Application and Evaluation of Teledermatology In An Underserved Area of Honduras

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(ABSTRACT)

Since the 1800's, technological advances have extended the foundation on which telemedicine could build. With its evolution, telemedicine has proven to be a means of offering effective health care interventions, from a multitude of disciplines. Teledermatology, a specialty application of telemedicine, offers great potential in improving the standard of dermatologic care by bridging the gap between the expert opinion of dermatologists and those without access to basic dermatologic care, particularly in developing nations, where skin disease continues to be a major public health problem. In Honduras, the setting for this study, and other developing nations, technology to support telemedicine is available.

Dermatologic disease is among the most common disease presentations in the developing world, which left untreated due to a lack of access to adequate medical care, can progress causing increased morbidity or even death. A potential but untested solution is teledermatology. Teledermatology offers great potential in improving the standard of dermatologic care by bridging the gap between the expert opinion of dermatologists and those without access to basic dermatologic care.

The purpose of this study was to evaluate the prevalence and types of dermatologic conditions and the feasibility of a store-and-forward teledermatology system in an underserved area of Honduras, so as to potentially provide more timely diagnosis and treatment, implementation of preventative measures, and offer long term solutions.

The justification and significance of this study was the potential of store-and-forward teledermatology to improve the standard of dermatologic care by improving access of populations in underserved areas to dermatology specialists through affordable technology.

The methodology of this study was primarily case study descriptive. This study was conducted at a public primary care clinic (JMA Clinic) and satellite sites in underserved areas of Francisco Morazán, Honduras. During a four week period in Spring 2011, patients with dermatologic conditions were examined and photos taken of condition. The patient information was sent to 3 U.S. board certified dermatologists, who provided diagnosis and treatment within 24 hours, which allowed the clinic physician sufficient time to review recommendations before patient follow-up. Patients would receive follow-up within 48 hours of initial visit. Diagnostic agreement, image quality, and user satisfaction were evaluated. IRB forms were submitted and clearance given. The data was analyzed with SPSS using descriptive statistics.

The primary findings were the types of dermatologic conditions, interobserver agreement, image quality, and patient and physician satisfaction. The findings of this study substantiate the need for dermatologic care, as approximately 1 out of every 5 patients of the JMA Clinic presented with a dermatologic condition. The majority of these patients were children or women in their late 20s and early 30s; many of whom had their condition for more than a year and most had not received prior therapy. The types of dermatologic conditions observed were typical of that seen at a dermatology clinic in the U.S., yet inclusive of tropical and regional differences. Dermatitis, infectious and pigmentary conditions were the most common presentations. The interobserver diagnostic agreement achieved was 78%, and improved when considering differential diagnoses. Image quality received high ratings. Patients and physicians recorded a high level of overall satisfaction. Physicians indicated improved knowledge of teledermatology.

Because of the unique environment and circumstances, the results are limited to the setting in which the study occurs. This project was a pilot study limited to 4 weeks of data collection and will be limited in significance by duration and sample size with respect to the conclusions that can be drawn about the prevalence and types of dermatologic conditions.

This study illustrates that teledermatology is a viable means of providing dermatologic care to those in an underserved area of Honduras, where a lack of or limited access to general healthcare or specialty dermatologic care exists. The data offers insights to draw conclusions and recommendations on the potential for similar models to be implemented in underserved areas throughout Honduras and other similar regions.

Dedication

I dedicate this work to my wife, Noriko, son, Kai and to our unborn son who will not be here soon enough. Noriko, you have always been by my side and have sacrificed much in my academic and professional pursuits. Much of my accomplishments could not have been possible without your love and support. You have truly been the wind beneath my wings. Thank you for sharing this journey with me. Kai, you are a true blessing. You have brought me great joy and allowed me to love at new levels.

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I also dedicate this work to my family in Japan. 私はこの論文を日本にいる私の家族、パパ さん、ママさんと、絵美 ちゃんに捧げます; 2001 年に紀子さんと結婚し、家族の一員に加えていただいた。私は本当に感謝しています。

パパさんとママさんは、これまで一生懸命仕事し, 子供たちのために自分を犠牲にしてまでもがんばっていらっしゃった。私はこの素晴らしい家族の一員となることに誇りを持っています。

自分は遥か遠いところにいますが、井野口家に名誉をもたらすことにこれからも最善を尽くし、紀子さんや子供たちのためにも忠誠心と名誉の美徳を高く持ち続けてこれからも頑張っていきたいと思います。お二人は私のインスピレーションです。

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Drs. Conte and Hurd, as clinicians and academicians, you have dedicated yourselves to the advancement of dermatologic medicine. Your instruction has allowed me to achieve a better understanding of the complexities often encountered in this specialty. I aspire to the commitment and contributions that you have given. You have mentored and provided me with

support and encouragement, and have put me closer to achieving my academic and professional goals. To you, I am most grateful for this.

Lastly and importantly, I want to thank the wonderful and generous Honduran patients who participated in this study. Without your help, this would not have been possible. Your contributions have set the stage for the standard of dermatologic care in Honduras to improve.

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Chapter 1

Introduction

Telemedicine

Telemedicine can be described as a means by which the delivery of health care services is rendered, using telecommunication systems (ATA, 2010). Typically, it is used in the context of mitigating the barriers to health care access to improve or assist with a patient's health status. Videoconferencing, transmission of still images, remote monitoring of vital signs, continuing medical education, and nursing call centers, are examples of telemedicine. In the simplest case, using a phone or facsimile machine for the transfer of medical information constitutes telemedicine. However, the employment of telemedicine is often far more complex, using broadband technology to send interactive, live video and audio.

Many sources give thoughts on the origin of telemedicine, however, no one seems to really know how it all began and developed. What is known is that telemedicine was not invented as a well-defined discipline. Rather, physicians would use technology as it became available for purposes other than those for which it was developed. For example, during the American Civil War, the military ordered medical supplies and transmitted casualty lists by telegraph, and it seems probable that some uses of the telegraph in its early decades involved medical consultations (Zundel, 1996). Then in the 1950's, the availability of black-and-white televisions greatly enhanced diagnosis by allowing the visualization of the patient's condition rather than just an audio description (Zundel, 1996). Most recently, in the 20th century, technology has allowed for medical information to pass back and forth, from Earth to space in caring for and monitoring the health of astronauts.

Although, telemedicine has evolved over its long history, telemedicine research and development did not accelerate until the late 1980s. Major facilitators for this growth were the transition from analog to digital communications along with the advancement of computers and information technologies such as mobile telephones. Since the early days of modern telemedicine, the U.S. has maintained almost half of the primary research, compared with 40% in Europe and 10% in Asia and Australasia (Wooton, Craig, & Patterson, 2006). Since at least the 1990's, telemedicine has been employed in many clinical specialties. A U.S. survey found that more than 85,000 teleconsultations were done in 2002, performed by more than 30 specialties (Grigsby, 2004). Sixty percent of these teleconsultations were in mental health, pediatrics, dermatology, cardiology and orthopedics (Grigsby, 2004). This does not include teleradiology, which remains the single most used application of telemedicine in the U.S. As telecommunication networks, processing speed, and data storage capacity continue to expand in parallel, so too will the availability and efficiency of telemedicine.

Globally, with the advancement of time, each nation will likely face difficulty with health care delivery to its citizens, particularly those countries that are identified as developing, or third-world. Contributing elements vary from one country to another but include shortages of physicians and specialists, the increasing number of elderly, the increasing cost of medical technology and other factors which drive up the cost of health care. In addressing these challenges, governments can increase taxation and/or find ways to make health care more cost effective. Telemedicine has the potential to reduce costs for insurers (patients seen in a more timely manner and decreased hospital stays), health care providers (reduced overhead) and the patient (reduced travel time and time missed from work). Moreover, in situations where visualization of an ailment is necessary and direct patient contact is not, telemedicine has the

potential to play a central role in improving the delivery of health care, particularly in medical subspecialties such as dermatology, radiology and pathology. In the underserved and remote areas of developing nations, communicable diseases and other maladies claim millions of lives worldwide each year. Telemedicine offers hope by transcending the barriers and providing a means of health care access.

Teledermatology

Teledermatology can be described as the employment of imaging instrumentation and communications technology in the practice of dermatology to facilitate the provision of health care (American Telemedicine Association [ATA], 2010). As previously noted, dermatology is well suited for telemedicine given its visual nature. Over the past decade or two, teledermatology in the U.S. has gained popularity and interest. A 2003 survey by the American Telemedicine Association (ATA) reported 62 active teledermatology programs in 37 U.S. states (ATA U.S. Teledermatology Survey, 2003). The interest and activity of teledermatology is evident in other countries such as the U.K. and Australia. However, when searching PubMed and similar medical databases for 'telemedicine in Honduras' or 'teledermatology in Honduras', no articles were listed. In an email correspondence, Dr. Silvio Vega, President of the Latin America Telemedicine Association, mentioned that he is not aware of any teledermatology work in Honduras and added that there are no proper telemedicine activities in this country (S. Vega, personal communication, January 3, 2011).

Most commonly, the use of teledermatology is aimed at providing care where there is limited or no access to a dermatologist and is not meant to replace the face-to-face evaluation. In the U.S., with the relative shortage of dermatologist especially in the rural and underserved areas, primary care physicians (PCPs) have helped to fill the need for dermatologic care. As the

shortage of dermatologists continue, more and more patients with skin disease will be diagnosed and managed by nondermatologists. Studies have shown that the diagnostic concordance between dermatologists and PCPs is around 57% (Lowell, et al, 2001). Given the circumstances, collaborative efforts between dermatologists and health care providers are necessary in order to address the patient demand, and to provide support and education. The shortage of dermatologists is not unique to the U.S. and poses problems for other countries as well. In an effort to overcome such shortages, the use of teledermatology is one strategy that continues to gain popularity and has been proven effective and cost effective in several domestic and international settings.

There are a few different approaches to teledermatology. The store-and-forward (S&F) approach (asynchronous) involves taking a digital image of the skin condition and then sending the image through a telecommunications system to a dermatologist in a different location for diagnosis. The main benefits to this approach are independence of time and location, as well as affordability, with the major costs being a digital camera, computer and internet access. The disadvantages of S&F teledermatology include no opportunity for rapport between the patient and dermatologist and poor image quality, making diagnosis difficult. The second method is video (real-time) teleconference (VTC) teledermatology, which uses a synchronous video and audio transmission to allow a live, interactive consultation between a patient and a remote dermatologist. The advantages to the VTC approach are the live interaction between the patient and dermatologist. The disadvantages are the difficulty in time coordination of patient and teledermatologist, and the expense associated with the equipment and the higher bandwidth needed. If feasible, the best approach may be to have both methods available and to use them interchangeably when needed.

Honduras

As the second largest country in Central America, the Republic of Honduras covers an area of 112,000 square kilometers, roughly the area of the state of Tennessee. The country is bordered by Guatemala and El Salvador to the west, Nicaragua to the southeast, and possesses access to both the Pacific Ocean and Caribbean Sea. Honduras is comprised of 18 departments or political territories, which are further divided into a total of 298 municipalities.

Figure 1.1: Map of Honduras and Neighboring Region

Honduras has a population of approximately 7.9 million people of which an estimated 48% reside in urban areas (Central Intelligence Agency [CIA], 2010). The official language of Honduras is Spanish, and the predominant religion is Roman Catholicism. The ethnic groups in Honduras are 90% mestizo (mixed Amerindian and European), 7% Amerindian, 2% black and 1% white (CIA, 2010). A 2001 census estimated the literacy rate (defined as those 15 years of

age and older who can read and write) to be 80% (CIA, 2010). The government of Honduras is a democratic constitutional republic.

The Honduran economy relies heavily on a narrow range of exports, notably bananas and coffee, making it vulnerable to natural disasters and shifts in commodity prices. In recent years, however, Honduras has experienced a significant increase in manufacturing, predominantly from U.S.-based companies establishing operations in the country. Economic growth remains dependent on the economy of the U.S., its largest trading partner, and on reduction of the high crime rate, as a means of attracting and maintaining investment. Moreover, it is worth noting that Honduras, with an estimated U.S. dollar per capita income of $4,100, is the second poorest country in Central America (CIA, 2010). Current estimates indicate the unemployment rate of approximately 5% and an underemployment rate of 28%, with 65% of the population living below poverty line (CIA , 2010; Economic Survey of Latin America…, 2008-2009).

The Honduran government spends 7.4% of its GDP on health care for its citizens (World Health Organization [WHO], 2010). Honduran workers outside the public sector and not employed by business or industry are not covered by the government health plan. Health care is also generally inadequate for the poor urban and rural laborers. There are about 6 physicians for every 10,000 persons (World Health Organization [WHO], 2010).

Accounting for 17% of Central America's population, Honduras has one of the region's highest numbers of HIV/AIDS cases. Of the approximate 380,000 people in Central America living with HIV, Honduras and Guatemala account for nearly one-third of the region's total (United States Agency for International Development [USAID], Honduras, 2010). According to 2009 estimates, Honduras is home to 39,000 people living with HIV, with four provinces (Cortés, Francisco Morazán, Atlántida, and Yoro) accounting for 76 percent of

HIV/AIDS cases (USAID, Honduras, 2010; UNAIDS/WHO Epidemiological Fact Sheet, 2004). The prevalence is highest in urban areas, especially in the two largest cities of Tegucigalpa and San Pedro Sula. The group 15-59 years of age comprised 90% of AIDS cases, of which 61% were males (Pan American Health Organization, n.d.). HIV/AIDS is the second leading cause of hospitalization and death in Honduras, after injuries and violence, and has been the leading cause of death among women of childbearing age (WHO, 2005). This epidemic has led to an increased incidence of HIV/AIDS related medical and social problems. Other major infectious diseases include bacterial diarrhea, hepatitis A, typhoid fever, dengue fever, malaria and leptospirosis. Currently, infant mortality in Honduras is about 21 infants per 1,000 live births, and the mortality rate for children under 5 years of age is 31 children per 1,000 live births (CIA, 2010).

As of 2006, 84% of the population (95% in urban, 74% in rural) are using improved drinking water and 66% (78% in urban and 55% in rural) are using improved sanitation facilities (United Nations Children's Fund [UNICEF], 2010). However, water quality tests have shown that only 44% of the water provided is effectively disinfected and that there is a lack of adequate water quality control and monitoring, especially in rural areas (Water For People [WFP], n.d.). Many rural communities have no water infrastructure whatsoever. The limited access to a safe water supply and lack of appropriate wastewater treatment mechanisms, combined with limited access to health care may be a contributing factor for the high incidence of skin infections and other dermatologic conditions throughout Tegucigalpa and much of the country.

Even with the socioeconomic and health disparities considered, Honduras has a thriving and relatively modern national telecommunication network which serves 7.7 million cellular

telephones and 830,000 land-line telephones (CIA, 2010). The number of internet hosts and internet users are 16,075 and 658,500, respectively (CIA, 2010).

Tegucigalpa

Tegucigalpa, the capital of Honduras, is home to an estimated 1.7 million people and is located in the department of Francisco Morazán. In October 1998, Hurricane Mitch destroyed thousands of homes, urban services were severely damaged, and tens of thousands of people were made homeless, further worsening the severe poverty that is endemic in this city. More than a decade later, the hurricane's destruction and effects can still be seen. The Edward Via Virginia College of Osteopathic Medicine (VCOM) operates a year-round clinic in Tegucigalpa in conjunction with the Baxter Institute. Each week, many patients from the surrounding impoverished neighborhoods arrive at the James Moody Adams (JMA) Clinic with a variety of medical and dental conditions. Many of the patients present with bacterial and fungal skin infections, and other skin conditions, the causes of which are often difficult to confirm because of a lack of available testing equipment and specialized training in this area. In just the past few years, the collaborative effort between VCOM and the Baxter Institute has resulted in improvements to the clinic including the addition of basic laboratory equipment, greater numbers and types of pharmaceuticals and the maintenance of the clinic's telecommunications infrastructure. This relationship has allowed U.S. student doctors to get firsthand experience to the health conditions and health delivery in a developing country, as well as increase the standard of care provided to the clinic's patients. The majority of medical, financial, and human resources will continue to be provided by VCOM and the Baxter Institute. In addition, outside philanthropists directly and indirectly provide material and financial support to the clinic on occasion. This unsolicited generosity will contribute greatly to the health of the community and

to the success of research projects based within the clinic. The concerning health statistics, endemic poverty, established telecommunication infrastructure, and limited access to medical care are characteristics that make the JMA Clinic an ideal site to conduct telemedicine-based research.

In regards to the current study, the JMA Clinic was chosen as the project site for several reasons. These include the medically underserved status and impoverished nature of the patient population, a daily census of approximately 30 patients, high incidence of skin problems, telecommunications capability of the clinic, and stable and cooperative efforts of the clinic staff, physician and the Ministry of Health.

Problem Statement

There is a current dearth of epidemiological data available documenting the cause and exact prevalence of skin infections at the regional and national level within Honduras. Patients present to the JMA Clinic with skin conditions often of unknown etiology, and could profit from access to a specialist for diagnosis and treatment. Unfortunately, there are too few specialists in Honduras to provide sufficient access.

Skin conditions are among the most common disease presentations in the developing world. For many Hondurans life can be exceptionally difficult on several levels. To those exposed to AIDS, malaria, dengue and other life-threatening diseases, a skin condition may not seem important. It is even more likely to go untreated in the circumstances that require a patient to travel to a clinic for medical treatment, meanwhile incurring loss of income from missed work and transportation costs. These and other barriers to access contribute to the delayed diagnosis and treatment of skin disease.

Purpose

The purpose of this study was to determine the types and prevalence of dermatologic conditions at the JMA Clinic and satellite sites located in underserved areas of Honduras. Understanding which skin disease types are most common will aid in the development of treatment protocols that may not be available. The study also examined the viability of store-and-forward (S&F) teledermatology with respect to diagnostic concordance, image quality, and patient and teledermatologists satisfaction on various aspects of this health care modality. Given the outcomes of the current study, it may serve as a model that could be adapted in other settings throughout Honduras further bridging the gap between medical specialist and those without access. These factors were evaluated in order to develop strategies for long term sustainable use of teledermatology.

Research Objectives

For patients presenting at the JMA Clinic in Tegucigalpa, Honduras, the research objectives were to determine:

1. Skin disease prevalence and type within the JMA Clinic and satellite sites
2. Interobserver diagnostic agreement
3. Technical and procedural image quality for transnational image transmission
4. Patients' satisfaction of store-and-forward teledermatology
5. Teledermatologists' level of knowledge and satisfaction of store-and-forward teledermatology

Limitations

Although a teledermatology project would be feasible in other underserved areas of the globe, because of the unique environment and circumstances in which the patients live, the results are limited to the indigent patient population of the JMA Clinic and satellite sites. This project was a

pilot study limited to 4 weeks of data collection and may be limited in significance by its duration. While no power or communication outages were expected, availability of such utilities critical to this study may not have remained consistent. The operating budget of the target clinic was far less than a U.S. clinic of comparable size and therefore the laboratory supplies necessary for certain tests may not have remained consistently available throughout the duration of the project. While written and oral consent were necessary before patient participation, it was unknown how interested or understanding patients would be of the research project, thus the number of participants may have been less than anticipated. While Spanish-English translators were available within the clinic, communication breakdowns between the researcher and patient were possible. Due to regular clinical responsibilities, the ability of volunteer dermatologist to provide consistent and timely telediagnosis my not have remained constant for the entirety of the project. While strict research protocols were followed, the internal validity of the study may have been compromised due to unforeseen influences on the participants from the instrumentation and/or researcher. The safety and health of the patient were paramount throughout the project. Therefore, in order to expedite the diagnosis and treatment of certain patients, urgent medical conditions took precedence over research.

Significance of Study

This study was designed to improve the standard of patient care at the JMA Clinic, as well as, to improve the efficiency of health care through increased diagnoses, decreased time to diagnoses, and increased continuity of care. The numerous patients with dermatologic conditions of various etiologies coupled with the importance of a timely diagnosis and intervention, demonstrated the utility of teledermatology at the JMA Clinic. Furthermore, this study contributed to the body of knowledge on telemedicine and dermatology in Honduras. The

results of this study have implications for the practice of medicine within Honduras and similar settings throughout Central America and the rest of the developing world. The further development of teledermatology within this setting is important given its potential to improve the efficiency of health care through increased diagnoses, decreased time to diagnoses, and increased continuity of care. This study focused primarily on S&F teledermatology feasibility and skin dermatologic disease prevalence at the JMA Clinic and satellite sites. From this pilot study, long-term use of teledermatology could be implemented at the national scale and patients triaged according to specific protocols, allowing skin disease to be treated appropriately and early.

Definition of Terms

Analog: A means of transmitting data as an electrical replication of the original signal. The signal is represented by a continuous waveform that varies in direct proportion to variation in the original signal.

Artifact: In digital imagery or video, an unwanted by-product of the image creation, compression, or transmission process. Especially with lossy compression techniques, errors can inadvertently appear in the compressed image that is perceptible to the viewer.

Asynchronous Communication: A mode of communication where the transfer takes place over a period of time, or in separate time frames, not requiring the transmission to take place simultaneously. Examples include e-mail or store-and-forward telemedicine.

Bandwidth: A measure of the information-carrying capacity of a communications channel. The higher the bandwidth, the greater the amount of data that can be transmitted in a given time period. Bandwidth is usually measured in Kilobits (Kbps – thousands of bits) or Megabits (Mbps – millions of bits) per second.

Bits Per Second (Bps): A measure of transmission rate. Bps, also called "bit rate," is concerned with the rate of data transmission.

Broadband: A telecommunications medium capable of transmitting multiple data signals simultaneously. The term broadband is also used to describe media that transmit data at a high rate, generally comparable to T1 or better, and occasionally as a synonym for DSL. Television, microwave, and satellite telecommunications are examples of broadband media.

Compression: This term refers to the mathematical means used to reduce bandwidth requirements for digital signals, enabling richer video and audio at a more manageable file size. A number of standards for both video and still picture data (e.g. MPEG, JPEG, and GIF) are in common use. Compression techniques are either "lossy" or "lossless."

Digital: Data that has been encoded into a discrete series of binary digits ("bits"), as opposed to the continuous variable waveforms of analog signals.

Digital Camera: A digital camera is typically used to take still images of a patient. General telemedicine uses for this type of camera include dermatology and wound care.

This camera produces direct capture images that can be transmitted to a provider/consultant over a network without scanning or conversion.

Digital Subscriber Line (DSL): A dedicated broadband technology that connects most homes and businesses today through the public telephone system to provide connectivity at relatively high speeds. DSL accomplishes this by dividing the existing telephone frequencies so that voice and data may be carried simultaneously without interference.

Encryption: Encoding of information to protect it from unauthorized access. Encryption is one facet of electronic communications security, and is often used along with digital signatures and similar techniques to verify the integrity and authenticity of the communication. Common

electronic encryption techniques include Public Key Infrastructure (PKI) for messaging and Secure Socket Layer (SSL) for transactions over the World Wide Web.

Hypertext Transfer Protocol Secure (HTTPS): a combination of the Hypertext Transfer Protocol with the SSL/TLS protocol to provide encrypted communication and secure identification of a network web server. HTTPS connections are often used for payment transactions on the World Wide Web and for sensitive transactions in corporate information systems.

Integrated Service Digital Network (ISDN): A dial-up digital connectivity medium used commonly for videoconferencing. ISDN can transmit voice, data, and video simultaneously over a connection.

Joint Photographic Experts Group (JPEG): A series of image compression formats made popular by their small file size and suitability for digital photography. JPEG images are typically *lossy* when compressed, depending on the algorithm employed by the device or selected when creating the file.

Lossy: A technique for data compression that achieves a relatively high level of file size reduction by removing elements of the original deemed to be unnecessary or imperceptible to the intended viewer. Lossy compression is most commonly used when processing audio, still image, or video data to produce an acceptable quality presentation while minimizing bandwidth requirements.

Megapixel: A measurement of the potential resolution of a digital camera, in millions of pixels. The megapixel rating of a given digital camera can give the user a general idea of the maximum effective print size and image resolution that it is capable of.

Modulator-Demodulator (Modem): A device that converts digital signals to analog tones, and vice versa, to enable data transmission over telephone lines. Commonly referred to as “dial-up,”

modem connectivity is limited in theory to the 64 Kbps rate used for voice telephony, though effectively, a modem connection is limited to 56 Kbps or less due to overhead and latency.

Pixel (Picture Element): The smallest unit of a video display, used as a measure of resolution for video formats.

Real Time: In telemedicine terms, conducting an encounter or consultation where both parties are available and interacting simultaneously. Real time telemedicine is generally conducted via full motion videoconferencing.

Resolution: The level of detail a given device is capable of displaying, generally measured in pixels, dots per inch, color depth, or similar criteria.

Secure Socket Layers (SSL): Functions by using a private key to encrypt data that is being transmitted over the Internet.

Store-and-Forward: A telemedicine encounter or consult that relies on the asynchronous transfer of still digital images of a patient, or clinical data from one site to another for the purpose of rendering a medical opinion or diagnosis.

Synchronous Communication: A mode of communication where the transfer takes place simultaneously. Examples include real time videoconferencing or standard telephony. T1/T3 high speed telecommunications lines support digital voice and data communication. The T1 has a transmission rate of 1.544 Mbps and the T3 line operates at 44.736 Mbps.

Telecommunications: Transmission and reception of voice, video, or other data over a distance. A telecommunications system has several components that include a transmitter, a transmission medium, and generally a specific channel. Telecommunications can be point-to-point (between two participants), multipoint (between three or more participants), or broadcast (one way transmission from a sender to multiple receivers).

Teleconsultation: Consultation between a provider and a specialist at a distant location, utilizing either store-and-forward telemedicine or real time videoconferencing.

Teledermatology: Dermatologist use of telemedicine to provide dermatological care at a distance.

Telemedicine: The use of telecommunications and information technologies for the provision of health care at a distance. The two most common models of telemedicine are videoteleconferencing (real time) and store-and-forward methodologies.

Videoteleconferencing (VTC): Two-way transmission of digitized video images occurring in real time between users at two or more locations.

Chapter 2

Review of Literature

Telemedicine

Telemedicine, as defined by the American Telemedicine Association (ATA) (2010), is the use of medical information exchanged from one site to another via electronic communications to improve the health status of a patient. Although there are many definitions given for telemedicine, perhaps the most encompassing describes telemedicine as a modality reliant on telecommunication networks for the delivery of health care across a distance to mitigate issues of maldistribution of health care resources (Sood, et al., 2007). This definition includes the key elements of telemedicine: the use of technology, supplying medical care, the provision of benefits, occurring over a distance.

Although telemedicine is not new, its employment has not always been consistent due to issues in funding and waning interests. The science and medical literature provide several examples of the early use of telemedicine. In 1948, radiologic image transmission by telephone line occurred between two counties in Pennsylvania (Zundel, 1996). In 1964, the first interactive video link was established in Nebraska between a psychiatric institute and a hospital located 112 miles away (Whittson & Benschoter, 1972). Radio transmission of electrocardiograms occurred over a distance of 4,700 miles in 1967 (Hirschman, Baker &Schiff, 1967). Telemedicine relied on and was limited by the available technology. As technology evolved so did telemedicine. With the introduction of television and subsequent developments in closed-circuit television and video telecommunications, medical personnel began to use television in clinical settings. In 1967, the first complete telemedicine system allowing physician-patient encounters was installed, linking Massachusetts General Hospital to the medical station at Boston's Logan Airport (Dwyer,

1973). In the 1970s, an early telemedicine project involving NASA, the Papago Tribe, the Lockheed Missile and Space Company, the Indian Health Service and the Department of Health, Education and Welfare, explored the possibilities of using technology to provide improved health care to a remote population in southern Arizona (Freiburger, Holcomb & Piper, 2007). This project, called STARPAHC (Space Technology Applied to Rural Papago Advanced Health Care), tested satellite-based communications to provide medical services to astronauts and to residents of an isolated reservation. The project demonstrated the feasibility of a consortium of public and private partners working together to provide medical care to remote populations via telecommunication. Developments in the manned space-flight program and the pioneering efforts of a few physicians using off-the-shelf commercial equipment have contributed to modern telemedicine (Zundel, 1996). The U.S. military has also played a key role in the development of advanced technology for management of remote patient populations primarily stemming from the necessity to rapidly manage battlefield casualties (Calcagni et al., 1996; Reed, Burr & Melcer, 2004). Internationally, there are also many instances where technology has been used over a distance to provide health care services, which include Moscow providing a telemedicine service to Azerbaijan (Samedov, 1998) and the British Armed Forces providing a telemedicine service in Bosnia. (Ritchie, 1998).

Recent years have shown a continual growth in the use of telemedicine as health and information technology advances and becomes more affordable, and as telemedicine becomes more clinically acceptable for both patients and doctors (Wootton & Darkins, 1997). Telemedicine has a variety of applications that include medical education, research, and patient care. The various health care focused applications of teledermatology include rural or underserved health care, links between PCPs and specialists in academic medical centers, and

military health care (e.g., battle field). Telemedicine programs have become a substantial component of rural health care delivery in the U.S. By the mid-1990s, 18% of rural hospitals reportedly had operational telemedicine programs (Wootton & Darkins, 1997). There are a variety of telemedicine models. The typical clinical telemedicine program consists of a two-way communications link between a medical clinic or center staffed by a specialty physician and satellite stations staffed by nurses, physician assistants or a PCP (e.g., family physician). This arrangement provides an opportunity for the patient to be seen by a staff member in the satellite station while both patient and nurse have full access to a specialty physician. As illustrated through the history and evolution of telemedicine, telemedicine systems can range from telephone networks to sophisticated video systems. Telemedicine can also be subcategorized as clinical disciplines. Medical specialties that have utilized the advent of telemedicine include radiology, psychiatry, cardiology, pathology, obstetrics, dermatology and surgery.

