust and telemedicine. Survey responses were measured based on scaled data in a uniform fashion, such as highest to lowest, yes or no, and strongly agree, agree, neutral, disagree, or strongly disagree. This scale provided a foundation for the framework being developed.

This research explored the role of trust from the perspectives of both the patient and the clinician. Since both parties are paramount to the success of telemedicine, it was important to examine the roles and distinctions from each perspective. The researcher then developed a best practices framework that describes the role of trust within a telemedicine application.

Definition of Terms

Evidence Based Medicine (EBM): The conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. The practice of EBM refers to the integration of individual clinical expertise with the best available external clinical evidence from systematic research (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996).

Fasting Glucose Levels: Test performed to measure the concentration of glucose during a period in which the patient has not eaten. (Stedman's Medical Dictionary, 2000)

Glucose: **1.** Blood Sugar. **2.** Monosaccharide sugar that has several forms; an important source of physiological energy. **3.** In diabetes mellitus, it appears in the urine. (Stedman's Medical Dictionary, 2000)

HbA_1C: **1.** Hemoglobin A_1C, glycosylated hemoglobin, glycated hemoglobin. **2.** A member of fractionated hemoglobin A to which D-glucose and related monosaccharides are covalently linked. **3.** Concentrations are increased in the erythrocytes of patients with diabetes, measurement of which can be used as a retrospective index of glucose control over time in diabetic patients, typically over a three month time frame. (Stedman's Medical Dictionary, 2000)

Health Economics Outcomes Research (HEOR): **1.** A multidisciplinary approach to examine the economic benefits when applied to the outcomes of healthcare. **2.** Improves the state of healthcare outcomes by examining the disease management process to expose areas where economic improvements can be made. **3.** Economic improvements are sought for the benefit of the patient, provider, pharmaceutical and healthcare providers or payers. (Epstein & Sherwood, 1996)

Medical Informatics: Sciences concerned with the gathering, manipulating, storing, retrieving, and classifying recorded information within the specific field of medicine. (Stedman's Medical Dictionary, 2000)

Morbidity: **1.** Relative incidence of a particular disease. **2.** The ratio of sick to well members/people in a community or population. **3.** The frequency of the appearance of complications following a procedure or treatment. (Stedman's Medical Dictionary, 2000)

Mortality: **1.** State of being mortal. **2.** Measure of the rate of deaths due to a particular disease within a given population. **3.** A fatal outcome. (Stedman's Medical Dictionary, 2000)

Salubrious: **1.** Healthy: promoting health; healthful; favorable to health of mind or body. **2.** A healthy climate. [N. *salubrity*: Quality of being salubrious and invigorating] (Stedman's Medical Dictionary, 2000)

Summary

Although telemedicine has been touted as having numerous opportunities and advantages in the treatment of patients, there has been a fundamental lack of adoption and adaptation throughout the healthcare community. The slow diffusion is seen from all perspectives including patient, clinician, providers, payers, and institutions. This lack of adoption may be present due to a variety of explanations, one of which may be trust. Trust has been demonstrated as a barrier in numerous other technological arenas, thus telemedicine may equally have an issue with trust. Therefore, this research examined the role of trust in telemedicine applications from the perspective of the Patient-to-Clinician. It was hypothesized that trust does play a role in the diffusion of telemedicine. Specifically, this research hypothesized that there was a significant impact on the trustworthiness of disease state management such as diabetes based on the content and technical design elements of a telemedicine system, as well as the interpersonal relationships between the subjects.

The researcher chose to examine the role of trust and telemedicine within the context of diabetes management due to diabetes being a worldwide pandemic (International Diabetes Federation, 2006). The growth rate associated with diabetes and impaired glucose tolerance (IGT), a form of pre-diabetes, is expected to increase 44% by the year 2025 (International Diabetes Federation). That translates into a projected increase from 500 million to over 800 million people impacted by diabetes (International Diabetes Federation).

Numerous co-morbidities also exist with diabetes and IGT, which include cardiovascular disease, renal disease, macular disease, circulatory disorders, obesity, and nerve damage (International Diabetes Federation, 2006). Diabetes and IGT also affect the mortality rate, often reducing the life span of those inflicted with the disease (International Diabetes Federation). Although there is no cure for diabetes, the disease can often be managed through education, diet, and exercise. When these modalities fail though, the healthcare community can often offer diabetes management support through medical intervention. However, a significant burden lies on the patient to follow the guidelines and instructions of their healthcare provider.

Diabetes not only impacts the quality of life for patients, but carries an enormous burden on the healthcare community, global resources, and society in general. It is a complex and systematic disease, which may potentially be combated through advances in telemedicine. In turn, the field of telemedicine may benefit by generalizing the knowledge of trust issues gained from the study of diabetic patients to that of other areas of focus such as cardiovascular disease, which is globally ranked number one in terms of mortality.

Chapter 2

Review of the Literature

Introduction

The purpose of this chapter is to provide a review of the relevant literature associated with trust and telemedicine as it applies to the disease state of diabetes. This will encompass the areas of trust, telemedicine, medical informatics, and diabetes management. Additionally, the roles of trust, telemedicine, and diabetes management will be studied together to form a foundation for the development of a trust based telemedicine system.

Trust

Trust has always been a cornerstone of the doctor-patient relationship. Patients must perceive a certain level of trust in their healthcare providers in order to follow their guidance and improve the quality of their lives. Establishing trust takes time, attention, and effort in human relationships; barriers to trust impede relationship development. Obviously medicine requires a high degree of relationship and trust in order to be effective. Chang, Hussain, and Dillon (2005) describe the issue of trust to be “fuzzy,” as in a vague sort of way. Trust is fragile, dynamic, and complex; one cannot readily place a specific definition around it (Chang et al., 2005). Trust may have a different meaning, look, or feel depending on who is giving the definition (Chang, 2005). It may also be measured by credibility (Fogg, 2003). In other words, a higher degree of credibility earned translates into having a higher degree of trust.

Fogg (2003) also focused a great deal of attention on persuasive technology. Persuasive technology is designed to change the behaviors or thought processes of its users (Fogg). Certainly healthcare professionals are constantly attempting to persuade their patients to live better lifestyles by losing weight, monitoring diet, exercising, and avoiding unhealthy habits. Telemedicine is simply an extension of that process, allowing healthcare professionals to utilize technology to assist in persuading patients.

Examples of persuasive computing fall into the realm of trust and credibility, which have been examined in terms of Web site usage (Fogg, Marable, Soohoo, Stanford, Danielson, & Tauber, 2003). Focusing attention on the details of Web site design was found to have a dramatic impact on the perceived credibility of the site. There could be significant repercussions if designers overlook key credibility concepts. These repercussions could eliminate any benefit or perceived benefit to the user. In terms of telemedicine, this could have a significant impact on the outcome of the patient's medical treatment, which would be unacceptable in a telemedicine application. Telemedicine's success may hinge on many of the factors that are attributed to credibility and users must feel that the site is meeting the highest of standards, just as would be expected in a direct and personal patient management scenario. Telemedicine must be able to extend the credibility and trust dynamics to a virtual environment and potentially pay greater attention to these details than those which other ventures may require.

Trust was also examined in the realm of e-commerce (Gefen, 2002), where online consumers were evaluated for trust and trustworthy dynamics. Gefen found that these dynamics may have multiple facets with numerous effects. Many of these may be linked to beliefs, education, cultural norms, or other influential aspects of human nature. E-commerce, although small in relation to all commerce, may have specific challenges that other forms of commerce may not face. Human relationships, particularly in medicine, have a unique educational and cultural aspect that must be acknowledged and understood in order to adequately address the trust dynamics involved. It may be more difficult to establish a firm relationship with a customer, which is essential for persuasion to take place (Bickmore & Picard, 2005). Without the aspects of trust and trustworthiness, the consumer may feel less inclined to follow through with a commerce decision. These dynamics proved vital to decisions based on low personal importance (Bickmore & Picard) such as buying a pair of shoes or perhaps hotel shopping for an upcoming trip. However, when it comes to matters of high personal importance such as those associated with medical decisions, trustworthiness and likeability may be overshadowed by factors such as relationships. Bickmore and Picard introduced the concept of relational agents that would attempt to influence or persuade users that are considering matters of high personal importance; certainly telemedicine could be utilized in this manner.

Persuasive computing has also become a topic of interest over the past few years. Saari, Ravaja, Laarni, Turpeinen, and Kallinen (2004) examined the psychological role of persuasive marketing techniques in e-commerce. These techniques involve personalizing the presentation and flow of information specifically to the user in order to maximize the persuasive impact. Areas of potential impact could involve user interface, visualization, layout, modalities, or data structure (Saari, Ravaja, Laarni, Turpeinen, & Kallinen).

Knowledge work also carries with it a strong reliance on trust and trust attributes (Van House, 2002). Medicine has a high degree of knowledge representation and communication that is built upon prior research. In particular, Evidence Based Medicine

(EBM) requires a great deal of knowledge management, representation, and processing. EBM is often cited in diseases such as diabetes due to the overwhelming amount of research conducted. This research allows clinicians to follow the best known outcomes based on the evidence collected in large scale trials. Moreover, any Clinician-to-Patient relationship is knowledge work in process. The educated clinician is transferring their knowledge to the patient in the form of examination, diagnosis, and treatment. Van House indicates that a strong relation in the form of trust is required to effectively transfer information from source to source.

Communication is a cornerstone of medical care (Alpay, Toussaint, & Zwetsloot-Schonk, 2004). Patients must communicate effectively with only their clinicians in most cases, while clinicians must communicate not only with the patient but with other clinicians as well. Healthy and constructive communication may be a function of a long-term Clinician-to-Patient relationship. Telemedicine must be able to facilitate healthy, constructive, open, and accessible communication in order to function as a replacement for direct Clinician-to-Patient care. In addition, the medical environment today requires a multidisciplinary approach; thus telemedicine must also facilitate clear and open communication between health care providers.

Trust has also been examined in the realm of health information in which trust building dynamics were measured against online health portals (Luo & Najdawi, 2004). In these cases, the information exchange is less controlled and may not relate to accurate or current standards of care or treatment recommendations. In terms of online health portals, the study found that the trust dynamics examined were well represented. It was noted that the site designers may have employed measures that simply enhanced the trustworthiness of the site, regardless of its effectiveness. Certainly design and content play a significant role in the increased trust or mistrust of an online health site (Sillence, Briggs, Fishwick, & Harris, 2004). These visualization techniques, such as the design elements, have been shown to be a barrier to trust in e-commerce and other online portals. In many cases, initial trust and early adoption can be increased through the use of visualization techniques in the design and formatting, yet long term trust and mistrust are impacted by the validity of the health information. Considering that telemedicine goes well beyond the simplicity of a health portal site, which is simply a repository for information, the necessity to examine the deeper roles of trust dynamics in telemedicine is warranted.

Telemedicine

Although telemedicine has been a focus of extensive research over the past 40 years, adoption of the field has been slow (Goldschmidt, 2005; Wilson, 2003). Many factors may play a role in the slow adoption of telemedicine; however, availability of technology is not one of them. Availability should be distinguished from accessibility in that the technology may be present in and available on the world market, yet it may not be accessible due to government restrictions, poverty, internal politics, or lack of infrastructure.

Despite the slow adoption of technology by the masses, each new technological advance has been adapted in some form by the medical field (Moore, 1996; King & Gribbins, 2002; Pinelle & Gutwin, 2006; Yu & Comensoli, 2004). This fact demonstrates the high interest level of the medical community. While telemedicine has failed to keep pace with the adoption rate of other industries (Goldschmidt, 2005), they have recognized benefits in productivity, efficiency, and speed related to adoption of other forms of new technology (Moore, 1996; King & Gribbins, 2002; Pinelle & Gutwin, 2006; Yu & Comensoli, 2004).

Yu and Comensoli (2004) and Moore (1996) both describe the scenario where the medical system itself is unique in the adoption of technology. The medical community readily adopts technology in the form of diagnostic instruments, such as EKG machines, radiological imaging, cardiac imaging, diabetic monitors, laboratory equipment, and devices such as pacemakers. However, this interest in technological instrumentation does not seem to translate into other forms of technology, such as healthcare information systems (HIS), telemedicine, digital patient records, or other informatics approaches. This reluctance may be due to the hierarchy of the healthcare system (Pinelle & Gutwin, 2006). Knowledge is at the core of the healthcare system; clinicians spend countless years in training and education in order to become competent clinicians. This knowledge-skill relationship is locked up in a tight structure where top level opinion leaders in any field of medicine carry with them the key to disseminating and controlling the information flow through research directions, treatment guidelines, protocols, professional associations, and fellowships. Control of that information may be a factor impeding the adoption of technology. This hierarchy may cause those empowered with high-level knowledge to be unwilling to relent to its ubiquitous availability (Moore, 1996; Yu & Comensoli, 2004). As medicine becomes more advanced, each specialty becomes more complex and more information intensive.

It would be impossible for any one person to become an absolute expert in every field of medicine; its specialties are overwhelmingly diverse and complex. Moreover, each specialty is wrought with a hierarchy of control permeating the entire profession, resulting in a top down approach to information dissemination (Moore, 1996; Yu & Comensoli, 2004; Pinelle & Gutwin, 2006). Those top tier clinicians determine what is appropriate and considered best practice within a given disease state and push that information down throughout the system. Although there is no mandate that a clinician follow the opinions of the hierarchy, they risk the potential loss of credibility and malpractice should an approach that deviates from the standard go awry. By following protocols of best practices, clinicians demonstrate that they are abiding by current standards of care in patient treatment, thus reducing their risk exposure. Therefore, there may be pressure within the system to abide by the status quo, thus resulting in less desire to adopt technology (Moore; Yu & Comensoli).

Moore (1996) further discusses the cultural roles within the healthcare system. Medicine has a certain culture that influences the adoption and adaptation of innovation. Each healthcare facility may carry with it a unique culture that either strengthens or weakens the adoption of technology. Moore elucidates ways in which negative cultural impact can be overcome, such as demonstrating a specific and clear outline of the outcomes of technology adoption to those at the top of the cultural hierarchy. In this way, the process of dissemination would be from the top down, thereby respecting the cultural nuances present in the medical system. By respecting the cultural distinctions of the hierarchy, Moore postulates that individuals at the top may be able to see the benefits of the use of technology. Lastly, Moore indicates that by changing the fundamental approach to training clinicians, the benefits of technology can be seen earlier and the adoption curve may shift. One such approach may be to shift the conversation from information technology being of benefit to the clinician, to being of benefit to the patient. By demonstrating a clear and distinct benefit to the patient, the clinician may find it hard to argue against technology adoption. Moore concludes by indicating that failure of clinical systems has not been a failure of technology, but rather the shortcomings of communication and implementation of clinical systems.

Telemedicine, which has been loosely defined as patient management through disparate locations, has also carried with it an issue of presence (Alem, Hansen, & Li, 2006), whereas the user may be influenced by the degree of presence as viewed by the participants. This research focused on the issue of trust within the realm of telemedicine. Failure to maintain a high level of presence in a telemedicine application could prove to be a major shortcoming and a major cause for the rejection of the technology. Alem et al. considered the value of presence in patient care as it relates to the clinician-specialist arena, which is commonplace in the medical arena. Clinicians often seek the advice of a specialist to either develop a treatment approach or to confirm that an approach is appropriate. Presence in this sense creates a stronger relationship between remote diagnosis and care than between other modalities such as telephone-based systems. Presence factors help to determine the success of the remote consultation. Alem et al. utilized questionnaires to capture the results of the participants.

One area that has seen success in the medical informatics field, of which telemedicine is a subgroup, is that of radiology. Radiology consults have grown into a worldwide outsourcing phenomenon (Tanriverdi & Iacono, 1998; Greenhalgh, Robert, Bate, Macfarlane, & Kyriakidou, 2005). This success is due in large part to the fiscal benefits met by such a system. The costs associated with having a radiologist on call during the night are overly burdensome. Therefore, if a medical facility utilizes a radiologist consultation on a case from, for example Australia or India, it proves to be very cost effective. However, this may also lead to concerns of licensing, training, and expertise from all parties concerned. Radiology and imaging certainly carry with it a large degree of subjective interpretation. Would these interpretations remain consistent if outsourced to other parts of the world?

Many of the barriers that have been experienced by the lack of adoption of telemedicine may be attributed to fiscal accountability. To whom should the cost of the telemedicine system be addressed? Numerous problems of this sort exist between the current healthcare system and proposed technological advances (Tanriverdi & Iacono, 1998; Paré & Trudel, 2007; Greenhalgh, Robert, Bate, Macfarlane, & Kyriakidou, 2005). Others include the way in which specialists are traditionally reimbursed for consultations. Many organizations require a personal visit between clinician and patient in order to seek reimbursement (Tanriverdi & Iacono). Systems must be created that will support the myriad of stakeholders involved. These may include, but are not limited to, clinicians, providers, institutions, patients, reimbursement organizations, and developers of the technology. This poses a significant challenge, as each stakeholder may seek payment for the technology by another. Incentives are required that support changes in the system to adopt the technology. These changes could be the result of either policy changes or discovery of marketplace opportunities that benefit the providers in some way, as in the example of the success in outsourcing radiological services.

According to Tanriverdi and Iacono (1998), and Robinson, Savage, and Campbell (2003), as well as Paré and Trudel (2007), there exist numerous knowledge barriers to the diffusion of telemedicine. These knowledge barriers can be addressed through appropriate education, training, and a successfully navigated learning process in order to diffuse the technology and reap the benefits (Tanriverdi & Iacono; Robinson, Savage, & Campbell; Paré & Trudel). Unless the learning barriers are addressed at an organizational and institutional level, diffusion may remain low. This translates into incorporating the process early in the training of clinicians and adapting them to the overall benefits of technology.

In addition to knowledge barriers being addressed, Tanriverdi and Iacono (1998) as well as Paré and Trudel (2007) suggest that behavioral changes on the part of the clinicians are necessary. Impact on roles, status, patient care, and autonomy must be addressed prior to the successful implementation (Tanriverdi & Iacono; Paré & Trudel).

Another barrier may be legal in nature; many states forbid the practice of medicine by any person who is not licensed to do so in that state (Tanriverdi & Iacono, 1998; Greenhalgh, Robert, Bate, Macfarlane, & Kyriakidou, 2005). How will this affect the practice of remote care? If the primary benefit of telemedicine is to provide care across disparate locations, will these laws prevent the full use of telemedicine? Officials must grapple with the challenges faced by such scenarios in order to foster the technology. Ironically, the most money spent on promoting the use of telemedicine thus far has been by the United States Government, which has spent billions of dollars through various departments such as the Department of Defense, Indian Health Services, Health and Human Services, and the Department of Veterans Affairs (Goldschmidt, 2005). Yet despite the enormous investment by the government, little attention has been placed on the legal issues surrounding telemedicine.

Medical informatics systems contain numerous components such as decision support systems, diagnostic tools, and evidence based medicine in the form of literature, image, video, and other tools. In addition, various medical informatics systems utilize a simulator to determine the effectiveness of a system prior to implementation (Lowery, 1998; Jin, Kagioglou, & Aouad, 2006). This research utilized such a simulated environment. Medicine lends itself well to the use of simulations to help foster the understanding and acceptance from the medical community. While Lowery (1998) and Jin, Kagioglou, and Aouad (2006) point out multiple approaches to the simulated medical system, one of its primary aspects is to determine its capabilities in matching the appropriate decision support system to the problem.

Adoption of technology by the healthcare sector is a multifaceted issue. The myriad issues related to why clinicians are reluctant to adopt the technology must be considered, as well as issues surrounding the security, privacy, accessibility, and protection of personal healthcare information. Moreover, the persons or agencies responsible for maintaining and regulating the information must be determined (Huston, 2001).

Li, Wilson, Stapleton, and Cregan (2006) discuss the demands on telemedicine that are beyond technical or knowledge management challenges, and deeply rooted in the human-computer interaction arena. While rich media plays a prominent role in being able to appropriately diagnose a disease or well-hidden malady in the radiological or dermatological arena, cultural aspects of the medical community must also be considered, extending from socio-technical to hierarchical understanding (Li, Wilson, Stapleton, & Cregan).

Designers must have a deep understanding of the demands of the healthcare arena, which are based on tradition and training. Participatory design may be a leading factor in the success of telemedicine. Li, Wilson, Stapleton, and Cregan (2006) found that working closely with the users in the development of an emergency care telemedicine system was a key component to the success of the system. By utilizing numerous human-computer interaction techniques, such as heuristic evaluation, user testing, cognitive walkthrough, and cognitive task analysis, the developers may be able to better understand the needs of the healthcare community.

Watts and Monk (1997), Monrad (2003), and Latifi (2004) consider the use of synchronous communications in telemedicine, which can be of benefit to underserved patients. However, they point out that the use of synchronous technologies often conflicts with the resounding push towards asynchronous technology expansion, such as radiological telemedicine. Yet, ultimately they proposed that there are five task characteristics that define the collaborative effects of telemedicine success. The first characteristic involves the oral aspect of expert consultations within the field of medicine (Watts & Monk; Monrad; Latifi). This may create additional demands on the technology to ensure that adequate voice and sound can be utilized effectively. The second characteristic emphasizes the many experts involved in a consultation (Watts & Monk; Monrad; Latifi). For example, a medic may contact the local emergency department seeking advice on the state of a patient suffering chest pain. In turn, the emergency clinician may involve a cardiologist or other expert based on the patient's symptoms. The third characteristic addresses the communication between clinicians and providers (Watts & Monk; Monrad; Latifi). In this case, a clinician must be able to quickly assess the knowledge base of the provider with whom they are speaking. Perhaps this person is not trained in specific techniques or does not possess the knowledge required to comprehend certain aspects. According to Watts and Monk, this will require that high quality sound systems be utilized in order for nuances in communication to be interpreted. The fourth characteristic of telemedicine success refers to the quality and relevance of the media (such as pictures or videos). Lastly, the patient's perspective must be accompanied by a high degree of confidence in order to fulfill the needs of the system (Watts & Monk; Monrad, Latifi). Failure to gain the confidence of the patient may undermine the intentions of the entire telemedicine system (Monrad; Latifi).

Chau and Hu (2004) found that the implementation of technology is a critical factor in the success for health care organizations. They paid particular attention to collaboration between clinicians, specifically specialists' consultations of secondary and tertiary providers in the management of patients. Ultimately, Chau and Hu discovered that certain specialists seemed to have a higher adoption rate than others; most notably the surgeons, who adopted the technology almost instantaneously. It was also noted that the clinicians who had a higher adoption rate tended to be more involved in the adaptation and adoption stages of the project (Chau & Hu). Chau and Hu further describe the processes necessary for telemedicine and technology to actually succeed, which involves properly addressing the challenges faced by the healthcare industry in terms of both technology and managerial issues. It is not a question of whether or not the technology will drive the changes, but rather how the technology can foster changes. Furthermore, the speed and efficiency by which the healthcare community addresses the issues faced are also pertinent (Chau & Hu).

Raghupathi and Tan (2002) consider the exponential growth of the implementation of information technology by the healthcare industry through the use of telemedicine, healthcare recordkeeping, hospital information systems, and the broader dissemination of health related information. However, significant challenges exist for those who attempt to implement health care related decisions within a technology based system (Raghupathi & Tan). Changes in the business model within the health care industry must shift from a revenue and cost containment perspective to that of patient outcomes. This model focuses attention on disease prevention and appropriate therapies to minimize the impact of the disease on the patient, and subsequently, on the health care system.

Additionally, Raghupathi and Tan (2002) introduce a framework of systems integration that separates the system into an internal and external approach. Internal integration focuses upon the ability of an organization to integrate multiple systems within an organization. External integration focuses upon the ability of an organization to integrate with outside organizations and systems (Figure 1). The area where they merge reflects the domain of telemedicine.

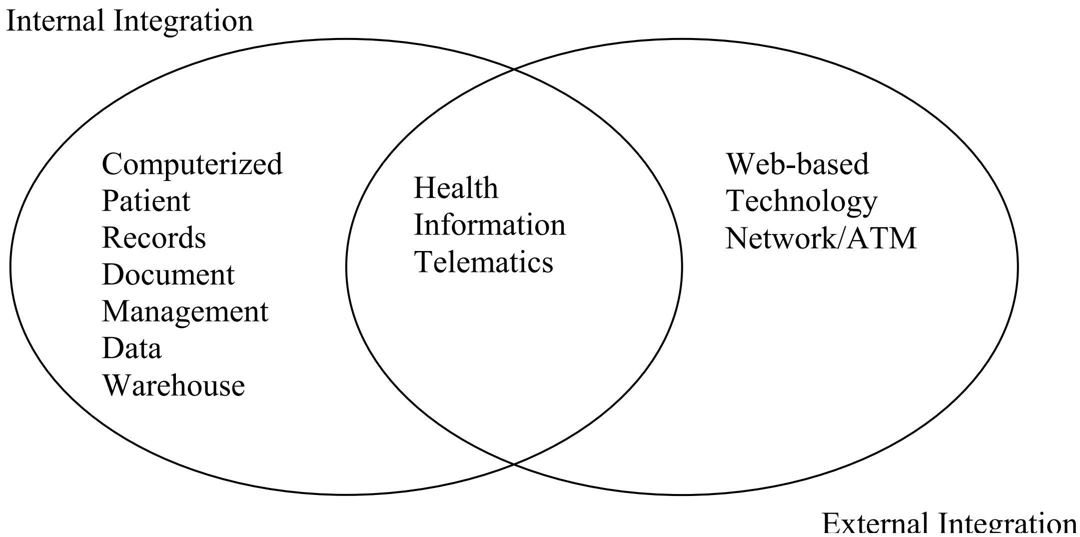


Figure 1 An Integrative Strategic IT Framework (Raghupathi and Tan, 2002). Copyright 2002 by ACM. Used with permission.

According to Raghupathi and Tan (2002), the use of data warehouses within the medical community often allows for the analysis of disease state trends and issues. These issues may have been unnoticed or disjoined in prior research, as they may have been hidden in plain site. For example, prior to the examination of data from the Framingham Study (1948-Present; American Heart Association, 2007), little was known about the cause and effect of diabetes on the cardiovascular system. Today, however, diabetes is considered a central factor in the development of cardiovascular disease. Oftentimes, unless major clinical trials are developed with specific outcomes research tied to them, these questions are never even asked, let alone answered. The utilization of telemedicine, a subset of medical informatics, can help to correlate disease specific questions so that further research can help to elucidate what is truly happening. The ability of this analysis also lends itself to deeper analysis of epidemiological or Health, Economic, and

Outcomes Research (HEOR). This results in better cost analysis and prevention, as well as in leading researchers on the correct path to a cure.

One of the largest data warehouses ever created by any one agency was announced in 1999 by the United States Department of Defense (DoD). Their plan included the development of a data warehouse in order to afford better care for enlisted members, retirees, and their families (Raghupathi & Tan, 2002). The DoD is currently attempting to convert from a cost containment model to a managed care model while utilizing the data warehouse to better serve its patients. The system, known as Computerized Executive Information System (CEIS), is expected to house information regarding nearly 8.5 million patients (Raghupathi & Tan). The system has gone through numerous iterations and is currently at the heart of the Military Health System (MHS), containing features such as decision support and medical surveillance.

Another issue raised by Raghupathi and Tan (2002) concerns the networking technology deployed in health care systems, such as asynchronous transfer mode, or ATM, which is quite agile in the transmission of multimedia content with little or no degradation. Telemedicine applications may require a high degree of media content in order for the clinician to fully elucidate the treatment and care of the patient. Technological resources that allow for a greater throughput and bandwidth may be required to accommodate the demands of high end image capture, transmission, and display devices.

Medical informatics, telematics, and telemedicine all encompass a wide variety of information demands. For example, the technologies may deal with clinical, biomedical, biological, chemical, biochemical, statistical, or cognitive analysis of information

(Raghupathi & Tan, 2002). These demands place an enormous burden on the technology, as well as its producers and managers. Such burdens include the management of ethics, privacy, security, standardization, governmental regulation, healthcare reimbursement, storage, retrieval, and processing concerns. Additionally, these systems often employ complex and demanding algorithms such as neural networks, artificial intelligence, fuzzy logic, decision support systems, and clinical decision tools. These algorithms require expertise throughout their development, deployment, management, and utilization (Raghupathi & Tan).

The high level demands that are required to produce adequate results in the field of health informatics will require attention to numerous details and challenges. Many promises have been made regarding the potential benefit of technology in healthcare, yet its advances are often isolated and difficult to quantify. This may be a result of poor adoption or adaptation; however, many of these issues more likely evolve from a lack of standardization, cost overruns, poor strategic planning, and implementation challenges (Raghupathi & Tan, 2002).

Diabetes

According to the American Diabetes Association (http://www.diabetes.org), diabetes is a disease in which the body is unable to produce or adequately utilize the hormone insulin. The body utilizes insulin to generate energy from foods such as sugar, starches, and other dietary sources, which are converted into an energy store known as glucose. Insulin acts as the key with which glucose may enter the cells and supply it with energy and nutrition. Without an adequate supply of properly functioning insulin, the glucose levels increase in the bloodstream and are unable to nourish the cells, resulting in high blood glucose levels.

The disease spectrum of diabetes includes a number of specific types such as Type 1, Type 2, Gestational, Impaired Glucose Tolerance (IGT), or pre-diabetes. The spectrum includes those persons who have not yet developed diabetes, but present with signs and symptoms that indicate predisposition to the disease. Numerous co-morbid conditions can lead a clinician to suspect that a patient is diabetic or pre-diabetic. These co-morbid conditions include but are not limited to: coronary artery disease, peripheral vascular disease, erectile dysfunction, retinopathy, neuropathy, and obesity.

Type 1 diabetes refers to the body's inability to produce insulin (National Diabetes Information Clearinghouse, 2007). Insulin facilitates the passage of glucose from the blood to the cell to be utilized as an energy source; the lack of insulin causes a rise in blood sugar glucose resulting in cellular damage. This condition was previously referred to as juvenile diabetes, or insulin dependent diabetes mellitus (IDDM), because it was historically diagnosed in children or young adults. The term Type 1 is now considered the official diagnosis, replacing juvenile and IDDM, where the body is no longer producing insulin, or is producing a very low volume. Patients who fall into this category require insulin injections in order to survive.

Insulin is normally produced in the pancreas via beta cells. Oftentimes, persons who suffer from Type 1 diabetes may be able to produce low amounts of insulin, however, over time these beta cells within the pancreas eventually burn out, resulting in a loss of insulin production. There is no cure for Type 1 diabetes. Yet it is not uncommon for Type

1 diabetic patients anticipating a kidney transplant to occasionally receive a dual organ transplant of a kidney and pancreas, resulting in a newfound ability to produce insulin.

Type 2 diabetes, sometimes referred to as non-insulin dependent diabetes mellitus (NIDDM), results when the pancreas produces insulin but the body's response to the insulin is flawed in some way, which is known as insulin resistance. Insulin resistance refers to the inability of the body to respond correctly to the insulin released by the pancreas.

Impaired glucose tolerance (IGT) is a condition common with pre-diabetes. In this case, the patient suffers from a rise in postprandial glucose levels, which occurs when glucose blood levels increase but are not sustainable to warrant a diagnosis of diabetes (International Diabetes Federation, 2006). However, eventually transition to Type 2 diabetes occurs in up to 70% of persons suffering from IGT (International Diabetes Federation).

Globally, diabetes mellitus is one of the most common non-communicable diseases, continuing its ever increasing pandemic (International Diabetes Federation, 2006). It is estimated that by the year 2025, when the world population reaches nearly 8 billion people, 6.3% will suffer from diabetes and nearly 9% will suffer from IGT (International Diabetes Federation). This represents nearly 800 million people worldwide suffering from complications of diabetes or IGT. Currently, diabetes ranks as the fourth or fifth leading cause of mortality in developed countries, while developing countries are also experiencing rapid increases in the diabetic population (International Diabetes Federation).

Health costs associated with diabetes are staggering on a global scale. Developed nations have some of the highest levels of diabetes and therefore cannot simply pass the burden off as an economic, social class, or third world issue. Diabetes is a global pandemic and management of this disease is critical for the public health system worldwide (International Diabetes Federation, 2006).

This research was focused on the area of diabetes, which follows specific medical intervention guidelines and protocols in order to avoid complications that may be renal, retinal, cardiovascular, or podiatric in nature. Tests that measure blood glucose levels, HbA_1C, and other metabolic systems can help determine the probability of experiencing certain complications. Research such as the Framingham Heart Study (1948-Present; American Heart Association, 2007) has demonstrated the risks associated with diabetes. This study, which has been tracking patients and their descendents for nearly 60 years, specifically helps to calculate the risk of having an ischemic event such as a heart attack or stroke over a projected five-year time period. Calculations result in a probability score reflective of the overall risk level. Similarly, probability statistics associated with the risk factors of diabetes were used in this study, and the simulators utilized included a prediction of patient's risk of diabetic complications. Since the medical literature provides a rather strong approach to probability indicators, a decision support system utilizing Markov Chains Monte Carlo were employed in the simulators.

Trust, Telemedicine, and Diabetes

Although a number of researchers have explored the issues of trust (Fogg, 2003; Fogg, Marable, Soohoo, Standford, Danielson, & Tauber, 2003; Falcone & Castelfranchi, 2004; Chang, Hussain, & Dillon, 2005; Slyke, Belanger, & Comunale, 2004), telemedicine

(Wilson, 2003; Watts & Monk, 1997; Raghupathi & Tan, 2002; Li, Wilson, Stapleton, & Cregan, 2006; Huston, 2001; Chua & Hu, 2004; Alem, Hansen, & Li, 2006), and diabetes (American Heart Association, 2007; International Diabetes Federation, 2006; Kahn & Weir, 2004; Khaw & Wareham, 2006; National Diabetes Information Clearinghouse, 2007) on an individual scale as noted above, there are limited instances in which the three have been studied in any combination (VanHouse, 2002; Tanriverdi & Iacono, 1998; Paré & Trudel, 2007; Sillence, Briggs, Fishwick, & Harris, 2004; Moore, 1996; Luo & Najdawi, 2004; Goldschmidt, 2005). Furthermore, there are no known studies in which all three aspects have been combined.

Contributions of this Research

This research was designed to extend beyond what has already been examined in relation to trust and telemedicine. Although trust has been examined in a number of roles, in particular e-commerce, there has not been a study examining the specific role of trust in a telemedicine application. Other research conducted on trust (Fogg, 2003; Falcone & Castelfranchi, 2004; Gefen, 2002; Luo & Najdawi, 2004) has indicated that the trust itself can impede the adoption of the technology. E-commerce, for example, has benefited greatly from the advances in trust research (Gefen, 2003). Although it is reasonable to assume that less trust in telemedicine would translate into less adoption, is there something unique or different about telemedicine that would require a unique framework? These nuances are where this research was focused, attempting to elucidate the factors that may or may not make telemedicine distinct from other forms of technology. This study attempted to contribute to the field in several ways. First, the research adds to the growing abundance of literature in the field of medical informatics and trust, allowing researchers and developers to create a better understanding of the key aspects of diffusion associated with telemedicine. This research focused on patient care and management in a virtual environment and considers trust dynamics that may play a key role. Secondly, this research contributes to organizations that are in the process of developing and implementing telemedicine applications, allowing them to better understand and improve upon dynamics that foster trust in the virtual environment.

Summary

The literature provides numerous analyses on the issues facing the areas of trust (Fogg, 2003; Fogg, Marable, Soohoo, Standford, Danielson, & Tauber, 2003; Falcone & Castelfranchi, 2004; Chang, Hussain, & Dillon, 2005; Slyke, Belanger, & Comunale, 2004), diabetes (American Heart Association, 2007; International Diabetes Federation, 2006; Kahn & Weir, 2004; Khaw & Wareham, 2006; National Diabetes Information Clearinghouse, 2007), telemedicine (Wilson, 2003; Watts & Monk, 1997; Raghupathi & Tan, 2002; Li, Wilson, Stapleton, & Cregan, 2006; Huston, 2001; Chua & Hu, 2004; Alem, Hansen, & Li, 2006), medical informatics (VanHouse, 2002; Tanriverdi & Iacono, 1998; Sillence, Briggs, Fishwick, & Harris, 2004; Moore, 1996; Luo & Najdawi, 2004; Goldschmidt, 2005), and related topics. However, there existed a gap in the information tying them all together. Considering the poor adoption rates of telemedicine, the need for broader healthcare initiatives to support those in disparate locales, the rapid increase in the prevalence of diabetes, and the vast amount of evidence that correlates the adoption to trust in other fields, the need for closer examination of trust in telemedicine was warranted. What aspects of the lack of adoption of telemedicine are directly attributable to trust? Is there a framework that would improve upon the success of telemedicine? The literature provides rich sources of trust research in areas such as e-commerce, health care portals, or other online services, but there is limited data on the issue of trust in terms of a specific disease management, such as diabetes, through telemedicine.

Diabetes has quickly become a global epidemic and is projected to increase dramatically in the foreseeable future. It is a slowly progressing disease that often translates into increased morbidity and mortality for those who suffer from the disease. Many of the ramifications associated with diabetes can be reduced by consistent and proper management of the patient's disease through diet, exercise, medications, and close monitoring of disease parameters. Diabetes management blends well with a telemedicine system. Often management of the disease comes from acute observations of glucose levels, diet, patient education, and constant reinforcement, which are all areas where telemedicine could offer a potential benefit.

Chapter 3

Methodology

As the population continues to age, advances in medicine have extended the life span of people throughout many parts of the world. Along with the increase in life expectancy comes an increase in co-morbidity of disease states within a single person. Oftentimes, multiple clinicians will be treating the same patient, increasing the likelihood that issues with communication between treating clinicians may arise. Telemedicine could provide an opportunity to increase the affordance of communication and ultimately quality of life. This study approached the issue of trust by examining trust dynamics from three perspectives: Patient-to-Clinician, Clinician-to-Patient, and Clinician-to-Clinician. Examining the trust dynamics from multiple perspectives allowed for a framework to be developed that incorporates these dynamics into the design of telemedicine applications. Thus, improved trust dynamics could potentially increase the credibility of telemedicine applications from the perspectives of the users.

It is important to recognize that this research was not focused simply upon online health portals. Indeed, numerous studies have been conducted assessing the value, trustworthiness, credibility, and impact of online health sites such as those from Gefen (2002), Luo and Najdawi (2004), and Sillence, Briggs, Fishwick, and Harris (2004). This research extends beyond online health sites, aspiring to a more robust approach to patient care in which the clinicians and patient can interact, communicate, diagnose, treat, and manage conditions through the use of technology. In order for such an experience to take place, there must be a certain degree of diffusion of the technology to create such a virtual environment.

By building a framework based on prior research with regard to trust, it will be possible to extend the reach of these frameworks to a more generalized form. A single web site was designed to encompass three aspects of users: Patient-to-Clinician feedback, Clinician-to-Patient feedback, Clinician-to-Clinician feedback. Measuring each of these areas against the hypotheses has allowed for increased understanding of the impact of trust on telemedicine ventures.

At this point, it is helpful to revisit the hypotheses of this research, which were based on examining trust dynamics within the health care community with a focus on the role of a telemedicine application. It was hypothesized that there is a significant impact on the trustworthiness of disease state management of diabetes based on the content and technical design elements of a telemedicine system, as well as the interpersonal relationships between the subjects. This impact was measured through the use of a detailed survey questionnaire, which was designed to draw distinctions between specific and detailed nuances of trust factors that influence the adoption and adaptation of telemedicine. This hypothesis is broken down into the following six sub-hypotheses.

H1: The perceived content of medical information (i.e., lab results, kidney function, wound care, etc.) presented to the patient from the clinician will have a significant impact on the trustworthiness of the telemedicine application

H2: The perceived content of the medical information (i.e., diet, exercise, daily glucose logs) presented to the clinician from the patient will have a significant impact on the trustworthiness of the telemedicine application.

H3: The perceived content of the medical information (i.e., diagnosis, medical therapy, disease state management and treatment options) presented to the clinician from the clinician will have a significant impact on the trustworthiness of the telemedicine application.

H4: The design elements (i.e., how the site is displayed or represented to the user) of the telemedicine system will have a significant impact on the perceived trustworthiness of the telemedicine application, measured across all stratified groups.

H5: The measure of perceived relationship between patient and clinician (bi-directional) will have a significant impact on the trustworthiness of the telemedicine application.

H6: Perceived patient outcome (bi-directional for patient and clinician) will have a significant impact on the trustworthiness of the telemedicine application.

The research explored the role of trust from the perspectives of both a patient and a clinician. Since both parties are critical to the success of telemedicine, it is important to examine the roles and distinctions from each perspective. Using information gained from this examination, the researcher then developed a best practices framework which describes the role of trust within a telemedicine application.

In developing the web site-based simulation for this dissertation, the researcher utilized a Markov Chains Monte Carlo process as a simulated decision support system. This approach has been used extensively in the medical simulation environment

(Shortliffe & Cimino, 2006; Tan, 2002). It is a stochastic process utilizing the Markov Chains property, which, under probability theory, considers the sequence of random variables designed to determine the probability of future events based on the current states. This research will focus on three states of a patient: salubrity, morbidity, and mortality. Each of these states will be based on probability statistics of the patient's current state. For example, if a patient has HbA_1C test results greater than 7, the likelihood that the patient will experience co-morbidity of their diabetes increases. Research has indicated that HbA_1C is a strong marker for future events (Khaw & Wareham, 2006). This can be translated, along with other factors, into Markov Chains in order to predict future outcomes based on a current state (Shortliffe & Cimino).

The purpose of the simulators was to allow the subject to experience an environment which incorporates the various aspects of trust that may be important for telemedicine adoption. By utilizing a simulator, the researcher was able to gain insight into the aspects of trust that are key environmental factors for the framework. The simulators offered an environment that is free from the difficulty of running a real world test, yet approximates the conditions and the environmental variables that may play a significant role and answer the primary questions posed by this research. Once the subject had experienced the simulated environment, a comprehensive survey was used to determine how the user experienced trust. The user compared a baseline of all of the trust dynamics to a subset of the trust dynamics. This allowed the researcher to isolate specific factors that play a more significant role in the trust equation. From this, the researcher was able to develop a hierarchy of trust dynamics which were utilized to build the framework.

In order to effectively test the hypotheses associated with this research, an evaluation of the current "best practices" associated with telemedicine was essential. These "best practices" were incorporated into simulators that examined the various aspects of trust and trustworthiness as it relates to telemedicine (Loane & Wootton, 2002; Stanberry, 2006; Yellowlees, 2005; Chang, Hussain, & Dillon, 2005; Falcone & Castelfranchi, 2004). As the methodology was developed and the trust parameters were established, two trust experts were used to help validate the model. Within the context of this research, trust experts were defined as individuals who have conducted research or work in the field of human relationships and trust, interpersonal trust, or trust and credibility work in other areas. Trust experts utilized had a background in psychology, psychiatry, human-computer interaction, or diffusion of innovation research. Trust experts were surveyed to establish the trust baseline and assign weights to each trust dynamic that were incorporated into the simulators.

The researcher examined diabetes as the specific disease state within the telemedicine application. Diabetes was selected due to the prevalence of the disease worldwide. In developed countries, diabetes ranks as one of the top five causes of mortality (International Diabetes Federation, 2006). It is linked to numerous other diseases such as hypertension, coronary artery disease, ischemic events, stroke, diabetic neuropathy, vision loss, amputation, renal disease, and organ transplantation (Kahn & Weir, 1994). Diabetes poses an enormous burden on the resources of the global healthcare institution, both from an economic and human resources perspective. It can also be a slowly progressive disease (International Diabetes Federation, 2006); sometimes taking years to fully realize its devastating impact. Appropriate management of diabetes is imperative to ensure quality of life and avoid premature morbidity and mortality. This is achieved through diet, exercise, regular blood glucose monitoring, and consultations with clinicians. As diabetes requires in-depth, consistent, and long term disease management its treatment creates a unique opportunity for telemedicine. An effective telemedicine application could facilitate the management of diabetes and dramatically improve the quality of life for millions of people.

The following outlines the specific steps that were required in designing the quantitative portion of the telemedicine framework. These steps include:

1. Simulated Interactions:
    a. Patient-to-Clinician (Simulator 1)
    b. Clinician-to-Patient (Simulator 2)
    c. Clinician-to-Clinician (Simulator 3)
2. Experts and Evaluators Utilized:
    a. Group 1: Two trust experts validated the trust dynamics chosen
    b. Group 2: Two medical experts validated telemedicine simulators
    c. Group 3: One patient and two clinicians pilot tested the simulators for programming errors.
3. Research Phases:
    a. An exhaustive literature review was conducted, focusing on the human computer interaction (HCI) area of trust dynamics. From this focus, the researcher generated a manageable list of 10-15 trust dynamics specific to telemedicine. Two trust experts were used to validate the trust dynamics selected.

b. IRB approval was acquired as required for the study.

c. A survey was developed to confirm trust dynamics (Appendix B).

d. Trust experts were surveyed (Appendix E) to validate the key trust dynamics,

    i. Survey was used to rank the trust dynamics

    ii. Validated rankings were used as the basis for trust dynamics simulators 100%, 75%, 50%, and 25%. The simulator with 100% of the trust dynamics was considered baseline, while the percentages of 75, 50, and 25 represent the subset of data that was compared to baseline. This allowed the researcher to isolate specific nuances of trust dynamics that may play a more important role in the framework.

e. Existing telemedicine models were surveyed by attending the American Telemedicine Association (ATA) and the American Medical Informatics Association (AMIA) conventions. By examining existing systems and validated approaches, the researcher established best practices standards that can be used to develop the simulations.

f. A framework was developed utilizing the best practices standard from step 3e.

g. The controlled study was enacted using all simulators and questionnaires through the uniform resource locator (URL) http://www.trusttelemedicine.com. There were three groups of subjects involved in the study. The first group consisted of 18 subjects acting as patients that simulated interactions with clinicians, 18 subjects acting as clinicians interacting with patients, and 18 subjects acting as clinicians interacting with clinicians. Each simulator contained a simulated telemedicine application that allowed for examination of the framework that was designed.

h. A survey was developed to validate diabetes simulators (Appendix C).

i. Medical experts were surveyed to validate diabetes simulators.

j. A Web-based telemedicine simulator was developed based upon the results of Survey 1 (Appendix B) and Survey 2 (Appendix C):

    i. Macromedia Studio CS4 as design platform
    ii. Patient-to-Clinician view (Simulator 1)
    iii. Clinician-to-Patient view (Simulator 2)
    iv. Clinician-to-Clinician view (Simulator 3)

k. The 54 subjects were randomized into the patient group or the clinician group.

    i. Clinicians were limited to the following professions:
        1. Medical Doctor (MD)
        2. Doctor of Osteopathic Medicine (DO)
        3. Podiatry (DPM)
        4. Psychology (PhD/PsyD)
        5. Pharmacy (PharmD/RPh)
        6. Physician Assistant (PA-C)
        7. Nurse Practitioner (NP)

8. Certified Diabetic Educator (CDE)

l. Validated trust dynamics were incorporated into the simulators based upon Survey 1 results. Trust dynamic groupings helped to isolate what dynamics play key roles in the formation of trust. Each trust dynamic held the same weighting and each simulator had a certain percentage of the trust dynamics removed consistent with all simulators of a similar dynamic grouping (i.e., simulator 1.75 was consistent with 2.75 and 3.75). Classifications were used to isolate each group; Simulator 1, Simulator 2, and Simulator 3 were used to classify the interaction category of Patient-to-Clinician, Clinician-to-Patient, and Clinician-to-Clinician, respectively. To further identify and classify the categories, each simulator held a trust dynamic number which identifies the percentage of trust dynamics that were included in the simulator. Therefore, Simulator 1.100 signified that the subject interacted with the Patient-to-Clinician simulator with 100% of the trust dynamics included. Simulator 2.50 signified the Clinician-to-Patient simulator with 50% of the trust dynamics included. Ergo, each simulator had four subsections that was used to interact with the users:

i. Patients were categorized into the following trust dynamic groupings, representing Patient-to-Clinician interactions (Simulator 1):

1. 100% of trust dynamics – Simulator 1.100
2. 75% of trust dynamics – Simulator 1.75
3. 50% of trust dynamics – Simulator 1.50

4. 25% of trust dynamics – Simulator 1.25

ii. Clinicians were categorized into the following trust dynamic groupings, representing Clinician-to-Patient interactions (Simulator 2) or Clinician-to-Clinician interactions (Simulator 3):

1. Clinician-to-Patient:

a. 100% of trust dynamics – Simulator 2.100

b. 75% of trust dynamics – Simulator 2.75

c. 50% of trust dynamics – Simulator 2.50

d. 25% of trust dynamics – Simulator 2.25

2. Clinician-to-Clinician:

a. 100% of trust dynamics – Simulator 3.100

b. 75% of trust dynamics – Simulator 3.75

c. 50% of trust dynamics – Simulator 3.50

d. 25% of trust dynamics – Simulator 3.25

m. A small group of pilot testers that included one patient and two clinicians were used to conduct a pilot test of the simulators, checking for errors or problems.

n. All study subjects who were patients interacted with the primary simulator for their category, Simulator 1.100. This established the baseline for all patient users.

o. All study subjects who were patients were then randomly assigned to interact with *one* of the following secondary simulators:

i. Simulator 1.75

    ii. Simulator 1.50
    iii. Simulator 1.25

p. All study subjects who were clinicians, as described in 3(k(i)), were categorized into either Clinician-to-Patient or Clinician-to-Clinician.

q. All clinicians within each subgroup interacted with the primary simulator for their category, Simulator 2.100 or Simulator 3.100, depending on their stratification.

r. All study subjects who were clinicians were then further randomized to interact with ONE of the following secondary simulators:

    i. Clinician-to-Patient randomized group
        1. Simulator 2.75
        2. Simulator 2.50
        3. Simulator 2.25
    ii. Clinician-to-Clinician randomized group
        1. Simulator 3.75
        2. Simulator 3.50
        3. Simulator 3.25

s. Following the simulation exercise, each user was asked to complete a questionnaire (Survey 3; Appendix G). Survey 3 was validated by both sets of experts (Appendix D). The questionnaire was completed by the subject at the end of the simulation. The responses were then used to establish the validity of the trust dynamics chosen.

t. Analysis of the questionnaires was conducted relative to the completed questionnaires at the end of the simulations. The researcher expected to see clear distinctions between the various levels of trust dynamics that were utilized in the simulators. With the trust dynamics decreasing incrementally within the four simulators, a comparison was drawn between each user group. The hypotheses were that data indicate a clear dissention as the trust dynamics are reduced in number. In other words, Simulator 1.25 should have only 25% of the established trust dynamics, while Simulator 1.100 (control) held 100%. Simulator 1.100 (control) should have a higher score than Simulator 1.75, Simulator 1.50, or Simulator 1.25 as they fall into 75%, 50%, and 25% inclusion of trust dynamics, respectively. Results from each score should follow a corresponding reduction. The research is not simply considering the reduction, but rather what is being reduced and the impact that reduction had on the user's perceptions of trust. One of the primary goals will be to identify trust dynamics that can become central to the framework for a successful telemedicine design.

u. Data was collected and processed through a statistical based software package, SPSS, to analyze the results.

v. The researcher's hypothesis were either accepted or rejected.

Statistical Analysis and Design

Statistical methodology details the analyses that were performed on the data that was collected through the surveys. This section details the approach and justification for each statistical method that the researcher utilized. Statistical analysis allows for predictions to be made relative to the hypotheses that have been put forth (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). The specific statistical approaches that were applied depend on numerous factors, including sample size, research design, survey questions, data types, variable type, and quality of data.

Appendix H details the statistical approach for sample size and related calculations. The sample size of three groups of 18 users each requires specific statistical tools in order to quantify the data in a reliable form. The remainder of this section will outline and justify the statistical approach to the set of data collected.

In general, the following statistical methods will be applied to the data:

1. Descriptive Statistics
2. Correlations and regressions
3. Differences
4. Risks and odds

Descriptive Statistics were utilized to form foundations such as counts (frequency), proportions (percentages), measures of central tendency (mean, median, and mode), and measures of variation (range and standard deviation) (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006).

Correlation analyses focused on the relationships found in the data. The researcher compared several types of data such as patient's level of trust in reference to the medical information presented. This may prove quite different for users who interact with the 75% group versus the 25% group. There may also be distinctions between groups, such as Clinician-to-Clinician versus the Clinician-to-Patient group. These correlations and regressions were analyzed by rank-order correlation and Pearson product-moment correlations. Rank-order was used on collected data where subjects had indicated a preference or selection from smallest to largest, lowest to highest, and so on. Ranking was key to data that was highly subjective in nature to which the researcher cannot apply specific and measurable variables, but can judge the respondent's perspective or view of the situation. Additionally, ranking data forced the respondents to decide based on equal weighting such as highest to lowest, or least to most, thus allowing a single value to be applied to the variable from that subject's perspective (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006).

This research examined the role of trust in telemedicine, which carries with it a great deal of subjective interpretations by the subject. Subjective data presents challenges in evaluating the qualitative and quantitative data that was collected by the respondents.

Regression analysis was applied to the collected data in order to predict outcomes of future events based on the results of the survey analysis. Regression analysis was a key component of this research, as it was focused on the development of a successful framework in telemedicine. The framework was based on the regression analysis of the data collected. Multiple regression analysis techniques were employed in order to consider numerous predictive values that arise from the data collected. Predictive values included age, income, study group, education, data layout, form, function, or other characteristics associated with the simulators or subjects (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006).

Another area of statistical analysis to be considered was the difference in outcomes between the groups. Perhaps one group of respondents had a marked improvement in the trustworthiness of the simulators. In order to analyze and draw upon the distinctions of the groups, the statistical methods of Chi-Squared, Mann-Whitney U Tests, and ANOVA were applied to the data (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006).

Chi-Squared techniques are used on categorical data such as counts, true-false, male-female, or normal lab values versus abnormal lab values. Based on the sample size of less than 20 subjects per group, a *t* test cannot be performed on the data. Therefore, the researcher applied Mann-Whitney U Tests. Mann-Whitney U Tests (also known as Wilcoxon rank sum) allowed the researcher to examine and compare two groups of less than 20 subjects; it is a test of equality of medians. Analysis of Variance (ANOVA) tests allowed the researcher to examine the group means or averages, testing averages or means of two or more groups.