Worldwide, telemedicine has been introduced to developing countries in effort to provide better health care for those in underserved areas where physicians or hospitals may be at a distance and specialists may be in limited numbers or not even exist. Although efforts using telemedicine have demonstrated positive effects in these settings, because of the extent to which maldistribution of health care resources occur, they have not substantially reduced or compensated for a fundamental lack of health care. There are examples which illustrate how telemedicine is helping in developing nations. One study from a hospital in Nepal demonstrated that a low-cost telemedicine link is feasible and can be a significant benefit in this developing nation (Graham et al., 2003). This study employed S&F technology and involved medical consultant specialists throughout the world in several medical disciplines. Consultant responses were received within one to two days and were deemed to be helpful for diagnosis, management

and education. Another telemedicine service was email-based and implemented in rural villages in Cambodia (Heinzelmann, Jacques & Kvedar, 2005). Each month, from 2001 to 2005, a Cambodian nurse traveled from the capital city of Phnom Penh to a health center 5 to 7 hours away. The nurse was equipped with a digital camera, and various medical instruments and supplies. Select patients at the health center received teleconsultation. Digital images, clinical history and patient assessments were sent to volunteer physicians in Phnom Penh and Boston. During this program, there were 469 teleconsultations. The wait time for proper patient intervention reduced dramatically over the study period. Patients surveyed were satisfied with their telemedicine experience. In fact, about 78% were willing to pay for their visits. This study demonstrated the value of email support for non-physician health care workers in the developing world.

In the U.S. and other developed nations, teledermatology projects do not often last because of limitations of personnel or funding. There is little sustained routine telemedicine activity. The underlying premise of teledermatology is to increase health care access to those who otherwise would go without or would expend significant financial resources to obtain it. It is therefore in these settings that telemedicine would be most useful. However, telemedicine in developing countries has been primarily educational in nature, and there is limited clinical experience (Wootton, 2001). Clinical application of telemedicine usually occurs as a result of disasters or to obtain second opinions. In 1988, in response to the many casualties suffered from the Armenian earthquake, telemedicine systems were created between medical teams in Armenia and physicians in the U.S. and Russia (Houtchens et al., 1993). This massive earthquake caused 25,000 deaths and 125,000 survivors in need of medical attention (Houtchens et al., 1993).

Through this international link, over a 12-week period, patient diagnosis and management was discussed.

Countries which have little or no experience can learn from those who do. The problem is that those countries more experienced with telemedicine, such as the U.S. are perhaps using more sophisticated and expensive equipment. Most developing countries will require low-cost, relatively low-technology solutions. For there to be adaptation and sustainability of a telemedicine service in a developing nation, it should be affordable. Developing countries face particular problems with the provision of medical services due to insufficient funds, facilities and personnel. Further, roads and transportation are inadequate and unreliable in transporting patients. For countries with limited resources, telemedicine can transcend these problems.

There are many benefits realized by the use of telemedicine. These include immediate access to specialty care regardless of patient location, more timely diagnosis and treatment, and economic benefits for the patient (mitigating transportation costs and lost wages from missed work), provider/health care system (reduced referrals by managing patients locally, PCP learning from specialist) and insurer (decreased hospital inpatient days) (Wootton & Darkins, 1997; McGowan 2008). Likewise, there are factors which could hinder the wider implementation of telemedicine. One drawback is that a telemedicine consultation can be more time-consuming than the equivalent in-person encounter. Other areas of concern and potential drawbacks include funding issues, image and diagnostic quality, and user acceptance in general. Also, there are still questions as to whether the technology and the infrastructure are sufficiently developed to support widespread adoption. It has been suggested that the biggest technical obstacle to widespread expansion is the lack of a fully functional broadband network which could transmit voice, video and data at an affordable cost. More specific to the U.S., a significant potential

issue is the threat of malpractice litigation resulting from misdiagnosis arising from the use of the telemedicine system. The lack of reimbursement from Health Care Financing Administration could also hamper widespread implementation of telemedicine in the U.S. There are also patient safety issues that deserve consideration. Technology failure, presents a major risk. A drop in the quality of the technology that leads to a wrong diagnosis or the inability of the provider to appropriately manage the technology could result in a misdiagnosis, causing unnecessary medical procedures, or a delay in the appropriate medical care.

Teledermatology

Although there are uncertainties about when teledermatology was first employed, one report dates back to the 1970s, when a live black-and-white video link was used by dermatologists to see airport employees in Boston (Murphy, Fitzpatrick, Haynes, Bird, & Sheridan, 1972). Since then, with technological advances in software, hardware, and the increased bandwidth, teledermatology has become a practical consideration. Between 1993 and 1998, the Association of Telemedicine Service Providers documented a total of at least 44 teledermatology programs in 30 states (Levin, 2009). In 1998, at least 58,000 telemedicine interactions occurred in the U.S. including 3,316 teledermatology encounters (Levin, 2009). A 2003 survey revealed 62 active teledermatology programs in the 37 U.S. states (ATA Survey on Teledermatology, 2003).

Through its application in a variety of settings, teledermatology has demonstrated great utility and holds potential for revolutionizing the delivery of dermatology services, especially to the underserved areas of the world. Barriers accessing health care, including poverty and lack of dermatologists in rural regions, have increased the need for the adoption of teledermatology. In addition to providing geographically isolated patients access to dermatologists, teledermatology

has been shown to have utility as a triage mechanism for determining the urgency or need for a clinic-based consultation. This helps ease demand by eliminating unnecessary referrals. Also, in cases of the elderly or those with chronic skin disease, travel to see a dermatologist may not be feasible. Some skin diseases such as leg ulcers, which often result from compromised blood flow to the legs, are chronic, need frequent monitoring, require a long duration of treatment and several follow-up visits. Traditionally, these have required visits to the dermatologist's office, and for many, involve long distance travels and wait times to see a dermatologist. Teledermatology could provide an avenue for direct follow-up care at a distance and minimize the costs and travel time for patients, thereby improving the quality of life for many people.

Technological Considerations

Image transfer of a teledermatology service has usually been by means of VTC equipment or S&F computer-based systems. For VTC, Integrated Services Digital Network (ISDN) lines, which are digital lines are preferred, as conventional telephone lines are slow and have poor quality imaging. ISDN lines allow enhanced digital transmission. The data-carrying capacity of a standard telephone line is up to 56 kbps; an ISDN has more data-carrying capacity (i.e., bandwidth). For example, one ISDN line has a data-carrying capacity of 128 kbps. By adding a second or third ISDN line, the capacity will double and triple, respectively. By increasing bandwidth using ISDN lines, motion artifacts are reduced (Malone, Athanassiou, Craigo, Simpson & D'Alton, 1998). For the transmission of still digital images, a standard telephone line will serve the purpose, as there is no transmission of real-time video and audio. According to the American Academy of Dermatology (AAD) (AAD position statement…, 2004), VTC systems work optimally when a connection speed of 384 kbps is used.

The type of technology hardware used distinguishes the two modes of teledermatology consultation. Modern VTC equipment allows real-time consulting between two or more parties. This equipment enables the dermatologist to see the patient through the video link, while the patient also has contact with the dermatologist. This allows direct interaction between the dermatologist, the patient and the person conducting the video imaging.

S&F teledermatology uses a digital camera to acquire an image that will be sent with patient information to a teledermatologist. Digital cameras have become readily available for consumers in a variety of colors, sizes, and specifications. The amount of detail that the camera can capture is called the resolution, and it is measured in pixels. The more pixels a camera has, the more detail it can capture, thus providing better resolution. Bittorf, Fartasch, Schuler and Diepgen (1997) have suggested that a resolution of 768 x 512 (approximately 0.4 megapixels) may be sufficient for routine dermatological purposes of recognizing the relevant details of patient images. Given the affordability of digital cameras with higher resolutions, Ratner, Thomas and Bickers (1999) suggests a camera with a resolution of at least 1024 x 768 pixels (approximately 0.8 megapixels) should provide the image quality needed. In a more recent publication, Pak (2002) recommended a camera resolution of 2048 x 1536 (approximately 3.1 megapixels). Thus, the literature recommendation for digital camera resolution varies, which is largely the result of rapid advances in technology. When a manuscript is written and submitted for publication, the available technology, and therefore technological recommendations, will likely vary by the time the manuscript is published. For S&F teledermatology, the American Academy of Dermatology (AAD position statement…, 2004) recommends a consumer-grade digital camera with a minimum of 800 x 600 pixel (approximately 0.5 megapixels) resolution. It is important to note that this is the minimum resolution, whereas Pak's (2002) recommendation

is likely made in the context of achieving optimal resolution. Anecdotally, today, consumer grade point-and-shoot type digital cameras with 10 megapixels or more are quite affordable and becoming the standard. This well exceeds the aforementioned recommendations. Perhaps, the most common and best suited digital camera for dermatology is the point-and-shoot type. Although there are several varieties of this type, most are affordable and with their small size, they are easy to transport. The liquid crystal display is an additional nice feature and imparts utility to this camera, as pictures taken can be instantly reviewed and discarded if desired. Once the images are captured by the digital camera, they can be easily transferred to a computer for storage and viewing on monitor.

Regarding transmission, web-based email providers coupled with the appropriate open-license software can form the electronic backbone of a simple and free way to transmit patient images between any two points on earth with IP access (Della Mae, 1999). In recent years, email providers (Gmail, Yahoo, etc) have increased their clients' transmission and storage capacity to several hundred megabytes. With such large transmission, reception, and storage capacities, there is no need for image compression or the loss of data that can occur with compression.

Diagnostic Reliability and Accuracy

When comparing teledermatology consultations with traditional clinic-based consultations, there are two important parameters to consider: diagnostic reliability and diagnostic accuracy. Diagnostic reliability refers to the agreement between two or more physicians on a particular diagnosis. For example, if all consulting physicians agree that a pigmented skin lesion is a melanoma, then the diagnostic agreement is 100%, and thus the diagnosis is reliable. Diagnostic accuracy refers to whether the diagnosis rendered by a physician is correct or incorrect. If all consulting physicians believe the pigmented skin lesion is

melanoma, yet a biopsy reveals the lesion to be benign, then the physicians provided an inaccurate diagnosis, even though their diagnosis is reliable. From these examples, therefore, reliability and accuracy are not synonymous. However, most studies that report diagnostic accuracy are comparing the teledermatology diagnosis to the clinical diagnosis, and it is the latter that is accepted to be the reference standard. Fewer studies compare the teledermatology diagnosis to the histologic diagnosis and report diagnostic accuracy (Eedy & Wootton, 2001; Oztas et al., 2004; Whited et al., 1999). Pathologic review of a tissue biopsy, which can represent a reference standard, is not universally used for diagnosis of dermatologic disease and even when available it does not always provide a definitive diagnosis. Both true reliability and accuracy assessments for dermatologic disease are difficult to establish. However, diagnostic agreement with clinical evaluation or histopathologic diagnosis is probably the best standard with which we can evaluate the diagnostic capability of teledermatology (Pak, 2002).

A study in the U.K. compared the accuracy of clinic-based and VTC consultation (Gilmour et al, 1998). One hundred and twenty-six patients underwent VTC consultation with a dermatologist located a distance away, and this teleconsultation was followed by clinic consultation with a dermatologist. From this group, 155 diagnoses were identified by the clinic consultation. The clinic consultation was taken as the reference standard. In 54% to 59% of cases the two modalities rendered identical diagnoses. However, when the teledermatologists extended their differential diagnosis with two or three additional diagnostic possibilities, there was marked improvement in the diagnostic agreement with the clinic dermatologist.

In a U.S. study, 60 patients with skin problems were initially evaluated by a dermatologist via VTC and then in-person by a dermatologist (Lesher, Davis, Gourdin, English & Thompson, 1998). In 78% of cases, the two modalities were in complete agreement. The

diagnostic agreement improved when the diagnostic possibilities were expanded. Based on their study results, the authors suggest that telemedicine is an effective means of diagnosing skin disease. Another U.S. study comparing diagnostic agreement between clinic consultation and VTC in 130 patient studies demonstrated a diagnostic agreement of 80% (Lowitt et al., 1998). Of the eleven biopsies taken in this study, there was agreement on seven (63%). Taken together, these studies demonstrate that clinic-based and VTC consultations have a diagnostic agreement of 54% to 80%, which is consistent with other reports (Pak, 2002; Whited, 2006; Whited, 2001; Heinzelmann, 2005).

In the literature, S&F teledermatology has also been described and compared with clinic-based dermatology consultation. A study by Kvedar et al (1997) investigated the diagnostic agreement between clinicians using S&F technology (digital photos and clinical history) and clinic-based clinicians. The authors found that when photographic quality was high, the clinicians were in agreement more than 75% of the time. The level of agreement increased to 80% when differential diagnoses were included. From these results, the authors suggest that still digital images can substitute for the dermatologic physical examination in the majority of cases. Zelickson et al evaluated the diagnostic agreement using the same dermatologist employing S&F technology, then two days later, evaluated the same patients in the clinic. The authors reported an 88% diagnostic agreement. Treatment plans had a higher correlation rate of 90% (Zelickson & Homan, 1997). In a study of 129 patients with 168 skin lesions, Whited et al (1999) demonstrated a 63% diagnostic concordance between two dermatologists providing clinic evaluations and three dermatologists evaluating digital images with clinical history. This level of agreement was based on the single most likely diagnosis. The agreement increased to 92% when the differential diagnoses of the digital image consultations were considered. From the results of

their study, the authors concluded that digital image consultations result in reliable and accurate diagnostic outcomes when compared with traditional clinic-based consultations. Oztas et al (2004) demonstrated the value of having clinical history in rendering a diagnosis via S&F teledermatology consultations. This study employed three S&F teledermatologists, one clinic-based dermatologist and 125 patients, each with a single dermatologic complaint. The range of agreement among the teledermatologists (interobserver) varied from 44% to 47% (no clinical information provided) to 55% to 70% (clinical information provided). When compared to the reference standard (in-patient diagnosis), the range of accuracy varied from 55% to 61% (no clinical information provided) to 62% to 80% (clinical information provided). This study demonstrates that access to clinical history improves the performance of teledermatology. High, Houston, Calobrisi, Drage and McEvoy (2000) evaluated 92 patients with 106 skin problems, employing S&F teledermatology and clinic-based consultation. The authors reported a diagnostic concordance of 81% to 89%, and found that the image quality had a direct correlation with diagnostic agreement. Furthermore, the authors demonstrated the use of an inexpensive camera and widely available computer equipment. Krupinski et al (1999) reported a study with 308 patients who had digital images taken at a clinic-based dermatology consultation. There was 83% concordance between in-person versus digital photo diagnoses. Agreement with biopsy results was achieved in 76% of the cases. Image sharpness and color quality were rated "good" to "excellent" 83% and 93% of the time, respectively.

Studies on diagnostic agreement between S&F teledermatology and clinic-based evaluation have reported a 59% to 93% correlation rate, results similar to those reported with VTC technology. There can be great variation in diagnostic agreement between clinic-based and teledermatology consultation within and among studies. There are a variety of confounding

factors that influence the outcomes of these studies, such as suboptimal image quality or monitor resolution, insufficient clinical information, or delay in image transfer (Oztas et al., 2004; Taylor, Goldsmith, Murray, Harris, & Barkley, 2001; Mahendran, Goodfield, & Sheehan-Dare, 2005). However, even in optimal situations, certain dermatologic conditions may be more difficult to diagnose than another type. For example, Pak, Harden, Cruess, Welch, & Poropatich (2003) found that eruptions and papulosquamous conditions were slightly more difficult to diagnose compared to other categories using teledermatology. This was a finding that was also noted by Zelickson and Homan (1997). Although there may be factors that challenge a study, what seems to be consistent from many studies, including the ones previously described, is that teledermatology can provide diagnostic concordance rates that compare favorably with clinic-based diagnoses. Many of the S&F studies described used low-cost, widely available equipment and software that could be quickly and efficiently implemented.

Patient Management and Outcomes

Little information exists on clinical management (i.e., pharmacologic treatment and diagnostic testing) and outcomes as they relate to teledermatology, compared to studies evaluating diagnostic agreement. Similar to diagnostic agreement studies, skin disease management recommendations are subject to variability. Studies evaluating management plans often use the clinic-based management recommendations as a reference standard. One study employing S&F technology found that teledermatologists and clinic-based dermatologists were in agreement on biopsy recommendations 90 to 100% of the time (Whited et al., 1998). A study by Whited et al (1999) compared the diagnostic agreement and medical management recommendations for clinic-based and S&F teleconsultations. While the authors found that S&F teleconsultations can yield diagnostic reliability, lesion management decisions, overall, were less

reliable. Gilmour et al (1998) compared the management plans of clinic-based with VTC consultations. In assessing the appropriateness of the management plans, the authors found that the teledermatologists arrived at a correct management plan in 72% of the cases. For the remaining patient cases, 8% were provided suboptimal plans and 20% had no management plans provided. Overall follow-up rates from both types of consultation were almost identical. Further, the authors concluded that 50% of patients seen could have been managed using a single VTC consultation without any requirement for further specialist intervention. Another investigation evaluated management plans between clinic-based and VTC consultations and found that 64% of the management plan consults were the same. In the study, the teledermatologist suggested a suboptimal treatment plan for 6% of cases, an inappropriate treatment plan in 11% of cases and was unable to provide a management plan in 19% of cases (Loane et al., 1998). It is worth noting that although dermatologists may arrive at different diagnostic decisions, the management may be the same. Thus, disparate diagnostic outcomes do not necessarily result in different management plans. Hsiao and Oh (2008) examined the time differences between S&F and clinic-based consultation in which patients with skin disease were evaluated, diagnosed, and treated. For conventional and teledermatology referrals, respectively, the overall mean time intervals for initial consults were 48 and 4 days, for biopsy were 57 and 38 days, and for surgery were 125 and 104 days. From their findings, the authors concluded that clinical outcomes in skin cancer management via teledermatology, as measured by times to diagnosis and to surgical treatment, can be comparable to, if not better than, management by conventional referrals for remotely located patients.

Ideally, interventions would be assessed through the measurement of clinical outcomes such as change in severity of disease and patient-related factors. However, clinical outcomes are

not as well researched. Although the majority of data describing diagnostic concordance is favorable and supportive of teledermatology as a viable utility, these studies cannot determine whether patients experience equivalent or improved outcomes in terms of morbidity, mortality, or quality of life. In a study evaluating clinical outcomes between teledermatology and clinic-based consultation, Pak, Triplett, Lindquist, Grambow, and Whited, (2007) found that in the in-person consultation group, improvement was realized in 65% of patients, while no change was noted in 32%, and 3% were worse. The teledermatology group found similar results with improvement in 64% of patients, no change in 33%, while 4% were worse. The study demonstrated similar clinical outcomes between S&F teledermatology and clinic-based consultation.

Cost Effectiveness

Teledermatology relies heavily on technology, and is more likely to be widely adopted if it is reliable, efficient and can demonstrate economic viability. An important part of considering its feasibility therefore will depend on the costs associated with implementation and sustaining this service. The technological costs of a teledermatology service will likely change within weeks to months from initial implementation, as will the technology. Because of these dynamics, cost is difficult to assess. Beyond the teledermatology system, there are two types of costs to consider, which are those incurred by society and the health care system. A societal economic perspective considers costs such as patient travel costs, decreased productivity, and time lost from work. Health care system costs include those costs incurred by the medical system (e.g., third-party payers of health care, such as federal governments or managed care organizations), and these will vary depending on its structure.

Because of the efficiency and convenience associated with S&F teledermatology, it has been suggested that this modality could be more cost-effective than real-time consultation (D'Souza, Shah, Misch, & Ostlere, 1999; Harrison, Kirby, Dickinson, & Schofield, 1998). The S&F modality avoids the high costs of the provider and equipment needed for real-time interactive service, while still being less time-consuming for patients. Perhaps, one of the most valuable applications of teledermatology is in the long-term management of patients with chronic skin conditions. Burgiss et al (1997) showed that S&F teledermatology can decrease the cost of care associated with chronic skin disease when treating patients in a rural U.S. community. In their study, the authors revealed that the average cost of care for a diagnosed dermatologic condition for each patient during an average period of eight months prior to teledermatology was $294 ($9.19/month), compared with $141 ($5.88/month)for the six months after diagnosis by teledermatology. Another study by Binder et al (2007) examined the costs of chronic wound management using S&F teledermatology. In their study, the authors described the role of teledermatological follow-up monitoring for patients with chronic leg ulcers. After an initial outpatient visit, teledermatological follow-up was performed by home care nurses. During the study, 71% of leg ulcers improved. There was also a 46% reduction in transportation costs for the insurance companies as well as for the patients owing to a significant decrease in the number of visits to the wound care center. A study by Zelickson and Homan (1997) suggested that, in a nursing home setting, S&F teledermatology was a cost-effective alternative to traditional nursing home consultation. In their study, the cost of each teledermatology consultation was $71, much less than the traditional office visit ($105) and nursing home consult ($295). In a study looking at the economic impact of S&F teledermatology in a U.S. Department of Veterans Affairs (VA) health care setting, Whited et al (2003) found that teledermatology was not cost saving when

compared to traditional care. Specifically, an average cost of $36.40 per teledermatology patient was incurred by the VA compared to an average of $21.40 per patient for conventional consults. However, a sensitivity analysis indicated that teledermatology has the potential to be cost saving if clinic visit costs, travel costs, or averted clinic visits were higher than observed in the study. The authors concluded that teledermatology was cost-effective for decreasing the time required for patients to reach a point of initial definitive care. Other cost studies evaluating S&F teledermatology indicate that such systems, using consumer-grade digital cameras, are likely to be both accurate in diagnosis and a cost-effective method (Whited et al., 1999; Tait & Clay, 1999; Bergmo, 2000).

VTC teledermatology has traditionally been found to be more costly than conventional care because of the need and timed demands of two providers (i.e., telepresenter and teledermatologist) and videoconferencing equipment. However, studies comparing the cost-effectiveness of VTC with clinic-based consultation revealed VTC advantages for the patients in terms of time off work, loss of income to the patient or productivity by the employer, as well as time and expense of traveling to hospital (Wootton et al., 2000; Loane et al., 1999; Oakley et al., 2000). Several studies have evaluated the economic impact of VTC consultation systems and have reached variable conclusions. Considering the societal perspective, results have most often shown that VTC teledermatology ranges from comparable in cost to being a more costly alternative, when compared to conventional care (Loane et al., 2001; Wootton et al, 2000; Lamminen, H., Tuomi, Lamminen, J., & Uusitalo, 2000). When considering costs to the health care sector, there are reports of cost savings in some settings (Bergmo, 2000; Chan, H., Woo, Chan, W., & Hjelm, 2000). Lamminen et al (2000) conducted a study in Finland that compared the costs of VTC teledermatology consultation for 18 patients with the costs had those patients

received a traditional clinic consultation. Considering costs from primarily a health care system perspective, the authors found that the teledermatology costs ($3,166 USD) were slightly higher compared with conventional consultations ($3,065). The authors also demonstrated the utility of teledermatology in triaging patients. Of their sample population of 25 patients, 18 did not need to travel to see the dermatologist. The main economic benefits of the VTC consultation were attributable to the reduced traveling and hospital costs. A study from Northern Ireland comparing the net societal cost of the initial dermatologic consultation between VTC and clinic-based modalities found that the costs of VTC were almost 3 times greater. VTC teledermatology was also thought to be time-consuming for the physicians. The use of a general practitioner as a telepresenter and underutilization of the telemedicine equipment were identified as significantly contributing to the cost of a teledermatology consultation. A sensitivity analysis revealed that longer patient travel distances and more efficient use of the equipment would have improved the cost effectiveness of teledermatology. The authors also found no significant differences between clinical outcomes of teledermatology and conventional dermatology. Loane et al (2000) measured societal costs of VTC teledermatology compared with conventional hospital care in New Zealand, and they reported that assuming equal outcome, teledermatology was a more cost-efficient use of resources than conventional hospital care. Bergmo (2000) did a cost-minimization analysis of a VTC teledermatology service in Norway and had similar findings, that VTC teledermatology service was less costly than the traditional alternatives.

By providing a means by which to triage patients, teledermatology has the potential to decrease costs to the patient and health care system. Further, this offers a potential solution for long wait times for patients who may need urgent dermatological care. For example, using S&F technology, triage of patients suspected of having skin cancer has been shown to be effective

both in decreasing time to diagnosis and surgical treatment, and in decreasing the number of unnecessary dermatology clinic visits when compared with the conventional referral system (Hsiao & Oh, 2008). Fewer clinic visits and shorter wait times for evaluation and intervention can lead to decreased costs. With a shorter time to medical intervention, the extent to which the skin cancer progressed could be minimized. This would likely lead to less invasive treatment and morbidity and yield improved outcomes. White, Gould, Mills, and Brindish (1999) evaluated S&F technology effectiveness in prioritizing dermatological patients needing secondary care. The authors found that 25% of patients did not require a clinic visit with a dermatologist. Another study, also using S&F technology, estimated that 31% of patients could have been managed by the referring clinician (Taylor, 2000). Further illustrating the utility of teledermatology as a triage mechanism, Taylor (2000) noted that fewer patients would have been called for urgent consultations after teledermatology review, 32% compared with 64%. Other studies have reported the utility of S&F teledermatology as an economical triage tool in prioritizing patient appointments (Lyon & Harrison, 1997; Pak, Welch, & Poropatich, 1999).

Patient and Physician Satisfaction

User satisfaction and acceptance is important to assess when considering the feasibility of teledermatology consult systems. Teledermatology will be better accepted as a standard treatment modality if it is acceptable to patients and physicians. Regardless of its clinical performance, if teledermatology is perceived by patients or clinicians to be unacceptable, the data results could be affected. Ideally, an instrument is desired to measure a certain variable. Satisfaction assessments suffer from the absence of a reliable and validated instrument that can be used for teledermatology consultations. The existing data on satisfaction is primarily anecdotal and derived from questionnaires proprietary to the individual study. Nevertheless, this

data is useful and may serve as a guide for the development of a more structured satisfaction assessment instrument.

Several VTC teledermatology studies have assessed user satisfaction (Gilmour et al., 1998; Lowitt et al., 1998; Pak, Welch, & Poropatich, 1999; Jones et al., 1996; Loane et al., 1998; Oakley et al., 1997). Overall, patients have indicated satisfaction with teledermatology as a means of obtaining a dermatology consultation. One study in the U.K. looked at patient satisfaction of VTC teledermatology (Loane et al., 1998). Two hundred ninety-two patients completed a questionnaire assessing their satisfaction with the service. The quality of the audio and display was highly acceptable to patients. Eighty-five percent of the patients felt comfortable with the video-link, and 88% thought that a teleconsultation could save time and expenditure associated with traveling to see a dermatologist. Gilmour et al (1998) surveyed 126 patients and found that 92% of respondents felt that VTC teledermatology saved them time and 63% thought it saved them money. Patients reported high levels of satisfaction with the teleconsultations. The general practitioners felt that 75% of the teleconsultations were of educational benefit. In a study from New Zealand, Oakley et al (1997) found 79% of the patients felt that the VTC teleconsultation saved them time and 65% thought it saved them money. Eighty percent of patients were comfortable with the technology, and 96% felt that the early diagnosis was better than if they had waited for a later, clinic-based appointment. The authors also reported that 74% of patients felt that having an early diagnosis reduced their stress.

Among patients stating a preference for clinic-based consultations, teledermatology is still perceived as an acceptable means of consultation. Studies show that 59% to 66% of patients felt that VTC teledermatology was as good as clinic-based care and perceived no disadvantages to the consult modality (Gilmour et al., 1998; Loane, et al., 1998). However, 7% to 18% of

patients felt uncomfortable or embarrassed with VTC consultation (Gilmour et al., 1998; Loane et al., 1998; Nordal, Moseng, Kvammen, & Løchen, 2001). Generational differences may play a role in acceptance, as younger patients tend to be more accepting of the new technology than the elderly (Lesher, Davis, Gourdin, English, & Thompson, 1998). Patients who may be less tolerant or do not do so well with real-time teleconsultation include the elderly, small infants, those who are shy and embarrassed at being videoed, and those with genital rashes (Elford, 1997).

Studies show that overall, patients are satisfied with S&F teledermatology and would recommend it as a consult method (Weinstock, Nguyen, & Risica, 2002; Kvedar, Menn, Baradagunta, Smulders-Meyer, & Gonzalez, 1999; van den Akker et al, 2001; Williams et al., 2001). Some undesirable experiences leading to patient concern were long waiting times to learn of consult results, with some not even receiving follow-up after the consult (Weinstock, Nguyen, & Risica, 2002; Pak et al., 1999). Williams et al (2001) found that while some patients were uncomfortable about not being able to speak to a dermatologist, 93% of patients were satisfied with the S&F teledermatology modality. In a S&F teledermatology study, Zelickson et al polled nursing home patients and found that the majority felt that they received good care through this modality. Further, the patients expressed preference for teledermatology rather than waiting for an in-person visit with a dermatologist (Zelickson & Homan, 1997). Perhaps more important than the consultation modality, patients want rapid access to an accurate diagnosis and an effective treatment plan. Individualized personal care is also important to patients (Collins, Browns, & Walters, 2004; Qureshi & Kvedar, 2003). When these aspects of service are considered, comparably high satisfaction ratings can be achieved with either teledermatology or conventional care.

Referring clinicians have also found S&F teledermatology to be a convenient consult method and to provide an educational benefit (Pak et al., 1999; Kvedar et al., 1999; van den Akker et al., 2001). Educational benefits of teledermatology have also been described in the literature in the dermatology training of medical residents (Williams et al., 2005). Weinstock et al (2002) reported that 74% of referring clinicians would recommend teledermatology. However, referring physicians felt that the consult process took too long with both S&F and VTC modalities (Weinstock et al., 2002; Kvedar et al., 1999; Gilmour et al., 1998). Perceived problems with the sound and visual quality associated with VTC teledermatology experience were also described (Jones et al., 1996; Gilmour et al., 1998). In other studies assessing referring clinicians' satisfaction, 98% of the respondents believed the VTC teledermatology consult system provided a valuable experience and 75% believed they also received an educational benefit (Jones et al., 1996; Gilmour et al., 1998). In a larger study, referring clinicians estimated the knowledge transfer effect of real-time consultation to be the equivalent of 6 days training per year (Wootton et al., 2000).

Dermatologist consultants have also reported positive experiences with teledermatology (Gilmour et al., 1998; Lowitt et al., 1998; Jones et al., 1996). One report revealed that 70% of consulting dermatologists were satisfied with the quality of the consultations (Pak et al., 1999), while another study showed that 80% of consulting dermatologists believed the VTC teledermatology was as thorough as a clinic visit (Nordal et al., 2001). A report by Lowitt et al (1998) revealed that both VTC and S&F consulting dermatologists had greater confidence in clinic-based diagnosis, and the majority felt that good rapport with patients was achieved. Lowitt et al (1998) also showed that VTC teleconsultants were more satisfied with consults performed using higher bandwidths and were more confident in their diagnosis. Criticisms with

both teledermatology modalities were usually concerned with picture quality and inability to palpate lesions or carry out diagnostic tests (Lowitt et al., 1998).

Dermatology in Developing Nations

In developing nations, skin disease continues to be a major public health problem. In these impoverished areas, the tropical climates combine with poor sanitation, close living quarters and malnutrition to create environments conducive to the development and spread of skin disease (Khatri, 2004). Despite the high prevalence of skin disease, the majority of the world's populations lack access to basic dermatologic care (Norton, 1999). In most developing countries, the few trained dermatologists are generally based in cities causing, a maldistribution among those specifically trained in the diagnosis and management of diseases of the hair, skin and nails (George, 1988). Further aggravating the situation is the AIDS epidemic, which predisposes to more infections and cancers of the skin because of a suppressed immune system.

Defining the magnitude of the problem is difficult, for at a quantitative level, data regarding disease prevalence in developing countries is scattered and scarce. In this setting, epidemiologic data often involve a special population or are confined to a specific skin disease (Porter, 1978). This data may be also based on information collected from medical records in specialized centers and does not necessarily represent the prevalence of skin disease in the community. However, regardless of the study type or data source, there exists a plethora of evidence that allows for the general understanding of widespread skin disease throughout the developing world, affecting a variety of ethnicities and age groups (Karthikeyan, Thappa, & Jeevankumar, 2004; Dogra & Kumar, 2003). In developed nations, the prevalence of skin disease in urban communities varies from 12 to 25% and it is estimated that the prevalence of skin disease is considerably higher in developing countries (Morris, Hay, Srinavasa, & Bunat,

1989; Bechelli et al., 1981). In this setting, it has been estimated that almost one-third of outpatient visits are due to skin disease (Kopf, 1993). It has also been suggested that skin disease is the second most common diagnosis made in primary care settings in the rural and urban areas of developing countries, and that 47% to 60% of people (especially children) in developing countries have skin problems (Figueroa, Fuller, Abraha, & Hay, 1998; Castanon & Andersson, 1992). With such a large proportion of the population affected, skin disease carries a significant burden. Skin disease is highly visible, produces discomfort and may lead to social alienation with socio-economic consequences. Dermatologic disorders are among the five most common causes of morbidity and loss of manpower in the rural areas of developing nations (Kopf, 1993). It was reported that the burden of skin disease Sub-Saharan Africa in 2001 was associated with mortality rates of 20,000 (Morrone, 2007). This burden was comparable to mortality rates attributed to meningitis, hepatitis B, obstructed labor, and rheumatic heart disease in the same region (Morrone, 2007).

The world's dermatologists are distributed inequitably, both in developed and in developing nations. More than 3 billion people in over 125 countries lack access to basic dermatologic care (Ryan, 1990). In many developing countries, dermatology is a neglected specialty. Where children die from malaria, diarrhea, or respiratory infections, skin disease is not regarded as such a serious health problem (Castanon & Andersson, 1992). Further, poverty in many areas is so rampant that financial resources for medical treatment are usually only available for life threatening disease. While skin disease may be of less importance in terms of morbidity and mortality compared to some of the other diseases that plague developing countries, it is one of the most common illnesses for which aid is sought in this setting (Schmeller, 1998; Morrone, 2007).

In many areas of the developing world, general physicians are scarce and specialists such as dermatologists are nonexistent. With no dermatologist available to the population majority, especially in the rural areas, most dermatoses are managed by nonphysicians with various levels of training who provide most of the health care to these areas. Most often, these auxiliary health workers are without proper training in dermatology (Ryan, 1990). Some rural communities do have general practitioners, which often are young doctors who have just completed their training. Frequently, however, villages do not have physicians and health care depends on the work of nurses, or those with minimal training such as health promoters or community health workers (CHWs) (Castanon & Andersson, 1992; Saxton-Daniels & Pandya, 2007). Often, these have little contact with specialized physicians like dermatologists to receive instruction. For even the most common skin conditions, this poses a problem with diagnosis and management. Because of this lack of medical education and health care access, the majority of skin conditions in developing countries is ignored or mismanaged (Saxton-Daniels & Pandya, 2007).

Studies performed in tropical countries have shown that skin disease in primary and specialist settings deals mostly with more common conditions, such as eczema, psoriasis, skin cancer, and bacterial and fungal infection, rather than exotic diseases (Morrone, 2007; Boyd, 1998; Norton, 1999). A 1985 study in rural Jamaica revealed that 6% of health care visits over the course of a year had a dermatologic condition as the primary diagnosis (Badame, 1988). The majority of the dermatologic diagnoses were infectious and parasitic diseases, with scabies (30.5%), impetigo (8.9%) and tinea (11.8%) being the most common. Noninfectious disease accounted for less than 10% of all diagnoses, with unclassified eczema making up the majority. In rural Rwanda, a study revealed that the most common dermatoses were scabies (29.9%), tinea capitis (13.3%), dermatitis (9.4%), pityriasis versicolor (8.6%), impetigo (3.8%), acne (2.0%)

and warts (1.8%) (Van Hecke & Bugingo, 1980). Overall, infectious skin disease accounted for the majority of dermatoses (66.8%). Parasitic disease was also quite common, with scabies being most common (29.6%). The authors noted that the scabies was widely impetiginized, necessitating local and general antibiotic treatment before scabicidal treatment. This often resulted in treatment failure, as patients would not return for the follow-up appointment. In a rural Tanzanian community, a study revealed that 34.7% of 800 villagers had one or more skin diseases, the most common of which were tinea capitis (12.2%), tinea corporis (10.1%), scabies (11.5%), acne (10.4%), and eczema (10.1%) (Satimia, McBride, & Leppard, 1998). Fifty percent of all skin disease affected children younger than 15 years of age. The pattern of skin disease varied according to age. For example, tinea was most common in ages 2 to 13, and scabies most common in those 6 to 17 years of age. Acne was most common in those 14 to 17 years old. A 1999 population-based survey in rural Indonesia revealed that the overall prevalence of skin disease was 28.2% (Saw et al., 2001). Most commonly, skin lesions were of infectious etiology (49.5%), with fungal lesions (43.5%) being the most frequent, followed by injuries and scars (16.3%), dermatitis (14.5%) and pigment disorders (8.5%). The predominant fungal lesion was tinea versicolor, followed by tinea cruris and tinea corporis. There were far fewer bacterial infections (4.6%) and no cases of skin cancer detected. The incidence of skin disease type is affected by geography. While many epidemiologic studies in developing countries take place in the setting of tropical climates, one study records the pattern of skin diseases encountered in a mountain city of Peru (Failmezger, 1992). Among patients examined over three summers, noninfectious dermatoses predominated. This is a contrast to the predominance of infectious skin diseases noted in the tropical climates of countries in the aforementioned studies. While bacterial, fungal and viral skin infections made up just 20% of

dermatoses, dermatitis, acne and pigmentary disorders made up 60% of the conditions seen. Acne was higher than reported in other studies, likely due to the relative youthfulness of Peruvians. In one study examining the dermatoses in Honduran children, 34% had positive skin findings (Kottenhahn & Heck, 1994). Bacterial infections were most common, occurring in 60.5% of patients, followed by fungal infections (42.2%), dermatitis (36.6%), and scabies (29.6%). The findings demonstrated significant variability in prevalence of skin pathology according to age. Bacterial skin infections and scabies were more common in the younger age groups. Fungal infections were more commonly seen in teenagers. Acne was demonstrated in the adolescent age group. Dermatitis showed no age predilection. A 1993 study in rural western Kenya found that 32.4 % of children examined suffered from skin diseases (Schmeller, 1998). Bacterial infections (39.2%) were most common, followed by fungal (31.2%) and arthropod infections (25.5%, most commonly scabies). Nonspecified dermatitis (5.1%) and skin reactions (13.1%) were common noninfectious skin diseases. One year later in this same setting, twelve CHWs received training in the signs, symptoms and treatment of common dermatoses. The CHWs carried out regular school visits once a week and diagnosed and treated children with dermatoses over the course of a year. In 1995, the schools were visited again to evaluate the long-term effects of the program. Skin disease prevalence in these children was 29.6%. Infectious skin disease was the most common, which included bacterial (36.5%), fungal (31.4%) and arthropod infections (35.6%). Noninfectious skin disease included nonspecified dermatitis (5.0%) and skin reactions (20.1%). Overall, the prevalence of dermatoses from 1993 to 1995 declined. Further, there was improvement in the extent and severity of skin diseases.

In developing nations, limitations imposed by resources and infrastructure, among many other factors, do not support the training of a sufficient number of dermatologists. To fill the

need for dermatologic care, primary care physicians or CHWs could be trained to identify and treat skin disease. As described previously, one study demonstrated that CHWs are capable of dealing successfully with the most common dermatoses following a short training period in limited aspects, such as how to eliminate common infectious diseases such as scabies, fungus or pyoderma (Schmeller, 1998). With the limited numbers of primary care physicians and dermatologists, these health care assistants are ideal for the provision of a primary health care scenario in dermatology, particularly in rural and underserved areas in developing countries (Ryan, 1992). However, in a later 5 year study in rural Kenya, despite regular and low cost treatment provided by CHWs, the prevalence rates of skin disease did not significantly change (Schmeller & Dzikus, 2001). Schmeller et al suggests that training CHWs is not enough to bring about a significant change in the prevalence of skin disease, particularly of infectious etiology (Schmeller & Dzikus, 2001). In addition to the training of CHWs, there needs to be improvements in living conditions such as overcrowded quarters and hygiene. Further, the higher frequency of skin infections in the developing world has been linked to low socioeconomic status (Karthikeyan et al., 2004). Infectious dermatoses in developing nations will only significantly improve when, in addition to medical treatment, the standards of living, health education and hygiene improve as well (Schmeller & Dzikus, 2001; Gibbs, 1996). Indeed, we know this, as we see in populations that have good nutrition, hygiene and water supply, disease prevalence is less, particularly of the infectious type. Castanon et al proposes that reduction of these problems will require a community-based approach which focuses on health education, improved access to health care and improvement in the socioeconomic condition of the village (Castanon & Andersson, 1992) In the community-based approach, community dermatology recognizes that often it may be more appropriate to manage diseases as

community problems, with treatment applicable to a large number of people, particularly when dealing with common infections such as scabies (Paredes et al., 1997). Community dermatology is based on a dual approach: training persons involved in primary care in the recognition of the common diseases and the acquisition of accurate epidemiologic data. From these data an appropriate approach to the management of the main problems affecting the community as a whole can be planned, taking into account poverty, low living standards, and the relative isolation of many of these deprived populations (Marrone, 2008). The focus therefore is on tackling the problems that are of the greatest importance to the community and simplifying their management.

In addition to the above models, there are a variety of organizations that have been involved with improving health care in developed nations. For example, The International Foundation of Dermatology (IFD) is a nongovernmental organization established in 1987 by the International League of Dermatology Societies to promote the care of skin disease in the developing world. (Kopf, 1993; Kopf, Ryan, & Strauss, 1996). The IFD has helped to establish two Regional Dermatology Training Centers, one in Africa and another in Central America, to teach dermatology to indigenous allied health professionals. Starting from an initial regional dermatology training center in Tanzania, many clinical officers and dermatology residents from different African countries have been trained (Hay & Marks, 2004; Ryan, 2006).

In the absence of the expert opinion of a dermatologist in the rural community, technology such as VTC or S&F teledermatology consultation systems could be used to connect the patient with the dermatologist over a distance. Teledermatology would allow communications to be stored and accessed later, independent of time zones and complicated schedules. Although the equipment needed for VTC would require more expensive equipment

and higher bandwidth internet service, equipment needed for S&F are available at reasonable prices in most parts of the world. Thus, S&F teledermatology systems seem to be a more suitable alternative in the setting of a developing country, allowing for digital images of skin disease to be shared and discussed by members of national or transnational teledermatologic networks with interests of raising the standard of care and bringing resolve to those who suffer from skin disease.

Treatment of skin disease in developing nations can vary significantly and include remedies from the traditional healer to modern medicine. The World Health Organization estimates that 80% of the population of most developing countries relies on traditional forms of health care as their primary source of health care (WHO, Health of indigenous people, 2010). In Tanzania, for example, traditional medicine is part of the culture. For the populations they serve, these healers are much more accessible, affordable and culturally appropriate (Satimia et al., 1998). In contrast, modern health service and treatments have not been part of the culture and are not as familiar. Further, these treatments are not as easily accessed, are likely much more expensive and the supply may be irregular. The authors of one study found that less than 50% of heads of households in a Tanzanian village said they would go to a traditional healer as their first choice for treatment of skin disease (Satimia et al., 1998). Age and education seemed to be the main factors to influence the choice of health care. Those less than 55 years of age and who had not been to school mainly used traditional healers. Religious affiliation also had an influence, as Christians were more likely to use modern health care. Perhaps, this is due to the possible association of traditional medicine with witch doctors. In a study in Rwanda, the authors reported that most cases of contact dermatitis were from application of products of botanical origin to the skin for the cure of some preexisting skin malady (Van Hecke & Bugingo, 1980).

Traditional medicines have been found to be useful for a variety of conditions, and the integration of both traditional and modern health care systems deserves consideration, as has been done in rural Uganda (Tumwesigye, 1996). This integration could optimize skin care so that people can benefit from locally available, cheap medicines rather than buying expensive, imported pharmaceutical products. Therapies that were most commonly used in developing countries for the treatment of skin disease were hydrocortisone acetate 1% cream for dermatitis, gentian violet 1% solution for bacterial skin infections, Whitfield's ointment (6% benzoic acid and 3% salicylic acid) in emulsifying ointment for fungal infections and benzyl benzoate emulsion 25% for scabies (Norton, 1999; Schmeller & Dzikus, 2001; Satimia et al., 1998).

In summary, skin disease is among the most common diagnosis in the developing world. Most of the world's populations lack access to basic dermatologic care, and the few dermatologists available are generally based in cities. Skin disease in tropical countries consists of more common conditions rather than exotic diseases.

Teledermatology has great utility and holds potential for revolutionizing the delivery of dermatology services in the developing world. Key elements of teledermatology include the use of technology to provide medical care over a distance. There are several factors to evaluate when considering the feasibility of a teledermatology consult system. Researchers conclude that S&F consultations provide reliable and accurate diagnostic outcomes when compared with clinic-based consultations. Studies show that patients and physicians are satisfied with S&F teledermatology. S&F teledermatology has also been shown to provide more timely access to specialty care compared to clinic-based consultation. Further, clinic-based and teledermatology outcomes have been shown to be equivalent. While VTC teledermatology has been found to be more costly than conventional care, S&F has been shown to be cost effective for a variety of

conditions in a variety of settings. Given these factors and circumstances, S&F teledermatology may be a suitable alternative, bridging the gap between the patient and skin specialist, and helping to raise the standard of care.

Chapter 3

Methodology

The information in the previous chapter demonstrates the many aspects to address when considering which type of teledermatology modality is most suitable for a given project. For the current study, store-and-forward (S&F) teledermatology was used. As previously described, the S&F study design allows for ease of instrument portability, affordability, and a flexible image reading schedule by the consultant dermatologists. According to Pak (2002), there is a general consensus among experts in the field of teledermatology that the S&F method of providing teledermatology will become the de facto standard for providing dermatology services via telemedicine.

The current study was conducted at the James Moody Adams (JMA) Clinic and satellite sites in underserved areas of Honduras, and included evaluation of the feasibility of implementing a telemedicine system based on the use of a digital camera coupled with S&F data transmission.

Population

The patient population of the JMA Clinic comes from local and distant communities. As the JMA Clinic is a medical clinic open to patients of all ages, those who participated in this study were distributed across various age groups. Patients included in this study were those who presented specifically with a dermatologic condition or presented with another complaint but physical exam revealed abnormal dermatologic findings (i.e., incidental finding), and who provided written consent to participate. Patients excluded from the study were those with no dermaologic findings on physical exam, those with skin disease who wished not to participate in this study, and those with urgent medical conditions that warranted immediate treatment.

Patients were informed of the option to opt out of the study at any time. Patients excluded from the study or who opted out were able to see the clinic physician as they normally would.

The typical patient load at JMA Clinic is 20 to 30 per day during an 8 AM to 4 PM work day. Thus, across a four week span, there would be a potential total population of 400 to 600 patients.

Sample

From the population, a convenience sample of 105 patients was selected to participate based on the previously described inclusion criteria. The sample consisted of patients of all ages and both genders. The sample approximation was based on a power test in order to determine significance at .05 Alpha. The test was verified with a biostatistician at the Virginia College of Osteopathic Medicine.

Patient participation in this study was voluntary. IRB approval was obtained, thus making this study totally compliant with the protection of human subjects. Objectives, risks, and benefits of the study were communicated to participants in their native language (Spanish) before signing the Patient Informed Consent Form (Appendix A1-A2). This study included participants of all ages. Therefore, children older than 5 years who were capable of understanding the purpose and content of the Child Assent Form (Appendix A3-A4) was requested to sign prior to their participation in this study. As the literacy rate in Honduras is about 80% (CIA, 2010), there may be patients who were unable to read the forms. The forms were issued to the patients in Spanish written form, and JMA Clinic staff with English and Spanish language competencies reviewed the forms with the patient verbally.

Procedure

The lead investigator was in charge of this study and provided training as it related to the study protocol to the medical staff at the JMA Clinic and the teledermatologists.

The physicians in this study consisted of the lead investigator who was at the JMA Clinic and 3 dermatologists located off-site in the U.S. Each physician is licensed to practice medicine in the U.S. The dermatologists are certified by a U.S. board of dermatology. As this study was set in Honduras, there were legal and health care parameters that needed consideration. This study received assistance and oversight at the national level by health officials within the Honduran Ministry of Health who have an appropriate level of authority to work with this study. Given their experience and breadth of knowledge with regards to these parameters, the health officials provided guidance to ensure that patients' rights were maintained and that the integrity of the study was carried out in a manner consistent with domestic regulations.

Dermatologists who participated in this study were recruited locally and nationally through the Virginia College of Osteopathic Medicine, the American Osteopathic College of Dermatology, the American Academy of Dermatology, and the American Telemedicine Association. The U.S. military has a long history of involvement in telemedicine and has been instrumental in its development. Several U.S. military dermatologists have experience in teledermatology and were invited to participate and/or advise the lead investigator.

Prior to study implementation, the researcher and on-site physician in Honduras reviewed American Telemedicine Association (Krupinski, 2008) and American Academy of Dermatology (AAD position statement…, 2004) recommendations on the technical aspects of teledermatology. Specifically, the digital camera and computer display monitor are important instruments to this study. The amount of detail that a digital camera can capture is called the resolution, and is measured in pixels. The more pixels a camera has, the more detail it can capture, thus providing

better resolution. As previously described in Chapter 2, there are several recommendations regarding digital camera pixel number used to photograph dermatologic conditions. The digital camera used in this study was 10 megapixels, which exceeds the minimum recommendations.

Quality digital images are dependent on many factors including good photographic technique and room lighting. It is important for the photographer to provide images that optimize the quality of skin lesion detail. Although this can be challenging, a quality photo enhances the diagnostic accuracy of the teledermatologist. Pak (1999) offers a guide on dermatologic photography that provides recommendations regarding common problems encountered with digital photos, room lighting, color of backdrop, and photography techniques to capture best and most relevant images. This guide was reviewed and followed. For the backdrop on which photography of the patient's dermatologic condition will take place, a light blue or green non-reflective surface is recommended (Pak, 1999; Kaliyadan, Manoj, Venkitakrishnan, & Dharmaratnam, 2008). Pak (1999) and Kaliyadan et al (2008) also recommend a naturally well-lit room and advise against intense bright light. The authors also recommend the camera's intrinsic flash for most situations, but warn of taking a photo too close to the patient as the flash could result in the loss of distinctive features of the lesion.

Regarding the display monitors on which the digital photos will be evaluated, the ATA recommends the resolution to match as closely as possible the resolution of the acquired image, or the originally acquired image resolution should be accessible using zoom and pan functions (Krupinski et al., 2008). As dermatology is a visually oriented specialty, each dermatologist participating in this study understands the importance of evaluating digital images of skin conditions on a high resolution display. Further, as each dermatologist was active in clinical practice at the time of the study, their daily examination of skin conditions in digital format

necessitatated their clinic to be equipped with high resolution displays. Each display used in the study had zoom and pan functions. For the current study, the digital camera and the monitor displays that were used exceeded the hardware specification recommendations set forth by both the ATA and AAD, which are globally recognized and accepted as the standard.

The study design was a case study approach involving the patient, lead investigator and consulting dermatologists (teledermatologists). The patient experience in this study was similar to what is illustrated in the Patient Flowchart (Appendix B). Patients presenting to the JMA Clinic with abnormal dermatologic findings had the option to participate in this study. Those who elected to participate were given the study objectives, risks, and benefits in verbal and written forms in their native language (Spanish). Staff at the JMA Clinic who read and spoke Spanish and English languages provided translation. Once the Patient Informed Consent Form (Appendix A1-A2) and/or the Child Assent Form (Appendix A3-A4) were signed, the patients were evaluated by a physician. Patients had digital images taken of their dermatologic condition. No pictures were taken of the patient's face that would have allowed for identification or identifying features. If lesions on the face were taken, identifying facial features were blocked out. As the Honduran physician rendered the final diagnosis and treatment independent of this study, patient information collected by researcher was kept separate from patient's clinic medical record. Patients were instructed to return to the clinic within 48 hours for follow-up. When the clinical information and digital photos were obtained, the data was transferred to the research computer. In transferring the photos to the researcher's computer, the USB cable that came with the camera from the manufacturer was used. The researcher's computer and camera was clearly marked with the researcher's name and contact information. At the end of the clinic day, approximately 4:00 PM each day, the images and Request for Diagnosis (RFD) Form (Appendix C) were transmitted to a teledermatologist for diagnosis and management recommendations. Only the

researcher handled the tasks involved with transfer of information to the researcher's computer and transmission of patient data to the teledermatologists. Images and documents related to patient telediagnosis was uploaded to an email using an email service that uses secure socket layer (SSL) or Hypertext Transfer Protocol Secure (HTTPS) encryption (e.g., Outlook Express, GMail), then transmitted via an internet connection to the teledermatologists. The transmission of data using a simple email protocol employed in the current study was adopted from several previous studies. In a study by Sutherland (2009), the author used GMail to upload and send sonographic imaging to U.S. based radiologists. In a journal manuscript, Vasallo (2003) described simple email protocols in telemedicine links established by the Swinfen Charitable Trust. In his/her discussion on simple email protocols, the author stated:

> "Patient confidentiality must be preserved, both within the text of the referral and in using digital images. Patients should only be identified by age and gender, not by name or in other ways,…"

This simple email protocol is described and used elsewhere in the literature (Vassallo, Swinfen, P., Swinfen, R., & Wootton, 2001; Graham, Zimmerman, Vassallo, Patterson, Swinfen, P., & Swinfen, R., 2003).

In the current study, no personally identifiable patient information such as name, birth date, or tattoos were transmitted or released in any way. While imaging reports transmitted in this manner had some risk of interception by a third-party, the images and/or reports remained untraceable to the individual patient. To ensure that the patient information is not used for purposes other than intended for this research study, the teledermatologists were asked to sign the Privacy Consent Form (Appendix D) before the study began. The teledermatologists had 24 hours to transmit their recommendations, after which the researcher provided this information to

the on-site Honduran physician for patient follow-up. The teledermatologists were blinded from one another's study interpretations to reduce potential interobserver bias. When the patients returned to the clinic, the Honduran physician rendered the diagnosis and treatment independent of this study, the teledermatologists, and the researcher. At the completion of their return visit, patients were asked to complete a Patient Satisfaction Survey (Appendix E1-E2). The questionnaires were issued to the patients in Spanish written form, and JMA Clinic staff with English and Spanish language competencies reviewed the questionnaire with the patient verbally. At the completion of the study, teledermatologists were asked to complete the Teledermatologist Knowledge and Satisfaction Survey (Appendix F).

Along with the patient images, the teledermatologists received a Request for Diagnosis (RFD) Form (Appendix C). The purpose of the RFD form was to provide pertinent patient medical information to the teledermatologists, evaluate the quality of the medical information sent by the researcher, and be the medium through which the consultant provided their diagnosis and management recommendations. Medical information provided to the teledermatologist included a description of the patient's presenting complaint, pertinent medical history, and physical exam findings. Appendix C provides a RFD form with a sample clinical history. On the RFD form, the teledermatologist were able to evaluate and rate the quality of the images and/or diagnostic value using a Likert scale. This information served as an evaluation tool and provided for improvements to be made throughout the study.

Teledermatologists participating in this study carefully evaluated the digital photos and clinical information and completed the RFD form to the best of their ability. The completed RFD form was transmitted to the researcher within 24 hours so that the attending physician had the information to follow-up with the patients. Teledermatologists were trained on the purpose,

elements and expectations of the RFD form by the researcher. The researcher was available for consultation throughout the study, monitored progress, and ensured the study was conducted as planned.

Teledermatologists were blinded to the patient's identity. The researcher assigned a code unique to each patient, which was used to identify the patient. The code consisted of a four digit numeric identifier. For example, the first patient who participated in this study was identified within the research study as patient 1001, the second patient was 1002, and the third 1003, and so on. The materials generated on each patient (e.g., digital photo, RFD form, etc.) provided the date of the exam and the patient's code. A codebook was kept by the researcher, which listed the patient's code with their name, address, telephone number and a person who could serve as an emergency contact with address and telephone number. The information in the codebook identified the patient as shown in Table 3.1.

Table 3.1: Codebook example entry

Patient: 1001	Emergency Contact: Relative/Friend
Name: First & Last	Name: First & Last
Address: Street, Department, Municipality	Address: Street, Department, Municipality
Telephone: Mobile and/or Land-line	Telephone: Mobile and/or Land-line
	Relationship to Patient: Relative/Friend

For convenience, each teledermatologist was assigned a unique code that allowed their consultation work to be identified. The code consisted of a three digit number. For example, the first teledermatologist was assigned 101, the second teledermatologist 102, and the third 103. Teledermatologists' codes and corresponding names will be kept in the codebook along with their contact information, similar to Table 3.1.

The codebook was also be used to keep track of each patient's clinic visit, transmission of patient's data to teledermatologists, and receipt of consultation from teledermatologists. The consultant's diagnosis and management recommendations was also listed. This information will

be kept in the codebook similar to the format in Table 3.2. Patient confidentiality was preserved in all aspects of text and digital images. All data will be destroyed within one year following completion of this study to protect participants.

Table 3.2: Codebook example entry

Patient	Date initially seen in clinic	Date of material transmission to teledermatologist	Date of consultation received from teledermatologist	Date of patient follow-up in clinic	Diagnosis	Management
1001	04/01/2011	101: 04/01/2011 102: 04/01/2011	101: 04/02/2011 102: 04/02/2011	04/04/2011	101: Tinea Corporis 102: Tinea Corporis	101: Clotrimazole 1% cream applied twice daily for 2 – 4 weeks 102: Ketoconazole 2% cream applied twice daily for 2 – 4 weeks

Instrumentation

The study instruments included a digital camera (Canon IXY Digital 110 IS 10.0 megapixels), personal computer (Toshiba Satellite M640), internet, questionnaires related to the study objectives (i.e., RFD form and satisfaction surveys), and informed consent forms. Appendix G provides the Study Design Illustration (Tait & Clay, 1999) adapted for this current study. The seminary college campus on which the JMA Clinic was located had restricted access and was staffed by security officers. The camera and computer was secured by the researcher at all times. Instruments that stored sensitive data were password protected. The infrastructure at the JMA clinic included internet access capability that was adequate for a S&F teledermatology study.