Risks and odds were used to examine the predictive outcome of a particular approach or survey topic. This analysis was applied to predict how telemedicine can be designed to offer the best approach based on patients' viewpoints, clinicians' needs or demands, and to find the independent values that are reflective of the needs of each group. Analyzing data in this way afforded the researcher significant insight into the successful design elements of telemedicine.

Each of these statistical tools helped to forge a deep understanding of the trust dynamics found in a telemedicine system. By analyzing the key components and drawing distinct and predictable outcomes based on the variables collected, the researcher was then able to identify the key aspects that were utilized in the development of the framework.

Additional analysis of the collected data also pointed to previously unidentified information that may be beneficial to either this researcher or future research. The researcher analyzed the data from numerous perspectives and examined the collected data for other trends or comparative relationships.

The researcher also paid particular attention to the statistical significance of analysis of the data. In order to either accept or reject the null hypothesis, the researcher utilized a statistical significance of $p < 0.05$, or a probability of no more than 5 times out of 100, that the difference in the data occurred by chance and the researcher incorrectly rejected the null hypothesis.

Incorrectly rejecting a true null hypothesis (Type I Error) or incorrectly accepting a false null hypothesis (Type II Error) may have a small probability of existing, yet it must be acknowledged and recognized. The researcher paid particular attention to the formation and possible occurrence of these types of errors. In addition to a *p*-value of <0.05, the researcher utilized a confidence interval of 95%, signifying that the results obtained are confidently assured to be accurate 95% of the time. All statistical analysis was conducted using SPSS Statistical Software, version 16.0.

Tools

The researcher utilized the Internet to create and deliver the simulations within this research. Web site resources were designed and developed using Adobe Creative Suite 3 (CS4) Master Collection. Adobe is a leading provider of high end Web and Internet design software and platforms. Specifically, Adobe InDesign CS4, Adobe Photoshop CS4 Extended, Adobe Illustrator CS4, Adobe Acrobat 9 Pro, Adobe Flash CS4, Adobe Dreamweaver CS4, Adobe Fireworks CS4, Adobe Contribute CS4, Adobe

ColdFusion CS4, Adobe After Effects CS4, Adobe Premier Pro CS4, Adobe Soundbooth CS4, Adobe Encore CS4, Adobe OnLocation CS4, and Adobe Director CS4 was employed. PHP 5.0 was utilized as the server-side programming language and JavaScript 1.8 was utilized as the client-side programming language. Microsoft Office 2003, Standard Edition, was utilized as well, which includes Word 2003 (word processor) and Excel 2003 (statistical/spreadsheet). Microsoft Visio 2003 (project workflow) and Microsoft Project 2000 (project management) software were also utilized. MySQL 5.1 was utilized as the primary database management tool. Limesurvey was utilized as the survey presentation tool. SPSS Graduate Pack 16.0 served as the statistical processing software. Finally, Biblioscape Professional was utilized as the bibliographic and citation tool.

Furthermore, the researcher utilized a web host company to manage the applications, surveys, and questionnaires. Aplus.net provided hosting of the Internet site. The domain name www.trusttelemedicine.com housed the surveys, questionnaires, Web applications, and simulators containing established elements of the trust frameworks. Simulator 1 (control) contained 100% of the trust dynamics, a second contained 75%, a third contained 50%, and a fourth contained 25% of the established trust dynamics. The researcher will maintain both the domain name and hosting through the date December 31, 2011 at a minimum.

Experts

The following experts offered assistance in relation to this research, specifically in validating its approach and foundations. It was essential to establish the needs from a clinical perspective as well as a technical perspective. Experts were selected from various fields of medicine including endocrinology, cardiology, pharmacology, and psychology. In addition, experts from the fields of human computer interaction, trust dynamics, and persuasive computing were also utilized to support the research efforts. They were able to provide guidance in the formation of research methodology, statistical design, simulation design, surveys, questionnaires, and framework design.

Table 1: Experts Who Validated Research Methodology

Robert Cohen, PAC Cardiovascular Disease and Diabetes Medical and Trust Expert Astellas Pharma US, Inc. New York, NY	Rory Hachamovich, MD, MSc Nuclear Cardiologist Medical Expert Cleveland Clinic Cleveland, OH
Lorraine Beck, PhD Clinical Psychologist Trust and Relationship Expert La Jolla, CA	Silvia Novelli, PhD Endocrinologist Medical and Trust Expert Astellas Pharma US, Inc. Napa, CA
Delilah Huesling, PhD Bioengineering/Cardiac Function/Diabetes Medical and Trust Expert Astellas Pharma US, Inc. St. Louis, MO	Patty Burkhardt, PharmD Clinical Pharmacist Medical Expert Astellas Pharma US, Inc Philadelphia, PA
Sue Miller, PharmD Clinical Pharmacist Medical Expert Astellas Pharma US, Inc. Portland, OR	Julie Greely, PharmD Clinical Pharmacist Medical Expert Astellas Pharma Global Development Omaha, NE
Janea McClain, PhD Medical and Trust Expert Astellas Pharma Global Development Baltimore, MD	Kalpesh Patel, PharmD Clinical Pharmacist Medical and Trust Expert Astellas Pharma Global Development Houston, TX

Summary of Methodology

The methodology of this study examined trust by considering the communication variables of three separate lines of communication. The first line was communication between patient and clinician; the second line was between the clinician and the patient; and the third line was between the clinician and clinician. These are typical lines of communication in a medical setting. The patient seeks the advice of a clinician, the clinician gives advice to the patient, and the clinician seeks advice from other clinicians. By examining the trust dynamics between these lines of communication, the researcher hoped to gain insight into the dynamics that promote trust.

The study was conducted with 18 subjects in the Patient-to-Clinician role, 18 subjects in the Clinician-to-Patient role, and 18 subjects in the Clinician-to-Clinician role. The communication occurred in a simulated online environment and did not actually occur between subjects.

The simulator utilized Markov Chains in order to determine the outcome of the treatment recommendations, lab tests, patient involvement, exercise, and dietary habits (Shortliffe & Cimino, 2006). Markov Chains are used extensively as decision support tools to help determine the outcomes given a certain set of data.

All subjects interacted with a simulator that had 100% of the trust dynamics that had been established. Additionally, each group of 18 subjects was further randomized into three subgroups. The first subgroup interacted with a simulator that had 75%, randomly generated, of the trust dynamics identified. The second and third subgroups had 50% and 25%, randomly generated, of the trust dynamics identified, respectively. Those subjects in each category of 75%, 50%, and 25% had random generation of those percentages of trust dynamics which will be maintained throughout the simulator exercise. The simulator tracked the random assignment of trust dynamics in order to isolate results of the psychometric data.

A pilot test was performed with a small set of users, one patient and two clinicians, to verify any problems with the simulator. This test also ensured that links were working correctly and that the graphic display of the Markov Chains was functionally correct. The pilot testers also ensured that the survey questionnaires were in working order. The researcher verified that the survey results were being captured and secured.

It was the intention of the researcher to draw distinct conclusions about the trust dynamics between all of the subgroups involved in the study. Once the data had been collected, statistical analysis guided the researcher to either accept or reject the hypotheses of this research.

Chapter 4

Results

Overview

This chapter reports and details the results of the study outlined in Chapter 3, the methodology section. The chapter is broken down into five main sections that specify particular aspects of the research. Section one focuses on the best practices and approach chosen by the researcher. Section two focuses on the results of the interactions of the Subject Matter Experts (SME) and reviews the results of the surveys, development of the trust framework, as well as outlining the limitations chosen for this research. Section three reviews the design, development, and construction of the simulators and each participant's survey. The fourth section of this chapter provides an analysis of the data collected from the total number of participants' surveys, while the fifth section discusses these findings.

Current Best Practices of Telemedicine

The researcher relied on several approaches to determine the best practices in the design of telemedicine applications, these included attending the American Telemedicine Association conferences (ATA 2009: 14th Annual International Meeting & Exposition, April 6-8, 2009, Las Vegas, NV), the American Medical Informatics Association conference (AMIA 2009: Biomedical and Health Informatics: From Foundation to Applications to Policy, November 14-18, 2009, San Francisco, CA). Attending these meetings allowed the researcher to gain insights into current best practices in telemedicine systems from both a research perspective, by attending scientific sessions, as well as developer perspective, by viewing demonstrations of exhibitors. The scientific sessions at these conferences showed the current state of research in the field, while exhibitions by vendors showed the current best practices of companies marketing telemedicine applications.

In an effort to develop a well-rounded and comprehensive simulated environment, the researcher noted the best practices presented at these important meetings. Those which were relevant to the subset of activities that the researcher wished to examine were incorporated into the design of the simulator.

One common element in the development and implementation of the telemedicine systems, employed in the majority of demonstrations by vendors was the use of a patient case study to demonstrate the utility of the software. A case study represents the presentation of a patient with a specific disease or illness, such as diabetes, which was typical or characteristic of what a clinician encounter. The case study is used to demonstrate the functionality, capabilities, and usefulness of the telemedicine system. The case study approach also allows the system to be fully realized without the hurdles and time consuming details of a dynamic system. The use of a case study limited the functionality and capabilities of the simulator; however it also allowed trust dynamics, the focus of this research, to be extensively explored while limiting the time demands placed on participants in the study. The researcher set a soft time limit of 30 minutes to complete the study, including time to interact with the simulators and completing the survey.

Additionally, it is customary in medical education and training to utilize the case study approach. Familiarity with the case study approach may account for the researcher's observations that clinicians at the conferences appreciated and adapted well to case studies presented via telemedicine systems. These demonstrations allowed clinicians to view the features and functionality of the system. It also allowed the clinicians to see the medical content and disease state management aspects as well as the patient information that was provided.

Another best practice was the provision of system security. It was also noted that the telemedicine systems used a variety of algorithms to manage security. Although most utilized Secure Sockets Layer (SSL), there were others which utilized a secure key, or other security device, as well as username and password protection. In many cases, the researcher observed that security was not necessarily obvious to the attendees at the conference: however, it was mentioned by the company representatives.

It was also noted that many telemedicine operators utilized a variety of medical resources within the systems. These include RSS feeds of medical information, adoption of medical or disease specific association treatment guidelines, published algorithms for procedures or therapy, as well as other sources for evidence-based medicine. The majority of these features were readily noted by the attendees and the researcher had an opportunity to observe users' positive responses to these features. They were clearly a strong selling point.

Best practices demonstrated that telemedicine providers are utilizing a variety of methods to interact with patients or clinicians. In order to develop the framework and create the simulators, the researcher selected several specific elements of current best practices used by telemedicine providers to incorporate into this simulated system. As do most providers, the researcher utilized a case study model in the simulated telemedicine system. The case will specifically be the treatment of diabetes, a disease affecting a large number of people and increasing worldwide as noted earlier in this work. The case presented to participants was validated by the medical subject matter experts. In addition, the researcher utilized published guidelines and algorithms related to the treatment of diabetes (Appendix J; Appendix K), providing best practices methodologies from leading medical authorities.

Design Elements Model

As with telemedicine best practices, telemedicine design models were collected while the researcher attended the ATA and the AMIA conference. Best practices in the field of telemedicine appeared to maintain a variety of approaches; however, one theme that seemed to be consistent was the similarities to medical charts, which contain a plethora of data on a single form. The approach that was utilized for the simulators combined a great deal of detailed medical information on one continuous form per patient, separated into appropriate sections, representing the patient history and disease state management. This format allowed the vendor to display the full capabilities for the system without concern of patient confidentiality.

Design also focused on the attributes of combining the medical information in a simple flow based process. In order to present the information in a consistent and applied manner, the researcher formulated the contents into logical groups, highlighting each group with a specific color (Appendix N). This design was a noted feature in several of the systems studied. Having viewed numerous systems, the researcher incorporated common elements in order to enhance the system design and to isolate the parameters and scope of the simulators (Appendix N).

The researcher instructed the participant through each category via the simulator, carefully explaining the process so that the presentation of the flow of data was clear and concise. The flow of instruction is represented in Appendix L. Color schemes and data categories were selected based on similar traits of the information, with the titles of each category as follows: Patient Demographic Information, Disease State Management, Treatment Options, Goals of Therapy, and Reference Material (Appendix N).

Simulation Models and Subject Matter Experts

The best practices researched for telemedicine, both content and design elements derived from current practices of providers and researcher were then used to develop a rough framework for the telemedicine trust model. The information was combined with the research conducted in Chapter 2, the literature review. In addition, the research conducted in Chapter 2 contributed to the framework of the trust model. The model was presented to the SME group to be reviewed and validated.

Three iterations of the trust model were realized by the researcher as the development process of the trust model was validated by the SME. The initial trust model attempted to capture the baseline aspects that the researcher felt were significantly tied to trust. As seen in Figure 2, the first tier of the initial framework considered the formation of trust from the individual perspective, which represents the components of trust based on the experiences and views of the individual. These elements are comprised of what the participant would bring to the table and are not considered attributes that telemedicine systems could manipulate.

The second category is institutional trust. This level represents the trust that a user may perceive in the clinician, the institution behind the clinician such as a major hospital or health care system, or the trust the clinician has in the patient. This area represents a complex and dynamic system of public opinion and personal perception. The category is separated out due to the nature of the institution or clinician, whose reputation may be enhanced or reduced by transient events, for example a series of front page headlines describing a medical breakthrough or a publicized case of gross negligence by the clinician or institution. A positive reputation built up over time builds trust (Josang, Ismail, and Boyd, 2007).

The third category was identified as online behavior which is considered to be a function of the user's comfort level, ability, or history with online systems, health information searches, and other factors that could enhance a user's trust in the system. A naïve user may have a difficult time trusting something in an environment such as telemedicine if they have no experience with online systems. Conversely, a user who has significant online experience may have a greater likelihood, at least initially, to trust the system.

The next tier identified was the medical, privacy, and design components of the system. One of the dissertation's major hypotheses is that the medical content, security, privacy, and design would impact the level of trust in the system. This category is unique in that it combines elements of the user predisposition to trust as well as the experiences of the telemedicine system. In this context however, the researcher is implying that the system needs to enhance the trust level through the experiences within the telemedicine system. All of these components working together would represent the trust model being designed. Figure 2 represents the trust model that was presented to the SMEs.

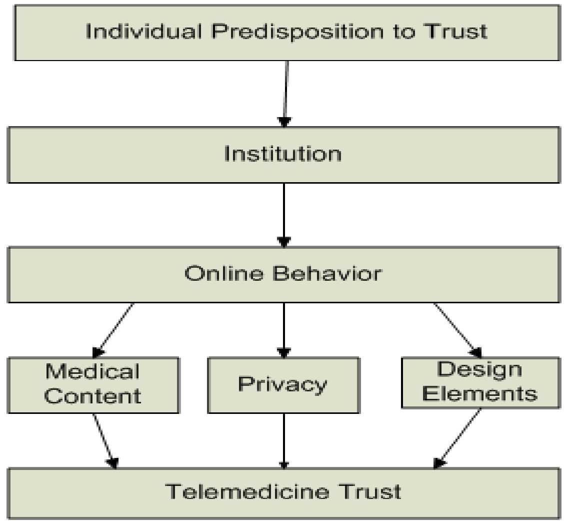


Figure 2: Initial Telemedicine Trust Framework

Feedback from the SME helped to direct the focus of the framework on more specific characteristics of trust. The comments indicated that more detail needed to be included in the levels of trust and how trust is formed from each perspective. Many of the SMEs indicated that clinicians may have a unique perspective as trust is formed. The SME feedback helped the researcher focus in on several key components, specifically the division between an individual's predisposition to trust and institutional trust. Within these categories another tier was introduced to capture three distinct categories: knowledge based trust, calculus based trust, and relational trust.

Knowledge based trust is comprised of the individual's predisposition to understand or operate in the realm of knowledge or education. Certainly a clinician should have an abundance of knowledge about the disease state, but he or she may wish to disseminate that knowledge. Some patients are more prone to expect that they will gain knowledge from their interactions with the clinicians, while others are simply happy when their clinician is not concerned about their condition. There is a great diversity in this area within each population; it should be accounted for from a specific approach. A one-size-fits-all approach would not be appropriate within the context of knowledge based trust design. Systems need to address the great diversity present within the population in order to maximize the benefit from this aspect of trust design.

Calculus based trust is a component of items that add or subtract to the trust model that are not necessarily specific, as in a culmination of numerous factors. Calculus based approaches consider items that may be outside of the scope of the trust model approach, but still may have a significant influence on the trust experienced by the user. It is individualistic in nature and therefore is closely tied to the individual predisposition to trust.

The field of medicine is one that is closely tied to the domain of relational trust, which is developed between clinician and patient. Some clinicians develop and manage close personal relationships with their patients, while others may maintain distance from their patients. Patients, on the other hand, may or may not wish to have a close relationship with their clinician. The possibilities are as complex and dynamic as they are in other sectors of the social network. These aspects are individualistic and distinct and therefore the research design attempts to take into account such influence, for example, by asking survey questions pertaining to the type of relationship with clinicians the respondent prefers.

The feedback from the SMEs also helped the researcher focus in on the attributes at the individual component level of the system. The medical, privacy, and design components each carry specific traits that may influence a patient's or clinician's overall level of trust in a telemedicine application.

Consultation with the SMEs helped to clarify some of these nuances, such as subcategories of the medical content component, which were further classified as EBM, medical content, disease state management, and perceived outcomes of the patient. Privacy components were broken down into privacy, security, and Health Insurance Portability and Accountability Act (HIPAA) compliance. Design components were recognized as page layout, navigation, professional design, and user experience.

The culmination of all of these dynamics created the level of trust that the user would experience through the telemedicine system. These criteria were then resubmitted to the SME group, as represented in Figure 3. The SME group again provided strong feedback on the content.

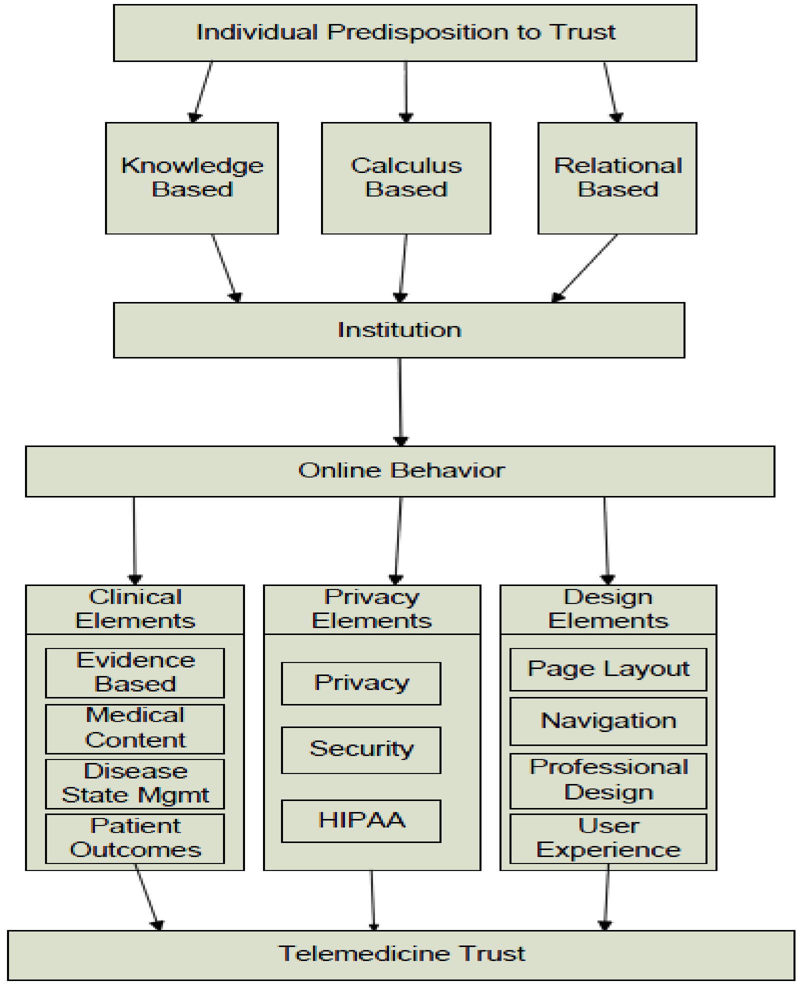


Figure 3: Adjusted Telemedicine Trust Framework

The SME response was to delve deeper into some of the correlations, which resulted in the final version of the framework, as seen in Figure 4. This iteration identified the characteristic of User Centric Trust (UCT) and System Centric Trust (SCT), which separated out the units that carry unique challenges. UCT is more fluid and dynamic with regards to individual user aspects while SCT carries more traditional system attributes. Online behavior was one aspect that was the bridge between the two elements. The SME group also helped to focus attention on potential bypass or backpropagation of the model, meaning that the individual predisposition could move directly to the institutional trust component, bypassing the knowledge, calculus, or relational based trust aspects. This may happen when a user perceives the quality of the institution to trump other aspects. For example, a user may feel that the institution is so highly reputable that they will not question the many aspects that would normally be applicable. However, institutional trust can also be backpropagated to the individual propensity. This scenario could be evident if the institution suddenly receives positive or negative press such as a user being told that Harvard, UCLA, or Cleveland Clinic had developed or were participating in the telemedicine project. Certainly front page headlines, whether of medical miracles or cases of malpractice, could sway an individual's predisposition to trust the institution. This predisposition is distinct from the individual's propensity in that these may include issues that reside outside of the individual's control that may influence trust.

Figure 4 illustrates the final version of the Telemedicine Trust Framework (TTF) as validated by the SMEs. Feedback from the experts also indicated several areas that may need to be addressed within the simulator models. One such area is the distinction that users will vary greatly in terms of their medical or scientific knowledge or aptitude. This could prove to be a difficult challenge within a telemedicine system and may be a limitation within the simulators due to the scope of the project. Another area pointed out by the experts is the degree of agreement among opinions and approaches that are established by clinicians in the treatment of a disease such as diabetes. Both of these may have been a limitation of the simulators and may be an opportunity for future research as they are beyond the scope of this work.

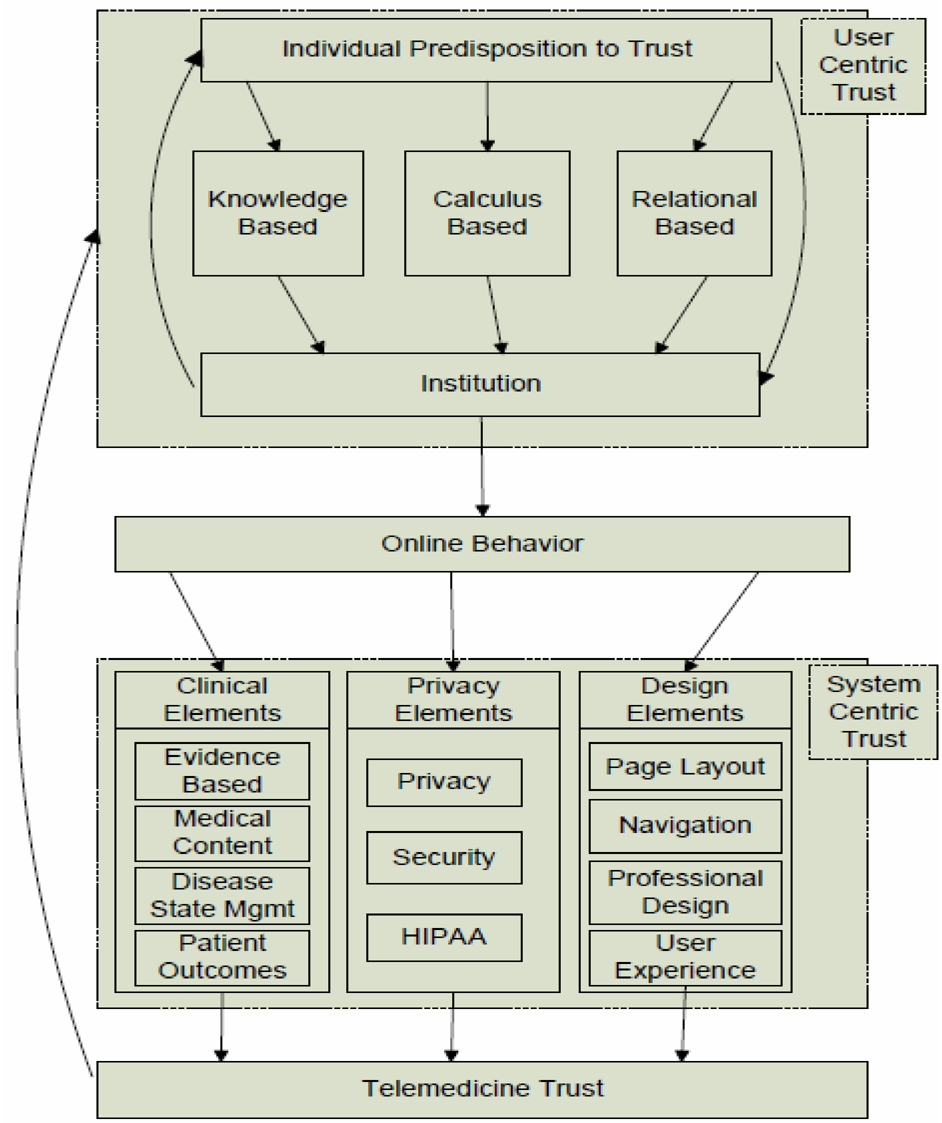


Figure 4: Telemedicine Trust Framework

Medicine is not an exact science, which often gives rise to the phrase the 'practice of medicine.' It is often subjective, with a variety of scientific approaches combined with the clinical judgment of the clinician. This creates challenges when attempting to develop a system that facilitates the treatment paradigm, as the system may or may not conflict with a particular clinician's view of the best approach. The researcher addressed this issue by selecting a number of approaches that are considered best practices in the treatment of diabetes, namely algorithms and guidelines developed by American

Association of Clinical Endocrinologists/American College of Endocrinology (AACE/ACE) as well as EBM of large scale clinical studies. Therefore, a by-the-book approach allowed the treatment algorithms to remain consistent within the case study for all participants. The trust variables were adjusted accordingly to help determine their impact on the user. Considering the small sample size of the study, it was important to remain consistent so as not to skew the results. Input and analysis from the subject matter experts validated the case study, disease state management, and treatment options sections of the framework and developed foundational support for the construction of the simulators.

This information allowed the development of a diabetes-specific simulator. This was coupled with the general telemedicine trust model which was developed to identify the clinical information and treatment options of the system. By incorporating disease specific information with the general model, the researcher was able to tie the trust model into the specifics of this research. The AACE/ACE guidelines are outlined in Appendix J, while the EBM model utilized is outlined in Appendix K. Privacy statements, security, and HIPAA compliance models were developed from current guidelines as published by the American Telemedicine Association and the American Medical Informatics Association. The model was validated by three SMEs in the field of diabetes management and includes the attributes outlined in Figure 4.

Simulated Comparative Interactions

The end result of developing a general trust framework, consulting with experts and organizations on treatment of diabetes mellitus, and combining these two aspects of the research, was a series of simulators which presented respondents with detailed information on a specific case of the disease. The clinicians' simulators presented them with a case study of a hypothetical patient, giving detailed information about the patient's demographic characteristics and social history.