Questionnaires related to the study objectives included the RFD (Appendix C), patient satisfaction (Appendix E1-E2), and physician satisfaction (Appendix F) forms. The RFD form

has been described. The patient and physician satisfaction forms evaluated satisfaction of experience as it related to this study and future likelihood of participating in teledermatology. Like the RFD form, these forms used a Likert scale by which the teledermatologist/patient specified his or her level of agreement to a particular statement.

Internal Validity

A panel of experts was used to determine instrument content validity to ensure the instruments met the study objectives. The instruments have been previously described and include the RFD and patient and teledermatologist satisfaction forms. Each panel member received a copy of the instruments along with the study objectives. The panel was asked to determine that the instruments sufficiently addressed the study objectives; and if necessary make suggestions to improve each instrument. Once finalized, these instruments were used as previously described.

Reliability

The reliability of the patient satisfaction instrument was accomplished by a pilot test of the instrument using 10 to 12 patients. A Cronback alpha coefficient was run to determine reliability from the data collected on the pilot test. Reliability is not applicable to the teledermatology aspect of this study (i.e., RFD and teledermatologist satisfaction).

Data Analysis

The data report contains the number of patients at the JMA clinic during the study duration, as well as the number of patients in the sample population. Information from the RFD forms (i.e., digital photo rating and diagnostic and management concordance) was evaluated and the variability measured. The types of skin disease were recorded and used to determine the

proportion of each in the sample population. Satisfaction surveys were evaluated. Data was recorded and analyzed using SPSS and related descriptive statistics.

Chapter 4

Findings

Introduction

The purpose of this research project was to examine the types and prevalence of skin conditions, and feasibility of store-and-forward teledermatology in a specific setting in Honduras over a 4 week period. The research objectives were to determine:

1. Skin disease prevalence and type within the JMA Clinic and satellite sites
2. Interobserver diagnostic agreement
3. Technical and procedural image quality for transnational image transmission
4. Patients' satisfaction of store-and-forward teledermatology
5. Teledermatologists' level of knowledge and satisfaction of store-and-forward teledermatology

The study was conducted at the James Moody Adams (JMA) Clinic, a VCOM sponsored primary care clinic in an underserved area of Tegucigalpa, and satellite medical mission sites in El Vino and Guajire. These are all municipalities in the Honduran Department, Francisco Morazán. A sample of 105 low-income patients of both genders and all ages with a skin condition were selected to participate taken from those presenting with dermatologic conditions during a one-month research cycle.

Clinic Census

The patients presenting at the JMA Clinic and satellite sites come from local and distant communities and present with a variety of health conditions, similar to what would be seen at a primary care clinic in the U.S.

Over a 4 week period, there were a total of 643 patients who received medical care at the JMA Clinic and the satellite sites, El Vino and Guajire (Table 4.1). Of these, the number of patients presenting with dermatologic conditions was 122. Overall, approximately 20% of patients presented with dermatologic complaints, with 17% participating in this study. Thus some patients were not eligible or chose not to participate.

Study Participant Demographics

Gender and Age

Gender distribution among the study patients were 63% females and 37% males (Table 4.2, Figure 4.1). The age group 1-5 was most represented, followed by the 6-10 age group (Table 4.2, Figure 4.2). The next most represented age groups were 26-30 and 31-35. The least represented age groups were <1 and >56-60. Over half (54%) of patients were 25 years and younger, while those older than 50 years made up only 10% of the patients. The average patient age was 24.0 years (SD = 19.0, median = 23, mode = 10).

Municipality

Sixty-nine percent of patients were from Tegucigalpa (Table 4.3). El Vino and Guajire had patient representation of 12% and 19%, respectively.

Occupation, Pets, Water Source and Sunscreen Use

Various factors can be associated with skin disease. With regards to occupation, children represented the largest group (42%) followed by housewives (25%) and students (14%) (Table 4.3). Automechanic (1%), teacher (1%) and painter (2%) were the least represented occupations (Table 4.3, Figure 4.3).

Table 4.1: Clinic and Satellite Site Dermatology Patients

Municipality	All Patients	Total Dermatogy Patients (n, %)		Study Dermatology Patients (n, %)	
Tegucigalpa	358	72	20%	72	20%
El Vino	143	27	19%	13	9%
Guajire	142	23	16%	20	14%
Overall	643	122	19%	105	16%

Table 4.2: Gender and Age Distribution

Description		n	%
Overall		**105**	**100%**
Gender			
	Female	66	63%
	Male	39	37%
Age			
	< 1	3	3%
	1-5	20	19%
	6-10	13	12%
	11-15	8	8%
	16-20	5	5%
	21-25	8	8%
	26-30	10	10%
	31-35	10	10%
	36-40	9	9%
	41-45	3	3%
	46-50	5	5%
	51-55	5	5%
	56-60	2	2%
	61-90	4	4%

Note: 61-90 have been categorized together to maintain adequate cell count for analysis.

Figure 4.1: Gender Distribution

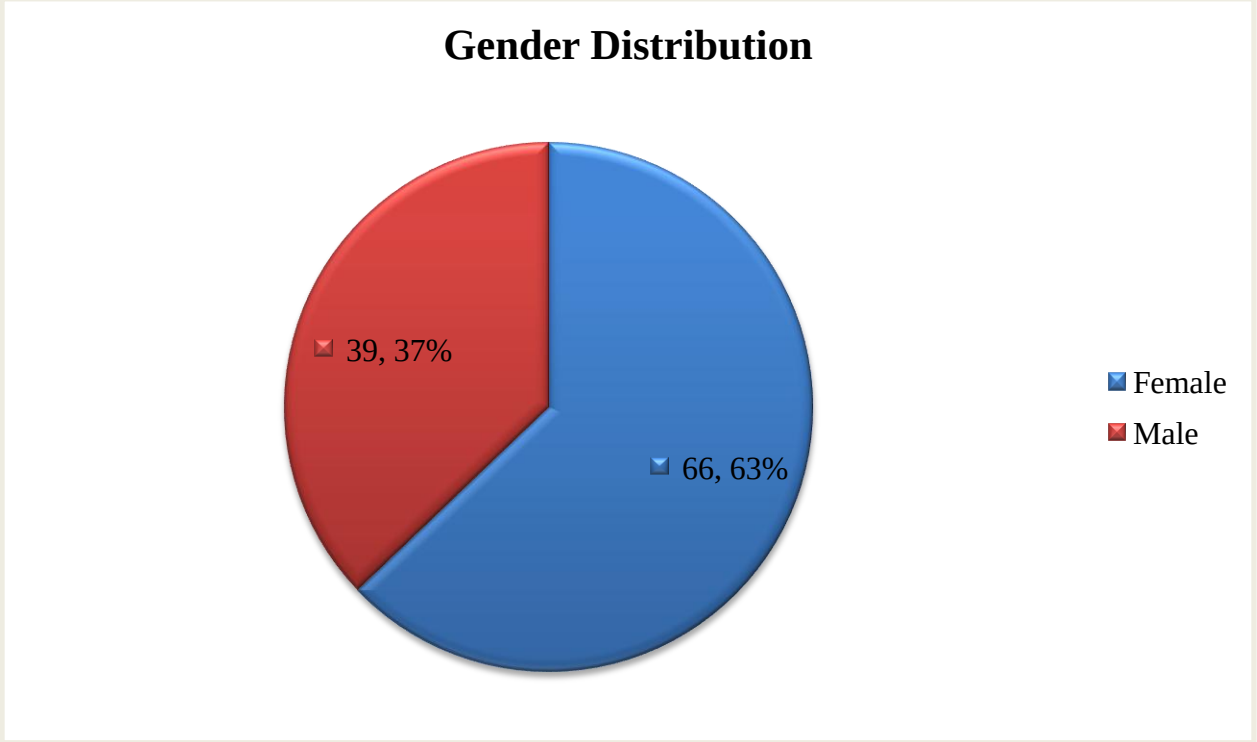
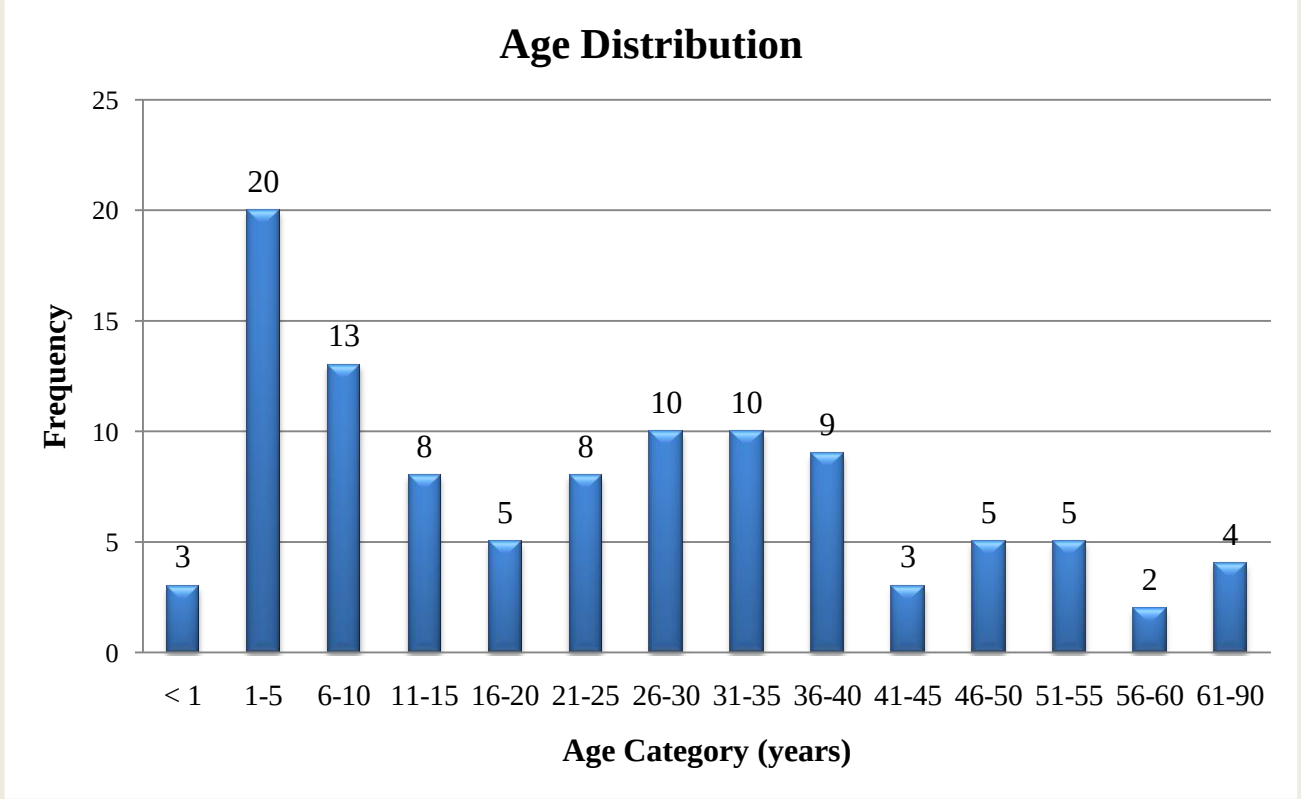


Figure 4.2: Age Distribution



Indoor occupations were the majority (99, 94%), compared with outdoor occupations (painter and farmer) (6, 6%) (Table 4.3, Figure 4.3). Patients may have been eligible for more than one occupation category, but were assigned to only one primary occupation. For example, children over 5 years generally were students and are categorized as such, while those less than 5 years and not in school were categorized as children. Likewise, there were a few housewives that were also students and were categorized as students.

The majority of patients (65, 62%) have one or more pets, whereas 38% (n = 40) of patients have none (Table 4.3). In a study this size, it would be difficult to draw conclusive significant correlation between pets and skin disease, but in a larger study this could yield important findings, as there are known human skin diseases associated with animal contact. Sixty-seven percent (n = 70) of patients use municipal water and 33% (n = 35) use non-municipal water, which could be from a well or stream (Figure 4.3). The majority of patients in Tegucigalpa use municipal water. El Vino and Guajire are rural villages that do not have a municipal water source.

Only 7% (n = 7) of patients reported to have ever used sunscreen, while 93% (n = 98) of patients have never used sunscreen (Figure 4.3).

Previous Treatment Received and Prior Dermatologist Visit

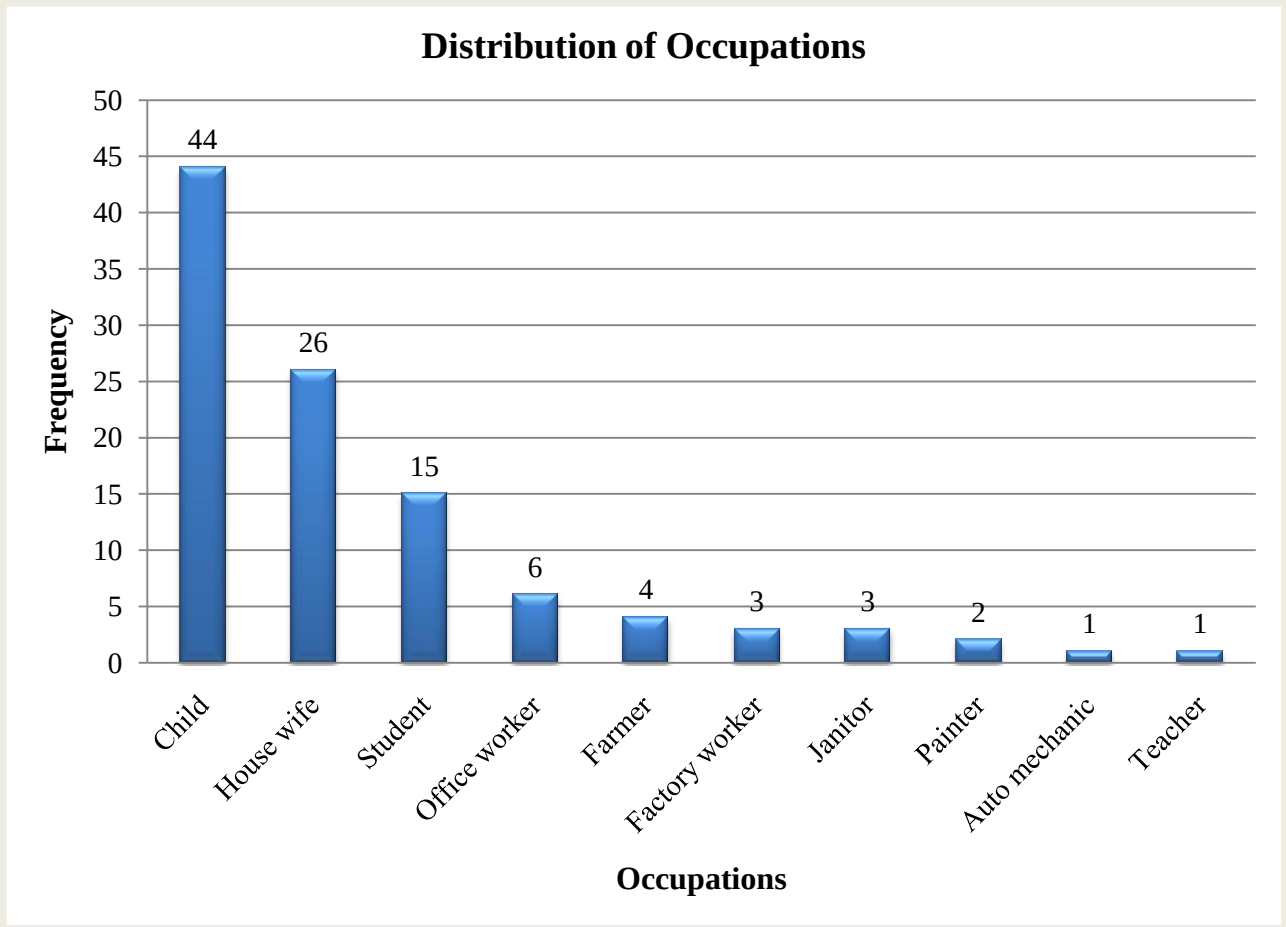
Seventy percent (n = 74) of patients had no prior treatment for their presenting dermatologic condition Table 4.3). The 30% (n = 31) of patients who received prior treatment, generally did so from a family physician. The majority of patients (92, 88%) have never been seen by a dermatologist. The majority of the 12% (n = 13) who had previously been seen by a dermatologists are from Tegucigalpa, where access to a specialist is greater compared to those who live in the rural areas.

Table 4.3: Demographic Information

Description		n	%
Municipal			
	Tegucigalpa	72	69%
	Guajire	20	19%
	El Vino	13	12%
Occupation			
	Child	44	42%
	House wife	26	25%
	Student	15	14%
	Office worker	6	6%
	Farmer	4	4%
	Factory worker	3	3%
	Janitor	3	3%
	Painter	2	2%
	Auto mechanic	1	1%
	Teacher	1	1%
Pet ownership			
	Yes	65	62%
	No	40	38%
Water source			
	Municipal water source	70	67%
	Non-municipal water source	35	33%
Sunscreen use			
	No	98	93%
	Yes	7	7%
Prior treatment received			
	No	74	70%
	Yes	31	30%
Prior Dermatologist visit			
	No	92	88%
	Yes	13	12%

Note: Municipal water source indicates a central supply. Nonmunicipal water source indicates a single-point source. Prior dermatologist visit is included in prior treatment received.

Figure 4.3: Distribution of Occupations



Chief Complaint Frequency and Duration

When patients presented at the clinic, they would describe their condition with a chief complaint in a few words, such as 'itchy rash'. Some patients also presented with more than one condition. For each condition, the patients' words describing their chief complaint were captured. Additionally, the frequency of specific words describing their complaint was recorded. If one patient described their complaint with 'itchy rash', then 'itchy' and 'rash' was accounted for one each. The most common chief complaint was 'itchy' (68, 37%), followed by 'light spots' (25, 14%) and 'dark spots' (18, 10%) (Table 4.4, Figure 4.4). 'Hair loss', 'inflammed' and 'pain' were descriptions of least frequency at 1% (n = 2) each. 'Other' chief complaint includes white flakes (patient with seborrheic dermatitis), scar (patient with a scar), and leg bump (patient with a lipoma on thigh). 'Itchy' (37%) occurred at a higher frequency than 'pain' (1%).

In addition to the chief complaint frequency, the duration of the condition resulting in the chief complaint was recorded. Forty-four percent (n = 68) of patients have lived with their condition for greater than 1 year (Table 4.5, Figure 4.5). Duration intervals 3-4 weeks (13, 10%) and 21-24 weeks (12, 9%) are next highest represented, but a distant 2nd and 3rd, respectively. The interval 13-16 weeks (3, 2%) was least represented. The average duration of complaint was 70.2 weeks (approximately 17.5 months) (STD = 91.6, median = 24, mode = 156).

Table 4.4: Chief Complaint and Frequency

Chief Complaint	n	%
Itchy	68	37%
Light spots	25	14%
Dark spots	18	10%
Redness	13	7%
Small bumps	12	6%
Rash	11	6%
Skin peeling	7	4%
Dryness	5	3%
Nail discoloration/deformity	5	3%
Burning	3	2%
Other	3	2%
Pimples	3	2%
Swelling	3	2%
Leg sore	3	2%
Hair loss	2	1%
Inflammation	2	1%
Pain	2	1%

Note: Terminology in Table is patients own words at presentation. A condition may be described by more than one term, such as 'itchy' and 'rash'. Patients may have had more than one condition. 'Other' chief complaint includes white flakes, scar and a big bump on leg.

Figure 4.4: Distribution of Chief Complaint Frequency

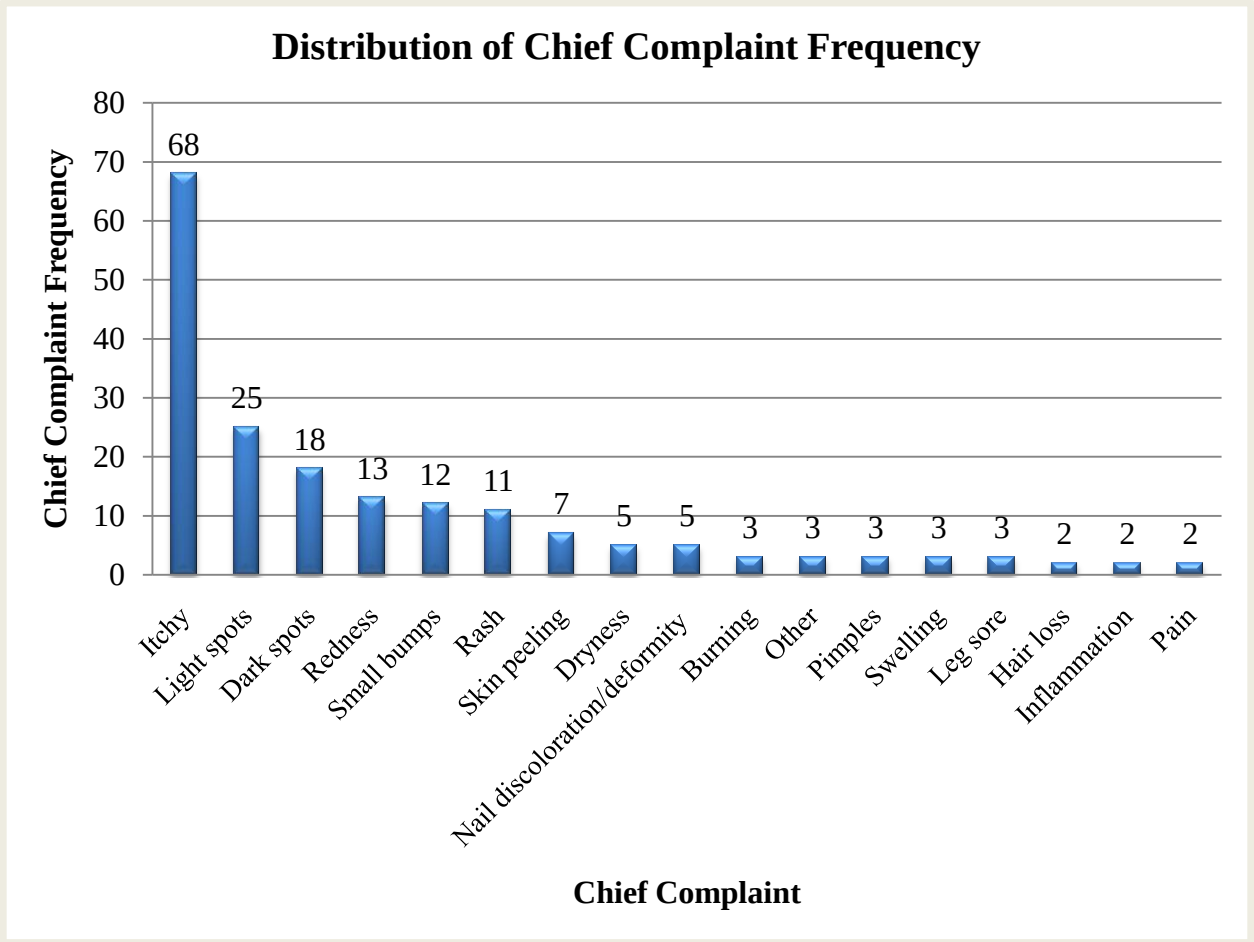
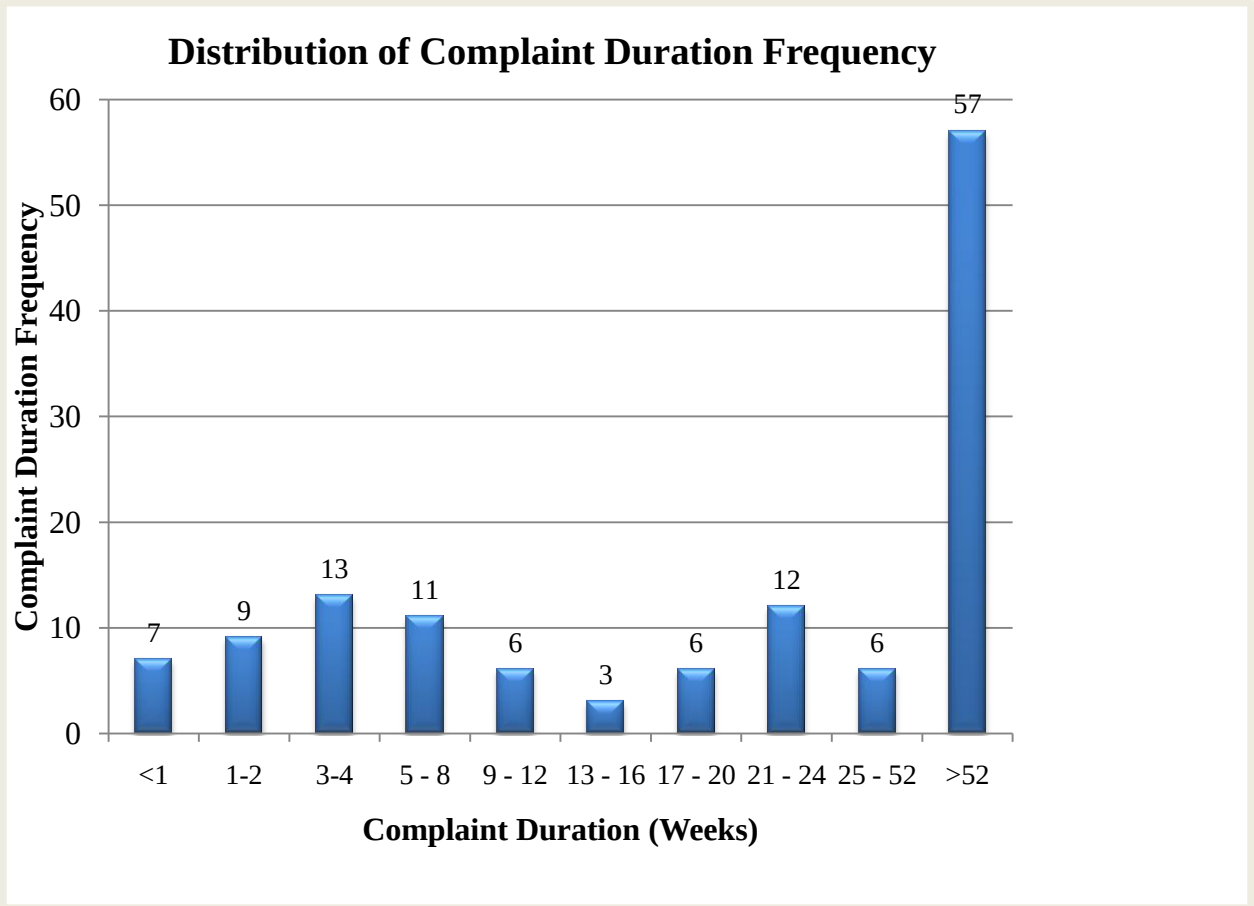


Table 4.5: Complaint Duration and Frequency

Complaint Duration (Weeks)	n	%
<1	7	5%
1 - 2	9	7%
3 - 4	13	10%
5 - 8	11	8%
9 - 12	6	5%
13 - 16	3	2%
17 - 20	6	5%
21 - 24	12	9%
25 - 52	6	5%
>52	57	44%

Figure 4.5: Distribution of Complaint Duration Frequency



Skin Condition Categories

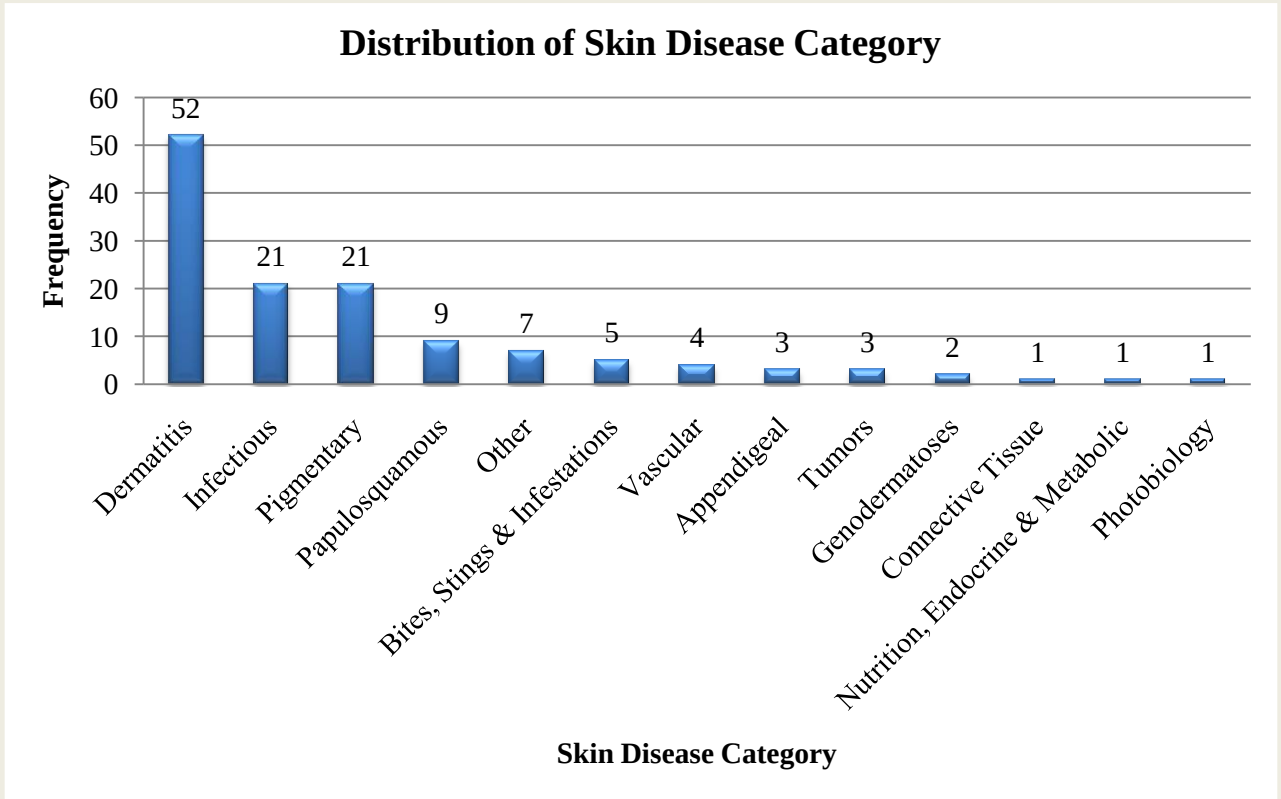
In the category of skin conditions, dermatitis (52, 40%), infectious (21, 16%), pigmentary (21, 16%) and papulosquamous (9, 7%) conditions were most represented, with the first three categories (dermatitis, infectious and pigmentary) representing 72% (n = 93) of all skin condition categories (Table 4.6, Figure 4.6). 'Other' category (7, 5%) represents dermatologic conditions that are not typically grouped with the specific categories listed. Bites, stings and infestations (5, 4%), vascular (4, 3%), appendigeal (3, 2%), tumors (3, 2%), and genodermatoses (2, 2%) were less common. Connective tissue (1, 1%), nutrition, endocrine and metabolic (1, 1%) and photobiology (1, 1%), were the least represented of all skin condition categories.