The case study simulation for the clinician presented detailed, medically relevant information about a particular patient, the case study was modified for the participants who where acting as patients to provide a more educational approach. During the building of the specific diabetes-related model for telemedicine, the researcher found that the model was heavily weighted towards diabetes education. Therefore, the model had to include a great deal of educational information for the patient. This also served as an excellent hybrid between the patient and clinician case study, as the patient simulator focused attention on the explanation of the disease.

Nine simulators plus the three baseline scenarios, for a total of twelve, were developed based on the case model. One set was developed for the Clinician-to-Clinician group, one set for the Clinician-to-Patient group, and one set for the Patient-to-Clinician group. Each group's simulator had a control simulator which contained 100% of the trust dynamics identified the baseline scenario. Each group also had three additional simulators developed, one simulator each contained 75%, 50% and 25% of the trust dynamics identified.

Each category of participant viewed the simulator appropriate for their role and which contained 100% of the trust dynamics. Next, the participants were randomized to view a second simulator containing 75%, 50%, or 25% of the trust dynamics, again appropriate to their role in the study. They were asked to take the survey and answer the questions based on the viewing of the second simulator.

Selection, Stratification, and Randomization Processes

The categorization noted above occurred as the participants navigated through the simulators. First, respondents were stratified according to (self identified) real-world qualifications. The two randomization processes further categorized subjects. The most obvious is the distinction between a clinician and a patient, which was chosen as a step process conducted by the participant. If the user met the requirements of a clinician, they would choose accordingly. If they did not qualify, they were expected to select the Patient category. There was not any qualification metrics applied to verify that the user made the correct choice, the selection process was user driven. This was characterized in Figure 5:

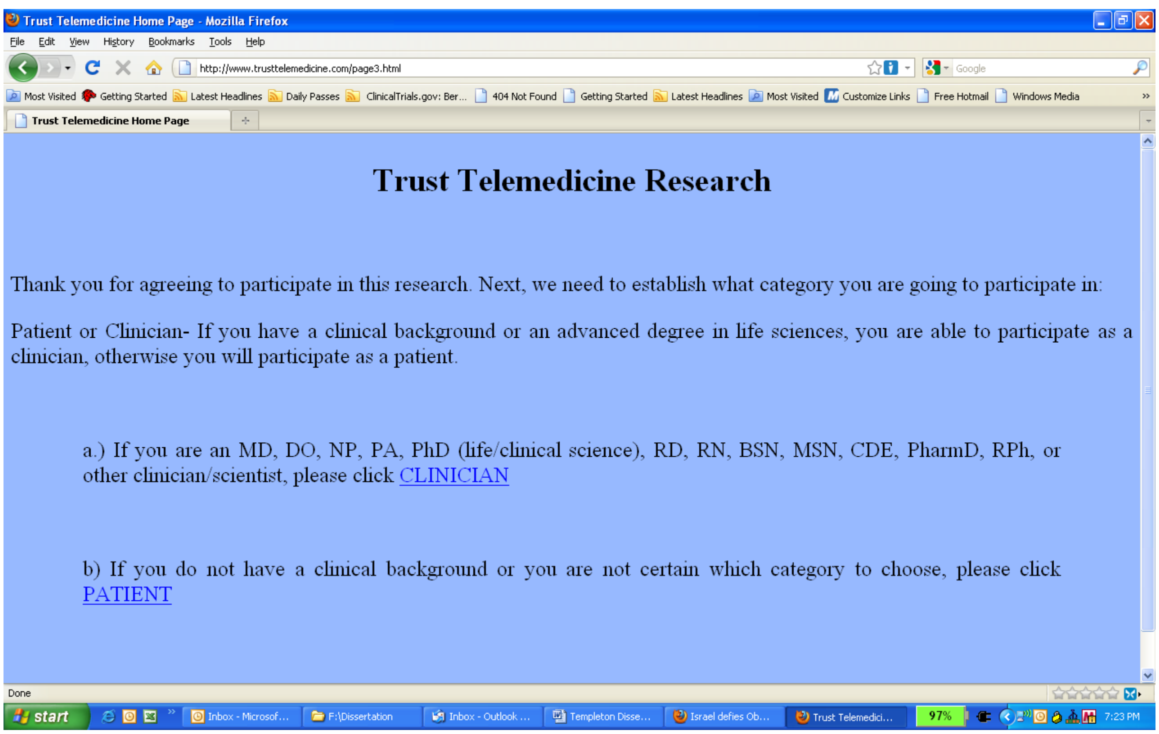


Figure 5: Selection Process of Simulator

However, if the user selected the Clinician approach, they could fall into one of two categories, Clinician-to-Patient or Clinician-to-Clinician. A formal process was set up to manage the stratification of the Clinician. Figure 6 illustrates the user interaction:

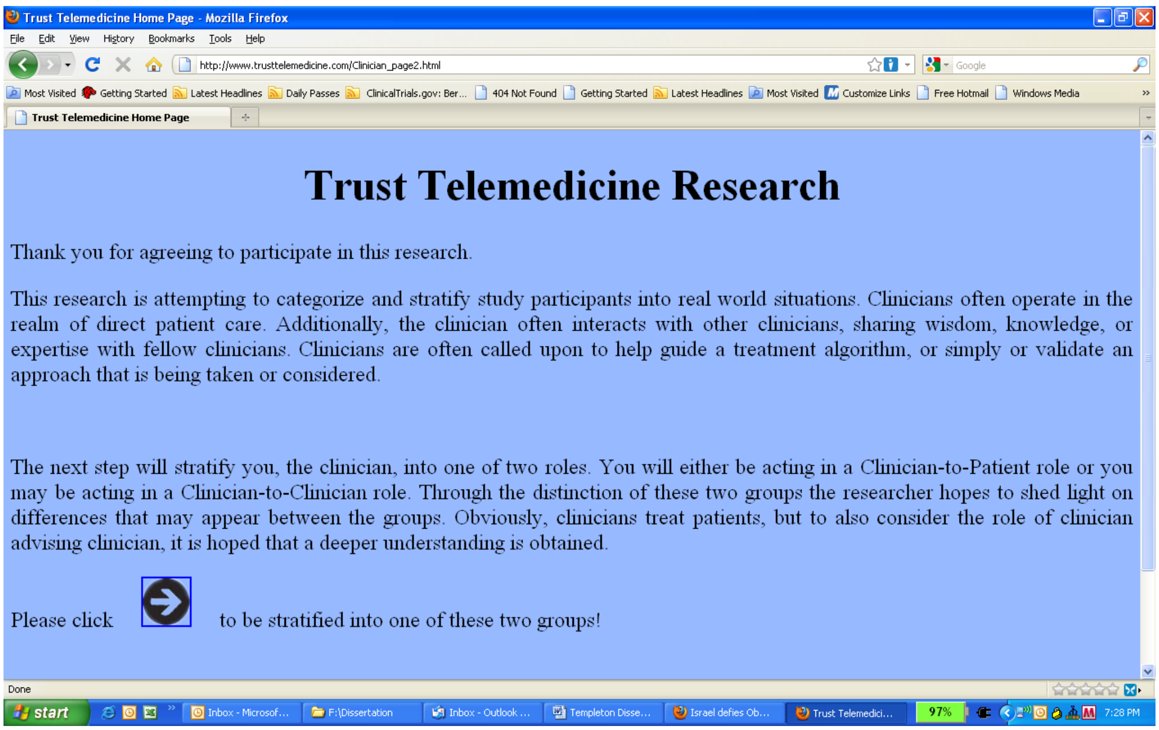


Figure 6: Stratification Process of Simulator

The process behind the stratification is database driven. As clinicians self-selected into the clinician category, they were then alternately assigned to the Patient-to-Clinician or Clinician-to-Clinician interaction group, either patient or clinician. Finally, the participants were randomized, within each group, to view the second simulator of 75%, 50%, or 25% of the trust dynamics. As participants navigated through the study, they were presented with the baseline simulator, or 100% of the trust dynamics, and then they were presented with the simulator with 75%, 50%, or 25% of the trust dynamics identified depending on their randomly assigned group. This process was accomplished via a database model approach.

Survey Construction

Limesurvey, a web-based software tool for survey development, was utilized to develop and administer the survey questionnaire to the study participants. Limesurvey automatically incorporated a number of database tables in order to record the interaction of the participants at the end of the survey. The database design and layout is found in Appendix M. The survey was constructed using triggers on each question that forced a response in order to continue. Only data from completed surveys was posted to the database. By forcing responses and accepting only completed surveys, the software removed any possibility of incomplete responses or missing data.

Pilot Test and Analysis

Prior to the launch of the study, the system was fully tested and analyzed for errors, omissions, and issues. A total of four SMEs agreed to test the system and validate the results. Minor changes and corrections were made to the system following the input from the SMEs.

Response Rate

A total of 55 participants (one more than anticipated in the Patient group) were included in the research study. Once each participant group was filled, the database was locked to avoid new entries from being included. However, it was noted that an error in programming did not lock the entire project out prior to one additional participant completing the survey in the Patient group. Once that was discovered, the database was locked and the study closed.

The response rate for the Patient group was rapidly filled, while the Clinician group proved to be more challenging. Friends and family responded quickly with the majority filling the patient groups, therefore few attempts at recruiting were needed to fill the patient group of the study. This fact could also introduce bias based on each participant's relationship to the researcher and the resulting skew in demographic characteristics. The clinician group was more difficult to fill, and required numerous approaches including posting to user groups at the American Medical Informatics Association and American Telemedicine Association, as well as posting messages at electronic boards of several southern California medical centers (UCSD Medical Center, UCLA Medical Center, and Loma Linda Medical Center). The researcher also found clinician-participants via work colleague networks. Ultimately, the researcher managed to acquire the necessary participation to complete the study.

Demographics of Respondents

Table 2 describes the demographics of the participants within each group to which they were randomized and/or stratified. The first section of the table represents the computer literacy of the participants. The majority of the participants in the clinician group indicated that they were either computer proficient or sufficient, with only 17% of the participants in the Clinician-to-Patient group indicating that they were computer experts.

Table 2: Demographic Data

Main Group		Frequency	Percent	Cumulative %
How would you rank your computer/online literacy?				
C2C	Computer/Online Proficient	14	77.8	77.8
	Computer/Online Sufficient	4	22.2	100.0
C2P	Computer/Online Expert	3	16.7	16.7
	Computer/Online Proficient	12	66.7	83.3
	Computer/Online Sufficient	3	16.7	100.0
P2C	Computer/Online Expert	4	21.1	21.1
	Computer/Online Proficient	9	47.4	68.4
	Computer/Online Sufficient	2	10.5	78.9
	Computer/Online Novice	4	21.1	100.0
Gender?				
C2C	Male	9	50.0	50.0
	Female	9	50.0	100.0
C2P	Male	6	33.3	33.3
	Female	12	66.7	100.0
P2C	Male	5	26.3	26.3
	Female	14	73.7	100.0
What is your age?				
C2C	18-25	3	16.7	16.7
	26-35	3	16.7	33.3
	36-45	1	5.6	38.9
	46-55	7	38.9	77.8
	56-65	3	16.7	94.4
	>65	1	5.6	100.0
C2P	26-35	3	16.7	16.7
	36-45	6	33.3	50.0
	46-55	5	27.8	77.8
	56-65	2	11.1	88.9
	>65	2	11.1	100.0
P2C	18-25	3	15.8	15.8
	26-35	1	5.3	21.1
	36-45	8	42.1	63.2
	46-55	2	10.5	73.7
	56-65	2	10.5	84.2
	>65	3	15.8	100.0

Table 2: Continued

Main Group		Frequency	Percent	Cumulative %
Education (highest level attained):				
C2C	MBA	1	5.6	5.6
	Clinical Healthcare Provider	13	72.2	77.8
	Doctorate - Life Science	4	22.2	100.0
C2P	Bachelors Degree/Adv Trade School	2	11.1	11.1
	Clinical Healthcare Provider	7	38.9	50.0
	Doctorate - Life Science	8	44.4	94.4
	Doctorate - Non Life Science	1	5.6	100.0
P2C	High School Graduate	2	10.5	10.5
	Some College	3	15.8	26.3
	Associates Degree/Trade School	1	5.3	31.6
	Bachelors Degree/Adv Trade School	6	31.6	63.2
	Masters Degree	3	15.8	78.9
	MBA	1	5.3	84.2
	Non Clinical Professional	1	5.3	89.5
	Doctorate - Life Science	1	5.3	94.7
	Doctorate - Non Life Science	1	5.3	100.0
Household Income Annually (optional):				
C2C	0	6	33.3	33.3
	$75,000 - $99,999	1	5.6	38.9
	$100,000 - $124,999	4	22.2	61.1
	$125,000 - 149,999	1	5.6	66.7
	$150,000 - $174,999	3	16.7	83.3
	$175,000 - $199,999	3	16.7	100.0
C2P	0	4	22.2	22.2
	$100,000 - $124,999	1	5.6	27.8
	$125,000 - 149,999	6	33.3	61.1
	$150,000 - $174,999	3	16.7	77.8
	$175,000 - $199,999	4	22.2	100.0
P2C	0	3	15.8	15.8
	Less than $25,000	1	5.3	21.1
	$25,000 - $49,999	1	5.3	26.3
	$50,000 - $74999	1	5.3	31.6
	$75,000 - $99,999	2	10.5	42.1
	$100,000 - $124,999	1	5.3	47.4
	$125,000 - 149,999	2	10.5	57.9
	$150,000 - $174,999	4	21.1	78.9
	$175,000 - $199,999	4	21.1	100.0

The patient group indicated a much wider range of computer literacy, with 68.4% of the respondents indicating computer literacy at the proficient or expert level. Interestingly, 21% also indicated that they were computer novices.

The next section represents gender, which surprisingly carried a disproportionate amount of females relative to the general population in both the Clinician-to-Patient and the Patient-to-Clinician; it was evenly split for the Clinician-to-Clinician. Could this possibly represent a higher degree of adoption or interest in telemedicine in females versus males? Although it is beyond the scope of this study, it would be interesting for future research to examine the trust dynamics and adoption rates based on gender (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006).

In terms of age, the researcher found that the majority of participants fell into the 35-55 year old group across all categories. However, it should be noted that each participant group produced responses from all age groups, helping to balance out the research in terms of age.

Education was the next category and, as expected, produced the most educated group in the clinician categories, with all but one clinician represented by clinical degrees or doctorates in life science. The patient group represented a much greater degree of variability in education, however 68.4% still reported that they had a bachelors degree or higher. These data indicate that there are a large number of highly educated participants in this study.

Income was an optional item that had mixed responses. Of those clinicians who responded, the vast majority of clinicians (61.2% of the Clinician-to-Clinician group and 77.8% of the Clinician-to-Patient) reported greater than $100,000 in annual income. This is most likely tied to age and education (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). The patient group was much more diverse and represented a one third split between incomes less than $100,000, one third between $100,000 and $150,000, and one third greater than $150,000.

Non-Response Bias Testing

Since all users were required to complete the survey in its entirety, the researcher did not need to calculate non-response bias testing. The design of the system forced all users to complete the survey, and all accompanying questions, prior to submitting the survey. Failure to complete all categories would simply dump the data and not post it to the appropriate databases. However, data was collected to determine how many participants accessed the system and began the process. The difference between total unique users who accessed the system to begin the study and the total users who actually completed the study gave the researcher an idea of the overall response rate. A total of 98 participants accessed the system during the trial period, with 55 subjects completing the process. This introduces a bias towards participants who have the wherewithal to complete the study, or those who were interested in the research (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). Feedback from some respondents indicated that the simulators and accompanying survey were long and rather involved. Future researchers should consider the time constraints that are involved for the participants.

Descriptive Statistics

The majority of variables that were utilized in this research were built upon a five-point scale. Those that were not based on this scale were adjusted to correlate with the five-point scale (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). Skewness measures the symmetry of the distribution of the data. If the resultant data were to fall outside of the normal range of +1 or -1, then the data is said to have substantial skewness. Table 3 represents the skewness values for each of the derived variables within the study, categorized by group (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006).

None of the results indicated significant skewness in the variables in relation to the populations of the study groups. It should be noted that results are reported for each group, with C2C representing Clinician-to-Clinician, C2P representing Clinician-to-Patient, and P2C representing Patient-to-Clinician.

Table 3: Skewness Table

Statistics[a]

Variable	C2C Skewness	C2P Skewness	P2C Skewness
Trust_Score	**-.277**	-.144	-.170
Health_Dynamics_Medical_Collection_Data	**-.400**	-.389	-.110
Design_Elements_Data	**-.250**	-.601	-.190
Outcomes_Information	**-.435**	-.407	-.093
Relationship_Information	**-.177**	-.054	-.170
Propen_Trust	**-.800**	-.247	-.459
Propensity_Patient_Clinician_Interactions_UP	**.409**	.316	.247

a. Main Groups = C2C (clinician-clinician) C2P (clinician-patient) P2C (patient-clinician)

A correlation matrix was established to estimate the degree of relatedness between the variables studied (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). Table 4 indicates the relationship between the dependent and independent variables, as calculated per group and as identified for the hypothesis testing. All variables indicated a direct correlation to the dependent variable at a level of $p<.01$.

Table 4: Correlation Matrix

Main Group			Trust Score	Health Dynmx	Design Dynmx	Diabetes Resource	Page Layout	Nav/Design Elements	Patient Clinician Interactions
C2C	Trust Score	Pearson Correlation	1	.880**	.986**	.847**	.867**	.870**	.852**
	Health Dynamics	Pearson Correlation	.880**	1	.853**	.787**	.775**	.756**	.803**
	Design Dynamics	Pearson Correlation	.986**	.853**	1	.841**	.859**	.868**	.802**
	DiabetesResource	Pearson Correlation	.847**	.787**	.841**	1	.648**	.631**	.642**
	Page Layout	Pearson Correlation	.867**	.775**	.859**	.648**	1	.950**	.869**
	Navigation Design	Pearson Correlation	.870**	.756**	.868**	.631**	.950**	1	.839**
	Patient Clinician	Pearson Correlation	.852**	.803**	.802**	.642**	.869**	.839**	1
C2P	Trust Score	Pearson Correlation	1	.916**	.951**	.746**	.746**	.785**	.918**
	Health Dynamics	Pearson Correlation	.916**	1	.866**	.850**	.727**	.756**	.842**
	Design Dynamics	Pearson Correlation	.951**	.866**	1	.735**	.714**	.792**	.873**
	Diabetes Resources	Pearson Correlation	.746**	.850**	.735**	1	.569*	.556*	.617**
	Page Layout	Pearson Correlation	.746**	.727**	.714**	.569*	1	.839**	.739**
	Navigation Design	Pearson Correlation	.785**	.756**	.792**	.556*	.839**	1	.835**
	Patient/Clin Inter	Pearson Correlation	.918**	.842**	.873**	.617**	.739**	.835**	1
P2C	Trust Score	Pearson Correlation	1	.729**	.957**	.745**	.624**	.661**	.738**
	Health Dynamics	Pearson Correlation	.729**	1	.725**	.843**	.433	.526*	.629**
	Design Dynamics	Pearson Correlation	.957**	.725**	1	.683**	.649**	.644**	.706**
	Diabetes Resources	Pearson Correlation	.745**	.843**	.683**	1	.429	.494*	.506*
	Page Layout	Pearson Correlation	.624**	.433	.649**	.429	1	.726**	.511*
	Nav/Design Elements	Pearson Correlation	.661**	.526*	.644**	.494*	.726**	1	.459*
	Patient/ Clin Interactions	Pearson Correlation	.738**	.629**	.706**	.506*	.511*	.459*	1

*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed).

Control Variables

The researcher included two control variables within the study. The purpose of a control variable is to establish a variable that will affect the dependent variable (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). Strong research characteristics demand the use of a control variable for the study to be robust (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). The goal of the researcher was to avoid using superfluous control variables within each subject group and to examine the relationships between the dependent and independent variables. The researcher categorized the propensity to trust as High, Medium, and Low split evenly across the five point scale (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). Table 5 represents the ANOVA of the propensity to trust variable and the patient clinician interaction variable compared to the trust variable. Table 5 indicates there is a division between propensity to trust, a value which is statistically significant and patient clinician interaction, a value which is not statistically significant. Propensity to trust does have a significant impact on trust across all groups, while patient clinician interaction does not produce any significance across all groups.

Table 5: Control Variables impact on trust

ANOVA							
Main Group			Sum of Squares	df	Mean Square	F	Sig.
C2C	Propensity to Trust	Between Groups	6.366	14	.455	14.197	**.002**
		Within Groups	.325	3	.108		
		Total	6.691	17			
	Propensity Patient Clinician Interactions	Between Groups	2.893	14	.207	.209	.983
		Within Groups	2.973	3	.991		
		Total	5.866	17			
C2P	Propensity to Trust	Between Groups	3.649	15	.243	18.297	**.001**
		Within Groups	1.640	2	.820		
		Total	5.289	17			
	Propensity Patient Clinician Interactions	Between Groups	1.924	15	.128	1.239	.535
		Within Groups	.207	2	.104		
		Total	2.131	17			
P2C	Propensity to Trust	Between Groups	3.223	12	.269	13.667	**.002**
		Within Groups	.118	6	.020		
		Total	3.341	18			
	Propensity Patient Clinician Interactions	Between Groups	3.352	12	.279	1.077	.492
		Within Groups	1.557	6	.259		
		Total	4.909	18			

Propensity to Trust

Propensity to trust is the first control variable that the researcher identified. The value of the variable was generated by combining several responses from the survey by each participant (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). The calculation is based on the mean scoring of a percentage assigned by the researcher. Table 6 illustrates the dimensions of the propensity to trust variable. The variable assigns a baseline value in order to measure the participant's propensity to trust other people, online medical data, clinicians, institutions, or organizations (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006).

Table 6: Propensity to Trust Questions (1-Strongly Disagree to 5-Strongly Agree)

7. Do you consider yourself a trusting person?
8. Do you trust until proven otherwise?
9. Do you consider yourself to have trust issues?
10. Do you generally believe in others?
11. In general, do you have trust when you are using the Internet?
12. Do you have trust in online medical information?

The calculation for an individual participant is established as a sum of a percentage of each category. The calculation for the group is the mean of those sums.

The second category of control variables is the patient-clinician interactions. This value represents the baseline measure for the characteristics that measure the relational propensity between patient and clinician (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). It does this by analyzing the key attributes associated with the survey that deal with a user's predisposition to patient-clinician interactions. The culmination of questions is represented in Table 7 and includes the statistical analysis of the set per group.

Table 7: Attitude Towards Patient Clinician Interactions (1-Strongly Disagree to 5-Strongly Agree)

13. How often do you visit a doctor?
14. How would you rate your general health?
15. In the last 6 months, how often have you sought medical information online?
16. How would you rate your online medical search experience?
17. How would you rate the quality of medical information online?
18. Do you have any future intentions of conducting online medical searches?
19. In general, are you concerned about your personal privacy of medical information online?
20. In communicating medical information online, are you concerned that the communication may not be received or communicated correctly?

Based upon the information in Table 6 and Table 7, a score calculation was performed for each group within each control variable. The calculated scores are identified in Table 8, broken down by group.

Table 8: Calculated Score for Control Variables

Main Group		Propensity to Trust	Attitude Towards Patient Clinician Interactions
C2C	Mean	3.2222	3.1664
	Std. Deviation	.62737	.58742
C2P	Mean	3.3056	3.3416
	Std. Deviation	.55780	.35406
P2C	Mean	3.4184	3.1896
	Std. Deviation	.43083	.52221

Dependent Variable

The dependent variable is identified as the trust score. It is a calculated variable based upon a number of survey questions that were directly related to trust. Table 9 provides a review of the trust related questions that were used to create the trust score. The trust score allows the researcher to categorize and analyze the results of the surveys in a uniform pattern. Changes that occur within the dependent variables provide the foundation of what is being examined by this research. The trust score is used to determine the influence that any one category, or group of categories, has on the participant.

By establishing the trust score, it allows the researcher to compare the results of each survey to the other critical areas being examined. It was expected that the trust score would vary based on the trust dynamics involved, however, the trust dynamics playing the most significant role were yet to be determined.

Table 9: Survey Questions included in calculating Trust Score (1-Strongly Disagree to 5-Strongly Agree)

Statistics
26. I trust the diabetes resources that were provided?
28. The dietary information was trustworthy?
31. I trust the exercise information that was provided:
38. I intend to seek medical information from other sources online to validate information received on this site.
39. I feel comfortable asking the Clinician (or Patient) for further explanation on (or understanding of) the medical information.
40. The institution behind the telemedicine site had a high degree of ethics and morals.
41. I felt a personal connection with the person with whom I was interacting online.
42. With regards to this site, I trusted the flow of information.
44. I felt a great distance between myself and the person with whom I interacted.
46. I trust the person on the other end of the conversation.
47. I trust that private medical information would be managed appropriately and carefully to prevent unauthorized access by others?
50. The Clinician (Patient) with whom you interacted had a high degree of ethics and morals.
51. The Clinician (Patient) was dependable and reliable.
61. Overall, the contents of the site support feelings of trust:
62. The images and graphics contained on the site instill a sense of purpose and trust:
70. How would you estimate your level of trust with telemedicine based on your experience with this site?

Independent Variables

Independent variables were categorized into four groups in order to capture the necessary relationships between the survey and the research hypotheses (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). The first category captured was Health Dynamics and the second is Design Elements, both of which are calculated variables, each based on its own group of related questions within the survey. Disease State Management data and Relational data are subsets of the Health Dynamics data that are more specific to those categories. Medical information is represented by the categories of Disease State Management data and Relational data, which are subsets of the Health Dynamics data.

One of the main focal points of this research was based on the medical information and how it was interpreted. Table 10 represents the items that were captured in order to calculate the Health Dynamics data.

Table 10: Health Dynamics (1-Strongly Disagree to 5-Strongly Agree)

21. The medical information on diabetes management was accurate and timely?
22. The recommendations or suggestions were consistent?
23. The recommendations or suggestions made to you (or your patient) were relevant?
24. The diabetes management plan will succeed or provide benefit?
25. My outlook on diabetes improved?
26. I trust the diabetes resources that were provided?
27. The resources were readily available for the disease through the system?
28. The dietary information was trustworthy?
29. The dietary information was reasonable and do-able.
30. I have (or your patient has) a better understanding of the food to eat to maintain my blood sugar.
31. I trust the exercise information that was provided:
32. The exercise information was relevant to your (or your patient
33. I believe that I (or my patient) would follow the exercise guidelines closely.
34. I believe that I (or my patient) will increase my exercise as a result of the information provided.
35. The medical information was understandable and readable.
36. The medical information was adequately explained.
37. The medical information was complete and accurate.
38. I intend to seek medical information from other sources online to validate information received on this site.
39. I feel comfortable asking the Clinician (or Patient) for further explanation on (or understanding of) the medical information.
40. The institution behind the telemedicine site had a high degree of ethics and morals.
41. I felt a personal connection with the person with whom I was interacting online.
42. With regards to this site, I trusted the flow of information.
43. The interactions were timely and complete.
44. I felt a great distance between myself and the person with whom I interacted.
45. I prefer interacting in an online environment versus a live interaction.
46. I trust the person on the other end of the conversation.
47. I trust that private medical information would be managed appropriately and carefully to prevent unauthorized access by others?
48. In the next six months, I will seek a personal visit with the Clinician rather than an online connection?
49. I prefer to intersperse the live visits with online management.
50. The Clinician (Patient) with whom you interacted had a high degree of ethics and morals.
51. The Clinician (Patient) was dependable and reliable.

Design elements were another key aspect focused upon in the research. In order to calculate the specific values, all survey questions that focused on user response to the design components of the system were included. Table 11 lists the survey questions that were included in this calculated variable.

Table 11: Design Elements (1-Strongly Disagree to 5-Strongly Agree or multi-select)

52. The page layout was easy to follow and understand.
53. The page layout was consistent throughout the site?
54. The site appeared to be professionally designed:
55. The content of the site was easily accessed:
56. The site content was visually appealing:
57. The site was easy to navigate:
58A. Colors
58B. Design
58C. Layout
58D. Formatting
58E. Font Size
58F. Font Shape
58G. Font Color
59. Considering the design elements of the site, the site was consistent in its design and message?
60. The medical content and visual content worked well together:
61. Overall, the contents of the site support feelings of trust:
62. The images and graphics contained on the site instill a sense of purpose and trust:
63. The graphics and images were professional in appearance, design, and layout:
64. The site should contain more graphic content:

The third category of independent variables is the calculated value of Outcomes Score. It is a subset of the Health Dynamics and only deals with the survey questions that were posed to users that directly related to the outcomes of the patient. Table 12 describes the survey questions that were included in this calculated category.

Table 12: Outcomes Score (1-Strongly Disagree to 5-Strongly Agree)

21. The medical information on diabetes management was accurate and timely?
22. The recommendations or suggestions were consistent?
23. The recommendations or suggestions made to you (or your patient) were relevant?
24. The diabetes management plan will succeed or provide benefit?
25. My outlook on diabetes improved?
26. I trust the diabetes resources that were provided?
27. The resources were readily available for the disease through the system?
28. The dietary information was trustworthy?
29. The dietary information was reasonable and do-able.
30. I have (or your patient has) a better understanding of the food to eat to maintain my blood sugar.
31. I trust the exercise information that was provided:
32. The exercise information was relevant to your (or your patient
33. I believe that I (or my patient) would follow the exercise guidelines closely.
34. I believe that I (or my patient) will increase my exercise as a result of the information provided.
35. The medical information was understandable and readable.
36. The medical information was adequately explained.
37. The medical information was complete and accurate.
38. I intend to seek medical information from other sources online to validate information received on this site.
39. I feel comfortable asking the Clinician (or Patient) for further explanation on (or understanding of) the medical information.
40. The institution behind the telemedicine site had a high degree of ethics and morals.

The last independent variable is Relationship Score and is calculated to determine the effect or relatedness of the interactions. This calculated value is comprised of the survey questions that impact this key variable. Table 13 illustrates the survey questions that were included in the calculated variable.

Table 13: Relationship Score

41. I felt a personal connection with the person with whom I was interacting online.
42. With regards to this site, I trusted the flow of information.
43. The interactions were timely and complete.
44. I felt a great distance between myself and the person with whom I interacted.
45. I prefer interacting in an online environment versus a live interaction.
46. I trust the person on the other end of the conversation.
47. I trust that private medical information would be managed appropriately and carefully to prevent unauthorized access by others?
48. In the next six months, I will seek a personal visit with the Clinician rather than an online connection?
49. I prefer to intersperse the live visits with online management.
50. The Clinician (Patient) with whom you interacted had a high degree of ethics and morals.
51. The Clinician (Patient) was dependable and reliable.

Internal Reliability of Scales

Utilizing Likert-like scales in research generally requires that some form of reliability metric is applied to determine the internal reliability of the combined scales (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). Therefore, a Cronbach's Alpha test was performed to determine the reliability of the models, the results of which are demonstrated in Table 14 (Shortliffe & Cimino; Hill & Lewicki). Cronbach's Alpha is a measure of internal coefficient of reliability and supports the researcher in establishing that the data obtained is consistent. As detailed in Table 14, the values consistently were above 0.70, which is generally regarded as an acceptable limit (Shortliffe & Cimino; Hill & Lewicki).

Table 14: Cronbach's Alpha Reliability Results

Group	Question Set	N of items	Cronbach's Alpha
C2C	Trust Score	17	.834
	Health Dynamics	31	.847
	Design Elements	19	.824
	Relationship	11	.721
	Outcomes	20	.779
	Propensity to Trust	6	.858
	Attitude Towards Patient Clinician Interaction	8	.799
C2P	Trust Score	17	.857
	Health Dynamics	31	.851
	Design Elements	19	.891
	Relationship	11	.764
	Outcomes	20	.799
	Propensity to Trust	6	.721
	Attitude Towards Patient Clinician Interactions	8	.781
P2C	Trust Score	17	.848
	Health Dynamics	31	.847
	Design Elements	19	.876
	Relationship	11	.794
	Outcomes	20	.778
	Propensity to Trust	6	.755
	Attitude Towards Patient Clinician Interactions	8	.815

Simulator-Group Analysis

As the simulators were adjusted by the researcher to reflect the various trust attributes that had been identified, it was anticipated that the trust score would be reflective of the removal of those attributes. Table 15 reflects the mean trust score for each category broken down by subgroup. As expected, the trust score reflects a linear reduction as the trust dynamics are removed.

Table 15: Mean Trust Score for All Simulators

Mean Trust_Score

Main Group	Subgroup	Mean	N	Std. Deviation
C2C	A	3.7059	6	.11765
	B	3.0980	6	.29451
	C	2.6275	6	.38423
	Total	3.1438	18	.52854
C2P	A	3.7451	6	.20264
	B	3.1471	6	.27528
	C	2.7157	6	.39968
	Total	3.2026	18	.51960
P2C	A	3.9020	6	.20264
	B	3.4020	6	.21506
	C	2.8908	7	.30268
	Total	3.3715	19	.48865
Total	A	3.7843	18	.18927
	B	3.2157	18	.28319
	C	2.7523	19	.35919
	Total	3.2417	55	.51202

Hypothesis Testing

Testing the six hypotheses was conducted through ANOVA tests for each category (Shortliffe & Cimino, 2006; Hill & Lewicki, 2006). The groups of participants were analyzed to determine the role of trust with regard to the Health Dynamics score, that is to determine how the Health Dynamics score as detailed in the independent variables section affects measures of trustworthiness of the telemedicine simulator.

Perceived medical information is characterized as the Health Dynamics score, perceived relationship is characterized as the Relational score, perceived patient outcomes is characterized as the Disease State Management score, while design is coded as the Design Elements score.

Hypothesis One

Hypothesis One stated that the perceived content of medical information (i.e. lab results, kidney function, wound care, etc.) presented to the patient from the clinician will have a significant impact on the trustworthiness of the telemedicine application. The null hypothesis, based on a non-directional hypothesis, can be stated in the following way:

> There is no significant difference in the trustworthiness of the telemedicine application based on the degree of perceived content of medical information (Disease State Management variable) presented by the clinician to the patient.

Table 16 illustrates the results of the ANOVA test on hypothesis one, which indicates the null hypothesis with a $p<0.05$ can be rejected.

Table 16: Hypothesis One ANOVA Test

ANOVA[a]					
Trust_Score					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.696	1	2.696	28.615	.000
Within Groups	1.602	17	.094		
Total	4.298	18			
a. Main Group = P2C					

Hypothesis Two

Hypothesis Two covers the same content as Hypothesis One, but from a different perspective, that of the clinician to the patient. Specifically, the perceived content of the medical information (i.e., diet, exercise, daily glucose logs) presented to the clinician from the patient will have a significant impact on the trustworthiness of the telemedicine application. The null hypothesis of this hypothesis can be stated as follows:

> There is no significant difference in the trustworthiness of the telemedicine application based on the degree of perceived content of medical information presented to the clinician from the patient.

The results of the ANOVA test can be seen in Table 17, which indicates the null hypothesis with a $p<0.05$ can be rejected.

Table 17: Hypothesis Two ANOVA Test

ANOVA[a]					
Trust_Score					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.564	2	1.282	9.493	.002
Within Groups	2.026	15	.135		
Total	4.590	17			
a. Main Group = C2P					

Hypothesis Three

Hypothesis Three states the perceived content of the medical information (i.e., diagnosis, medical therapy, disease state management and treatment options) presented to the clinician from the clinician will have a significant impact on the trustworthiness of the telemedicine application. This can be stated as the null hypothesis in the following way:

> There is no significant difference in the trustworthiness of the telemedicine application based on the degree of perceived content of medical information presented to the clinician from the clinician.

Table 18 illustrates the results of the ANOVA test for hypothesis three and indicates that the null hypothesis can be rejected with a $p<0.05$.

Table 18: Hypothesis Three ANOVA Test

ANOVA[a]					
Trust_Score					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.649	2	1.824	24.873	.000
Within Groups	1.100	15	.073		
Total	4.749	17			
a. Main Group = C2C					

Hypothesis Four

Hypothesis Four states the design elements (i.e., how the site is displayed or represented to the user) of the telemedicine system will have a significant impact on the perceived trustworthiness of the telemedicine application, measured across all stratified groups. The null hypothesis can be stated as:

> There is no significant difference in the trustworthiness of the telemedicine application, measured across all stratified groups, based on the design elements.

Table 19 represents the results of the ANOVA test associated with Hypothesis Four and indicates that the null hypothesis can be rejected with a $p<0.05$.

Table 19: Hypothesis Four ANOVA Test

ANOVA						
Trust_Score						
Main Group		Sum of Squares	Df	Mean Square	F	Sig.
C2C	Between Groups	3.455	2	1.727	20.025	.000
	Within Groups	1.294	15	.086		
	Total	4.749	17			
C2P	Between Groups	2.847	2	1.424	12.255	.001
	Within Groups	1.743	15	.116		
	Total	4.590	17			
P2C	Between Groups	2.697	2	1.348	13.475	.000
	Within Groups	1.601	16	.100		
	Total	4.298	18			

Hypothesis Five

Hypothesis Five states that the measure of perceived relationship between patient and clinician (bi-directional) will have a significant impact on the trustworthiness of the telemedicine application. This can be rewritten to produce a null hypothesis statement as follows:

> There is no significant difference in the trustworthiness of the telemedicine application based on the degree of perceived relationship between patient and clinician (bi-directional).

Table 20 illustrates the results of the ANOVA test on Hypothesis Five and demonstrates the null hypothesis with a $p<0.05$ can be rejected.

Table 20: Hypothesis Five ANOVA Test

ANOVA						
Trust_Score						
Main Group		Sum of Squares	Df	Mean Square	F	Sig.
C2C	Between Groups	3.885	2	1.943	33.739	.000
	Within Groups	.864	15	.058		
	Total	4.749	17			
C2P	Between Groups	3.445	2	1.722	22.558	.000
	Within Groups	1.145	15	.076		
	Total	4.590	17			
P2C	Between Groups	2.504	2	1.252	11.168	.001
	Within Groups	1.794	16	.112		
	Total	4.298	18			

Hypothesis Six

Hypothesis Six was stated as perceived patient outcome (bi-directional for patient and clinician) will have a significant impact on the trustworthiness of the telemedicine application. In this case, the null hypothesis can be stated as follows:

> There is no significant difference in the trustworthiness of the telemedicine application based on the degree of perceived patient outcome.

Table 21 illustrates that the null hypothesis for Hypothesis Six can be rejected with a $p<0.05$.

Table 21: Hypothesis Six ANOVA Test

ANOVA						
Trust_Score						
Main Group		Sum of Squares	Df	Mean Square	F	Sig.
C2C	Between Groups	3.649	2	1.824	24.873	.000
	Within Groups	1.100	15	.073		
	Total	4.749	17			
C2P	Between Groups	2.564	2	1.282	9.493	.002
	Within Groups	2.026	15	.135		
	Total	4.590	17			
P2C	Between Groups	2.696	1	2.696	28.615	.000
	Within Groups	1.602	17	.094		
	Total	4.298	18			

Research Questions

A number of questions were posed in Chapter 1 that was beyond the hypotheses of this research, which included the trust dynamics that may impede or support telemedicine. The researcher sees a number of factors that are specific in the success of telemedicine that are distinct from other factors. One of the primary factors involves the relationship between clinician and patient, which is quite distinct from other forms of commerce or exchange. It is often developed over time and is a delicate balance between the requirements of both the clinician and the patient. Trust also depends upon the risks associated with the participants; a patient presenting with a broken finger carries a distinct risk that may be less than a patient presenting with major trauma. Similar to other environments such as ecommerce or health portals (Slyke, Belanger, & Comunale, 2004; Sillence, Briggs, Fishwick, & Harris, 2004; Luo & Najdawi, 2004; Gefen, 2002), risk carries with it a great deal of consideration in the trust development life cycle. These attributes are identified in the User-Centric portion of the trust model. The clinician and the patient each brings with them a certain set of standards, perceptions, needs, and factors that must be met in order for a sound and healthy relationship to be built. These factors are highly dynamic and dependent upon previous, current, and future physical states of the patient. If one party is not getting their needs met, the trust may be diminished. These aspects are quite unique from other forms of personal exchange that may occur. Certainly the fact that trust has been demonstrated to impact ecommerce (Gefen, 2002) translates into telemedicine, however, with telemedicine, there appears to be a deeper, diverse, and more robust formula that must be applied.

Health portals, ecommerce, and other tenets of human computer interaction have all demonstrated that trust is a key factor (Geffen, 2002; Sillence, Briggs, Fishwick, & Harris, 2004; Slyke, Belanger, & Comunale, 2004) with their own requirements and frameworks that have been developed. This research proposes a new approach to that of telemedicine, which accounts for numerous factors that are shown to create the telemedicine trust model. The framework that the researcher has examined in this model captures the unique and challenging aspects that are part of the dynamic interpersonal relationship that exists between clinician and patient.

One aspect that was discussed in Chapter 1 is the fact that telemedicine lags behind the development of other technology advances by 10-15 years (Goldschmidt, 2005). While considering the challenges that exist in understanding the nature of interpersonal relationships faced within the healthcare environment, this may not be such an anomaly. As the telemedicine trust model suggests, attention needs to be given not only to the system but also the demands of the user. As the trust model matures within a system, it may be possible to increase the trust components, thus increasing adoption.

Chau and Hu (2004) describe telemedicine as a broad utilization of advanced telecommunications, networking, dissemination of expertise, distribution of information, and exchange of healthcare information or services between geographically disparate participants. However, the vast majority of services may be applied to underserved populations, which may require more focus on specific characteristics of the population. Underserved populations may pose unique challenges in regards to infrastructure, education, technologic aptitude, and compliance with medical recommendations. These all bring forth unique challenges that must be addressed. Future research should focus on these specific attributes to uncover some of the unique characteristics.

Summary of Results

The goals of this research were to examine the role of trust within the telemedicine environment to establish the importance of trust dynamics. The research included the following stages:

1. Survey of the telemedicine environment
2. Construction of a set of core dynamics that represent the study areas
3. Construction of a framework that establishes the Telemedicine Trust Model (TTM)
4. Construction of a telemedicine simulator based upon the trust model
5. Perform research including collecting survey data to test the six hypotheses; test the TTM via the respondents' reactions to the simulator at when the levels of elements thought to produce trust were varied.

The survey of the telemedicine environment revealed that a gap exists between current adoption rates and the potential benefits of telemedicine. The environment is well suited to a framework that could potentially increase the adoption rates. Best practices in telemedicine certainly contribute to continued growth and adoption, but other elements also appear to have an influence. Increased exposure and attention to the trust dynamics could enhance the adoption rates and, over time, expand the user base of telemedicine.

The core models that were developed through the literature review represent key areas where trust could play a role. The SME reviews helped to establish the baseline for the analysis. Three iterations of the trust model were utilized to focus the model on the core attributes. The trust models represented in Figure 7, focused on two primary areas, user centric trust and system centric trust, and were tied together by online behavior. The model established that a system must be able to adapt to a wide range of users, both from a technical point of view and a medical point of view. The model compartmentalized the clinical dynamics, privacy elements, and design elements in order to identify the key areas of research.

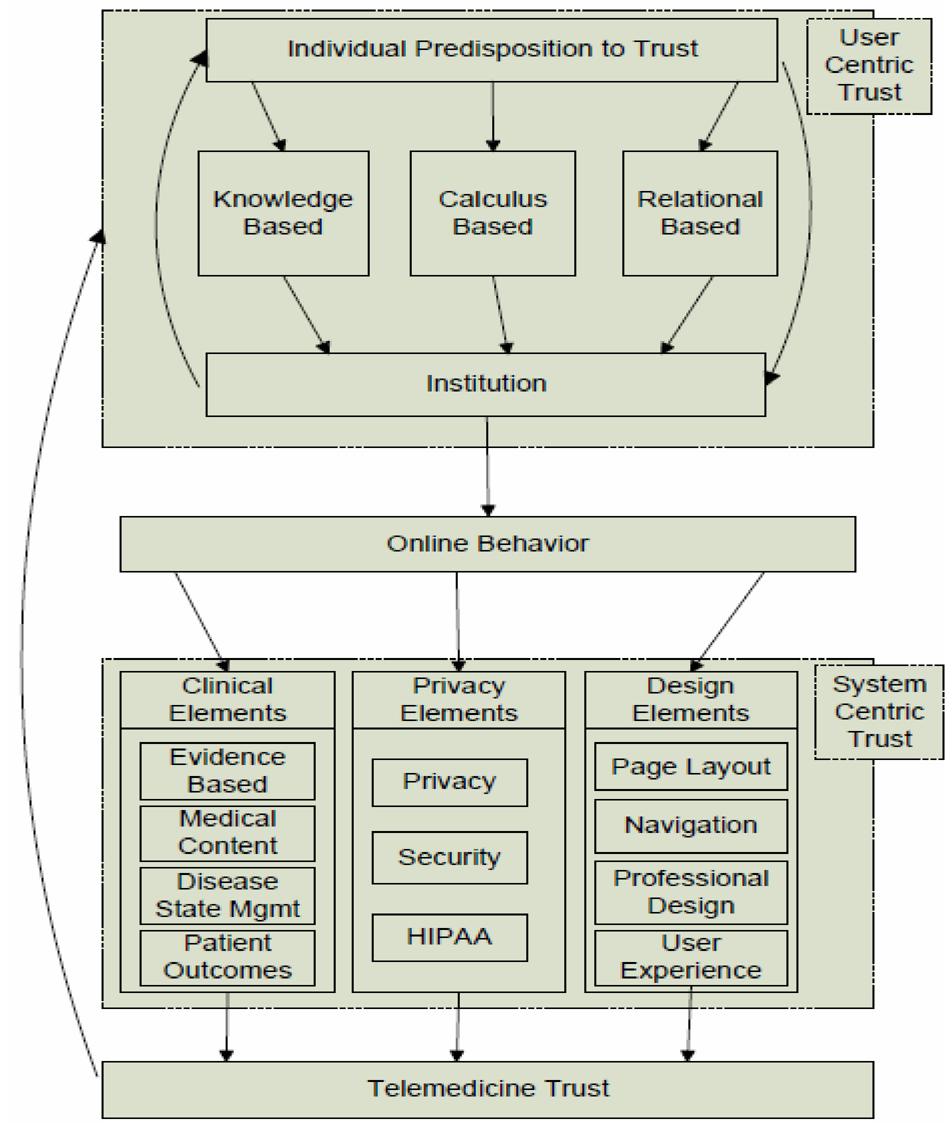


Figure 7: Final Telemedicine Trust Model

The SME feedback provided assistance in producing the final TTM model by building upon the initial model and enhancing the attributes that may influence trust. The survey results confirmed that the components of the trust model were intact and that the elements described in the system centric model hold.

The author utilized the TTM in the development of the simulators. The TTM was combined with best practices that were noted in the telemedicine environment survey, along with the development of a case study, diabetes management algorithms, and evidence-based medical information. The researcher anticipated that the survey would reveal that trust would be based upon these dynamics.

The results of the hypothesis testing revealed that medical information from patient to clinician, clinician to patient, and clinician to clinician, design elements, relationship, and perceived outcomes of the patient would have a significant impact on the trust of the telemedicine system. All six null hypotheses were rejected, based upon the survey results and are outlined in Table 22. It was noted that as the trust dynamics were removed, the trust score followed a linear pattern of reduction, as expected.

Table 22: Summary of Hypotheses

Hypothesis	Null Hypothesis Statement	Results of Significance Testing	Comments
H1	Medical Information to patient from clinician has no impact on trust	Rejected	Medical Information to patient from clinician has a positive impact on trust
H2	Medical Information to clinician from patient has no impact on trust	Rejected	Medical Information to clinician from patient has a positive impact on trust
H3	Medical Information to clinician from clinician has no impact on trust	Rejected	Medical Information to clinician from clinician has a positive impact on trust
H4	Design Elements have no impact on trust	Rejected	Design Elements have a positive impact on trust
H5	Measure of perceived relationship has no impact on trust	Rejected	Measure of perceived relationship has a positive impact on trust
H6	Perceived patient outcome has no impact on trust	Rejected	Perceived patient outcome has a positive impact on trust

Chapter 5

Conclusions, Implications, Recommendations, and Summary

Overview

Development of a framework for the successful design of telemedicine was examined through this research. The roles of various users, including clinicians and patients, were captured through the use of online simulators and online surveys. Medical information, design elements, disease state management, as well as privacy all proved to be positive attributes in the development of trust.

Conclusions

Trust is a highly dynamic, individualized, complex, and unique process that often depends upon numerous factors in its development. Developing a framework of trust cannot be placed in a simple algorithm as if it were a one-size-fits-all approach. This research demonstrated that trust factors that may be appropriate for one agent, may not be appropriate for another. In the field of telemedicine, numerous users must be able to realize trust from a user centric approach as well as a system centric approach. These factors are independent of one another and must be managed in a unique way. The framework that was developed from this research was based on the focused approach of the UCT and SCT aspects.

User centric approaches must realize that trust depends upon the life experiences, personality traits, needs, and other factors that are specific to individuals or groups. In this sense, the research found that an individual's propensity to trust played a role in the development of trust. Beyond the user's propensity to trust several other factors emerge as key attributes to the UCT model, these include knowledge based attributes, calculus based attributes, relational based attributes, as well as institutional attributes.

Knowledge Based attributes were captured as part of the UCT due to the individual nature of these requirements. Clinicians would most often fit into this role for a telemedicine system, requiring a great deal of knowledge based information present in the system. However, patients may also play a significant role in this realm due to the fact that patients may choose to educate themselves on their disease, thus increasing the requirement for a more robust knowledge base.

Calculus Based attributes represents the variability in how a user may form the foundation of trust in medicine, these could be areas that are outside of the other factors, yet are still important. This domain may be built upon numerous factors such as cultural norms, perceptions, exposure to the medical community, or other factors.

Relational Based aspects include the formulation, expectation, need, or attributes associated with the ongoing clinician-patient relationship. This attribute plays a key role in the development of trust for some users. It would be important to recognize this as a UCT component due to the unique nature of relatedness. Some users may have a different interpretation of their own relationship needs and those of the user with which they are interacting.

Institutional Based attributes are also unique in that they may supersede some other aspects, such as Knowledge Based, Calculus Based, or Relational Based attributes. This is most likely to occur in an environment that carries a very high profile, highly respected, and authoritative atmosphere. A user may feel that since they are interacting with such a reputable institution, they may not need to be as concerned about other attributes. This is one attribute that may also feed back to the user's propensity to trust due to the ongoing interactions or reputation. If the reputation of the institution is damaged along the way, it may alter the level of trust, thus shifting the model.

Moving outside of the UCT environment the transition moves to the attribute for online behavior of the participant. It appears outside of the realm of both UCT and SCT due to its unique nature. It is somewhat of a hybrid of both UCT and SCT and certainly can be influenced by both, yet appears to carry enough uniqueness to remain separate.

System Centric Trust is developed within the telemedicine application beginning with three primary categories. Within this area lies the most abundant resource for trust building within telemedicine design. The first category is the health related information that the user is exposed to, which must be accurate, timely and adaptable to the users needs. If the user is naïve to the disease, it may require more explanation and resources, while a well seasoned clinician may require a different set of resources.

Privacy and security are also a primary focal point of SCT, and also a compliance issue with many regulatory agencies. Its importance must be recognized and the system must be able to demonstrate to the user the high importance that the system places on privacy and security, but it must also be manageable for the user. Some privacy and security features discovered by the researcher during attendance at conferences were found to be difficult and prone to user interface challenges. A delicate balance of usability and features will be required to support such a system.

The final section of the SCT represents the design elements that are present. User design must meet the demands of the audience. In particular, they should be feature rich with easy to follow structure and flow. Medical information can be difficult for some to comprehend, or users may present with disabilities such as visual, hearing, manual dexterity, or other concerns that limit their ability to interact with a telemedicine system. Another factor could be the vast amount of resources that may be available on a disease. This information must be managed so as not to overwhelm the user. Design will be a paramount component to the development of SCT, but it must not be viewed in isolation.

Implications

Theoretical Implications

Trust is a very complex and highly dynamic environment, wrought with challenges from an individual perspective, a system perspective, along with a component for reputation. The dynamic nature makes it especially challenging to capture any single group of attributes that are universally applicable. Many aspects are based on individual needs, preferences, and the propensity to trust. The framework developed from this study clearly illustrates that trust is based on a number of key factors, but carry different weights depending on the user.

From this research there appears to be an opportunity for much more in-depth analysis of the framework. The researcher sees a clear link between the framework developed and trust models developed for artificial neural networks. A logical step would be to examine the weights of each trust attribute, based on the user scenarios studied in this research, while training a database to improve the overall trust score for each user.

Telemedicine Implications

Telemedicine has experienced numerous hurdles with regards to adoption of the technology. Establishing a stronger foundation of trust with all involved may help to foster a greater adoption rate. This research has demonstrated that there exist areas for improvement and further exploration. Trust attributes should be considered by both telemedicine developers and implementers.

The field of medicine is constantly evolving with increased scrutiny with regards to privacy, HIPAA regulations, security, patient safety and outcomes, appropriate use criteria, evidence-based medicine, personalized medicine, and vast arrays of developments in all fields. This exponential expansion of medicine creates an ideal environment for technology to help manage and foster. However, systems have to consider all aspects of users in order to become fully effective. What the user brings to the table in terms of their predisposition is only a small portion of the user perspective.

In terms of clinicians, there needs to be a strong and consistent effort to develop robust and engaging environments that capture the diversity that exists in medical care. The practice of medicine creates a challenge due to the variety of approaches and thought processes that clinicians employ. Certainly best practices, evidence based medicine, treatment algorithms, standards of care, and disease state management techniques help to support levels of trust, but attention needs to be paid to more than just those items.

On the side of the patient, attention needs to be placed on not only patient outcomes but also on supporting the patient from their perspective. Some patients will be highly informed and educated on their disease, while others will have little knowledge or interest in learning much about their disease. Technology needs to assist all patient types, not just limit itself to a narrow spectrum of the patient group.

Recommendations

Telemedicine has vast opportunities to improve usability and increase trust with the various agents that will be interacting with the system. Trust can play a role in developing and supporting those systems. The trust framework developed from this research can help to guide development of more robust studies within this area.

The researcher also sees a unique opportunity to expand the trust model into an artificial neural network environment by labeling the trust attributes with user specific weights. Measuring the fluctuation in the weight of the trust attribute and capturing the data in a database table, the system could theoretically change the nature of the presentation to gain the maximum level of trust for the user. This approach is modeled in Figure 8.