Previously, it was revealed that the most common complaint duration was greater than 1 year (Table 4.5, Figure 4.5). The average age of this segment of the population sample was 31.1 years (STD = 19.0, median = 32.5, mode = 35). Females (30, 71.4%) outnumbered males (12, 28.6%). The skin condition categories represented by this segment was examined (Table 4.7, Figure 4.7). Dermatitis (18, 32%), pigmentary (16, 28%) and infectious (11, 19%), were the most common, making up 79% (45) of the total. Papulosquamous (5, 9%) tumors (2, 4%), genodermatoses (1, 2%) and vascular (1, 2%) were less common. While representative of the clinic presentation between 8 AM to 5 PM, there is caution to draw any inferences to the general population because men may be working during these hours and, thus, not accessible to the clinic.

Table 4.6: Distribution of Skin Condition Category

Skin Condition Category	Number of Skin Conditions (n)	Percent of Skin Conditions (%)
Dermatitis	52	40%
Infectious	21	16%
Pigmentary	21	16%
Papulosquamous	9	7%
Other	7	5%
Bites, Stings & Infestations	5	4%
Vascular	4	3%
Appendigeal	3	2%
Tumors	3	2%
Genodermatoses	2	2%
Connective Tissue	1	1%
Nutrition, Endocrine & Metabolic	1	1%
Photobiology	1	1%
Total Conditions	130	100%

Figure 4.6: Distribution of Skin Condition Category



Previously, it was also revealed that 30% (n = 31) of patients received prior treatment for their dermatologic condition (Table 4.3). This segment of the sample population was examined. Females (18, 58.1%) outnumbered males (13, 41.9%). The average age of this segment was 28.3 years (STD = 18.8, median = 31, mode = 31). The skin condition categories represented by this segment was also examined (Table 4.8, Figure 4.8). Dermatitis (8, 26%), infectious (7, 23%) and papulosquamous (6, 19%) were the most common, making up 67.7% (n = 21) of the total. Less common were pigmentary (3, 10%) and vascular (3, 10%). 'Other' (2, 6%) consisted of acne vulgaris and rosacea). Infestation and metabolic associated conditions had equal representation (1, 3%). The average time duration of chief complaint was 92 weeks (23 months) (STD = 80.5, median = 104, mode = 156).

Dermatitis

Overall, dermatitis was the most common type of dermatologic condition (Table 4.6, Figure 4.6). Atopic dermatitis (15, 12%) and pityriasis alba (11, 8%) were among the most common skin conditions, both overall and within the dermatitis category (Table 4.9, Figure 4.9). Contact dermatitis (8, 6%) and eczema (6, 5%), lichen simplex chronicus (4, 3%) and nummular dermatitis (3, 2%) were less common. Stasis dermatitis (3, 2%), and dyshidrotic hand eczema (2, 2%) were the least common dermatitis skin conditions.

Infectious

Infectious skin conditions were also common. Within this category, tinea pedis (5, 4%), onychomycosis (4, 3%) and verruca vulgaris (4, 3%) were the most common (Table 4.10, Figure 4.10). Pyoderma (2, 2%), tinea versicolor (2, 2%), viral exanthem (2, 2%), hordeolum (1, 1%) and molluscum contagiosum (1, 1%) were less common.

Table 4.7: Distribution of Skin Condition Category With Complaint Duration >1 Year

Skin Condition Category	Number of Skin Conditions (n)	Percent of Skin Conditions (%)
Dermatitis	18	32%
Pigmentary	16	28%
Infectious	11	19%
Papulosquamous	5	9%
Other	3	5%
Tumor	2	4%
Genodermatoses	1	2%
Vascular	1	2%

Figure 4.7: Distribution of Skin Condition Category With Complaint Duration >1 Year

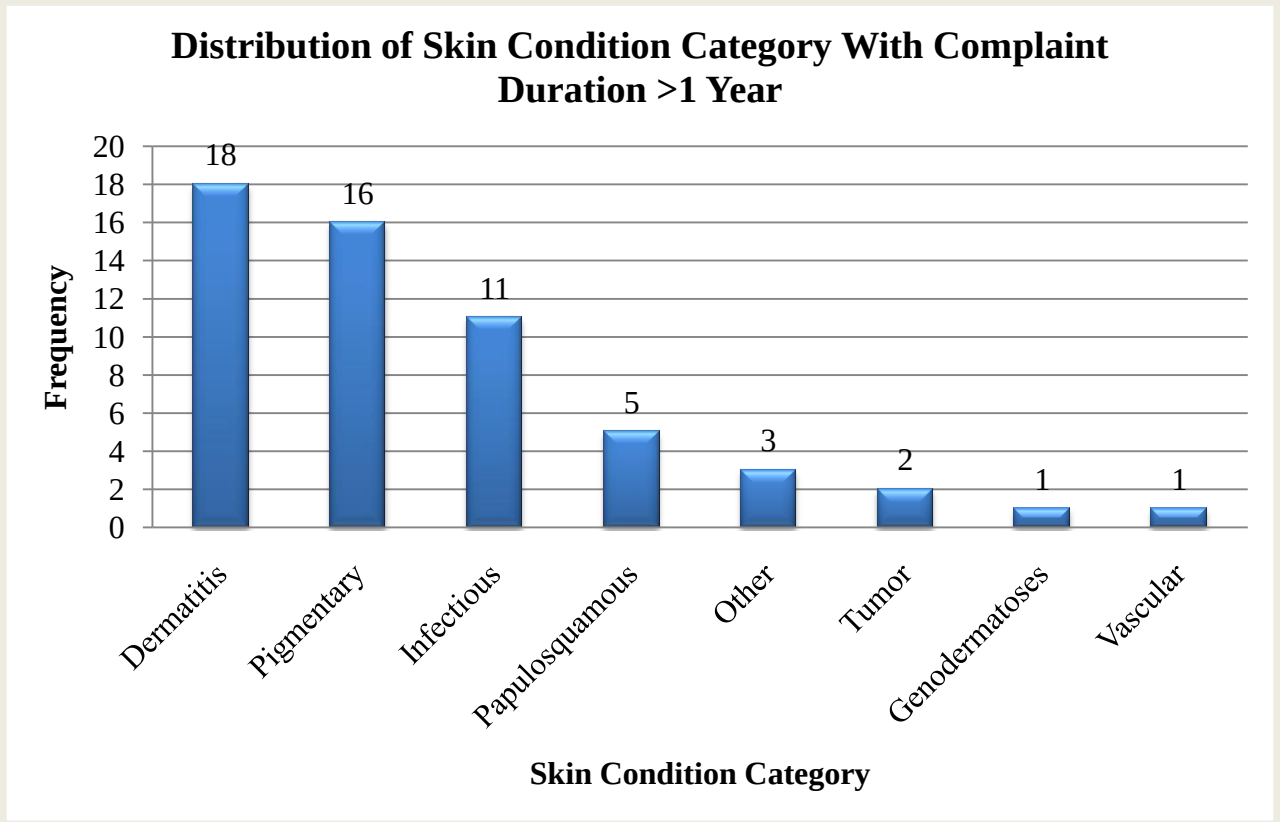


Table 4.8: Distribution of Skin Condition Category In Patients With Prior Physician Visit

Skin Condition Category	Number of Skin Conditions (n)	Percent of Skin Conditions (%)
Dermatitis	8	26%
Infectious	7	23%
Papulosquamous	6	19%
Pigmentary	3	10%
Vascular	3	10%
Other	2	6%
Bites, Stings & Infestations	1	3%
Nutrition, Endocrine & Metabolic	1	3%

Figure 4.8: Distribution of Skin Condition Category In Patients With Prior Physician Visit

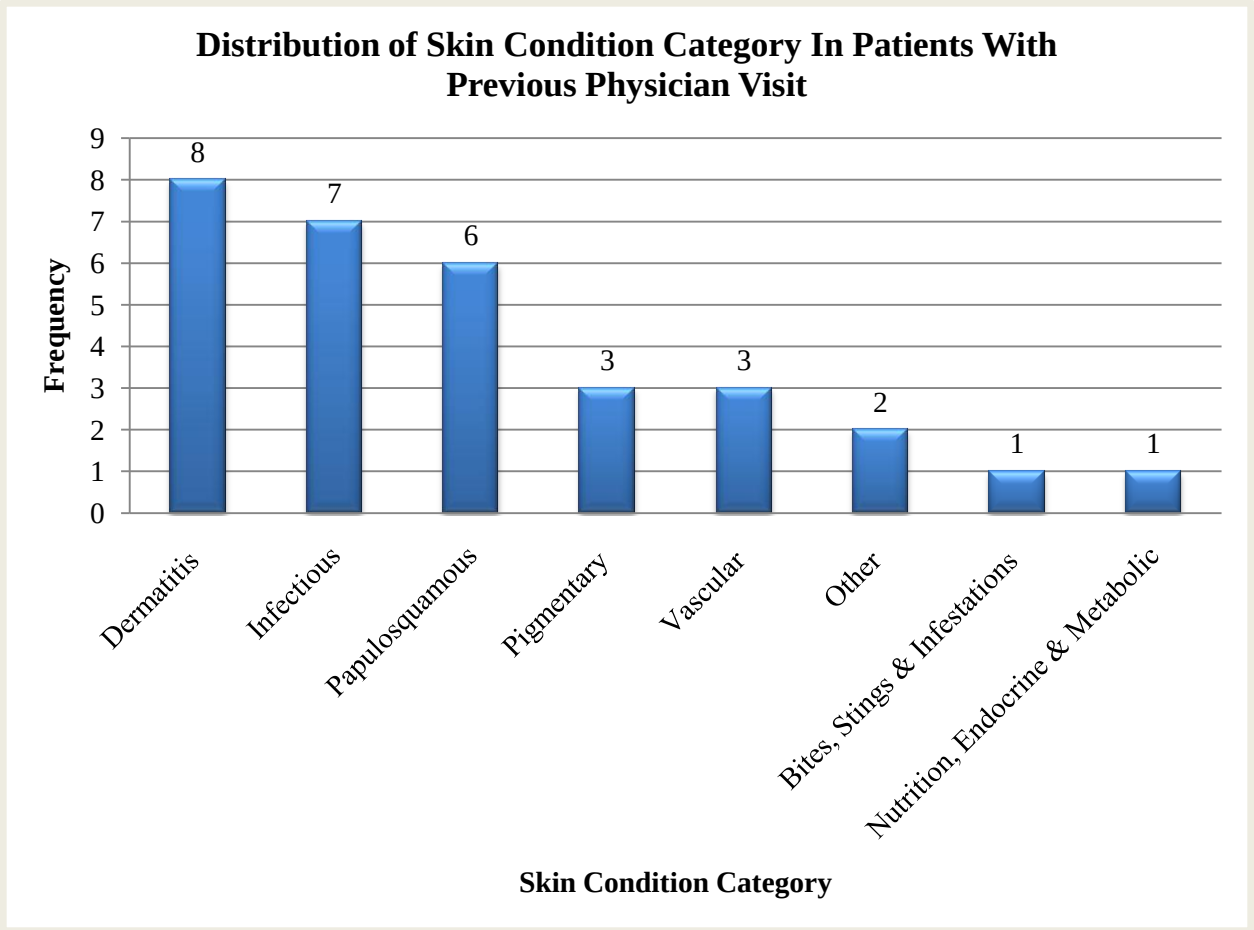


Table 4.9: Distribution of Dermatitis Skin Conditions

Condition Category	Specific Condition	n	Within Category %	Overall %
Dermatitis				
	Atopic Dermatitis	15	29%	12%
	Pityriasis Alba	11	21%	8%
	Contact Dermatitis	8	15%	6%
	Eczema	6	12%	5%
	Lichen Simplex Chronicus	4	8%	3%
	Nummular Dermatitis	3	6%	2%
	Stasis Dermatitis	3	6%	2%
	Dyshidrotic Hand Eczema	2	4%	2%

Note: 'Within Category' refers to the construct of a dermatologic category (i.e., Dermatitis), where in, which specific dermatologic conditions (i.e., atopic dermatitis) are categorized. 'Overall' refers to the representation of a specific condition in one category among the total number of specific conditions from several categories.

Figure 4.9: Distribution of Dermatitis Skin Conditions

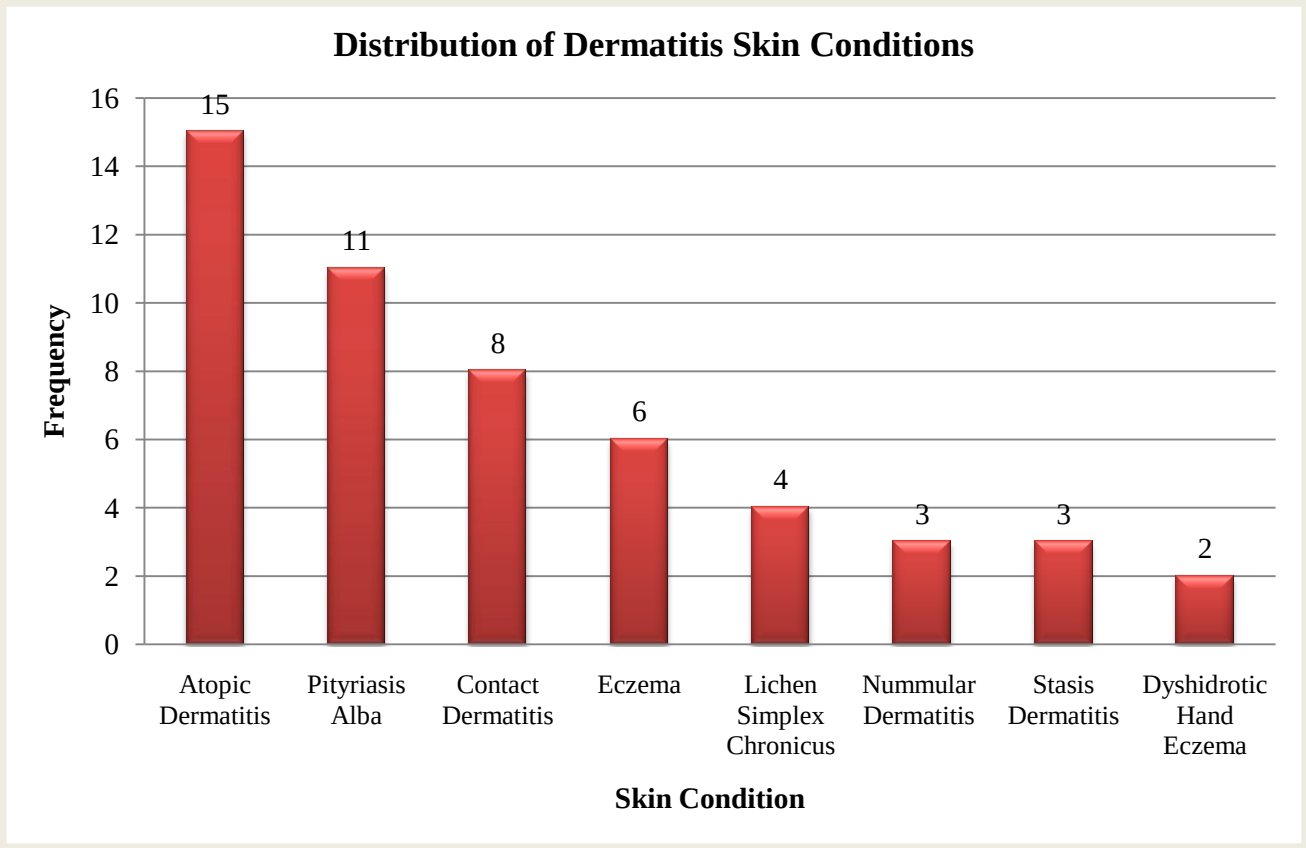
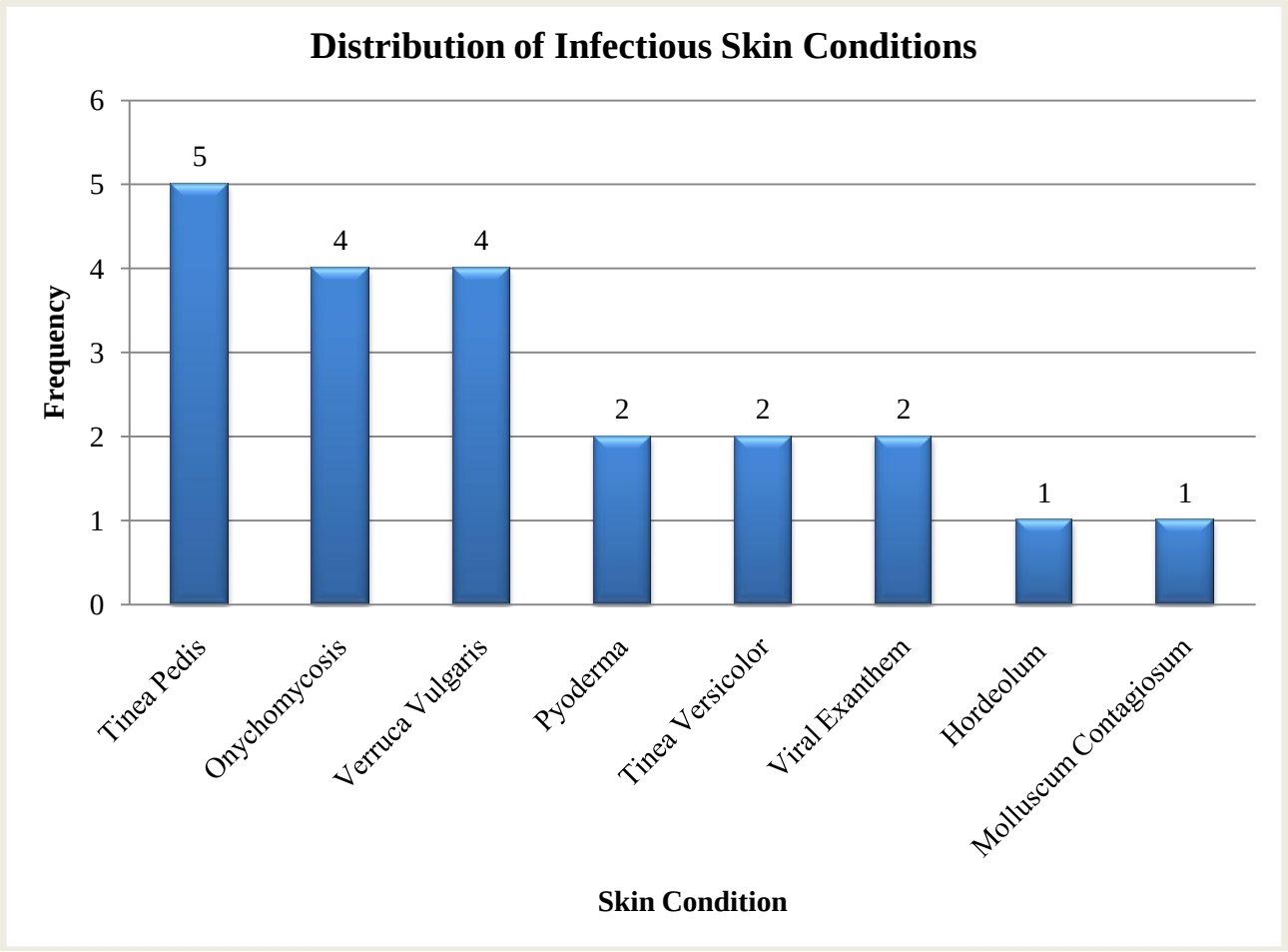


Table 4.10: Distribution of Infectious Skin Conditions

Condition Category	Specific Condition	n	Within Category %	Overall %
Infectious				
	Tinea Pedis	5	24%	4%
	Onychomycosis	4	19%	3%
	Verruca Vulgaris	4	19%	3%
	Pyoderma	2	10%	2%
	Tinea Versicolor	2	10%	2%
	Viral Exanthem	2	10%	2%
	Hordeolum	1	5%	1%
	Molluscum Contagiosum	1	5%	1%

Note: 'Within Category' refers to the construct of a dermatologic category (i.e., Dermatitis), where in, which specific dermatologic conditions (i.e., atopic dermatitis) are categorized. 'Overall' refers to the representation of a specific condition in one category among the total number of specific conditions from several categories.

Figure 4.10: Distribution of Infectious Skin Conditions



Pigmentary

Pigmentary skin conditions were also common. Within the pigmentary category, melasma (12, 9%) was the most common condition and was among the most common skin conditions overall (Table 4.11, Figure 4.11). Postinflammatory hypopigmentation (3, 2%), idopathic guttate hypomelanosis (2, 2%), postinflammatory hyperpigmentation (2, 2%) and vitiligo (2, 2%) were less common.

Papulosquamous

As a category, papulosquamous skin conditions had less common representation than other types. Within this category, psoriasis vulgaris (3, 2%) and seborrheic dermatitis (2, 2%) were most common (Table 4.12, Figure 4.12). Keratolysis exfoliativa (1, 1%), lichen nitidus (1, 1%) and pityriasis rosea (1, 1%) were less common. There was one occurrence in which there was no diagnostic agreement. For this occurrence, there was diagnostic agreement on skin condition category, but not on specific diagnosis.

Other, Bites, Stings & Infestations and Vascular

'Other' category includes conditions not grouped elsewhere. The most common condition is acne vulgaris (3, 2%) (Table 4.13a). Friction blister (1, 1%) and rosacea (1, 1%) were less common. There was one occurrence in which there was no diagnostic agreement. For this occurrence, there was diagnostic agreement on skin condition category, but not on specific diagnosis.

Infestations and bites were represented by scabies (3, 2%) and insect bite reaction (2, 2%), respectively. Venous ulcer (3, 2%) and urticaria (1, 1%) were the only vascular associated conditions.

Table 4.11: Distribution of Pigmentary Skin Conditions

Condition Category	Specific Condition	n	Within Category %	Overall %
Pigmentary				
	Melasma	12	57%	9%
	Postinflammatory Hypopigmentation	3	14%	2%
	Idiopathic Guttate Hypomelanosis	2	10%	2%
	Postinflammatory Hyperpigmentation	2	10%	2%
	Vitiligo	2	10%	2%

Note: 'Within Category' refers to the construct of a dermatologic category (i.e., Dermatitis), where in, which specific dermatologic conditions (i.e., atopic dermatitis) are categorized. 'Overall' refers to the representation of a specific condition in one category among the total number of specific conditions from several categories.

Figure 4.11: Distribution of Pigmentary Skin Conditions

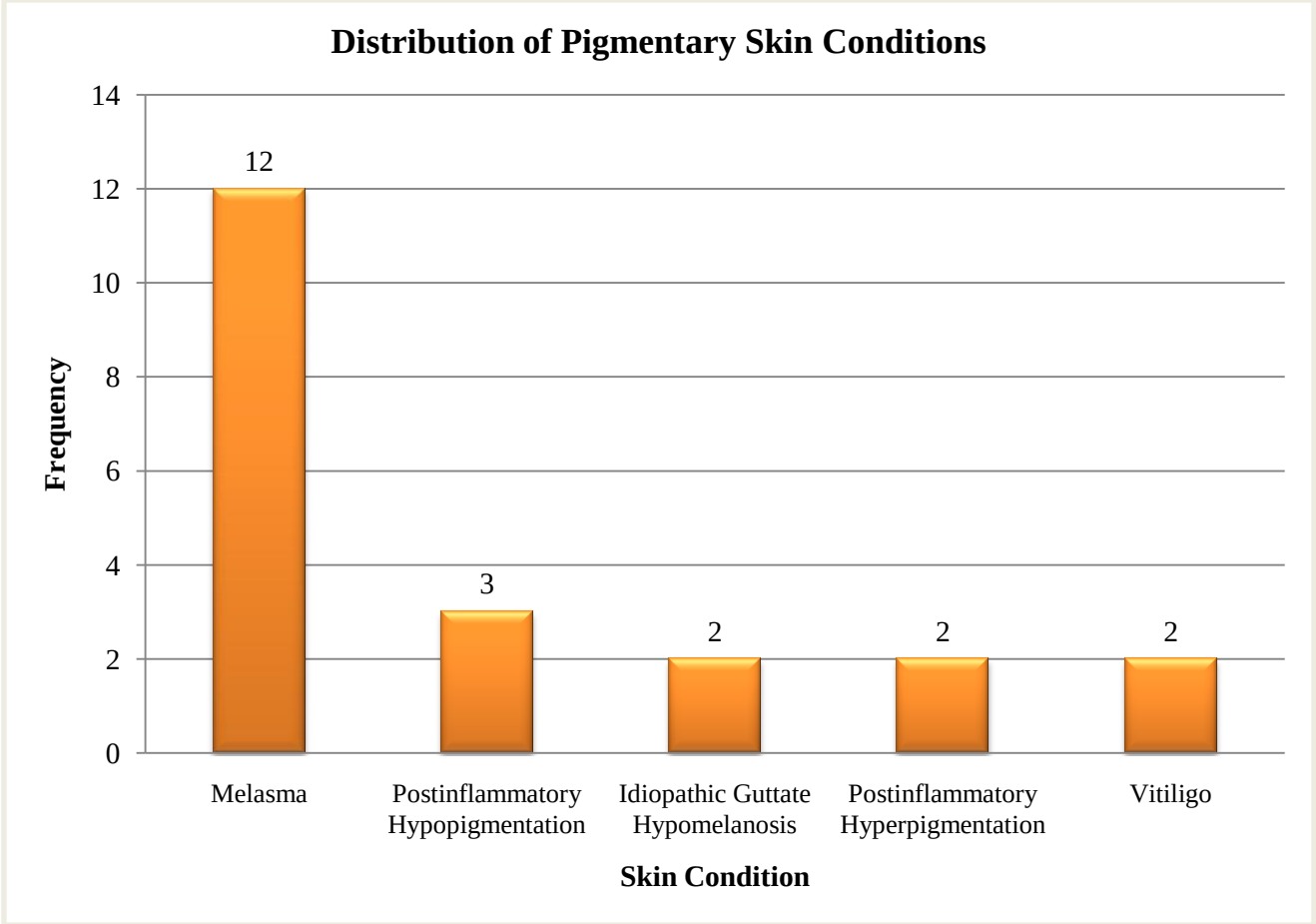


Table 4.12: Distribution of Papulosquamous Skin Conditions

Condition Category	Specific Condition	n	Within Category %	Overall %
Papulosquamous				
	Psoriasis Vulgaris	3	33%	2%
	Seborrheic Dermatitis	2	22%	2%
	Keratolysis Exfoliativa	1	11%	1%
	Lichen Nitidus	1	11%	1%
	No Agreement	1	11%	1%
	Pityriasis Rosea	1	11%	1%

Note: 'Within Category' refers to the construct of a dermatologic category (i.e., Dermatitis), where in, which specific dermatologic conditions (i.e., atopic dermatitis) are categorized. 'Overall' refers to the representation of a specific condition in one category among the total number of specific conditions from several categories.