Considering that a robust telemedicine system would have numerous opportunities to increase trust as the dynamic nature of disease state management unfolds, perhaps an artificial neural network (ANN) would prove beneficial. Medicine and disease state management are a constantly evolving paradigm, something that may be appropriated from other trust based systems such as e-commerce.

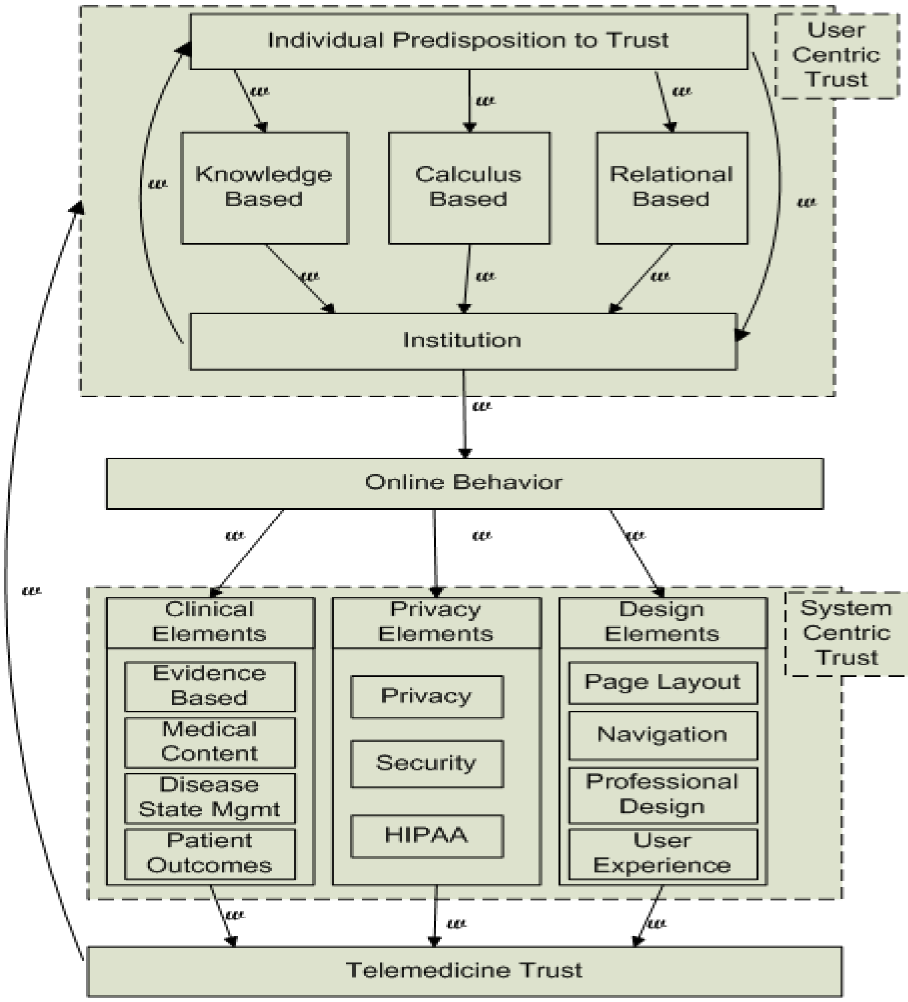


Figure 8: Suggested Future Research ANN Model

Summary

This study focused on the development of a framework that would enhance the level of trust in a telemedicine system. The framework developed illustrates the complex nature of trust in telemedicine and the challenges faced by developers to enhance overall adoption rates and trust within a system.

Chapter 1 focused on the description of the environment of telemedicine and the need for the study. The problem that the researcher introduced laid the foundation for the research. The focus was on the significant divergence in the adoption and adaptation of technology within the healthcare and medical community. It was suspected that this divergence, which may be rooted in a lack of trust in the technology being applied, may hinder the advancement and treatment of patients, thus increasing morbidity and mortality. The barriers of the research were also introduced and ways the researcher would attempt to minimize their impact were discussed.

Chapter 2 contained a rich examination of the literature, exploring the research of medicine, telemedicine, diabetes, trust, and the various aspects studied. Much of the literature review focused on trust dynamics and how they have evolved over time. Telemedicine has also faced the challenge of improving adoption rates; this creates a strong incentive for the examination of trust in telemedicine to determine if any correlations exist between adoption rates and trust.

This research focused on three specific user groups and how trust could impact each group. This was outlined in Chapter 3, the methodology section. A simulator was developed that explored the dynamics of trust with regards to the treatment of diabetes mellitus, a common disease. Participants were grouped as a clinician based on their background, if they had clinical training or a graduate degree in life science. Other participants acted as patients being treated by the clinician. Following the simulated exercise, the participants were asked to take a survey.

Chapter 4 outlines the results of the simulated environment and the survey, where the data indicated that the trust dynamics of relationship, clinical data, outcomes, and system design were all significantly tied to trust of the telemedicine system. The researcher has also offered insight into what areas may require more research to understand the dynamics of trust and telemedicine.

This research has shed light into the complex and dynamic world of telemedicine and some of the factors that may influence the low adoption rates. Adoption, as pointed out in the literature review, has been significantly delayed when compared to other technology sectors. This research has been carried out to potentially influence and alter the landscape in terms of telemedicine. Certainly more research should be done to continue to discover the attributes that influence the ways in which medicine can be practiced. For diseases such as diabetes, the more opportunities for education and disease state management, the more opportunities there will be to slow the devastating progression of this and other diseases. Telemedicine has abundant opportunities to have a positive impact on the health of future generations, but understanding the fundamental ways in which to deliver that healthcare is paramount.

Appendix A

Letter to Research Participants (Patients and Clinicians)

James R. Templeton
7770 Regents Road
#113-602
San Diego, CA 92122
jtemplet@nova.edu

January 2, 2010

Dear Participant,

My name is James Templeton and I am a graduate student at Nova Southeastern University conducting research on the elements of trust in telemedicine. The focus of the research will be on how well diabetic patients and clinicians manage their disease to improve outcomes in order to build a framework for the successful design of telemedicine systems. I am developing a survey questionnaire that will help to define the specific attributes that enhance trust in these systems. I am hoping that you will join me in this exciting and important research study.

The study will be conducted during a twelve-week period between January 5, 2010 and March 20, 2010. For each participant, the entire study should take about 30 minutes to complete. NSU's Institutional Review Board (IRB) has approved this research. Please note that at no time will any personally identifiable data be collected on any participant.

If you are interested in participating in this research study, additional information can be found at www.trusttelemedicine.com. Please feel free to visit the web site for a more detailed explanation of the study design and research.

In addition, participants in the study will each receive a $5 gift card. Three participants will also be randomly selected to receive a $75 gift card. This will be managed by a third party website ensuring the anonymity of the user throughout the process.

Thank you very much for your support and participation in this research. Your participation is very important to me and to the advancement of the body of knowledge in this area.

Sincerely,

James R. Templeton

Appendix B

Letter to Diabetes Subject Matter Experts

James R. Templeton
7770 Regents Road, #113-602
San Diego, CA 92122
jtemplet@nova.edu

November 1, 2009

Dear Colleague,

My name is James Templeton and I am a graduate student at Nova Southeastern University conducting research on the elements of trust in telemedicine. The focus of the research will be on how well diabetic patients and clinicians manage their disease to improve outcomes in order to build a framework for the successful design of telemedicine systems. I am developing a survey questionnaire that will help to define the specific attributes that enhance trust in these systems. Specifically, I am hoping that you will assist me in determining the most important parameters of diabetes care by ranking the importance of the following categories:

_____ Patient Education (patient comprehension for diabetes management)
_____ Patient Compliance
_____ Fasting Glucose Levels
_____ Postprandial Glucose Levels
_____ HbA_1C testing
_____ Diet/Weight Management
_____ Exercise
_____ Wound Care
_____ Cardiovascular Disease - Cholesterol
_____ Cardiovascular Disease - Hypertension
_____ Diabetic complications (i.e. Nephropathy and Neuropathy)
_____ Family History, Demographics, and Race

Please rank the above with the number 1 applied to the most important category. Also, feel free to rank ties accordingly (i.e. two items can rank first, if desired). Feel free to comment briefly on the reverse side to provide further insight into the management of diabetes.

Additional information can be found at www.trusttelemedicine.com. Please visit the web site at any time for a more detailed explanation of the study design and research. You may also visit in the future to review the outcomes of the study.

Please return the information within two weeks via the postage paid envelope. Thank you very much for your support and participation in this research.

Sincerely,
James R. Templeton

Appendix C

Letter to Trust Subject Matter Experts – Trust Dynamics

James R. Templeton
7770 Regents Road
#113-602
San Diego, CA 92122
jtemplet@nova.edu

November 1, 2009

Dear Colleague,

My name is James Templeton and I am a graduate student at Nova Southeastern University conducting research on the elements of trust in telemedicine. This research focuses on diabetic patients and clinicians managing diabetes in order to improve outcomes. The goal of the research is to build a framework for the successful design of telemedicine systems. I am developing a survey questionnaire that will help to define the specific attributes that enhance trust in these systems. Specifically, I am hoping that you will assist me in determining the most important parameters of diabetes care by answering the following questions (please use the reverse side if additional space is needed):

Did you find bias (preference towards any issue or idea) in the trust dynamics identified?

____

If yes, what recommendations would you have to eliminate or minimize these biases?

____

Did you find the trust dynamics to be a reliable approach?

____

Would any trust dynamics benefit from rewording, rephrasing, or replacement?

____

What is missing from the trust dynamics?

____

What would you do to improve the trust dynamics identified?

____

Additional information can be found at www.trusttelemedicine.com. Please feel free to visit the web site at any time for a more detailed explanation of the study design and research.

Thank you very much for your support and participation in this research.

Sincerely,

James R. Templeton

Appendix D

Letter to Trust Subject Matter Experts – Participants Survey

James R. Templeton
7770 Regents Road
#113-602
San Diego, CA 92122
jtemplet@nova.edu

November 1, 2009

Dear Colleague,

My name is James Templeton and I am a graduate student at Nova Southeastern University conducting research on the elements of trust in telemedicine. This research focuses on diabetic patients and clinicians managing diabetes in order to improve outcomes. The goal of the research is to build a framework for the successful design of telemedicine systems. I am developing a survey questionnaire that will help to define the specific attributes that enhance trust in these systems. Specifically, I am hoping that you will assist me in determining the most important parameters of diabetes care by answering the following questions (please use the reverse side if additional space is needed):

Did you find any bias (preference towards any issue or idea) in the survey?

____

If yes, what recommendations would you have to eliminate or minimize these biases?

____

Did you find the survey questions readable and understandable to a layperson?

____

Would any survey questions benefit from rewording or rephrasing?

____

What is missing from the survey?

____

What would you do to improve the survey?

____

Additional information can be found at www.trusttelemedicine.com. Please feel free to visit the web site at any time for a more detailed explanation of the study design and research.

Thank you very much for your support and participation in this research.

Sincerely,

James R. Templeton

Appendix E

Trust Dynamics

Trust dynamics are described as a spectrum within which most people operate in their interactions with the environment and specific situations.

Baseline trust dynamics are established via a propensity to trust scale. The following questions are posed to develop the baseline values of trust from the perspective of a subject.

Trust Propensity (general attitude)–

1. Do you consider yourself a trusting person?
    - Yes
    - No
    - Sometimes
2. Do you trust until proven otherwise?
    - Yes
    - No
    - Sometimes
3. Do you consider yourself to have trust issues?
    - Yes
    - No
    - Sometimes
4. Do you generally believe in others?
    - Yes
    - No
    - Sometimes
5. In general, do you have trust when you are using the Internet?
    - Yes
    - No
    - Sometimes

6. Do you have trust in online medical information?

    - Yes
    - No
    - Sometimes

Another baseline trust dynamic will be established via the patient/clinician interaction scale. This category reflects how patients and clinicians view their interactions, how they view perceptions of medical, health, privacy, and other online aspects. This psychometric scale is determined by the following questions:

Patient and/or Clinician Interactions –

7. How often do you visit a doctor?

    - Only when needed
    - Monthly
    - Quarterly (every three months)
    - Twice/Year
    - Once/Year
    - Less than Once/Year
    - Never

8. How would you rate your general health?

    - Excellent
    - Good
    - Fair
    - Poor
    - Don't know

9. In the last 6 months, how often have you sought medical information online?

    - Never
    - 1 - 2
    - 3 - 5
    - 6 - 10
    - More than 10

10. How would you rate your medical search experience?

    - Excellent
    - Very Good
    - Good
    - Fair
    - Poor
    - I don't know how to do medical searches online

11. How would you rate the quality of medical information online?

    - Excellent (never had any complaints or problems)
    - Very Good (minimal complaints or problems)
    - Good (some complaints or problems)
    - Fair (frequent complaints or problems)
    - Poor (numerous complaints or problems)
    - N/A (I do not search medical information online)

12. Do you have any future intention of conducting online medical search?

    - Definitely plan to conduct online search for medical data
    - Probably will conduct online search for medical data
    - Might conduct online search for medical data
    - Probably will NOT conduct online search for medical data
    - Most definitely will NOT conduct online search for medical data

13. In general, are you concerned about your personal privacy (or patient privacy) of medical information online?

    - Yes
    - No
    - Don't Know (never really considered it)

14. In communicating medical information online, are you concerned that the communication may not be received or communicated correctly?

    - Yes
    - No
    - Don't Know (never really considered it)

The specific trust dynamics that are associated with the simulators are broken down into two primary categories, Health Dynamics and Design Elements.

Health Dynamics
- Diabetes Management
- Diabetes Resources
- Dietary Information
- Exercise Information
- Medical Information
- Patient and/or Clinician Interactions

Design Elements
- Page Layout
- Navigation
- Graphics Layout

Appendix F

Research Survey Model

Category	Questions
Demographics	1-5
Trust Propensity	6-11
Patient and/or Clinician Interactions	12-15
Health Dynamics	
- Diabetes Management	20-24
- Diabetes Resources	25-26
- Dietary Information	27-29
- Exercise Information	30-33
- Medical Information	34-39
- Patient and/or Clinician Interactions	40-50
Design Elements	
- Page Layout	51-55
- Navigation	56-60
- Graphics Layout	61-63
General Overview	64-70

The survey which will be utilized in the research is provided in Appendix E. The online version will contain the following modifications:

1. Survey questions will be specific to the choice made in question 1 (Patient or Clinician)
2. Headings will be removed and categorized by Roman Numerals

Appendix G

Survey Questions

Computer/Technology Savvy –

1. How would you rank your computer/online literacy (select one)?

   - Computer/Online Expert
   - Computer/Online Proficient
   - Computer/Online Sufficient
   - Computer/Online Novice

Topic Categories -

Demographic Information –

2. What Communication Category did you participate in (select one)?

   - Patient to Clinician
   - Clinician to Patient
   - Clinician to Clinician

3. What is your age (Select one)?

   - 18 – 25
   - 26 – 35
   - 36- 45
   - 46-55
   - 56-65
   - >65

4. Gender (Select one)?

   - Male
   - Female

5. Household Income Annually (Optional):

   - < 25,000
   - 25,000 –49,999
   - 50,000 – 74,999
   - 75,000 – 99,999
   - 100,000 – 124,999
   - 125,000 – 149,999
   - 150,000 – 199,999
   - 200,000 +

6. Education:

   - Not High School Graduate
   - High School Graduate
   - Some College
   - Associates Degree/Trade School
   - Bachelors Degree/Advanced Trade School
   - Masters Degree
   - MBA
   - Non-Clinical Professional (Lawyer, Architect, etc.)
   - Clinical Professional (Physician, or Health Care Professional, i.e. Nurse, Certified Diabetic Educator, PharmD, etc.)
   - Doctorate – Life Sciences (PhD, PsyD, DSc, etc.)
   - Doctorate – Non Life Sciences (EdD, PhD, etc.)

Trust Propensity (general attitude)–

7. Do you consider yourself a trusting person?

   - Yes
   - No
   - Sometimes

8. Do you trust until proven otherwise?

   - Yes
   - No
   - Sometimes

9. Do you consider yourself to have trust issues?

- Yes
- No
- Sometimes

10. Do you generally believe in others?

- Yes
- No
- Sometimes

11. In general, do you have trust when you are using the Internet?

- Yes
- No
- Sometimes

12. Do you have trust in online medical information?

- Yes
- No
- Sometimes

Patient and/or Clinician Interactions –

13. How often do you visit a doctor?

- Only when needed
- Monthly
- Quarterly (every three months)
- Twice/Year
- Once/Year
- Less than Once/Year
- Never

14. How would you rate your general health?

- Excellent
- Good
- Fair
- Poor
- Don't know

15. In the last 6 months, how often have you sought medical information online?

    - o Never
    - o 1 - 2
    - o 3 - 5
    - o 6 - 10
    - o More than 10

16. How would you rate your online medical search experience?

    - o Excellent
    - o Very Good
    - o Good
    - o Fair
    - o Poor
    - o I don't know how to do medical searches online

17. How would you rate the quality of medical information online?

    - o Excellent (never had any complaints or problems)
    - o Very Good (minimal complaints or problems)
    - o Good (some complaints or problems)
    - o Fair (frequent complaints or problems)
    - o Poor (numerous complaints or problems)
    - o N/A (I do not search medical information online)

18. Do you have any future intentions of conducting online medical searches?

    - o Definitely plan to conduct online search for medical data
    - o Probably will conduct online search for medical data
    - o Might conduct online search for medical data
    - o Probably will NOT conduct online search for medical data
    - o Most definitely will NOT conduct online search for medical data

19. In general, are you concerned about your personal privacy (or patient privacy) of medical information online?

- Yes
- No
- Don't Know (never really considered it)

20. In communicating medical information online, are you concerned that the communication may not be received or communicated correctly?

    - Yes
    - No
    - Don't Know (never really considered it)

Health Dynamics –

Diabetes Management -

21. Do you trust that the medical information on diabetes management was accurate and timely?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

22. Did you feel that the recommendations or suggestions were consistent?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

23. Did you feel the recommendations or suggestions made to you (or your patient) were relevant?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

24. Do you believe the diabetes management plan will succeed or provide benefit?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

25. Has your outlook on diabetes has improved?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

Diabetes Resources –

26. Did you trust the diabetes resources that were provided?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

27. Did you feel that the resources were readily available for the disease through the system?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

Dietary Information –

28. Do you feel the dietary information was trustworthy?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

29. Do you feel the dietary information was reasonable and doable?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

30. Do you (or does your patient) have a better understanding of the food you need to eat to maintain your blood sugar?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

Exercise Information –

31. Did you trust the exercise information that was provided?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

32. Was the exercise information relevant to your (or your patient's) lifestyle and ability?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

33. Do you believe that you (or your patient) would follow the exercise guidelines closely?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

34. Do you believe that you (or your patient) will increase your exercise as a result of the information provided?

    - No
    - Some Increase
    - Neutral
    - Moderate Increase
    - Absolutely, I have adopted a regular exercise routine

Medical Information –

35. Did you feel the medical information was understandable and readable?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

36. Did you feel the medical information was adequately explained?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

37. Do you trust that the medical information was complete and accurate?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

38. Do you intend to seek medical information from other sources online to validate information?

    - Strongly Disagree
    - Disagree
    - Neutral

- Agree
- Strongly Agree

39. Would you feel comfortable asking the Clinician (Patient) for further explanation on the medical information?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

40. Do you believe the institution behind the telemedicine site had a high degree of ethics and morals?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

Patient and/or Clinician Interactions

41. Did you feel a personal connection with the person with whom you were interacting online?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

42. Did you trust the flow of information?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

43. Did you believe that interactions were timely and complete?

    - Strongly Disagree
    - Disagree
    - Neutral

- Agree
- Strongly Agree

44. Did you feel a great distance between yourself and the person with whom you interacted?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

45. Do you prefer interacting in an online environment versus a live interaction?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

46. Did you trust the person on the other end of the conversation?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

47. Did you trust that private medical information would be managed appropriately and carefully to prevent unauthorized access by others?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

48. In the next six months, will you seek a personal visit with the Clinician (or Patient) rather than an online connection?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree

- Strongly Agree

49. Do you prefer to intersperse the live visits with online management?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

50. Do you believe that the Clinician (Patient) with whom you interacted had a high degree of ethics and morals?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

51. Do you believe that the Clinician (Patient) was dependable and reliable?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

Design Elements -

Page Layout –

52. Did you feel the page layout was easy to follow and understand?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

53. Did you feel the page layout was consistent throughout the site?

    - Strongly Disagree

- Disagree
- Neutral
- Agree
- Strongly Agree

54. Do you feel the site appeared to be professionally designed?

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

55. Do you feel that the content of the site was easily accessed?

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

56. Do you feel that the site content was visually appealing?

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

Navigation –

57. Do you feel that the site was easy to navigate?

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

58. Considering the design elements of the site, do you consider the following aspects to have been visually appealing (choose all that apply)?

- Colors
- Design

- Web Layout
- Formatting
- Font Size
- Font Shape
- Font Color

59. Considering the design elements of the site, do you feel that the site was consistent in its design and message?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

60. Do you believe that the medical content and visual content work well together?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

61. Overall, do you feel that the contents of the site support feelings of trust?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

Graphics Layout –

62. Do you feel that the images and graphics contained on the site instill a sense of purpose and trust?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

63. Do you believe that the graphics and images were professional in appearance and design and layout?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

64. Would you recommend more graphic content on the site?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree

General Overview –

65. Do you feel that the privacy policy influenced your feelings of the site?

    - Strongly Disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly Agree
    - I did not read the privacy policy

66. Of the following, do you consider any single aspect of the site the most important feature (select one, if appropriate):

    - Medical Content
    - Access to Clinician (Patient)
    - Disease State Management
    - Navigation of Site
    - Availability
    - Privacy Policy

67. Of the following medical components, which do you feel stand out as a key point in your level of trust in the system (Choose all that apply)?

    - Diabetes Management
    - Dietary Management
    - Exercise Management

- o Clinician comments/suggestions

68. Of the following design elements, which would you consider to stand out as key points in your level of trust in the system (choose all that apply)?

    - o Navigation of Website
    - o Color Scheme
    - o Font Size
    - o Graphics and Images
    - o Page Layout

69. Do any of the following security and privacy features stand out as a key point in your level of trust in the system (choose all that apply)?

    - o Secure Site
    - o Privacy Policy
    - o HIPPA Policy
    - o Private communication with Clinician (Patient)

70. How would you estimate your level of trust with telemedicine based on your experience with this site?

    - o No Trust
    - o Some Trust
    - o Trust
    - o Moderate Trust
    - o Complete Trust

71. Would you be willing to recommend telemedicine to others through your experience with this site?

    - o Strongly Agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly Disagree

Appendix H

Sample Size - Statistical Design and Analysis

Definition of terms:

n= Sample number
$\bar{x}$ = Sample mean
s^2 = Sample variance
s = Sample standard deviation
μ = Population mean
H_0 = Null hypothesis
H_a = Alternative hypothesis
H_1 = Hypothesis
σ = Population standard deviation
σ^2 = Population variance

Hypotheses:
H_1 = Trust dynamics have a bearing on the adoption of telemedicine
H_0 = Trust dynamics **do not** have a bearing on the adoption of telemedicine

Objective:
Hypothesis testing to either accept or reject the null hypothesis H_0
Determine, through Statistical Inference, the impact of trust dynamics on the treatment of diabetes through a telemedicine system

Population:
Prevalence of Diabetes; Global = 300,000,000 people
Prevalence of Diabetes; US = 20,000,000 people

Sample Size and Calculation:

N = Sample Size
Sample pool = Random
Sample Parameters:

A) Patient - Person with Type I Diabetes
B) Patient - Person with Type II Diabetes
C) Patient - Person with Impaired Glucose Tolerance
D) Patient - Person with Pre-Diabetes
E) Clinician - MD, DO, PharmD, CDE, NP, PA, RN, PhD, RD

Potential Systematic Bias: potential bias exists in the sample due to access to and understanding of technology. Lower income or elderly diabetic patients may not have access to the Internet, may not own a computer, or understand how to utilize a system such as simulated medical environment. This results in a potential bias in the sample pool by eliminating their potential to participate (Hill & Lewicki, 2006).

Random Sample Error: Potential to overestimate the results due to bias that exists in the selected sample pool. Participants may offset the results through the clustering of the samples (Hill & Lewicki, 2006).

Central Limit Theorem = States that a sample size will be fairly normal (i.e. follow a normal curve) for large sample sizes (N>30) (Hill & Lewicki, 2006).

According to the Central Limit Theorem, the mean of a sampling distribution of means is an unbiased estimator of the population mean.

$$\mu_{\bar{x}} = \mu$$

Similarly, the standard deviation of a sampling distribution of means is

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

The larger the sample, the less the variation of the sample mean. This value is also known as the standard error of the mean. Every statistic has a standard error, which is the measure of a statistics random variability.

Considering that the sample n > 30, the Central Limit Theorem allows for consideration of the properties of a normal curve. The normal curve indicates that 95% of all values relevant to the mean will be found within $\pm 2\sigma$, or with two standard deviations of the mean (Hill & Lewicki, 2006).

Additionally, the area of the normal curve must be standardized by converting it to a z-score. To convert a value to a z-score is to express it in terms of how many standard deviations it is above or below the mean.

$$z = \frac{x - \mu}{\sigma}$$

Where x is the value to be converted, μ is the population mean, and σ is the population standard deviation.

Sample Size Calculation

Sample size calculation requires a careful balance of resources, needs, and requirements. To obtain a smaller, more precise margin of error of the population's proportion, we must either decrease the degree of confidence or increase the sample size. Similarly, if we want to increase the degree of confidence, we may either accept a wider margin of error or increase the sample size.

In setting up a survey to obtain a confidence interval estimate of the population proportion, what should we use for $\sigma_{\bar{p}}$? Using the formula $\sqrt{\frac{\pi(1-\pi)}{n}}$ we find that the largest value that it can be is $\frac{0.5}{\sqrt{n}}$. This will be the basis for the determination of the sample size for this study.

Another factor to consider is the Confidence Level, which will be considered at 85%, 90%, 95%, or 99%. In order to utilize these values, the z-score must be obtained for each. They are as follows:

Table 23: Confidence Level

Confidence Level	z-score
85%	1.04
90%	1.28
95%	1.96
99%	2.32

The last factor to consider is the Margin of Error, which represents a certain percentage above or below the amount obtained when applied to the population of the group (Hill & Lewicki, 2006). The Margin of Error is inversely related to sample size, to a point; it is also directly related to the confidence level. In other words, as sample sizes increase, the margin of error begins to decrease. However, as sample sizes get larger, the rate of change for the margin of error slows down and becomes very difficult to eliminate. Furthermore, a decrease in the confidence level makes it easier to tighten the Margin of Error. All of these factors are related in the following formula:

$CL(\frac{0.5}{\sqrt{n}}) \leq E$ where CL represents the Confidence Level converted to a z-score and E represents the Margin of Error

Based on the above calculations, the following tables represent the varying margin of errors and confidence levels at a variety of sample sizes.

Table 24: Minimal Margin of Error Calculations to Determine Sample Size

Confidence Level	z-score	Margin of Error	Constant	$\sqrt{n}$	Sample size
85%	1.04	0.025	0.5	20.8	433
	1.04	0.05	0.5	10.4	108
	1.04	0.075	0.5	6.933333	48
	1.04	0.1	0.5	5.2	27
	1.04	0.125	0.5	4.16	17
90%	1.28	0.025	0.5	25.6	655
	1.28	0.05	0.5	12.8	164
	1.28	0.075	0.5	8.533333	73
	1.28	0.1	0.5	6.4	41
	1.28	0.125	0.5	5.12	26
95%	1.96	0.025	0.5	39.2	1537
	1.96	0.05	0.5	19.6	384
	1.96	0.075	0.5	13.06667	171
	1.96	0.1	0.5	9.8	96
	1.96	0.125	0.5	7.84	61
99%	2.33	0.025	0.5	46.6	2172
	2.33	0.05	0.5	23.3	543
	2.33	0.075	0.5	15.53333	241
	2.33	0.1	0.5	11.65	136
	2.33	0.125	0.5	9.32	87

Table 25: Realistic Sample Size Comparison to Determine Margin of Error

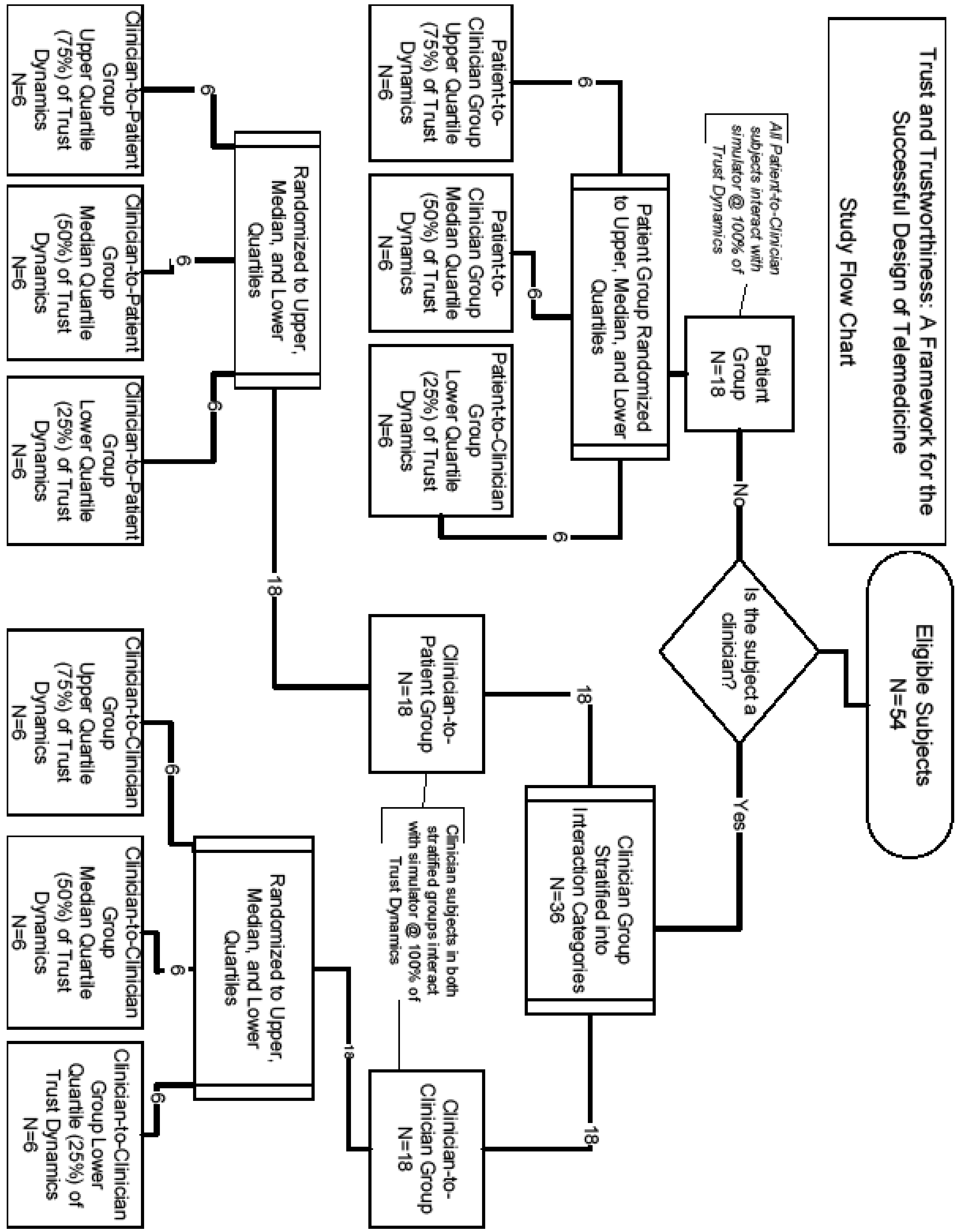
Confidence Level	z-score	Margin of Error	Constant		n-squared
85%	1.04	0.134263423	0.5	$\sqrt{n}$ [illegible]33	15
	1.04	0.122565175	0.5	4.242641	18
	1.04	0.104	0.5	5	25
	1.04	0.094938577	0.5	5.477226	30
	1.04	0.070763037	0.5	7.348469	54
90%	1.28	0.165247289	0.5	3.872983	15
	1.28	0.150849447	0.5	4.242641	18
	1.28	0.128	0.5	5	25
	1.28	0.116847479	0.5	5.477226	30
	1.28	0.087092969	0.5	7.348469	54
95%	1.96	0.253034912	0.5	3.872983	15
	1.96	0.230988215	0.5	4.242641	18
	1.96	0.196	0.5	5	25
	1.96	0.178922702	0.5	5.477226	30
	1.96	0.133361108	0.5	7.348469	54
99%	2.33	0.300801707	0.5	3.872983	15
	2.33	0.274593133	0.5	4.242641	18
	2.33	0.233	0.5	5	25
	2.33	0.212698926	0.5	5.477226	30
	2.33	0.158536419	0.5	7.348469	54

Sample Size Comparison to Determine Margin of Error

In order to establish an appropriate sample size that is within time, budgetary, and resource constraints, either the Confidence Level or the Margin of Error must be adjusted (Hill & Lewicki, 2006). In this case, the researcher has determined that a 95% Confidence Level is an appropriate level for the study. Therefore, the researcher must accept a high Margin of Error in order to accommodate the relatively high Confidence Level and lower N.

As highlighted above, the researcher has selected a 95% Confidence Level, a 13.3% Margin of Error, and a Sample Size of 54.

Appendix I


Trust and Trustworthiness: A Framework for the Successful Design of Telemedicine
Study Flow Chart
Eligible Subjects N=54
Is the subject a clinician?
No
Yes
Patient Group N=18
All Patient-to-Clinician subjects interact with simulator @ 100% of Trust Dynamics
Patient Group Randomized to Upper, Median, and Lower Quartiles
6
Patient-to-Clinician Group Upper Quartile (75%) of Trust Dynamics N=6
Patient-to-Clinician Group Median Quartile (50%) of Trust Dynamics N=6
Patient-to-Clinician Group Lower Quartile (25%) of Trust Dynamics N=6
Clinician Group Stratified into Interaction Categories N=36
18
Clinician-to-Patient Group N=18
Clinician-to-Clinician Group N=18
Clinician subjects in both stratified groups interact with simulator @ 100% of Trust Dynamics
Randomized to Upper, Median, and Lower Quartiles
Clinician-to-Patient Group Upper Quartile (75%) of Trust Dynamics N=6
Clinician-to-Patient Group Median Quartile (50%) of Trust Dynamics N=6
Clinician-to-Patient Group Lower Quartile (25%) of Trust Dynamics N=6
Randomized to Upper, Median, and Lower Quartiles
Clinician-to-Clinician Group Upper Quartile (75%) of Trust Dynamics N=6
Clinician-to-Clinician Group Median Quartile (50%) of Trust Dynamics N=6
Clinician-to-Clinician Group Lower Quartile (25%) of Trust Dynamics N=6

Appendix J

AACE/ACE Diabetes Algorithm for Glycemic Control

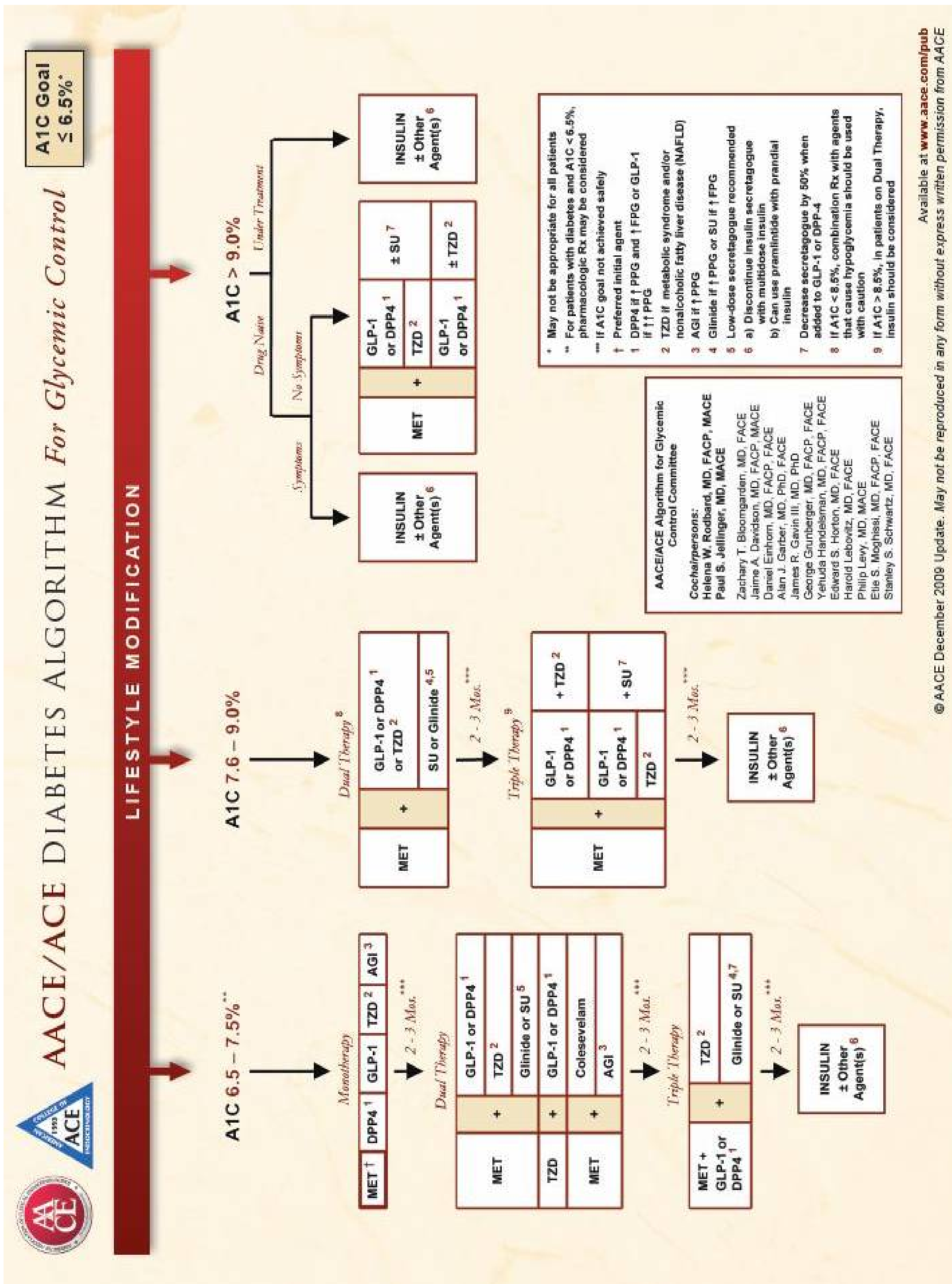


TABLE 1

SUMMARY OF KEY BENEFITS AND RISKS OF MEDICATIONS

Benefits are classified according to major effects on fasting glucose, postprandial glucose, and nonalcoholic fatty liver disease (NAFLD). Eight broad categories of risks are summarized. The intensity of the background shading of the cells reflects relative importance of the benefit or risk.*

	MEDICATIONS*									
	Metformin (MET)	DPP4 Inhibitor	GLP-1 Agonist (Incretin Mimetic)	Sulfonylurea (SU)	Glinide**	Thiazolidinedione (TZD)	Colesevelam	Alpha-glucosidase inhibitor (AGI)	Insulin	Pramlintide
BENEFITS										
Postprandial Glucose (PPG) - lowering	Mild	Moderate	Moderate to Marked	Moderate	Moderate	Mild	Mild	Moderate	Moderate to Marked	Moderate to Marked
Fasting glucose (FPG) - lowering	Moderate	Mild	Mild	Moderate	Mild	Moderate	Mild	Neutral	Moderate to Marked	Mild
Nonalcoholic fatty liver disease (NAFLD)	Mild	Neutral	Mild	Neutral	Neutral	Moderate	Neutral	Neutral	Neutral	Neutral
RISKS										
Hypoglycemia	Neutral	Neutral	Neutral	Moderate	Mild	Neutral	Neutral	Neutral	Moderate to Severe	Neutral
Gastrointestinal Symptoms	Moderate	Neutral	Moderate	Neutral	Neutral	Neutral	Moderate	Moderate	Neutral	Moderate
Risk of use with renal insufficiency	Severe	Reduce Dosage	Moderate	Moderate	Neutral	Mild	Neutral	Neutral	Moderate	Unknown
Contraindicated in Liver Failure or Predisposition to Lactic Acidosis	Severe	Neutral	Neutral	Moderate	Moderate	Moderate	Neutral	Neutral	Neutral	Neutral
Heart failure / Edema	Use with caution in CHF	Neutral	Neutral	Neutral	Neutral	Mild / Moderate Contraindicated in class 3,4 CHF	Neutral	Neutral	Neutral unless with TZD	Neutral
Weight Gain	Benefit	Neutral	Benefit	Mild	Mild	Moderate	Neutral	Neutral	Mild to Moderate	Benefit
Fractures	Neutral	Neutral	Neutral	Neutral	Neutral	Moderate	Neutral	Neutral	Neutral	Neutral
Drug-Drug interactions	Neutral	Neutral	Neutral	Moderate	Moderate	Neutral	Neutral	Neutral	Neutral	Neutral

* *The abbreviations used here correspond to those used on the algorithm (Fig. 1).*

** *The term 'glinide' includes both repaglinide and nateglinide.*

Available at **www.aace.com/pub**

Appendix K

Evidence Based Medicine Model
Reasoning/Justification of treatment:

The following table represents an examination of randomized controlled trials (RCTs) with combination therapy in naïve patients:

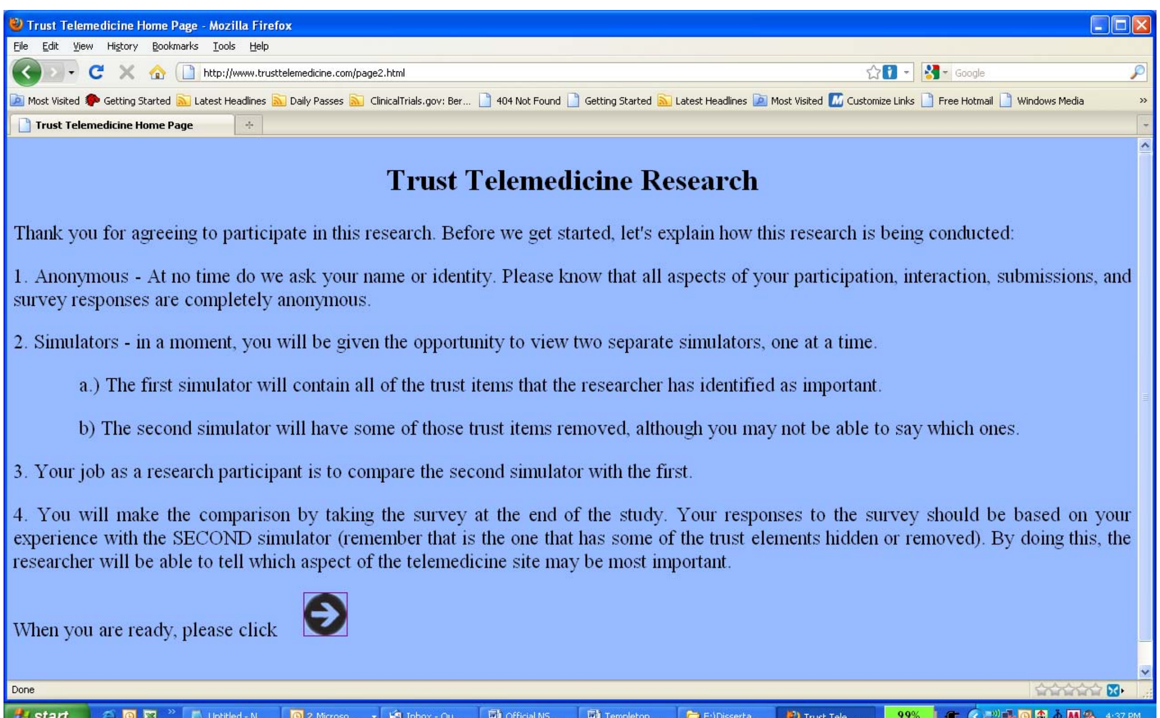
Randomized Controlled Trial - Drug Combination Therapy in Naïve Patients	Total HbA_1C Decreases (%)[a]	
Rosiglitazone + metformin (N = 468, 32 weeks)[15]	Rosiglitazone 8 mg + metformin 2000 mg[d]	2.3[b]
	Rosiglitazone 8 mg[d]	1.6
	Metformin 2000 mg[d]	1.8
Rosiglitazone + glimepiride (N = 901, 28 weeks) [9]	Rosiglitazone 8 mg + glimepiride 4 mg	2.5[b]
	Rosiglitazone 8 mg	1.8
	Glimepiride 4 mg	1.7
Saxagliptin + metformin (N = 1306, 24 weeks)[12]	Saxagliptin 10 mg + metformin	2.5[b]
	Saxagliptin 10 mg	1.7
	Metformin 2000 mg	2.0
Vildagliptin + metformin (N = 1179, 24 weeks)[8]	Vildagliptin 100 mg + metformin 2000 mg	1.8[b]
	Vildagliptin 100 mg	1.1
	Metformin 2000 mg	1.4
Sitagliptin + metformin (N = 885, 54 weeks)[16]	Sitagliptin 100 mg + metformin 2000 mg	1.9
	Sitagliptin 100 mg	1.4
	Metformin 2000 mg	1.6
Sitagliptin + metformin (N = 1091, 24 weeks)[11]	Sitagliptin 100 mg + metformin 2000 mg	2.1[b]
	Sitagliptin 100 mg	0.8
	Metformin 2000 mg	1.3
Sitagliptin + metformin (N = 1250, 18 weeks)[13]	Sitagliptin 100 mg + metformin 2000 mg	2.4[b]
	Metformin 2000 mg	1.8
Vildagliptin + pioglitazone (N = 607, 24 weeks)[14]	Vildagliptin 100 mg + pioglitazone 30 mg	1.7[c]
	Vildagliptin 100 mg	1.1
	Pioglitazone 30 mg	1.4
Alogliptin + pioglitazone (N = 655, 26 weeks)[10]	Alogliptin 25 mg + pioglitazone 30 mg	1.7[b]
	Alogliptin 25 mg	1.0
	Pioglitazone 30 mg	1.2

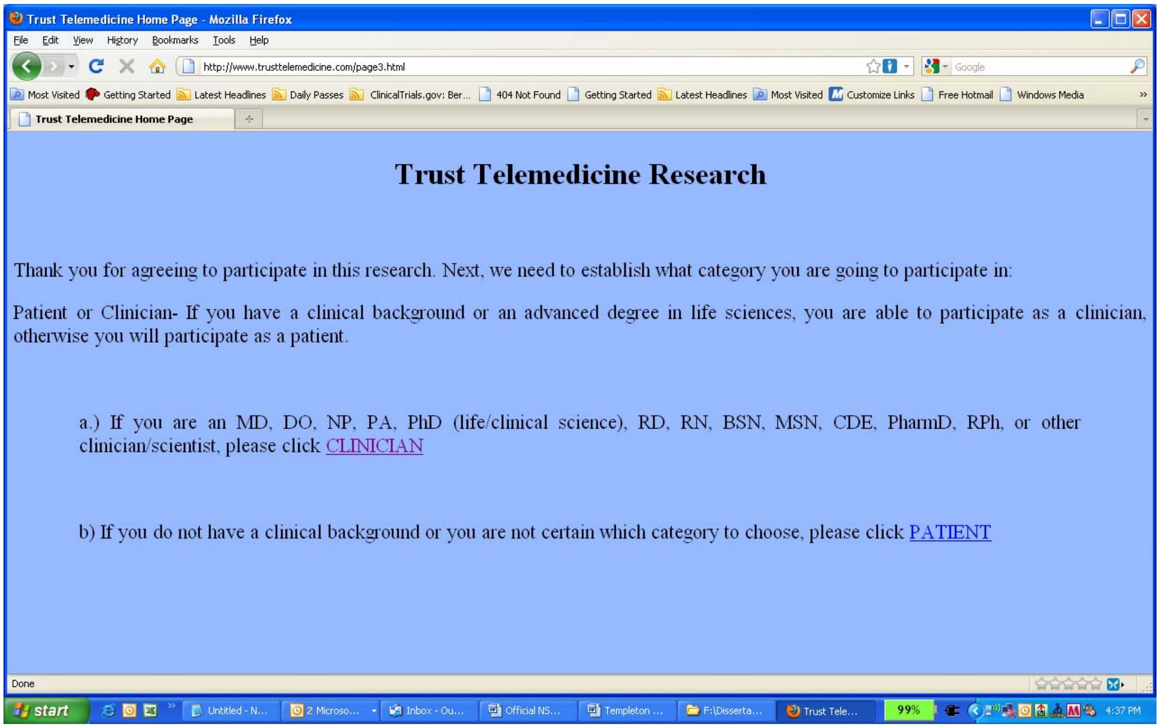
a Therapeutic doses represent maximum daily dose.
b $P < .05$ vs monotherapy.
c $P < .05$ vs pioglitazone.
d Doses may be titrated as follows: metformin [500-2000 mg] and rosiglitazone [2-8 mg].
HbA_1C = Hemoglobin A1c [glycated hemoglobin].

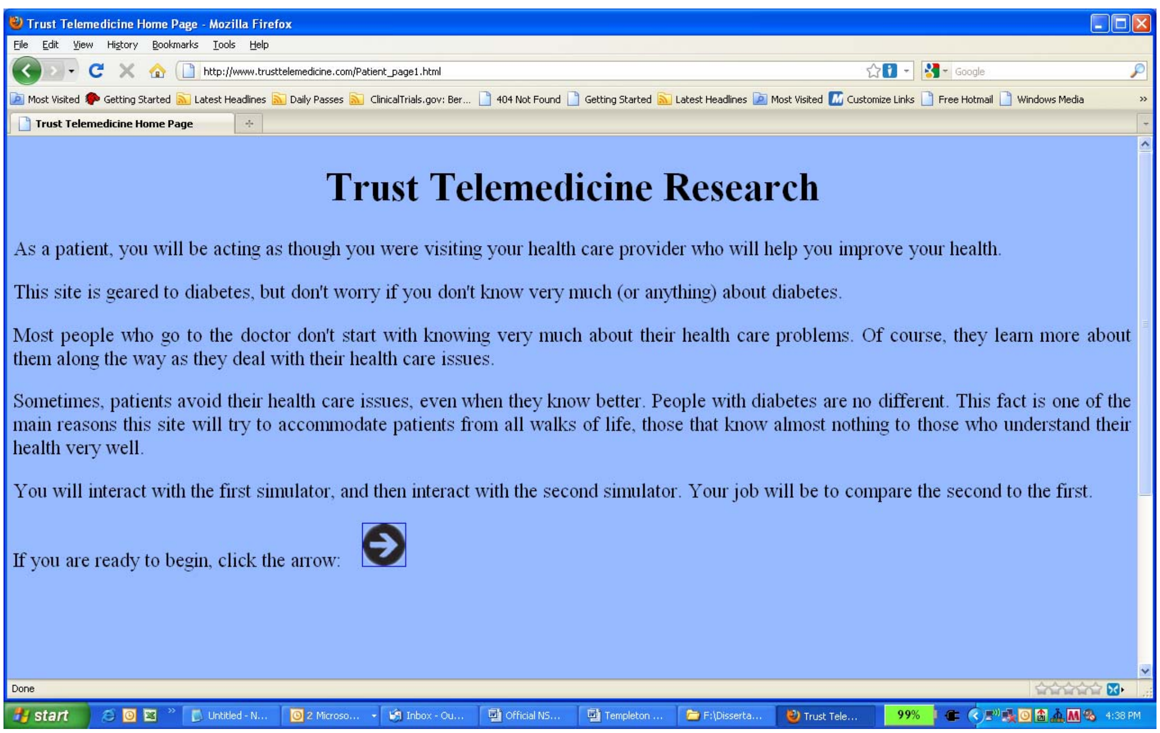
Appendix L

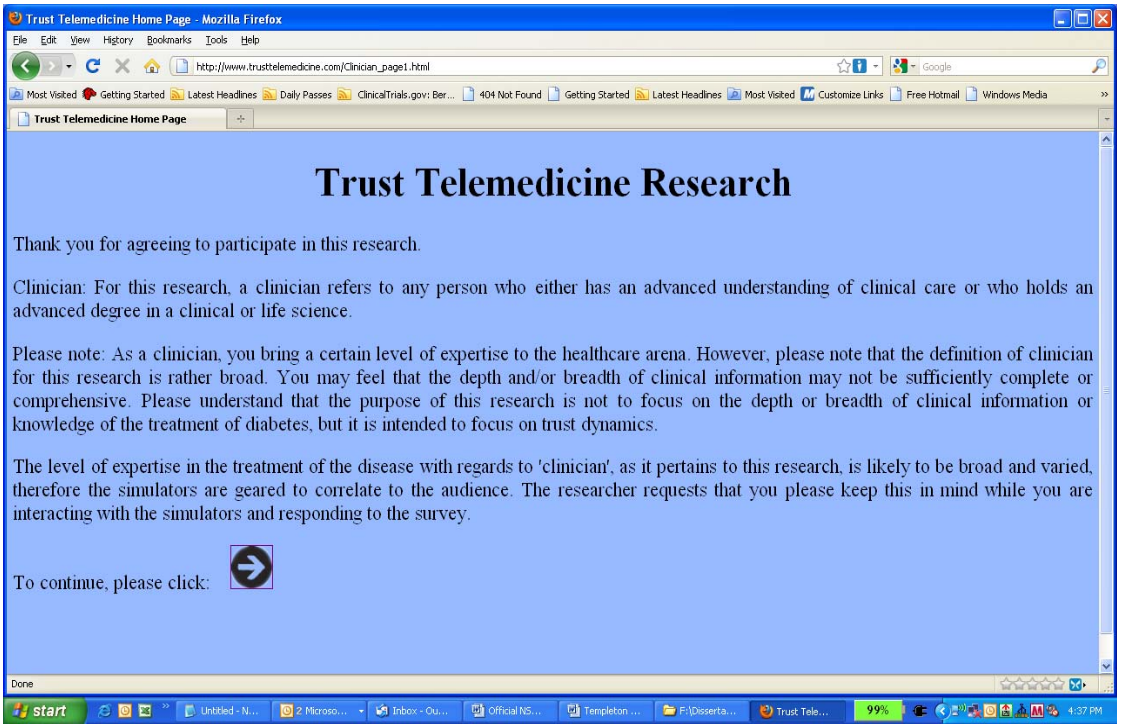
Participant Instructions and Flow of Simulators