Figure 4.12: Distribution of Papulosquamous Skin Conditions

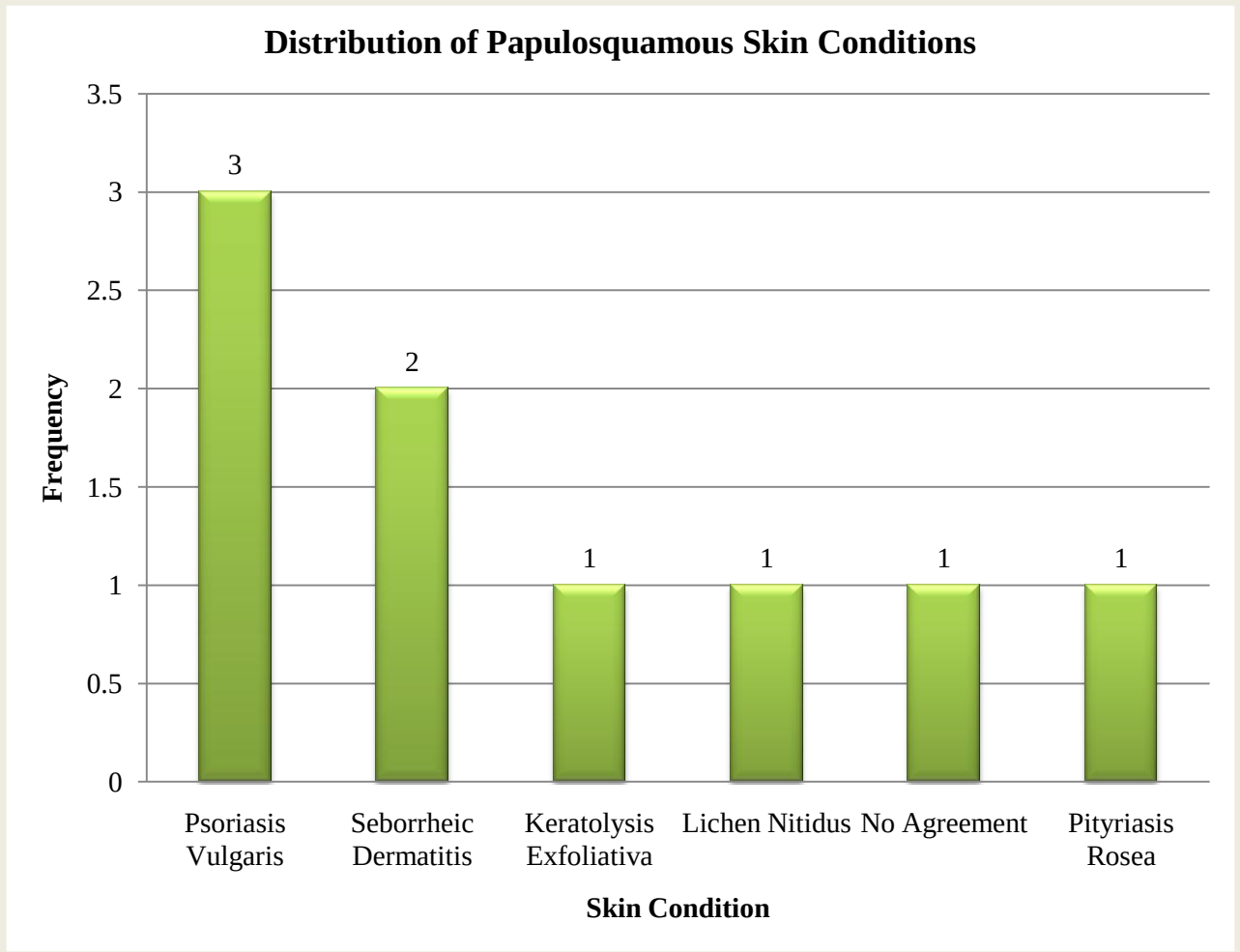


Table 4.13a: Distribution of Specific Skin Conditions

Condition Category	Specific Condition	n	Within Category %	Overall %
Other				
	Acne Vulgaris	3	50%	2%
	Friction Blister	1	17%	1%
	No Agreement	1	17%	1%
	Rosacea	1	17%	1%
Bites, Stings & Infestations				
	Scabies	3	60%	2%
	Insect Bite Reaction	2	40%	2%
Vascular				
	Venous Ulcer	3	75%	2%
	Urticaria	1	25%	1%

Note: 'Within Category' refers to the construct of a dermatologic category (i.e., Dermatitis), where in, which specific dermatologic conditions (i.e., atopic dermatitis) are categorized. 'Overall' refers to the representation of a specific condition in one category among the total number of specific conditions from several categories.

Appendigeal, Tumors, Genodermatoses, Connective Tissue, Nutrition, Endocrine & Metabolic, and Photobiology

The final categories make up the remaining 12% and are mostly of equal representation (Table 4.13b). Alopecia areata (2, 2%), miliaria rubra (1, 1%) were the only appendigeal conditions. Tumors were a Beckers nevus (1, 1%), intradermal nevus (1, 1%) and lipoma (1, 1%). Icthyosis vulgaris (1, 1%) and keratosis pilaris (1, 1%) were the only genodermatoses. There was one connective tissue condition, a hypertrophic scar (1, 1%). Acanthosis nigricans (1, 1%) was the only condition associated with possible metabolic anomalies. Photodermatitis (1, 1%) and sun burn (1, 1%) were the photobiological conditions represented.

Interobserver Diagnostic Agreement

Each teledermatologists recorded their diagnosis and management recommendations, independent of one another, on the Request For Diagnosis (RFD) form, as described in Chapter 3. The volunteer dermatologists returned a diagnosis for 130 dermatologic conditions on 105 patients (1.2 diagnosis per patient) to the lead study investigator. Each teledermatologists rendered either a single diagnosis or multiple differential diagnoses. For the analyses of diagnostic agreement, any form of agreement, partial or complete, was defined as the correct diagnosis. Diagnostic agreement had three possibilities. If all three dermatologists agreed on a diagnosis, this is taken to mean complete agreement. If two of the three dermatologists agreed on a diagnosis, this is partial agreement. If none of the dermatologist agreed on a diagnosis, this was complete diagnostic disagreement. Diagnostic Agreement was measured by calculating the percentage represented by one of the three diagnostic possibilities. Complete agreement was reached in 106 (82%) of the single most likely diagnosis of the skin condition category (Table 4.14).

Table 4.13b: Distribution of Specific Skin Conditions

Condition Category	Specific Condition	n	Within Category %	Overall %
Appendigeal				
	Alopecia Areata	2	67%	2%
	Miliaria Rubra	1	33%	1%
Tumors				
	Beckers Nevus	1	33%	1%
	Intradermal Nevus	1	33%	1%
	Lipoma	1	33%	1%
Genodermatoses				
	Icthyosis Vulgaris	1	50%	1%
	Keratosis Pilaris	1	50%	1%
Connective Tissue				
	Hypertrophic Scar	1	100%	1%
Nutrition, Endocrine & Metabolic				
	Acanthosis nigricans	1	100%	1%
Photobiology				
	Photodermatitis	1	50%	1%
	Sun Burn	1	50%	1%

Note: 'Within Category' refers to the construct of a dermatologic category (i.e., Dermatitis), where in, which specific dermatologic conditions (i.e., atopic dermatitis) are categorized. 'Overall' refers to the representation of a specific condition in one category among the total number of specific conditions from several categories.

Complete agreement increased to 112 (86%) with the two additional diagnostic possibilities. Partial agreement occurred in 24 (18%) instances. Partial agreement decreased to 18 (14%) with the two additional diagnostic possibilities. There were no instances of complete diagnostic disagreement when considering skin condition category. In other words, there was some form of agreement, complete or partial, in 130 (100%) of the diagnoses rendered for the skin condition category.

When looking at the single most likely diagnosis of a specific dermatologic condition, complete agreement occurred in 101 (78%) instances (Table 4.15). Complete agreement increased to 107 (82%) with the two additional diagnostic possibilities. Partial agreement occurred in 27 (21%) instances. Partial agreement decreased to 21 (14%) with the two additional diagnostic possibilities. There were 2 (2%) occurrences in which there was complete disagreement. To place this in perspective regarding the diagnosis of 130 conditions, there was some form of agreement, complete or partial, in 128 (98%) instances.

Table 4.14: Dermatologic Category Diagnostic Agreement

Description of Agreement	Dermatologic Category Diagnosis (n, %)		Dermatologic Category Diagnosis with Differential (n, %)	
3/3	106	82%	112	86%
2/3	24	18%	18	14%
None	0	0%	0	0%

Note: 3/3 refers to complete diagnostic agreement among three teledermatologists. 2/3 refers to diagnostic agreement among two of the three dermatologists. 'None' refers to no diagnostic agreement among the three dermatologists. Differential refers to the inclusion of two additional diagnostic possibilities.

Table 4.15: Specific Dermatologic Condition Diagnostic Agreement

Description of Agreement	Specific Dermatologic Condition Diagnosis (n, %)		Specific Dermatologic Condition Diagnosis with Differential (n, %)	
3/3	101	78%	107	82%
2/3	27	21%	21	16%
None	2	2%	2	2%

Note: 3/3 refers to complete diagnostic agreement among three teledermatologists. 2/3 refers to diagnostic agreement among two of the three dermatologists. 'None' refers to no diagnostic agreement among the three dermatologists. Differential refers to the inclusion of two additional diagnostic possibilities.

Diagnostic Confidence

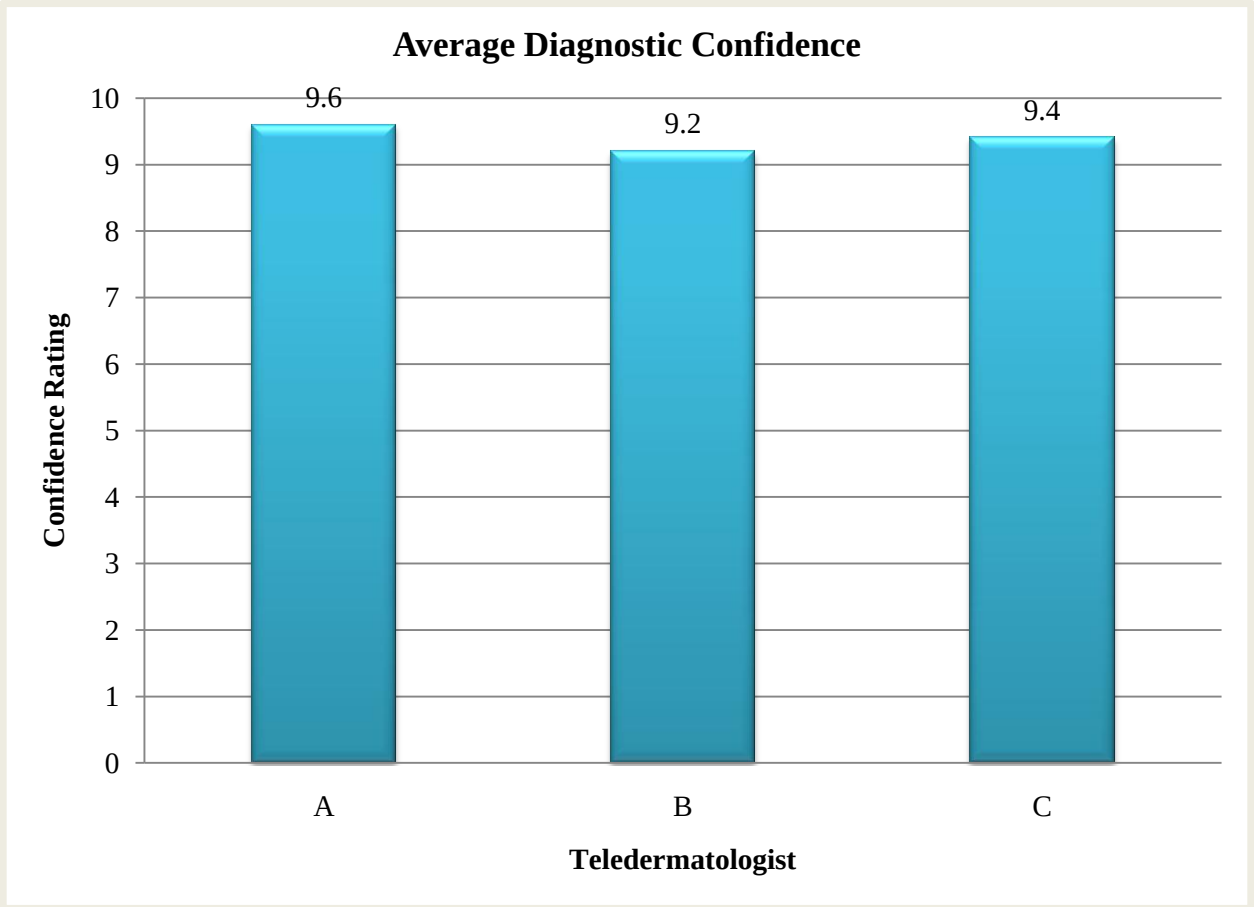
Three volunteer dermatologists using a scale of 0 to 10 rated their diagnostic confidence for each condition they diagnosed (with a rating of 0 meaning the dermatologist has no confidence in the diagnosis and a rating of 10 meaning the dermatologist has the highest confidence possible in the diagnosis). The teledermatologists returned a diagnosis for 130 dermatologic conditions on 105 patients to the lead study investigator. In terms of diagnostic confidence (Table 4.16, Figure 4.13), Teledermatologist "A" recorded an average confidence rating of 9.6 (SD = 1.0). Teledermatologist "C" recorded an average confidence rating of 9.4 (SD = 0.77). Teledermatologist "B" recorded an average confidence rating of 9.2 (SD = 1.2). When combining ratings from the three teledermatologists, the overall average confidence rating was 9.4 (SD = 0.20).

The relationship between diagnostic agreement and diagnostic confidence rating was also considered. For the dermatologic conditions that had no agreement, the average diagnostic ratings among the 3 teledermatologists was 7.8 (SD = 0.29). For the dermatologic conditions that had partial agreement, the average diagnostic ratings among the 3 teledermatologists was 9.2 (SD = 0.35). For the dermatologic conditions that had total agreement, the average diagnostic ratings among the 3 teledermatologists was 9.5 (SD = 0.20). To test the significance of these findings a One-way Analysis of Variance (ANOVA) was performed, which demonstrated statistical significance ($p < 0.05$).

Table 4.16: Average Diagnostic Confidence

Teledermatologist	Average Diagnostic Confidence
A	9.6
C	9.4
B	9.2

Figure 4.13 Average Diagnostic Confidence



Technical and Procedural Image Quality

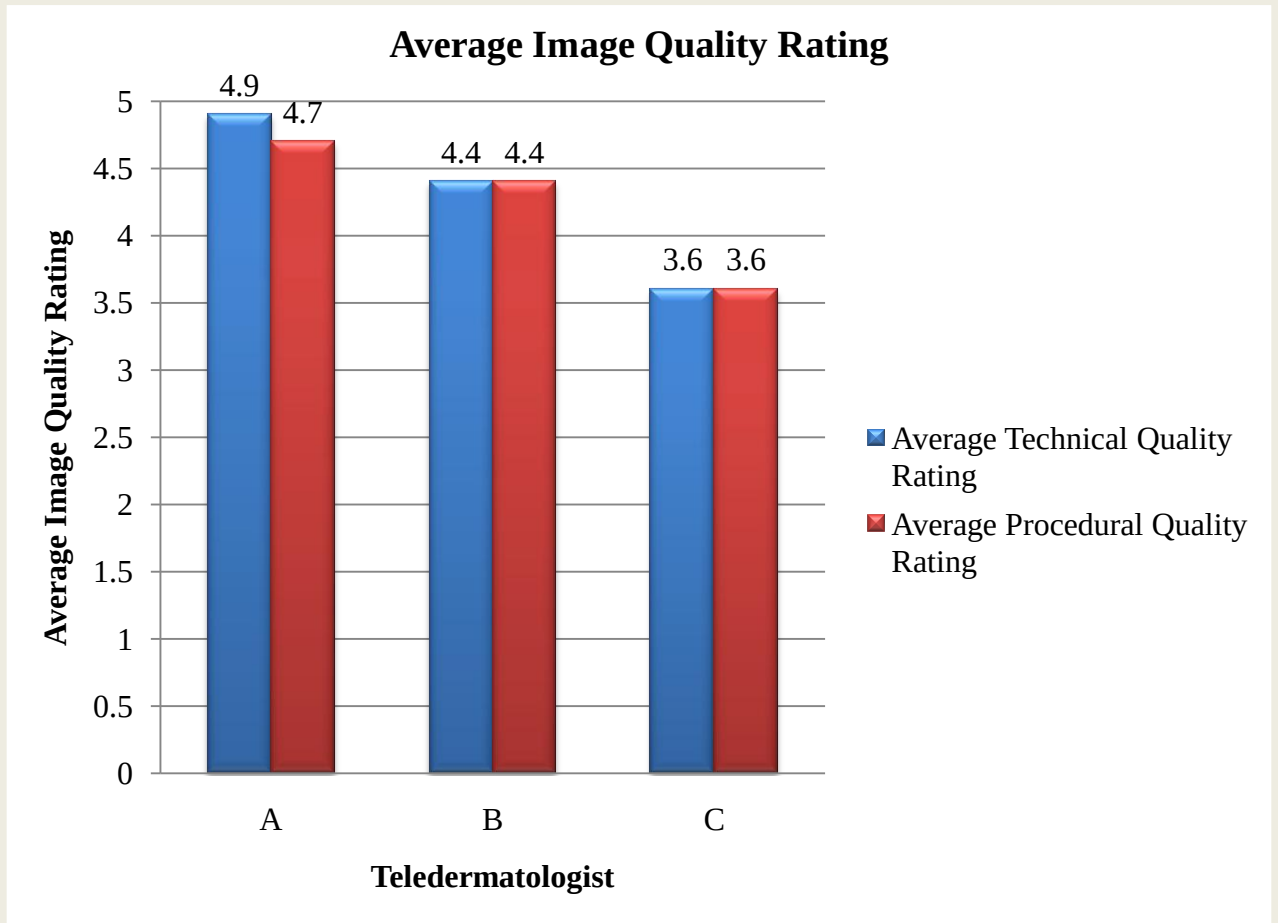
Three volunteer dermatologists rated image quality on a 5-point Likert-type scale (with a rating of 1 meaning "very poor/no diagnostic value" and a rating of 5 meaning "very good/excellent diagnostic value"). Technical image quality refers to intrinsic factors such as image color and resolution. Procedural image quality refers to extrinsic factors such as image view point direction and lighting.

The volunteer dermatologists returned a diagnosis for 130 dermatologic conditions on 105 patients to the lead study investigator. In terms of image quality ratings (Table 4.17, Figure 4.14), teledermatologist "A" recorded an average technical quality rating of 4.9 (SD = 0.47) and average procedural quality rating of 4.7 (SD = 0.58). Teledermatologist "B" recorded an average technical quality rating of 4.4 (SD = 0.76) and average procedural quality rating of 4.4 (SD = 0.73). Teledermatologist "C" recorded an average technical quality rating of 3.6 (SD = 0.54) and average procedural quality rating of 3.6 (SD = 0.54). When combining ratings from the three teledermatologists, the overall average technical quality rating of 4.3 (SD = 0.65) and overall average procedural quality rating of 4.2 (SD = 0.57). There was a high positive correlation between technical and procedural ratings (r = 0.94).

Table 4.17: Average Image Quality Rating

Teledermatologist	Average Technical Quality Rating	Average Procedural Quality Rating
A	4.9	4.7
B	4.4	4.4
C	3.6	3.6

Figure 4.14: Average Image Quality Rating



The relationship between diagnostic agreement and image quality rating was also considered. For the dermatologic conditions that had no agreement (n = 2), the average technical and procedural ratings among the 3 teledermatologists were 3.7 (SD = 0.47) and 3.7 (SD = 0.00), respectively. For the dermatologic conditions that had partial agreement (2 of 3 in agreement), the average technical and procedural ratings among the 3 teledermatologists were 4.3 (SD = 0.35) and 4.2 (SD = 0.43), respectively. For the dermatologic conditions that had total agreement, the average technical and procedural ratings among the 3 teledermatologists was 4.3 (SD = 0.41) and 4.2 (SD = 0.45), respectively.

Patient Satisfaction

Fifty-four patients (75%) from the JMA Clinic returned to the clinic for follow-up, after which they completed a survey (Appendix E1). The survey used a 5-point Likert-type scale and asked patients to rate their satisfaction on the timeliness of their visit, and overall experience with store-and-forward (S&F) teledermatology. The satisfaction rating scale was 1 (very dissatisfied) to 5 (very satisfied). Regarding the timeliness of their visit, 50 patients (93%) were very satisfied (table 4.18). Forty-nine patients (91%) were very satisfied with their overall teledermatology experience.

Based on their experience with the current study, patients were asked to respond to their likelihood of future use of S&F teledermatology, of recommending this modality to a family member and on the utility of teledermatology in an underserved area. The rating scale was 1 (strongly unfavorable) to 5 (strongly favorable). Forty-seven patients (87%) indicated that they would use it again if given the opportunity and 48 patients (89%) would recommend teledermatology to a family member (Table 4.19). Forty-seven patients (87%) indicated that teledermatology has great utility.

In terms of satisfaction, patients recorded an average rating 4.8 (SD = 0.93) for timeliness and 4.7 (SD = 1.1) for overall satisfaction (Table 4.20, Figure 4.15). For likelihood of future use of, and recommending S&F teledermatology, patients recorded an average rating of 4.8 (SD = 0.62) and 4.8 (SD = 0.61), respectively. Regarding the utility of teledermatology in an underserved area, patients recorded an average rating of 4.8 (SD = 0.47).

Table 4.18: Patient Satisfaction Rating

Satisfaction Rating	Timeliness (n, %)		Overall (n, %)	
1. Very Dissatisfied	3	6%	4	7%
2. Dissatisfied	0	0%	0	0%
3. Indifferent	0	0%	1	2%
4. Satisfied	1	2%	0	0%
5. Very Satisfied	50	93%	49	91%

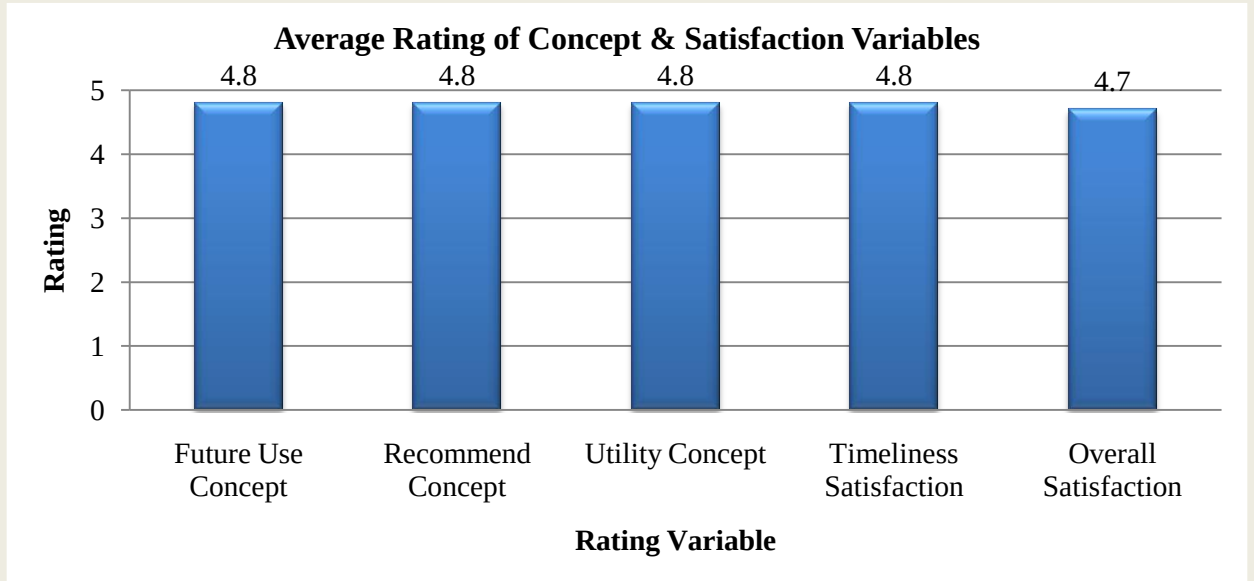
Table 4.19: Patient Concept Rating

Concept Rating	Future Use (n, %)		Recommend (n, %)		Utility (n, %)	
1. Strongly unfavorable	1	2%	1	2%	0	0%
2. Unfavorable	0	0%	0	0%	0	0%
3. Undecided	0	0%	0	0%	2	4%
4. Favorable	6	11%	5	9%	5	9%
5. Strongly favorable	47	87%	48	89%	47	87%

Table 4.20: Average Rating of Concept and Satisfaction Variables

Description	Average Rating
Future Use Concept	4.8
Recommend Concept	4.8
Utility Concept	4.8
Timeliness Satisfaction	4.8
Overall Satisfaction	4.7

Figure 4.15: Average Rating of Concept and Satisfaction Variables



Teledermatologist Satisfaction

Three U.S. board certified dermatologists assisted with this study as teledermatologists. They provided the single most likely diagnosis and therapeutic management recommendations for 130 dermatologic conditions. Additionally, when applicable, they provided 2 alternate diagnoses. After the teledermatology study was completed, the 3 teledermatologists responded to a survey (Appendix F) by using a 5-point Likert-type scale. Table 4.21 portrays the teledermatologists post-study survey response. Using a knowledge rating scale was 1 (no knowledge) to 5 (expert), the prestudy ratings were one physician as 'knowledgeable'(3) and two physicians with 'some knowledge' (2). The average prestudy knowledge rating was 2.3. Regarding post-study knowledge levels, two physicians indicated 'very knowledgeable' (4) and one physician 'knowledgeable' (3). The average poststudy knowledge rating was 3.7.

The physicians also responded to the utility of teledermatology to provide patient care in underserved areas, and as a learning modality for dermatology residents. Again, this was a five point rating scale (1 = strongly unfavorable to 5 = strongly favorable). For each utility, one physician was 'strongly favorable' (5), while two physicians were 'favorable' (4), giving an average rating of 4.3. Regarding interest to participate in a future teledermatology study, two physicians were 'strongly favorable' (5), while one physician was 'undecided' (3), also yielding a 4.3 average rating. When asked about integration of teledermatology into their current practice model, each physician responded differently with 'strongly favorable' (5), 'favorable' (4) and 'unfavorable' (2), an average rating of 3.7.

Based on their experience with the current study, using a 5-point rating scale (1 = very dissatisfied to 5 = very satisfied), two physicians rated their satisfaction regarding data transfer quality as 'very satisfied'(5) and one physician was 'satisfied'(4), providing an average rating of

4.7. Regarding time requirement, each physician responded differently with ‘very satisfied’ (5), ‘satisfied’ (4) and ‘indifferent’ (3), for an average rating of 4.0. Two physicians indicated that overall satisfaction was ‘very satisfied’ (5), while one physician was ‘indifferent’ (3), providing an average rating of 4.3.

Rating their overall diagnostic confidence (1 = very poor to 5 = very good), one physician recorded ‘very good’ (5) and two physicians recorded ‘good’ (4) for an average rating of 4.7.

Regarding the written patient clinical information provided, two physicians felt the data provided on each patient was ‘very helpful’ (4) in reaching their diagnosis, while one physician felt the data was ‘helpful’ (3), providing an average rating of 3.7. This was based on a rating scale of ‘not helpful’ = 1 to ‘could not have made diagnosis without data’ = 5.

The physicians also recorded the average time needed to review the patient data and render diagnosis and treatment recommendations for each condition. Times recorded were ‘1 - 5 minutes’, ‘6 – 10 minutes’, and ’11 – 15 minutes.

The teledermatologists were asked to provide recommendations for replication of the current study. To facilitate the tasks of recording diagnosis and treatment recommendations, it was suggested that a software program or a standardized form be created. Limiting the number of digital images for each condition to 3 or 4 was also suggested. To improve treatments, it was recommended that the medication formulary be expanded and updated.

The trends provide insights into patient demographics of those presenting with skin conditions to the JMA Clinic and satellite sites. The skin condition types, diagnostic agreement, image quality, and patient and physician satisfaction are also described. Characterizing these unique findings warrants a discussion that considers potential contributors. Understanding these

factors will allow for effective and efficient solutions to be constructed, resulting in a higher standard of dermatologic care to be delivered in this setting.

Table 4.21: Post-study Teledermatologist Survey Response

Teledermatology Description	Teledermatologist A	B	C
Knowledge Before Study†	Knowledgeable	Some knowledge	Some knowledge
Knowledge After Study†	Very Knowledgeable	Very Knowledgeable	Knowledgeable
Utility For Patient Care††	Strongly favorable to concept	Favorable to concept	Favorable to concept
Utility For Resident Learning††	Strongly favorable to concept	Favorable to concept	Favorable to concept
Interest To Participate In Future Study††	Strongly favorable to concept	Strongly favorable to concept	Undecided
Integration Into Current Practice Model††	Favorable to concept	Strongly favorable to concept	Unfavorable to concept
Average Time Needed For Recommendations	1 - 5 minutes	6 - 10 minutes	11 - 15 minutes
Overall Diagnostic Confidence†††	Very good	Good	Good
Helpfulness of Clinical Information††††	Very helpful	Very helpful	Helpful
Satisfaction of Data Transfer†††††	Very satisfied	Very satisfied	Satisfied
Satisfaction of Time Requirement†††††	Very satisfied	Satisfied	Indifferent
Overall Experience Satisfaction†††††	Very satisfied	Very satisfied	Indifferent

Note: Responses consists of 5-point Likert-type scale. †None to Expert. ††Strongly unfavorable to Strongly favorable. †††Very poor – Very good. ††††Not helpful – Could not have made diagnosis without data. †††††Very dissatisfied – Very satisfied.