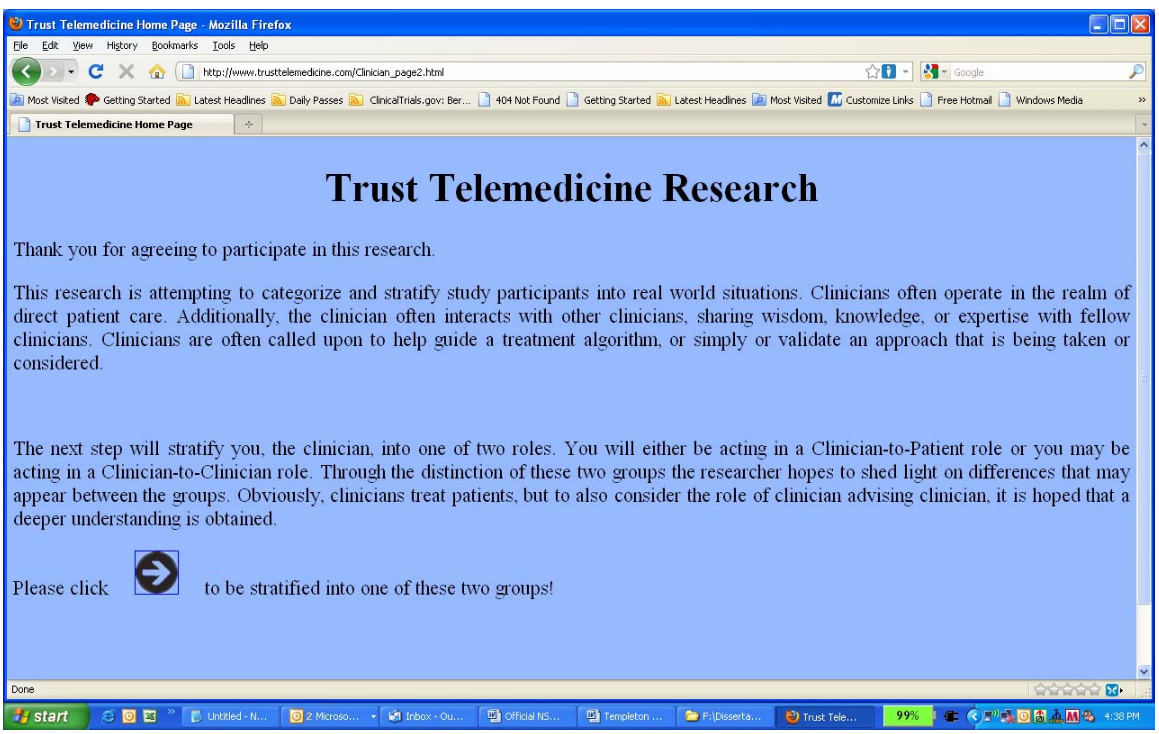
The following screen shots represent the instructions given to participants of the study:




Trust Telemedicine Home Page - Mozilla Firefox
http://www.trusttelemedicine.com/page3.html
Trust Telemedicine Research
Thank you for agreeing to participate in this research. Next, we need to establish what category you are going to participate in:
Patient or Clinician- If you have a clinical background or an advanced degree in life sciences, you are able to participate as a clinician, otherwise you will participate as a patient.
a.) If you are an MD, DO, NP, PA, PhD (life/clinical science), RD, RN, BSN, MSN, CDE, PharmD, RPh, or other clinician/scientist, please click CLINICIAN
b) If you do not have a clinical background or you are not certain which category to choose, please click PATIENT
Done
start
4:37 PM


Trust Telemedicine Home Page - Mozilla Firefox
http://www.trusttelemedicine.com/Patient_page1.html
Trust Telemedicine Research
As a patient, you will be acting as though you were visiting your health care provider who will help you improve your health.
This site is geared to diabetes, but don't worry if you don't know very much (or anything) about diabetes.
Most people who go to the doctor don't start with knowing very much about their health care problems. Of course, they learn more about them along the way as they deal with their health care issues.
Sometimes, patients avoid their health care issues, even when they know better. People with diabetes are no different. This fact is one of the main reasons this site will try to accommodate patients from all walks of life, those that know almost nothing to those who understand their health very well.
You will interact with the first simulator, and then interact with the second simulator. Your job will be to compare the second to the first.
If you are ready to begin, click the arrow:
Done
start
4:38 PM


Trust Telemedicine Home Page - Mozilla Firefox
http://www.trusttelemedicine.com/Clinician_page1.html
Trust Telemedicine Research
Thank you for agreeing to participate in this research.
Clinician: For this research, a clinician refers to any person who either has an advanced understanding of clinical care or who holds an advanced degree in a clinical or life science.
Please note: As a clinician, you bring a certain level of expertise to the healthcare arena. However, please note that the definition of clinician for this research is rather broad. You may feel that the depth and/or breadth of clinical information may not be sufficiently complete or comprehensive. Please understand that the purpose of this research is not to focus on the depth or breadth of clinical information or knowledge of the treatment of diabetes, but it is intended to focus on trust dynamics.
The level of expertise in the treatment of the disease with regards to 'clinician', as it pertains to this research, is likely to be broad and varied, therefore the simulators are geared to correlate to the audience. The researcher requests that you please keep this in mind while you are interacting with the simulators and responding to the survey.
To continue, please click:
Done
start
4:37 PM


Trust Telemedicine Home Page - Mozilla Firefox
http://www.trusttelemedicine.com/Clinician_page2.html
Trust Telemedicine Research
Thank you for agreeing to participate in this research.
This research is attempting to categorize and stratify study participants into real world situations. Clinicians often operate in the realm of direct patient care. Additionally, the clinician often interacts with other clinicians, sharing wisdom, knowledge, or expertise with fellow clinicians. Clinicians are often called upon to help guide a treatment algorithm, or simply or validate an approach that is being taken or considered.
The next step will stratify you, the clinician, into one of two roles. You will either be acting in a Clinician-to-Patient role or you may be acting in a Clinician-to-Clinician role. Through the distinction of these two groups the researcher hopes to shed light on differences that may appear between the groups. Obviously, clinicians treat patients, but to also consider the role of clinician advising clinician, it is hoped that a deeper understanding is obtained.
Please click
to be stratified into one of these two groups!
Done
start
4:38 PM

Appendix M

System Database Design and Layout

MySQL Table: C2C_Random

Server: sql5c40a.carrierzone.com ▸ Database: C2C_Random_jtemplet_site_aplus_net ▸ Table: C2C_Random

C2C_Random

Field	Type	Null	Default
Primary	int(11)	No	
Random	varchar(10)	No	
current	int(11)	No	

Indexes:

Keyname	Type	Cardinality	Field
PRIMARY	PRIMARY	3	Primary

Space usage:

Type	Usage
Data	60 B
Index	2,048 B
Total	2,108 B

Row Statistics:

Statements	Value
Format	dynamic
Rows	3
Row length ø	20
Row size ø	703 B
Creation	Feb 18, 2010 at 04:26 PM
Last update	Mar 23, 2010 at 04:38 PM

MySQL Table: C2P_Random

Server: sql5c40a.carrierzone.com ▸ Database: C2P_Random_jtemplet_site_aplus_net ▸ Table: C2P_Random

C2P_Random

Field	Type	Null	Default
Primary	int(11)	No	
Random	varchar(10)	No	
current	int(11)	No	

Indexes:

Keyname	Type	Cardinality	Field
PRIMARY	PRIMARY	3	Primary

Space usage:

Type	Usage
Data	60 B
Index	2,048 B
Total	2,108 B

Row Statistics:

Statements	Value
Format	dynamic
Rows	3
Row length ø	20
Row size ø	703 B
Creation	Dec 5, 2009 at 04:08 PM
Last update	Mar 23, 2010 at 09:09 AM

MySQL Table: Clinician_Strat

Server: sql5c40a.carrierzone.com ▸ Database: Clinician_Strat_jtemplet_site_aplus_net ▸ Table: Clinician_Strat

Clinician_Strat

Field	Type	Null	Default
Primary	tinyint(1)	No	
Strat	varchar(10)	No	
Current	int(11)	No	

Indexes:

Keyname	Type	Cardinality	Field
PRIMARY	PRIMARY	2	Primary

Space usage:

Type	Usage
Data	40 B
Index	2,048 B
Total	2,088 B

Row Statistics:

Statements	Value
Format	dynamic
Rows	2
Row length ø	20
Row size ø	1,044 B
Creation	Dec 5, 2009 at 02:49 PM
Last update	Mar 23, 2010 at 08:41 PM

MySQL Table: P2C_Random

Server: sql5c40a.carrierzone.com ▸ Database: P2C_Random_jtemplet_site_aplus_net ▸ Table: P2C_Random

P2C_Random

Field	Type	Null	Default
Primary	int(11)	No	
Random	Varchar(10)	No	
current	int(11)	No	

Indexes:

Keyname	Type	Cardinality	Field
PRIMARY	PRIMARY	3	Primary

Space usage:

Type	Usage
Data	60 B
Index	2,048 B
Total	2,108 B

Row Statistics:

Statements	Value
Format	dynamic
Rows	3
Row length ø	20
Row size ø	703 B
Creation	Dec 5, 2009 at 03:30 PM
Last update	Mar 23, 2010 at 10:55 PM

MySQL Table: cardlist5

Server: sql5c40a.carrierzone.com ▸ Database: gcard_jtemplet_site_aplus_net ▸ Table: cardlist5

cardlist5

Field	Type	Null	Default
id	int(3)	No	
code	varchar(20)	No	
status	varchar(10)	No	
Value	int(3)	No	

Indexes:

Keyname	Type	Cardinality	Field
PRIMARY	PRIMARY	54	id
code	UNIQUE	54	code

Space usage:

Type	Usage
Data	2,008 B
Index	6,144 B
Total	8,152 B

Row Statistics:

Statements	Value
Format	dynamic
Rows	54
Row length ø	37
Row size ø	151 B
Next Autoindex	55
Creation	Dec 05, 2009 at 11:44 PM
Last update	Mar 23, 2010 at 04:54 PM

Appendix N

Simulated Telemedicine Layout/Page Properties (Note: Numerous formatting features of HTML page adjusted to fit into document)

Patient Information: Patient J.R. is a 35 year old Hispanic male who is newly diagnosed with Type 2 DM. He is naïve to drug treatment and currently has an A1c = 9.0%. Patient would like to seek treatment options other than insulin.	***Clinical Presentation:*** Patient is a 35 y.o. obese Hispanic male who presents for routine diabetes care follow up. Patient diagnosed with Type 2 Diabetes Mellitus four months prior to visit.	***Social History:*** Patient is married with two children, ages 7 and 9. Patient is acutely aware of diabetes complications, as father had foot amputation at age 45 while patient was a teenager. He is self-employed as an electrician and is concerned about potential loss of income due to manifestations of disease complications. He feels encouraged to manage his Type 2 DM with lifestyle changes and oral medication.
Patient History: Patient diagnosed with Type 2 Diabetes Mellitus four months ago and is returning for follow up visit. Diet and exercise have resulted in modest improvements in weight loss of 8 lbs. Patient is also being treated for dyslipidemia and hypertension. Family history of diabetes.	***Current Medications:*** • Atorvastatin: 10 mg once daily (cholesterol) • Amlodipine: 5 mg once daily (blood pressure)	***Physical Exam and Review of Systems:*** • Overweight Hispanic Male in no acute distress • Height = 66" • Weight = 249 lbs • BMI = 40.2 kg/m^2 • BP = 142/80 (controlled with CCB) • HR = 77 beats per minute and regular • Respiratory rate = 14 breaths per minute and regular • HEENT Exam = Normal • Lung and Abdominal exams unremarkable • Foot exam normal • Patient denies nausea, vomiting, fatigue, melancholy, and syncope

		• Most recent eye exam (1 year ago) revealed no indication of diabetic retinopathy

Lab Values:

- HbA1c = 9.0%
- FPG = 140 mg/dl
- PPG = 240-272 mg/dl
- T-C = 248 mg/dl
- LDL-C = 110 mg/dl
- HDL-C = 34 mg/dl
- TG = 194 mg/dl
- Electrolytes, WBC, urinary albumin, serum creatinine, and BUN are within normal ranges

Three month goal attainment - management:

Despite initial hopes to manage blood glucose, the patient has been unable to adequately manage weight loss and glucose levels. In consulting with the patient, a course of therapy which includes oral agents has been agreed upon along with a more aggressive diet and exercise routine. Patient will be meeting with dietician next week to discuss meal plan and further education.

Goals of treatment:

- minimize risk and severity of hypoglycemia
- minimize risk and magnitude of weight gain
- inclusion of major classes of FDA approved glycemic medications, including incretin-based therapies and thiazolidinediones TZDs
- selection of therapy stratified by hemoglobin A1c and based on documented A1c-lowering potential
- consideration of both fasting and postprandial glucose levels as end points
- consideration of total cost of therapy to the individual and society at large, including costs related to medications, glucose monitoring requirements, hypoglycemic events, drug-related adverse events, and treatment of diabetes-associated complications
- clinical judgment and experience

Recommendations:

It is recommended that the patient be placed on combination oral therapy. This course may be the most appropriate given the level of glucose control that is necessary. The current A1c is at 9%, pointing to a high probability of adverse outcomes. The optimal level and goal for A1c should be 6.5%, a reduction of 2.5% from current levels.

Monotherapy alone may not help the patient reach this goal. Given the patient preference to avoid insulin, this may be the most appropriate direction.

The recommended combination therapy is:

- Saxagliptin 10 mg + Metformin 2000 mg, once daily, titrated from lower

dose (initial dose: saxagliptin 2.5 mg + metformin 500 mg titrated weekly)

- Increase dose of atorvastatin to provide tighter control of lipids

- Increase dose of amlodipine to provide tighter control of hypertension

Based on randomized clinical trials (RCT), our goal should be to reduce A1c by 2.5% to reach a target of 6.5% or less.

Review of Symptoms (ROS) - Clinician should explore further the following potential symptoms to uncover overt or occult signs of complications:

- Chest pain (CP)
- Dyspnea on Exertion (DOE)
- Shortness of Breath (SOB)
- Urinary and Ophthalmologic issues
- Dietary Review - make sure patient does not attempt radical weight loss diet
- Adverse Event from Medication/Diet - Concomitant medical therapies or diet such as the (i.e. Grapefruit Diet), which could cause issues with metabolism such as CYP3A4 pathway (i.e. complications from statin therapy such as myalgia).
- Liver Function Test (LFT) - to monitor statin
- Family History of Stroke/Ischemia/Infarct - detailed explanation of risk
- Consider Cardiovascular Stress Test to determine baseline risk stratification
- Concomitant medications- especially herbal/over-the-counter medications

It is further recommended that the treating clinician discuss with the patient the potential benefits of tighter control with insulin. Discussion and education from this perspective may help to prepare the patient for the addition of insulin, which is a real possibility in this case.

Markov Chain Monte Carlo Risk Calculation

Low Risk	**Low Risk**	**Borderline Risk**	**Moderate Risk**	**Moderately High Risk**	**High R**

Patient is at HIGH RISK: Primary risk factors include blood sugar (HbA1c) value (9.0%), (SBP) systolic blood pressure (142 mmHg), (T-C) total cholesterol (248 mg/dl), and HDL-C (34 mg/dl). Primary focus should be the lowering of HbA1c to <6.5% and to consider tighter control for blood pressure and lipid management.

Markov Chain Monte Carlo (MCMC) Risk Calculations attempt to predict the probability of a future events based on current states. Results shown are the estimated risk of having a heart attack, stroke, or negative outcome within 10 years. This result is NOT a prediction but rather a calculated estimate of the future risk. It is based upon the large scale studies called United Kingdom Prospective Diabetes Study (UKPDS) as well as the Framingham Heart Study. The primary weighting is placed on blood sugar (HbA1c), blood pressure, total cholesterol, and HDL-C. Risk calculation predictive values increase in accuracy with a greater number of measured and validated data points included in the calculation. These results may be skewed by the limited quantity or quality of information available.

Reasoning/Justification of treatment:

The following table represents an examination of RCTs with combination therapy in naïve patients:

Randomized Controlled Trial - ıg Combination Therapy in Naïve Patients	**Total HbA1c Decreases (%)[a]**
Rosiglitazone + metformin (N = 468, 32 weeks)[15]	Rosiglitazone 8 mg + metformin 2000 mg[d]
	Rosiglitazone 8 mg[d]
	Metformin 2000 mg[d]
Rosiglitazone + glimepiride (N = 901, 28 weeks) [9]	Rosiglitazone 8 mg + glimepiride 4 mg
	Rosiglitazone 8 mg
	Glimepiride 4 mg
Saxagliptin + metformin (N = 1306, 24 weeks)[12]	Saxagliptin 10 mg + metformin
	Saxagliptin 10 mg
	Metformin 2000 mg
Vildagliptin + metformin (N = 1179, 24 weeks)[8]	Vildagliptin 100 mg + metformin 2000 mg
	Vildagliptin 100 mg
	Metformin 2000 mg
Sitagliptin + metformin (N = 885, 54 weeks)[16]	Sitagliptin 100 mg + metformin 2000 mg
	Sitagliptin 100 mg
	Metformin 2000 mg
Sitagliptin + metformin (N = 1091, 24 weeks)[11]	Sitagliptin 100 mg + metformin 2000 mg
	Sitagliptin 100 mg
	Metformin 2000 mg
Sitagliptin + metformin (N = 1250, 18 weeks)[13]	Sitagliptin 100 mg + metformin 2000 mg
	Metformin 2000 mg
Vildagliptin + pioglitazone (N = 607, 24 weeks)[14]	Vildagliptin 100 mg + pioglitazone 30 mg
	Vildagliptin 100 mg
	Pioglitazone 30 mg
Alogliptin + pioglitazone (N = 655, 26 weeks)[10]	Alogliptin 25 mg + pioglitazone 30 mg
	Alogliptin 25 mg
	Pioglitazone 30 mg

erapeutic doses represent maximum daily dose.
< .05 vs monotherapy.
< .05 vs pioglitazone.
ɪses may be titrated as follows: metformin [500mg - 2000 mg] and rosiglitazone [2 mg - 8
= Hemoglobin A1c [glycated hemoglobin].

References:

1. American Association of Clinical Endocrinologists (AACE) Diabetes Mellitus Clinical Practice Guidelines Task Force. American Association of Clinical Endocrinologists medical guidelines for clinical practice for the management of diabetes mellitus. *Endocrine Pract*. 2007;13(suppl 1):3-68.
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monotherapy: a randomized controlled trial. *Diabetes Obes Metab*. 2009;11(6):611-22.
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Patient Progress and Update:

You were diagnosed with diabetes 4 months ago. As your clinician, I will work closely with you to help manage this disease. With the right combination of education, diet, exercise, medication, awareness, and action, you can live a full and productive life, free from many of the complications that diabetes can produce.

Patient Awareness and Action:

The initial point of being diagnosed with diabetes can be overwhelming and stressful. But don't give up. Diabetes is a disease that can be managed and dealt with, but it is important that you play an active role in managing your diabetes. Education is key and so is following the directions of your clinical team. We are always here to help you understand and manage your diabetes, but without you we can't help.

Patient Education:

As a patient with diabetes, it is important that you understand what the disease is and what it does to you. First off, know that you are not alone. According to the American Diabetes Association, millions of Americans have been diagnosed with diabetes and even more don't even know that they are at high risk for diabetes.

Certain groups of people have a higher risk for developing Type 2 diabetes: African Americans, Latinos, Native Americans, Asian Americans, Native Hawaiians and other Pacific Islanders, as well as the elderly.

What is diabetes and why did I get it? This is a common question. There are several different forms of diabetes, however the most common form, and the form that you were diagnosed with, is called Type 2 diabetes. Type 2 diabetics have one of two problems, both having to do with a hormone called insulin. Either your body does not produce enough insulin or the cells in your body reject the insulin. Some people even have both problems.

What is insulin? Insulin is a hormone that is found in your body. Whenever you eat food, your body breaks down the starches and sugars into glucose. Glucose is also called blood sugar and it is the fuel that your body needs to supply energy to all of the different parts, like your cells. However, the doors to your cells are locked and glucose can't get in by itself. That is where insulin comes in; it acts as the key to open the cell and allows the glucose to come in and provide energy to the cell. Without insulin, the glucose would not be able to enter the cell; it would simply build up in the blood causing your blood sugar, or glucose, to rise. This is where the dangers of diabetes complications come in. Your cells are not getting the nutrients and fuel that are necessary, and over time the cells become damaged by this lack of energy.

Various parts of your body are at more risk from the damage over time from diabetes. This includes your eyes, heart, kidneys, feet, skin, blood pressure, and even your mental health. These areas suffer because, over time, diabetes starves these regions of much needed fuel and energy, causing them to break down and creating serious problems for the diabetic patient. Heart disease and stroke are the leading causes of death to diabetics. These complications can be managed and delayed if you take the time to learn how to alter your lifestyle to and improve your health.

Lab Values and what they mean:

- **HbA1c = 9.0%**
    - Glycosated hemoglobin or A1C (A1C is the standard name). This test gives a long term (say 3 month) idea of how well you are controlling your blood sugar. As a diabetic, your goal is 6.5%, or as close to it as possible. Your value is too high so we need to reduce it. This will be done by a combination of therapies, including diet, exercise, oral medication, or insulin.
- **FPG = 140 mg/dl**
    - Fasting Plasma Glucose is a test to measure how much glucose (sugar) is present in the blood. The test is normally given in the morning when you have not eaten in 8 hours. Normal ranges for blood sugar would be less than 100 mg/dl, levels above 126 mg/dl usually indicate diabetes. Yours is at 140 mg/dl, which is a key indicator that you suffer from diabetes. This test was taken at your last doctor's visit. You may have heard this test referred to as a Fasting Blood Sugar.
- **PPG = 240-272 mg/dl**
    - Postprandial Plasma Glucose is another test that measures the amount of glucose (sugar) in your blood, but this time it is taken within two hours of eating a meal. Normal values are less than 140 mg/dl. Your values are between 240-272 mg/dl and are considered HIGH.
- **T-C = 248 mg/dl**
    - Total Cholesterol is the total amount of cholesterol in the blood. Cholesterol is called a lipid, or fat, and is important to watch because too much cholesterol in your blood means that your arteries may become blocked. Your level of 248 mg/dl is considered HIGH RISK. When you add diabetes to the list, it becomes even more important to manage your cholesterol levels. Our goal is that diet and exercise will lower this value below 200 mg/dl. If not, we may need to add to your medications to help.
- **LDL-C = 110 mg/dl**
    - Low Density Lipoprotein - Cholesterol is part of the total cholesterol value above and is often referred to as "BAD" cholesterol. Anything less than 100 mg/dl is considered optimal; your value of 110 mg/dl is NEAR-OPTIMAL. This value is actually quite good.
- **HDL-C = 34 mg/dl**
    - High Density Lipoprotein - Cholesterol is also part of the total cholesterol value above and is often referred to as the "GOOD" cholesterol. HDL seems to have a protective property that helps to keep things in check. Unlike the other values associated with cholesterol, we want this value to be higher. Any value over 40 mg/dl is considered good in men, while a value over 50 mg/dl in women is better. A value of 60 mg/dl has shown to give protection against heart disease. We need to work on improving this value. Your dietician will help you to develop a healthy diet which may help in this area.

- **TG = 194 mg/dl**
  - Triglycerides are another area of the total cholesterol value above. Triglycerides are another form of fat and often go along with a higher total cholesterol value when they are elevated. Your value of 194 mg/dl is considered HIGH. The normal range is less than 150 mg/dl. Triglycerides are easily influenced by lifestyle changes. I encourage you to watch your diet and eat healthy foods in order to improve these numbers. If diet and exercise alone cannot reduce your cholesterol levels, including your triglyceride levels, we may have to add some medication to help.

Three month goal attainment - management:

Despite initial hopes to manage blood glucose levels by diet and exercise, your glucose levels are still dangerously high. We need to start a course of therapy which includes oral agents, so that we can control your HbA1c levels, as well as a more aggressive diet and exercise routine. Meeting with your dietician next week to discuss meal plans and further education should also help get you started.

Goals of treatment:

- Minimize risk and severity of hypoglycemia: We don't want your blood sugar (glucose) to drop too low, as this can cause major health problems.
- Minimize risk and magnitude of weight gain: Managing your weight is tough, and certain diabetes medications make it even more difficult to manage your weight. So we need to keep on eye on which treatment options we utilize.
- Inclusion of major classes of FDA approved glycemic medication: We only want to use safe, proven therapies that work and are approved by the FDA to be used for diabetes.
- Selection of therapy stratified by hemoglobin A1c and based on documented A1c-lowering potential: We want to focus on the long term effects, not just the short term effects.
- Consideration of both fasting and postprandial glucose levels as end points: We want to examine the effects of your diabetes both after you eat (postprandial) as well when you have been fasting as they are all important.
- Consideration of total cost of therapy to the individual and society at large, including costs related to medications, glucose monitoring requirements, hypoglycemic events, drug-related adverse events, and treatment of diabetes-associated complications: We want to select treatments that not only work, but are affordable and attainable to you. Without that you are unlikely to be successful with your treatment.
- Clinical judgment and experience: We want to rely on the knowledge and expertise of your clinical team which includes your doctor, nurse, diabetes educator, dietician, and others who advocate for your health.

Recommendations:

First, let's schedule time for you to meet with your dietician to plan out a meal and exercise routine. You will need to also visit the eye doctor to get an exam.

Education is key to dealing with diabetes. We will use this system combined with face to face meetings to help you better manage your diabetes.

I also recommend that you begin taking a combination of oral medication. My recommendations for you are based on two main factors: your elevated A1C levels of 9.0% and your elevated PPG (blood glucose levels after eating). Diet and exercise are unlikely to lower your levels to an appropriate level. This course may be the most appropriate given the level of glucose control that is necessary. Your current A1c is at 9% and we need to do something to reduce it to goal. The optimal level and goal for A1c should be 6.5% which is a reduction of 2.5% from your current levels.

We will start with oral medication to see if that can work, if not we may need to include insulin into your therapy. We will determine that as we continue to monitor and treat your diabetes.

The recommended combination therapy is:

- Saxagliptin 10 mg + Metformin 2000 mg, once daily (diabetes medication)

- Atorvastatin 10 mg, once daily (cholesterol medication)

- Amlodipine 10 mg, once daily (blood pressure medication)

We will start with lower doses and work our way up to avoid side effects and to also determine how well it is working. You may not need that much medicine, so we will take our time and slowly increase the dosage to the maximum above.

We may also need to consider including insulin into your therapy. During our next discussion, we will begin to educate you on some of the other choices.

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