Chapter 5

Discussion

Clinic Census

The JMA Clinic census revealed approximately 20% of patients presented with a skin condition. This demonstrates the need for dermatologic care in this particular setting. Many of these patients in the Tegucigalpa area may have access to a primary care physician and less likely a dermatologist. Those in the villages of El Vino and Guajire aren't as fortunate, as for some, the only access to a physician is when medical mission teams visit their village. The need for dermatologic care is needed. Ideally, these patients would benefit from the expert opinion of dermatologists. Studies have shown that the diagnostic accuracy of dermatologists is superior to nondermatologist physicians, thus decreasing health care utilization and improved patient outcomes (Clark & Rietschel, 1983; Federman, Hogan, Taylor, Caralis, & Kirsner, 1995; Feldman, Fleischer, & Chen, 1999; Feldman, Fleischer, Young, & Williford, 1999). To illustrate the degree of this difference, reviewing several published studies, Federman, Concato, and Kirsner (1999) found that dermatology residents and attending dermatologists demonstrated a diagnostic accuracy of 93% , compared to 52% of nondermatologist physicians. The current study illustrates the potential of increasing the standard of care by bridging the gap between the expert opinion of dermatologists and patients in underserved areas with dermatologic conditions.

Patient Demographics

The majority of patients who presented with skin conditions were those of female gender (66, 63%) ages 1 to 10 years (33, 31%) and 26 to 35 (20, 20%). This is probably not much different in other locations and societies where women serve the role of house wife, while the husband works, and is less likely to take time off to visit the physician. Since there is lack of

data to explain the high percentage of female medical attention compared with male, it would be useful to poll communities to determine health care needs of males and strategies to address these needs in terms of clinic hours and services. For example, extending the clinic hours, special times for men's health, publicity on programs for men's health care or other strategies could be useful to address the working schedule of men who are often working from sun up to sun down; and to address any stigma of men taking time to go to clinic for health checkup and medical attention. These findings are significant for the dermatologist, as it is necessary to have an idea of the patient population due to dermatologic conditions that have gender and age group predispositions. Further, therapeutic management may change when treating a child or a female of reproductive age with unknown pregnancy status.

Various factors can be associated with skin disease. A limitation of this study is that the size of the sample is limited and need further study for conclusive associations between occupation and skin conditions. Of the sample population, the three most common occupations (child, housewife and student) represent 85% of the sample population. These occupations are less likely to be exposed to occupational hazards than a farmer or auto mechanic. In the U.S., work-related skin diseases account for approximately 50% of occupational illnesses (Adams, 1990). Industries in which workers are at highest risk include manufacturing, food production, construction, machine tool operation, printing, metal plating, leather work, engine service, and forestry (Adams, 1990). Contact dermatitis, which includes irritant contact dermatitis and allergic contact dermatitis, accounts for the majority of skin disorders acquired in the workplace. There is an interest by the lead investigator to perform a future larger study in this same setting, so that the relationship between occupation and dermatologic conditions can be evaluated.

In Chapter 1, it was reported that water quality tests in Honduras were reported to have shown that only 44% of the water provided is effectively disinfected and that there is a lack of adequate water quality control and monitoring, especially in rural areas (Water For People [WFP], n.d.). Although, no published studies could be found correlating untreated water with increased skin infections, it is generally accepted that provision of an adequate quantity of safe water are basic necessities for the maintenance of good health. Many of the patients, particularly those in rural areas are dependent on groundwater for their drinking water. Arsenic naturally occurs in the environment and can get into drinking water supplies drawn from groundwater. Modern water treatment systems have demonstrated great effectiveness and efficiency with removal of arsenic from drinking water. Many people rely on groundwater, particularly those in underserved areas of developing countries. Arsenic has also been shown to cause several types of cancer, including skin cancer (Smith, 1992). A consideration for a future study would be to investigate the water quality from the end water source of patients at the JMA Clinic and satellite sites.

Very few patients reported using sunscreen (7, 7%). Persons with darker skin tones have inherent sun-protecting properties. For example, in African American skin, melanin provides a sun protection factor (SPF) approximately equivalent to 13.4, compared to 3.4 in white skin (Gloster & Neal, 2006). Perhaps those from Latin American backgrounds have a natural SPF between that of black skin and white skin; however, they are still at risk for skin cancer. In the U.S., skin cancer is the most common cancer in persons of Hispanic ethnicity. The incidence of skin cancer is even higher among Hispanic populations living in sunnier climates of New Mexico and Arizona (Gloster & Neal, 2006; Harris, Griffith, & Moon, 2001). Thus, although the natural dark skin tone of many Hondurans afford some protection, it is not sufficient to offer complete

protection from skin cancer. Many of these patients are in the sun several hours each day. Unfortunately, for most Hondurans, acquiring sunscreen is cost prohibitive. At a Tegucigalpa supermarket, a 240 milliliter bottle of Hawaiian Tropic® SPF 45 sunblock cost $25 USD. This same product cost $9 USD on Amazon.com. With an estimated U.S. dollar per capita income of $4,100 USD (CIA, 2010), this product will be difficult for most Hondurans to afford.

Previous Treatment Received and Prior Dermatologist Visit

Understanding the most common complaints or symptoms may provide guidance for the procurement of most useful medications to be kept at the JMA Clinic pharmacy and to have on hand when on a medical mission trip in this setting. The most common chief complaint was itchiness (68, 37%) and pain (2, 1%) being the least. This information will allow consideration of the most appropriate quantities of various types of medication when going into this setting to treat patients with dermatologic conditions. This will be variable by clinic site, which cannot be fully determined by limitations of this study; thus replication of this study is suggested.

Considering the chief complaint duration, 44% of patients have lived with their condition for greater than 1 year. The majority of representation was from skin condition categories dermatitis, pigmentary and infectious. From these categories, atopic dermatitis, melasma, and tinea pedis were most common. It was also previously presented that the number of patients who received prior treatment for their condition was 30%. In this segment of the sample population, dermatitis, infectious and papulosquamous conditions were most common. The average complaint duration was 92 weeks, approximately 25% longer than the complaint duration of the overall sample. It seems that patients who have previously sought medical treatment have longer complaint durations. There are several factors that could explain this. Most of these patients are seeing nondermatologists for their dermatologic care. As described previously, the diagnostic

accuracy of nondermatologist is not equal to dermatologists, thus leaving some patients with an incorrect diagnosis and treatment. Perhaps, they receive the correct diagnosis and treatment, but they aren't able to afford their medication. Maybe these patients have medication but they are not compliant. While there are several factors that likely contribute to the long complaint duration, there are factors that may play a greater role than another, such as the limited access to healthcare. Many patients of the JMA Clinic are dependent on others for transportation to the clinic, or public transportation, which may not be affordable. For many in the villages, their receipt of healthcare is dependent on medical mission teams.

Description of Most Common Encountered Skin Conditions

The skin condition categories that were most common overall were dermatitis, infectious and pigmentary. This same pattern was recognized when examining the conditions associated with complaint duration greater than 1 year. These conditions are commonly encountered in a U.S. dermatology clinic. However, the setting in which this conditions occur is different between the U.S. and Honduras. To understand the challenges that the Honduran patients are faced with, a brief description of three of the most common conditions is provided. A thorough discussion of these conditions is beyond the intentions of this chapter. However, a general overview has been provided to illustrate the complexity of the condition and treatments.

In the current study, atopic dermatitis (AD) was the most common dermatitis. This is a complex condition, which has resulted in entire reference books. The cause of atopic dermatitis is unknown, although it is thought to be multifactorial, including genetic predisposition. Environmental factors such as temperature extremes, cold or hot, can contribute. AD is commonly described as an itch that rashes, as the condition starts with itching. Abnormally dry skin and a lowered threshold for itching are important features of AD. It is more common in

infants and children, with the majority of patients developing AD before they reach 5 years. AD requires constant oversight by the parent and regular follow-up visits to the physician due to the intermittent and unpredictable nature of the flare and remissions. Central to the treatment of AD are moisturizing agents (i.e., ointments and creams) and topical corticosteroids. There are a variety of topical steroids of different strengths and types (i.e., creams, ointments) from which to choose. The primary decision as to which steroid to use, is based on the age of the person and the location needing treatment. To achieve this level of care in Honduras would be challenging. Most patients are not able to afford Vaseline or creams. Further, while this condition can be uncomfortable and predispose to skin infections, it may not be a primary consideration when larger issues are at hand, such as having enough resources to feed the family. However, the small effort of supplying patients with a tub of Vaseline to apply to the affected areas, particularly after bathing, could significantly help to reduce symptoms and improve the condition.

Melasma is a common acquired pigmentary disorder that occurs mainly in women. While the cause of melasma is unknown, genetic predisposition, ultraviolet light exposure, and estrogen exposure are thought to be important contributors. Estrogen is thought to induce melasma, as it often develops during pregnancy and with use of exogenous sources such as oral contraceptives.

Melasma presents as brown to grey macules and patches on areas of the sun exposed face, such as the cheeks, nose and upper lip. Although melasma poses no direct health risks, the disfigurement can significantly affect psychological and social wellbeing, contributing to lower productivity, social functioning, and self-esteem (Anderson & Rajagopalan, 1997). Treatment options consist of hydroquinone cream and sun protection. Without a strict regimen of sun block application and minimizing sun exposure, the hydroquinone will have limited benefit. This

combination therapy is used every day until the desired results are achieved, which could take several months. Patients in this study, diagnosed with melasma, were relieved to finally learn of their condition. Unfortunately, the majority of these patients will not be able to afford therapy for reasons previously discussed.

Tinea pedis and onychomycosis were the most common infectious conditions in the sample population. Tinea pedis is a fungal infection of the feet most commonly caused by *Trichophyton rubrum.* This dermatophyte invades and is limited to the most superficial layer of the skin. Tinea pedis is very common, particularly in hot, humid, tropical environments. Prolonged use of occlusive footwear, with the resulting complications of hyperhidrosis and maceration, are risk factors for tinea pedis. Tinea pedis manifests as itching and scaling of the feet and, often, painful fissures between the toes. If not treated, this infection can spread to the hands and toe nails (onychomycosis), or lead to secondary bacterial infections. Tinea pedis can easily spread to family members. Onychomycosis results in discoloration, thickening and dystrophy of toenails. Most often, this is a cosmetic nuisance than a direct threat to health. Tinea pedis is usually easy to treat with topical antifungals and can take weeks of daily application for cure. However, with onychomycosis, topical antifungals are not very effective and patients will need to take an oral antifungal for several months. This therapy needs to be monitored and blood tests followed, as some oral antifugals can stress the liver. Recurrence of tinea pedis is often due to a patient's discontinuance of medication after symptoms abate.

Vascular related dermatologic conditions were less common. However, in this setting, there is one condition that deserves attention. Venous leg ulcers are ulcers of the lower leg, most commonly on the medial aspect of an ankle, and are the result of reduced tissue oxygen levels caused by venous hypertension and stasis (i.e., compromised blood flow). Contributing factors

include obesity, trauma and diabetes mellitus. Appropriate management includes vascular studies to exclude arterial disease and to assess superficial venous reflux to look for venous incompetence. Bacterial culture of the ulcer is necessary to determine the most appropriate antibiotic. Stage-adjusted management of ulcer with moist wound therapy with goals of cleaning and healing encouragement are needed. Firm compression bandages, such as an unna boot (zinc paste impregnated bandage wrap) helps with venous hypertension and healing of the ulcer. Venous ulcers that go unmanaged are at risk of super-infection. In time, this can lead to infection spreading to the bone necessitating lower limb amputation. The goal is to start management of these ulcers early. This can be a challenge when patients do not have access to even the most basic forms of healthcare.

Interobserver Diagnostic Agreement

In rendering a diagnosis, clinicians rely on several sources of information, including the patient presentation, medical history, physical exam and clinical experience. However, there may not always be enough information, and clinicians have become accustomed to making decisions with limited information. Relative to in-person consultations, there is a reduction in available data with teledermatology. In the current study, for each patient, the teledermatolosist received a brief history of the complaint, medical history (i.e., social history, comorbidities and current medications), and digital images of the condition. The documentation that the teledermatologist received on each patient was not much different than that of an in-person exam. However, dermatology is a field that employs visual qualities such as spatial, texture and color features. Enhancing the visual experience, touch allows for determination of depth beyond the skin's surface. Touch provides further discernment on the texture of a condition, as well as physical properties such as temperature. It is essential for the information sent to the

teledermatologist to capture as much of this as possible. In Chapter 2, a S&F teledermatology study by Oztas et al (2004) demonstrating that access to clinical history improves diagnostic agreement was presented. Also in Chapter 2, another S&F teledermatology study (High et al, 2000) found that the image quality had a direct correlation with diagnostic agreement. An accurate diagnosis is dependent on the quality of images and how well they provide representation of the condition, and on a good history and detailed physical exam. Therefore, the lead investigator invited feedback on ways to improve throughout the study. For example, early in the study, feedback suggested that focal length (i.e., distance between lens and focal point) needed to be increased to achieve better resolution. The change was made and improvement was noted by higher image quality ratings. To be a safe and effective modality, the teledermatology process needs to demonstrate acceptable levels of agreement between the teledermatologists. Further, as a safeguard to patients, there is often a healthcare provider (usually a primary care physician) that receives the diagnosis and management recommendations from the teledermatologists, who can coordinate efforts locally to ensure that the patient receives the most appropriate management. In Chapter 2, the diagnostic agreement among S&F teledermatology studies presented varied from 63% (Whited et al, 1999) to 89% (High et al, 2000). This current study achieved a 78% complete diagnostic agreement, which was further improved to 82% when factoring in the differential diagnoses. Regarding the diagnosis of 130 conditions however, there was some form of agreement, complete or partial, in 128 (98%) instances.

Diagnostic Confidence

Dermatologists, in general, have significant experience in making diagnoses from photographic images. However, this is often in a more controlled setting (i.e., lighting, background). The current study involved international transmission of images taken in a less

controlled setting. For example, the type and amount of room lighting was not always consistent. Also, the teledermatologists had little access to additional diagnostic information such as that provided by performing skin scrapings and viewing this under the microscope, or the results of a Woods lamp test. The diagnostic confidence rating provides the teledermatologist opportunity, after considering the medical information and images for each patient, to rate their level of confidence. In other words, it is a reflection of how certain the dermatologist felt about their diagnosis. The teledermatologists in this study had a wide rating scale (0 to 10). The ratings ranged from 9.2 to 9.6. The overall average rating was high (9.4) and with little variation (±0.20), which presents a strong case for the viability of S&F teledermatology. Elements such as room lighting, background color and photography experience affect the image quality. In theory, it would seem that if the images were not adequate in terms of technical or procedural quality, this could compromise the teledermatologists ability to render an accurate diagnosis, and therefore one with a high confidence rating. The relationship between diagnostic agreement and diagnostic confidence rating was considered. To test the significance of these findings a One-way Analysis of Variance (ANOVA) was performed, which demonstrated statistical significance ($p < 0.05$). This suggests that confidence ratings could provide useful information about the expected level of agreement. In situations where the confidence rating is below 8.0 (i.e., 80% confident), it may be advisable for the patient to receive a second opinion or have a biopsy performed.

Technical and Procedural Image Quality

As previously described, there are many factors that can affect image quality. In this study, the lead investigator took all photographs and used the same camera. The images of the dermatologic conditions maintained a spatial resolution of 1600 x 1200 pixels, with 24-bit color

resolution. Limiting the pixel count close to the visual threshold can offer a faster transmission time and less needed storage space. However, a higher pixel count was used to provide a resolution that would offer greater onscreen magnification without loss of sharpness. Several pictures of each condition were taken. There was effort by the lead investigator to begin each series of images with a general regional view of the affected area followed by intermediate distance and close-up.

Separating the image quality rating by the technical and procedural parameters allowed for better understanding of the changes that were needed to achieve a higher quality image. If for example the procedural quality received a low rating, this allowed the lead investigator to improve by adjusting the shot angle or focal length for a particular condition type. The teledermatologists technical quality ratings averaged 4.9 to 3.6. For procedural quality, the teledermatologists ratings averages ranged 4.7 to 3.6 on a five point rating scale. There was a high positive correlation between technical and procedural ratings ($r = 0.94$). Images with good procedural ratings generally received good technical ratings. The overall rating averages for technical and procedural quality were high, 4.3 and 4.2, respectively. There are differences between the ratings provided by each physician. Each physician received the same images and patient information, so the technical aspect remained consistent. Therefore, a likely contributor is individual differences in interpretation of the image quality or personal style on using the rating scale. However, regardless of what the contributing factors may be, the ability of the physicians to receive and interpret the data led to a 78% diagnostic agreement.

Patient Satisfaction

Patient satisfaction constitutes an important aspect of quality of care and is a key factor in evaluating the acceptance and therefore, the feasibility of teledermatology. Patient satisfaction

of his/her teledermatology consultation experience is important, as this information can be predictive of a program's success or failure. Regardless of any benefits that may be realized, patient dissatisfaction with this type of consult process would likely prevent successful implementation. The high satisfaction provides evidence for the viability and feasibility for use in the study setting.

The number of satisfaction reports, and thus the representation of the sample population, was dependent on the success of patient follow-up. Fifty-four patients (75%) from the JMA Clinic returned to the clinic for follow-up, after which they completed a satisfaction survey. Virtues of teledermatology are that it can reduce time needed for the patient to receive dermatologic care and overcome many of the issues that limit access to care. Regarding timeliness or wait time to receive dermatologic care, 93% of the patients were very satisfied, and 91% were very satisfied with their overall teledermatology consult experience. It seems unusual that 3 patients had such a strong dissatisfaction with their experience when there was such a strong level of satisfaction among the vast majority. The very few negative reaction observed by the researcher were attributed by the patient to a lack of a particular medication at the clinic pharmacy for a particular diagnosis. Many patients visit the clinic expecting the on-site clinic pharmacy to have their prescribed therapy. When this does not happen, patients will need to use an outside pharmacy at an increased financial cost. So, while they are pleased to have their diagnosis and treatment, they are less than satisfied that the on-site pharmacy does not have their treatment. While this observation does not have a statistical reference point, it is the most plausible explanation for the few negative reactions and one which by nature of the reason not directly associated with Teledermatology. The overwhelming attitudes of patients were that teledermatology has great utility in this setting, and not only would they would use this modality

again, but they would recommend it to a family member. As reported in Chapter 2, other studies have evaluated patient satisfaction (Weinstock et al., 2002; Kvedar et al., 1999; van den Akker et al., 2001; Williams et al., 2001), and have also reported high levels of patient satisfaction with the teledermatology consult process.

Teledermatologist Satisfaction

As just described, user satisfaction and acceptance are important to assess when considering the feasibility of teledermatology consult systems. Teledermatology will be better accepted as a standard treatment modality if it is acceptable to patients and physicians. Regardless of its clinical performance, if teledermatology is perceived by patients or clinicians to be unacceptable, the data results could be affected, or affect implementation.

The three teledermatologists participating in the current study have a combined experience as dermatologists of approximately 60 years and are currently in practice full-time. All three physicians reported that their knowledge of teledermatology increased, with the most significant gain being 'some knowledge' prestudy to 'very knowledgeable' poststudy. Each physician felt that teledermatology has utility in patient care and medical education. Educational benefits of teledermatology have been described in the literature in the training of medical residents (Williams et al., 2005). Two of the three physicians indicate great interest in participating in a future teledermatology study. Integration of teledermatology into the current practice model had mixed responses with this limited sample of 3, with 2 of the 3 physicians being mostly favorable to the concept. Regarding the current study, two physicians were very satisfied with their overall experience. Potential explanations that would warrant further study is the personal styles and preferences of physicians. For example, preferences regarding use of technology, ability for direct interaction with patients, and personal touch that is afforded during

an exam. This may explain the differences in the physicians rating their overall satisfaction and interest with future study participation. This is consistent with other studies in which the dermatologist consultants have reported positive experiences with teledermatology (Gilmour et al., 1998; Lowitt et al., 1998; Jones et al., 1996). In the current study, all physicians were satisfied with the quality of data transfer, and indicated that the patient clinic data was helpful in formulating their diagnosis and treatment recommendations. Oztas et al (2004) demonstrated the value of having patient clinical history in rendering a diagnosis via S&F teledermatology consultations. The time needed to review the patient data and render diagnosis and treatment recommendations for each condition varied from 1 to 15 minutes.

As previously described, patient and physician satisfaction assessments suffer from the absence of a reliable and validated instrument that can be used for teledermatology consultations. The existing data on satisfaction is primarily anecdotal and derived from questionnaires proprietary to the individual study.

To facilitate their performance, teledermatologists recommended that future studies include an expanded and updated formulary, and standardized forms or software be used. Perhaps, a solution to this is a secure internet-based server (i.e., multi-purpose communication platform) that could eliminate the need to download materials, and diagnosis and therapy recommendations could be logged directly on the patients' profile. Establishing these types of servers for a study can be cost prohibitive. To assist with this, the International and Appalacian Outreach Department at VCOM is investigating the establishment of institutional servers that could be used for medical education purposes and research. Although, not mentioned by the teledermatologists in the current study, in the literature, criticisms with teledermatology

modalities were usually concerned with picture quality and inability to palpate lesions or carry out diagnostic tests (Lowitt et al., 1998).

Conclusions

Teledermatology can be conducted using a variety of technologies and cost. The utility and feasibility of teledermatology in developing countries cannot be assumed, but requires evaluation in that specific setting. The present study is the only known teledermatology study to have been implemented in Honduras. Further, it may be the only study describing dermatologic conditions across all age groups. This study illustrates that teledermatology is a viable means of providing dermatologic care to those in an underserved area of Honduras, where a lack of or limited access to general healthcare or specialty dermatologic care exists. This study contributes to the broader efforts of bringing high-standard dermatologic care to similar underserved communities around the globe.

The need for dermatologic care is substantiated by approximately 1 out of every 5 patients of the JMA Clinic presenting with a dermatologic condition. The majority of these patients were children or women in their late 20s and early 30s; many of whom had their condition for more than a year and most had not received prior therapy.

The types of dermatologic conditions that presented to the JMA Clinic and satellite sites was typical of that seen at a dermatology clinic in the U.S., yet inclusive of tropical and regional differences. Dermatitis, infectious and pigmentary conditions were the most common presentations. Whereas atopic dermatitis and pityriasis alba were the most common dermatitis, tinea pedis and onychomychosis were the most common infectious skin conditions. Melasma was the most common pigmentary condition.

The interobserver diagnostic agreement achieved was in the upper tier of the ranges reported in the literature. Diagnostic confidence ratings were high, with little variation and could be an indicator as to the expected level of agreement.

Image quality received high ratings, which contributed to the level of diagnostic agreement among teledermatologists. There was a high positive correlation between technical and procedural ratings.

The Honduran patients recorded a high level of overall satisfaction of store-and-forward teledermatology, which supports the feasibility of this modality in providing dermatologic care in this setting.

The teledermatologists indicated improved knowledge of teledermatology after this experience. They also recorded high ratings for the utility of teledermatology and agreed that this is a convenient, user-friendly way for them to provide dermatologic care to patients in underserved areas.

Recommendations

There are few existing studies in the literature that examine clinical outcomes of S&F teledermatology consult systems. A potential evolvement of the current study could investigate the patient therapeutic outcomes at various time intervals (i.e., weekly, monthly). Particularly, this would be beneficial for patients with chronic dermatologic conditions that pose greater health risks, such as those with venous ulcers of the lower extremities. Also, an outcomes study in the setting of Honduras would be the first such study in this setting using teledermatology, and could yield findings relevant for this modality of management to the rest of the developing world. With regards to the current study, in terms of evaluating the interobserver diagnostic agreement and feasibility of S&F teledermatology in the setting of Honduras, the findings add to the

accumulating evidence that teledermatology is a viable clinical tool that has the potential to increase the standard of healthcare in underserved areas around the globe.

For future studies, using a technology that combines video teleconferencing (real-time) and S&F technologies in each patient encounter (i.e., hybrid technology) could provide dditional benefits. For example, the teledermatologists could interact with the patient while performing an exam in real-time. During the exam, if the teledermatologist wanted to better visualize a lesion, high quality digital images are sent for immediate viewing.

The existing data on satisfaction assessments are primarily anecdotal and derived from questionnaires proprietary to the individual study. Validated instruments to assess patient satisfaction with S&F teledermatology do not exist. Studies that develop and validate satisfaction instruments will be important in advancing the current status of patient satisfaction with telemedicine research. It is the hope of the lead investigator that the findings of this study will be useful and that they may serve as a guide in formal instrument development and validation.

In general, the findings of this study demonstrate that S&F teledermatology is a feasible modality in an underserved setting of Honduras. Based on the findings and conclusions of this study, the following recommendations were developed for the future study, public health sector model development, and related areas:

1. To achieve a better representation of dermatologic conditions in the Honduran population, it would be desirable to have a larger sample for future studies. This would also provide the capability for associations or contributing factors to be drawn.

2. Future studies should be conducted in different settings; perhaps with a similar population in terms of socioeconomic level, ethnicity and other factors. Comparative studies looking at

dermatologic conditions in the urban versus rural setting, or between different villages would provide useful information. This can allow for the establishment of treatment formularies specific for each setting or determine a core treatment formulary. Understanding the differences (and similarities) would allow for potential associations or contributing factors (e.g., geographical, environmental) to be explored.

3. Future studies could also assist in the development and validation of satisfaction instruments, which will be important in advancing the current status of patient and physician satisfaction with telemedicine research.

4. To facilitate the delivery of patient materials and communication between the lead investigator and teledermatologists, a secure internet-based server (i.e., multi-purpose communication platform) could be helpful. This would save the teledermatologists time, as a server would eliminate the need to download materials, and diagnosis and therapy recommendations can be logged directly on the patients' profile.

5. To provide the teledermatologists with additional diagnostic information, a lab consisting of basic materials such as a microscope, slides and stains should be constructed and maintained. Reports of these exams could assist the teledermatologists in making a diagnosis.

6. Based on findings from this study, the JMA clinic and other similar health care units should review their formulary to meet needs from best available donations and supplement sources such as nongovernmental organizations.

7. Future research can build on this study to systematically develop a comprehensive research program that can over time link cause and effect on patient outcomes.

8. Future projects should continue to refine low-cost data manipulation and transmission methods pertinent to this form of teledermatology.

9. Given the success of this study and the reliability of telecommunications at the JMA Clinic, teledermatology, the ultimate progression could lead to this methodology being considered as a routine standard of care for patients with dermatologic presentations. Of course, this will depend on a variety of factors including preference and resources of those administering the clinic.
10. Based on this research, health officials in the Honduran Ministry of Health could explore telecommunications technology deployment in rural clinics to enhance the standard of health care in the region.
11. This model may be considered for implementation in other countries with similar conditions of underserved populations and limited access to dermatologic care.

This study of teledermatology illustrated the viability for future use based on factors and the sample within the research parameters. There are fertile opportunities for development of clinical practice with teledermatology and a positive trajectory for future research.

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Appendix A1

Patient Informed Consent Form (English)

Patient Informed Consent Form

EDWARD VIA VIRGINIA COLLEGE OF OSTEOPATHIC MEDICINE

Application and Evaluation of Teledermatology In An Underserved Area of Honduras

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I. Investigators' Statement

We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether to be in the study or not. Please read the form carefully. You may ask questions about the purpose of the research, the possible risks and benefits, and anything else about the research or this form that is not clear. When we have answered all your questions, you can decide if you want to be in the study or not. This process is called "informed consent." We will give you a copy of this form for your records.

II. Purpose of this Research/Project

This project is being directed by a physician working towards a graduate level academic degree in Global Health Leadership at a major American university. You have been chosen for this project because you or your child has a skin condition, which may/may not cause symptoms and may/may not need treatment. In the telemedicine studies, digital photography has been used successfully to diagnose and treat patients with skin disease. This project will help identify the most common skin diseases and test the feasibility of teledermatology in the setting of the James

Moody Adams Clinic. There will be approximately 80 to 120 patients involved in this study from a variety of age groups and both genders.

III. Procedures

If you choose to participate, you or your child will have a skin exam and have digital images taken of your skin condition. After you are examined and digital photos of your skin condition are obtained, please return to the clinic within 48 hours for the results.

Should you or your child have a skin condition that we are unable to diagnose or treat, you will be referred to the nearest dermatologist or hospital dermatology department.

IV. Risks, Stress or Discomfort

Digital photography of the skin is a safe and painless way to capture an image(s) of your skin condition. However, there may be persons that may not be comfortable or feel emabrrased about being photographed. Should this be an issue with you, please inform us.

The exam duration will take 10 to 20 minutes, but could take more or less time depending on the complexity of the skin condition or the presence of other health problems. Not all skin conditions are harmful or need treatment. The physicians in this study may not be able to make a clinical diagnosis of you or your child's skin condition. In this case, you will be referred to the nearest dermatologist or hospital dermatology department.

V. Alternatives to Taking Part in this Study

If you or your child do not want to participate in this project, you will still be able to see a clinic physician for diagnosis and treatment.

VI. Benefits of the Study

No promise or guarantee of benefits has been made to encourage you to participate in this study. The societal benefits of the study include the advancement of knowledge regarding skin disease types and prevalence in Honduras. Also, the utility of teledermatology tested in this setting could serve as a model for future projects in Honduras and around the globe.

At the conclusion of the study, you may contact the investigators for a summary of the research results. For children who wish to learn of the research results, the parent/guardian must make the request.

VII. Extent of Anonymity and Confidentiality

Only you and your doctors will know the results. Your identity and other personal information will be kept confidential and will be stored in a locked room within the JMA Clinic. Personal information regarding this project will be destroyed before June 1, 2011.

Government staff or VCOM Institutional Review Board members sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, you records may be examined. The reviewers will protect your identity. The study records will not be used to put you at legal risk of harm.

Your identity in this study will be treated as confidential. The results of the study, including laboratory or any other data, may be published but will not give your name or include any identifiable references to you. However, any records or data obtained as a result of your participation in this study may be inspected by the persons conducting this study and/or The Virginia College of Osteopathic Medicine's Institutional Review Board, provided that such inspectors are legally obligated to protect any identifiable information from public disclosure, except where disclosure is otherwise required by law or a court of competent jurisdiction. These records will be kept private in so far as permitted by law.

VIII. Compensation

You are not being offered compensation by the investigators for participation in this study. Although your examination by your doctor will be free of charge, there may be therapies prescribed that you will need to pay for.

If you think you have an injury or illness related to this study, contact the study staff right away. The study staff will treat you or refer you for treatment. You will be responsible for the cost of such treatment.

IX. Freedom to Withdraw

Your participation is completely voluntary. If you want to stop your participation in this research project at a later date, you will still receive appropriate medical attention.

You are free to choose whether or not to participate in this study. There will be no penalty if you choose not to participate. You will be provided with any significant new findings developed during the course of this study that may relate or influence your willingness to continue participation. In the event you decide to discontinue your participation in the study, please notify the clinic physicians of your decision so that your participation can be terminated in an orderly fashion.

X. Subject's Responsibilities

I voluntarily agree to participate in this study. I have the following responsibilities*:*

1. If selected to participate in this study and have digital photos of my skin condition taken, I will return to the JMA Clinic within 48 hours for the results.
2. If my skin condition becomes worse during this time, I will return to the JMA Clinic. Should the clinic be closed, I will proceed to the nearest urgent care clinic or hospital emergency department for treatment.

XI. Subject's Statement

I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent:

"I have had all of my questions answered. I realize that I will receive a copy of this form. I hereby acknowledge the above and give my voluntary consent. I realize that my consent does not take away any legal rights. I give permission to the researchers to use my medical records as described in this consent form."

By signing below, I agree and realize that I will be participating in this study at my own risk. Further, by signing below, I hereby consent to participating in this study as described above.

_____ _____

Printed name of participant Signature of participant

_____

Date

When participant is a minor:

_____ _____

Printed name of parent Signature of parent

_____

Date

When subject is not able to provide consent:

_____ _____

Printed name of representative Signature of representative

_____

Date

_____

Relationship of representative to participant

Should I have more questions about this research or its conduct, research subjects' rights, or research-related injury, I may contact:

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For questions I may have about this study.

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For questions I may have about my rights as a research subject.

This Informed Consent is valid from 03/15/11 to 05/15/11 .

Appendix A2

Patient Consent Form (Spanish)

Formulario de Consentimiento Informado del Paciente

LA UNIVERSIDAD EDWARD VIA DE MEDICINA OSTEOPÁTICA

Adopción y Uso de Teledermatología para Mejorar el Estándar de Cuidado a Pacientes Dentro de una Comunidad Dominicana

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I. Declaración de los Investigadores

Le estamos pidiendo participar en un estudio de investigación. El propósito de este formulario de consentimiento es darle la información que usted necesite para ayudarle a decidir si quiere participar o no en el estudio. Por favor, lea cuidadosamente el formulario. Usted puede hacer preguntas sobre el propósito de la investigación, los riesgos y las ventajas posibles y cualquier otra pregunta que tenga acerca de la investigación o este formulario que no es clara. Cuando hayamos respondido a todas sus preguntas, usted puede decidir si desea participar o no en el estudio. Este proceso se llama "consentimiento informado." Le daremos una copia de este formulario para sus archivos.

II. Propósito de este Proyecto

Este proyecto está siendo dirigido por un médico que está trabajando para conseguir un título académico de nivel posgrado en el liderazgo mundial de la salud en una universidad americana principal. Usted ha sido elegido para este proyecto porque usted o su hijo tiene una condición de la piel que pueda o no causar síntomas y pueda o no necesitar un tratamiento. En estudios de la

telemedicina, la fotografía digital se ha utilizado con éxito para diagnosticar y tratar a los pacientes con enfermedades de la piel. Este proyecto ayudará a identificar las enfermedades de la piel más comunes y a probar la viabilidad de teledermatología en la clínica de JMA. Habrá aproximadamente 80 a 120 pacientes participando en este estudio de una variedad de grupos de edades y de ambos sexos.

III. Procedimientos

Si decide participar, usted o su hijo tendrá un examen de la piel y tendrá imágenes digitales tomadas de su condición de piel. Después de que le examinen y las fotos digitales de su condición de piel se obtienen, por favor regrese a la clínica en 2 días por los resultados.

Si su condición de piel llega a ser peor durante este tiempo, por favor regrese a la clínica. Si la clínica está cerrada entonces proceda al departamento urgente más cerca o el departamento de emergencias del hospital para recibir tratamiento.

IV. Los Riesgos, El Estrés o Malestar

La fotografía digital de la piel es una manera segura y sin dolor para capturar una imagen de su condición de piel. Sin embargo, hay personas que no se sienten cómodos o se sienten avergonzados de ser fotografiado. Si este es un problema con usted, por favor infórmenos.

La duración del examen tardará 10 a 20 minutos, pero podría tomar más o menos dependiendo de la complejidad de la condición de piel o la presencia de otros problemas de salud. No todas las condiciones de piel están dañosas o necesitan tratamiento. Los médicos en este estudio pueden o no ser capaz de hacer un diagnóstico clínico de su condición de piel o de su hijo. En este caso, le referirán al dermatólogo o al departamento de dermatología del hospital.

V. Alternativas a Participar en este Estudio

Si usted o su hijo no quiere participar en este proyecto, usted podrá ver a un médico de la clínica para diagnosis y el tratamiento de piel.

VI. Los Beneficios del Estudio

Ninguna promesa o garantía de las prestaciones se han hecho para animarle a participar en este estudio. Los beneficios sociales del estudio incluyen el avance del conocimiento sobre los tipos de enfermedad de la piel y la prevalencia en Honduras. También la utilidad de teledermatología probado en este proyecto podría servir como modelo para futuros proyectos en Honduras y en todo el mundo. En conjunto, estos ayudarán a mejorar la calidad de la atención en este contexto. Al final del estudio, puede comunicarse con los investigadores para obtener un resumen de los resultados de la investigación. Para los niños que deseen aprender de los resultados de la investigación, el padre o el guardián debe hacer la petición.

VII. Anonimato y Confidencialidad

Sólo usted y sus médicos sabrán los resultados. Su identidad y otros datos personales serán mantenidas confidencial y mantenidas en una habitación cerrada con llave dentro de la Clínica de JMA. La información personal con respecto a este proyecto será destruida en el plazo de un año de finalización del estudio.

El personal del gobierno o miembros de VCOM Institucional de Revisión al veces revisar los estudios como éste para asegurarse de que se están haciendo de manera segura y legal. Si hay una revisión de este estudio, sus registros pueden ser examinados. Los revisores protegerán su identidad. Los registros del estudio no se utilizarán para ponerle en un riesgo legal de daño.

Su identidad en este estudio será tratada como confidencial. Los resultados del estudio, incluyendo laboratorio o cualquier otro dato, pueden ser publicados pero no dará su nombre o incluirá ninguna referencia de identificación en su caso.

Sin embargo, los registros o datos obtenidos como resultado de su participación en este estudio pueden ser inspeccionados por las personas que conducen este estudio y / o el Colegio de Virginia de la medicina osteopática de la Institucional de Revisión, los inspectores son obligados legalmente de proteger cualquier información de identificación de divulgación pública, pero no cuando su divulgación es exigida por ley o una corte de la jurisdicción competente. Estos registros se mantendrán en privado en la medida permitido por la ley.

VIII. Remuneración

Los investigadores no le ofrecen una remuneración por la participación en este estudio. Aunque su exanimación de su doctor será gratis, es posible que las terapias recetadas tendrá que pagar usted mismo.

Si usted piensa que tiene una lesión o enfermedad relacionada con este estudio, contacte con el personal del estudio inmediato. El personal del estudio le tratará o le referirá para el tratamiento. Usted será responsable del coste de tal tratamiento.

IX. Libertad de retirase

Su participación es totalmente voluntaria. Si usted quiere parar su participación en este proyecto de investigación más adelante, usted todavía recibirá la atención médica apropiada.

Usted está libre de elegir si desea o no participar en este estudio. No habrá penalidad si decide no participar. Le proporcionarán cualquier nuevo resultado nuevo y significativo durante el curso de este estudio que pueda relacionar o influenciar su buena voluntad de seguir participando. En el caso de que decida suspender su participación en el estudio, por favor notifique a los médicos de la clínica de su decisión para que su participación pueda terminar en una manera ordenada.

X. Responsabilidades del participante

Acuerdo voluntariamente participar en este estudio. Tengo las responsabilidades siguientes:

1. Si es seleccionado para participar en este estudio y tiene fotos digitales tomadas de mi condición de piel, voy a volver a la Clínica de JMA en 2 días para los resultados.

2. Si mi condición de piel llega a ser peor durante este tiempo, voy a volver a la Clínica de JMA. En caso que la clínica este cerrado, voy a proceder al departamento urgente más cerca o el departamento de emergencias del hospital para recibir tratamiento.

XI. Declaración del participante

Todas mis preguntas han sido contestadas. Reconozco por este medio lo anteriormente escrito y doy mi consentimiento voluntario:

"Todas mis preguntas han sido contestadas. Entiendo que recibiré una copia de esta forma. Reconozco por este medio lo anteriormente escrito y doy mi consentimiento voluntario. Entiendo que mi consentimiento no quita ningún derecho legal. Doy el permiso a los investigadores para utilizar mis informes médicos según lo descrito en esta forma del consentimiento."

Firmando en la línea de abajo acepto que estoy participando en este estudio bajo mi propio riesgo. Además, con dicha firma acuerdo participar en este estudio según lo descrito arriba.

_____	_____	_____
Nombre del participante	Firma del participante	Fecha

Cuando el participante es un menor de edad:

_____	_____	_____
Nombre del padre	Firma del padre	Fecha

Cuando la persona no puede dar el consentimiento por si mismo:

_____	_____	_____
Nombre del representante	Firma del representante	Fecha

_____
Relación entre el representante y el participante

Si tiene más preguntas sobre esta investigación, sobre los derechos del participante o sobre alguna lesión relacionada a la investigación, puede estar en contacto con:

Michael Baze, DO
Candidato de PhD
Virginia Tech
504-245-4320/23 (Honduras)
1+540 818-5886 (U.S.)
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H. Dean Sutphin, PhD
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Col. San José de la Vega
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contigüo a Iglesia Mormona
Comayagüela, Honduras
504-245-4320/23
e_xiomara@hotmail.com

Para las preguntas que pueda tener sobre este estudio:

Presidente de VCOM IRB
Hara P. Misra, DVM, PhD
(540) 231-3693, misra@vt.edu

Para las preguntas que pueda tener sobre sus derechos como participante de este estudio:

Este consentimiento informado es válido a partir de la 03/01/11 a 05/01/11.

Appendix A3

Child Assent Form (English)

Child Assent Form

EDWARD VIA VIRGINIA COLLEGE OF OSTEOPATHIC MEDICINE

Application and Evaluation of Teledermatology In An Underserved Area of Honduras

My name is Michael Baze. I am trying to learn about the types of skin problems in your country. Understanding what skin problems are most common has many benefits. For example, this information could allow for us to provide treatment faster. You can be in my study if you would like.

If you decide you want to be in my study, a doctor will look at your skin and have pictures taken of your skin condition. After this, we will need you to return to see the doctor within 48 hours for the results.

Taking photos of your skin is safe and does not cause pain. However, there may be persons that may not be comfortable about being photographed. Please let us know if you are not comfortable with having photos taken of your skin.

The skin examination by the doctor will take about 10 to 20 minutes. There are many types of skin conditions and not all need treatment.

I will put the information I learn about you together with things I learn about other patients, so no one can tell what things came from you. When I tell other people about my research, I will not use your name, so no one can tell who I am talking about. No other people, except your parents, will know if you are in my study.

Your parents, or whoever takes care of you, have to say it's Okay for you to be in the study. After they decide, you get to choose if you want to do it or not. If you don't want to be in the study, no one will be mad at you. If you want to be in the study now and change your mind later, that's Okay too. You can stop being in this study any time.

To contact me, please call 504-245-4320/23 or 1-540-818-5886. You can call me if you have questions about the study or if you decide you don't want to be in the study any more.

I will give you a copy of this form in case you want to ask questions later.

AGREEMENT

I have decided to be in the study because I want to. I know that I do not have to do this. Michael Baze has answered all my questions.

_____	_____
Signature of Study Participant	Date
_____	_____
Signature of Researcher	Date

Appendix A4

Child Assent Form (Spanish)

Niño Forma el Asentimiento

LA UNIVERSIDAD EDWARD VIA DE MEDICINA OSTEOPÁTICA

Aplicación y Evaluación de Teledermatología en un área Desatendida de Honduras

Mi nombre es Michael Baze. Estoy tratando de aprender las enfermedades de piel en su país. Entendiendo los problemas de piel que son más comunes tiene muchos beneficios. Por ejemplo, esta información podría permitir a nosotros proporcionar un tratamiento más rápido. Usted puede estar en mi estudio si quiere.

Si usted decide que quiere estar en mi estudio, un médico examinará su piel y sacará fotos de su condición de piel. Después de esto, usted tiene que volver a ver al doctor dentro de 48 horas para los resultados.

Sacando fotos de su piel es seguro y no causa dolor. Sin embargo, puede haber personas que no se sienten cómodas en ser fotografiadas. Por favor, díganos si usted no se siente cómodo si saquemos fotos de su piel.

El examen de piel por el doctor tomará aproximadamente 10 a 20 minutos. Hay muchos tipos de enfermedades de la piel y no todos necesitan tratamiento.

Voy a poner la información que obtengo de usted junto con cosas acerca de otros pacientes para que nadie pueda decir lo que fue de usted. Cuando discuto mi investigación con otra gente, no voy a usar su nombre, así que nadie puede saber de quien estoy hablando. Ninguna otra persona, a excepción de sus padres, sabrá si está en mi estudio.

Sus padres, o quien le cuida, tienen que decir que está bien que usted participe en el estudio. Después que ellos deciden, usted puede elegir si quiere hacerlo o no. Si no quiere estar en el estudio, nadie se va a enojar consigo. Si quiere estar en el estudio ahora y después cambia de opinión más adelante, está bien también. Usted puede dejar de participar en este estudio en cualquier momento.

Para ponerse en contacto conmigo, por favor llame a 504-245-4320/23 o 1-540-818-5886. Usted me puede llamar si tiene preguntas sobre el estudio o si usted decide que no quiere estar en el estudio más.

Voy a darle una copia de este formulario en caso que tenga preguntas después.

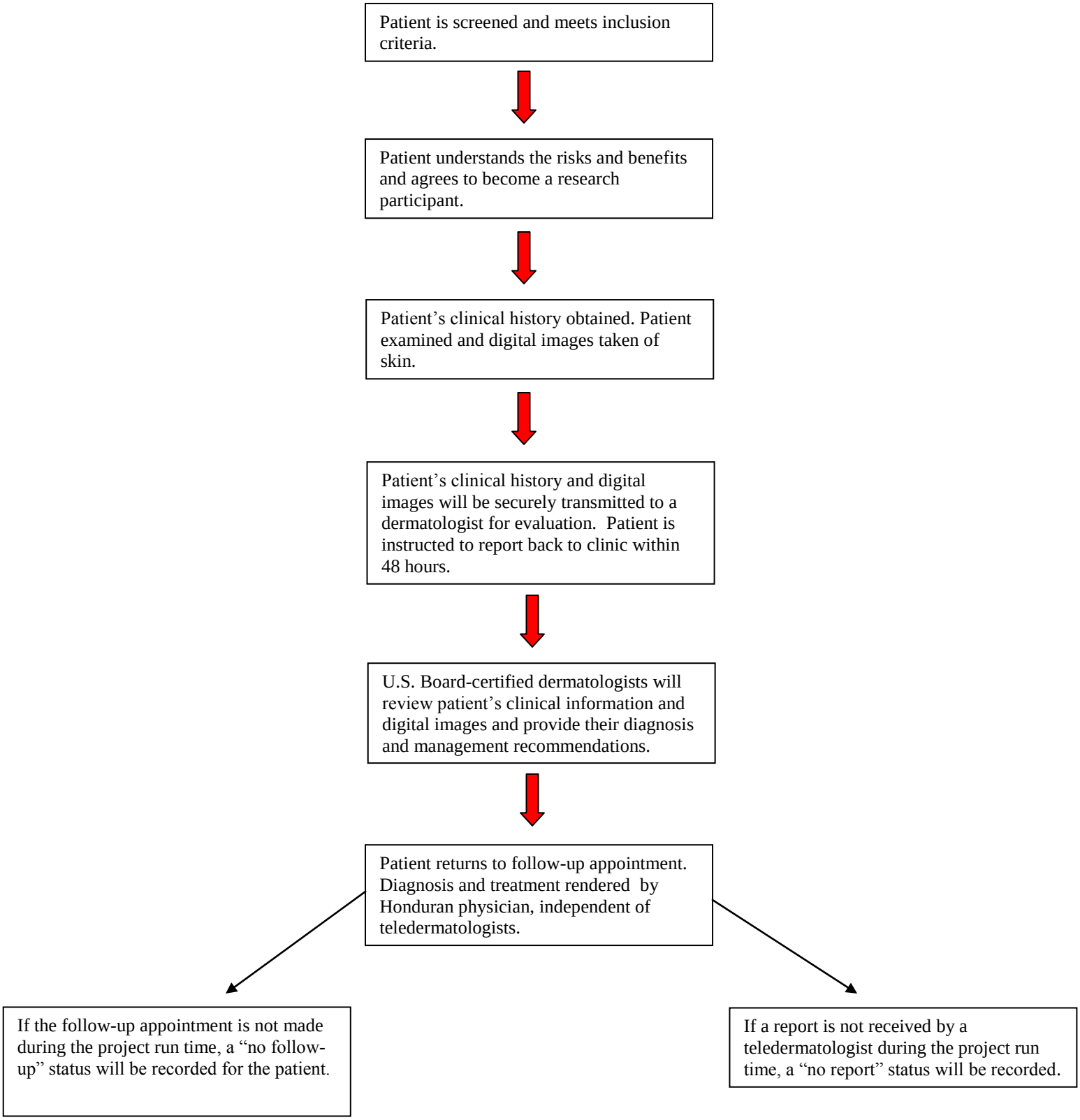
Acuerdo

Yo he decidido participar en el estudio porque quiero hacerlo. Yo sé que no tengo que hacer esto. Michael Baze ha respondido a todas mis preguntas.

_____	_____
Firma del Participante del Estudio	Fecha
_____	_____
Firma del Investigador	Fecha

Appendix B

Patient Flowchart



Appendix C

Request for Diagnosis Form

Request for Diagnosis Form

EDWARD VIA VIRGINIA COLLEGE OF OSTEOPATHIC MEDICINE

Application and Evaluation of Teledermatology In An Underserved Area of Honduras

A. Patient Encounter:

Patient #: 1001 Gender: F Age: 63

Clinical history: Obese patient (pt) presents to clinic with a 10 day history of itchy rash on left side of face. Pt states affected has doubled in size since first noticing it and has remained localized to the cheek. Her only symptom is itching in the area of the rash. She has not previously experienced this rash. No one in her household has this rash. House animals include a dog that is free roaming. Pt occasionally holds dog in lap and will allow dog to climb on her, possibly exposing neck and face to dog. She has not sought treatment or tried self-treating.

Medical history: Significant for uncontrolled diabetes mellitus and obesity.

Social history: Retired. Has six other members in home, and one dog. No alcohol/tobacco use.

Physical exam: Findings include a scaly, well circumcised 4 cm x 4 cm annular lesion with raised and hyperpigmented borders. Rash limited to left cheek.

Diagnosis & Management: Please refer to the accompanying digital photos and complete the following requests:

1. **Diagnosis Table**: Place an 'x' in the box to indicate the most likely diagnosis (Diagnosis 1), and to which disease category your diagnosis belongs. Repeat this for two alternate diagnoses (Diagnosis 2 & 3) if applicable. Under the Specific Diagnosis heading, give your specific diagnosis, as it correlates to Diagnosis 1, 2 or 3 and the Disease Category. For each diagnosis, rate your diagnostic confidence. Each increment will be taken to mean 10 percentile units. A diagnostic confidence score of 8 correlates with 80%.
2. **Management Recommendation Table**: Please complete in a similar manner as described for Diagnosis Table.

Diagnosis Table:

Diagnosis 1	**Diagnosis 2**	**Diagnosis 3**	**Disease Category**	**Specific Diagnosis**	**Diagnostic Confidence** (Scale: 0 – 10)

			Tumors		
			Infectious		
			Papulosquamous		
			Bullous Diseases		
			Dermatitis		
			Connective Tissue		
			Genodermatoses		
			Pigmentary		
			Bites, Stings & Infestations		
			Nutrition, Endocrine & Metabolic		
			Photobiology		
			Vascular		
			Appendigeal		
			Mucous Membrane		
			Other		

Management recommendations:

Manage-ment 1	**Manage-ment 2**	**Manage-ment 3**	**Management Category**	**Specific Management**	**Management Confidence** (Scale: 0 – 10)
			Antiviral		
			Antifungal		
			Antibacterial		
			Antiparasitic		
			Corticosteroid		
			Antihistamine		
			Procedural*		
			Referral*		
			Other		

*Note: Procedural should be taken to mean skin scraping, biopsy, comedone extraction, etc. Referral should be taken to mean patient referral to institutional dermatology department.

Specific comments or critiques of patient encounter information are welcome.

B. Image Quality:

Request: Referring to key immediately below, please rank both the technical (e.g., color, resolution, etc.) and procedural (image view point direction, lighting) quality of the overall digital image(s) on a scale of 1 to 5 in the spaces provided below.
1 = very poor / lacks most appropriate views / no diagnostic value
2 = poor / contains few appropriate views / little diagnostic value
3 = barely acceptable / contains some appropriate views / marginal diagnostic value
4 = good / contains most appropriate views / high diagnostic value
5 =very good / contains all appropriate views / excellent diagnostic value

---

Very Poor – Data from study provides for diagnostic certainty <10% (area of interest is not visualized; dark, bright, resolution)
Poor – Data from study provides for diagnostic certainty <30% (area of interest is visualized with many deficiencies with regard to lighting, resolution, image-size, field of view, etc.)
Barely Acceptable – Data from study provides for diagnostic certainty >50% (area of interest is visualized but still lacks in some aspect(s) of lighting, resolution, image-size, field of view, etc.)
Good – Data from study provides for diagnostic certainty >70% (area of interest is visualized with few deficiencies with regard to lighting, resolution, image-size, field of view, etc.)
Very Good – Data from the image provides for diagnostic certainty >90% (area of interest is well visualized with no deficiencies with regard to lighting, resolution, image-size, field of view, etc.)

Technical quality of image(s) (color, resolution) [1-5]:

Procedural quality of image(s) (image view point direction, lighting) [1-5]:

Specific comments or critiques of images are welcome.

Appendix D

Privacy Consent Form

Privacy Consent Form for Participants in Research Projects Involving Human Subjects

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EDWARD VIA VIRGINIA COLLEGE OF OSTEOPATHIC MEDICINE

RE: Application and Evaluation of Teledermatology In An Underserved Area of Honduras

The current study will involve Honduran patients at the James Moody Adams Clinic in Tegucigalpa, Honduras; the lead investigator and consulting dermatologists (teledermatologists). Patients in this study will have clinical information and digital images taken of their skin condition. When the clinical information and digital photos have been obtained, the data will be transferred to the research computer. At the end of the clinic day, this information will be transmitted to the teledermatologists for diagnosis and management recommendations.

Patient confidentiality will be preserved in all aspects of text and digital images. No personally identifiable patient information such as name, birth date, identifying facial features or tattoos will be transmitted or released in any way. In all aspects of this study, every measure possible must be taken to ensure patient confidentiality. It is therefore necessary that the teledermatologists participating in this study consent to privacy with regards to confidential information they receive. 'Confidential information' means any patient information embodied in written or digital form. All confidential information transmitted must be used within the context of this current study and not transferred to persons outside this study or used for any purposes outside this study. All confidential information transmitted should be destroyed immediately after the conclusion of the current study.

By signing this consent to privacy, as a participating member of the current research study, I agree to the terms described above.

Signature: _____ Date: _____

Appendix E1

Patient Satisfaction Survey (English)

Patient Satisfaction Survey

EDWARD VIA VIRGINIA COLLEGE OF OSTEOPATHIC MEDICINE

Application and Evaluation of Teledermatology In An Underserved Area of Honduras

Please rate the following:

From your experience with this study, how satisfied are you with the timeliness of your teledermatology visit compared with the wait time to see a dermatologist?

1. Very Dissatisfied
2. Dissatisfied
3. Indifferent
4. Satisfied
5. Very Satisfied

From your experience with this study, how satisfied are you with the costs associated with your teledermatology visit compared with the costs to see a dermatologist in a clinic-based setting?

1. Very Dissatisfied
2. Dissatisfied
3. Indifferent
4. Satisfied
5. Very Satisfied

From your experience with this study, how do you rate your overall satisfaction with S&F teledermatology?

1. Very Dissatisfied
2. Dissatisfied
3. Indifferent
4. Satisfied
5. Very Satisfied

How likely are you to choose S&F teledermatology for your future dermatologic care compared to a clinic-based visit to a dermatologist?

1. Strongly unfavorable to the concept
2. Unfavorable to the concept
3. Undecided
4. Favorable to the concept

5. Strongly favorable to the concept

How likely are you to recommend teledermatology to a family member for their dermatologic care compared to a clinic-based visit to a dermatologist?

1. Strongly unfavorable to the concept
2. Unfavorable to the concept
3. Undecided
4. Favorable to the concept
5. Strongly favorable to the concept

In general, what do you think about the utility of teledermatology in an underserved area as a means of providing dermatologic care to those without access to a dermatologist?

1. Strongly unfavorable to the concept
2. Unfavorable to the concept
3. Undecided
4. Favorable to the concept
5. Strongly favorable to the concept

Appendix E2

Patient Satisfaction Survey (Spanish)

Encuesta de Satisfacción del Paciente

LA UNIVERSIDAD EDWARD VIA DE MEDICINA OSTEOPÁTICA

Aplicación y Evaluación de Teledermatología en un área Desatendida de Honduras

Por favor califique el siguiente:

En general, ¿cómo valora la utilidad de la teledermatología en un área desatendida como medio de proporcionar atención dermatológica a los que no tienen acceso a un dermatólogo?

1. Muy Pobre
2. Pobre
3. Apenas
4. Bueno
5. Muy Bueno

Desde su experiencia con este estudio, ¿qué tan satisfecho está usted con la oportunidad de su visita teledermatología en comparación con el tiempo de espera para ver a un dermatólogo en una clínica?

1. Muy Insatisfecho
2. Insatisfecho
3. Indiferente
4. Satisfecho
5. Muy Satisfecho

Desde su experiencia con este estudio, ¿qué tan satisfecho está usted con los costos asociados con su visita teledermatología en comparación con los costos para ver a un dermatólogo en una clínica?

1. Muy Insatisfecho
2. Insatisfecho
3. Indiferente
4. Satisfecho
5. Muy Satisfecho

Desde su experiencia con este estudio, ¿cómo calificaría su satisfacción general con S&F teledermatología?

1. Muy Insatisfecho
2. Insatisfecho

3. Indiferente
4. Satisfecho
5. Muy Satisfecho

¿Qué posibilidades hay que usted elija teledermatología S&F para su cuidado dermatológico en el futuro en comparación con una visita a la clínica de un dermatólogo?

1. Muy desfavorable para el concepto
2. Desfavorable para el concepto
3. Indeciso
4. Favorable para el concepto
5. Muy favorable al concepto

¿Qué posibilidades hay de que usted recomiende teledermatología a un miembro de la familia para su cuidado dermatológico en comparación con una visita a la clínica de un dermatólogo?

1. Muy desfavorable para el concepto
2. Desfavorable para el concepto
3. Indeciso
4. Favorable para el concepto
5. Muy favorable al concepto

Appendix F

Teledermatologist Knowledge and Satisfaction Survey

Teledermatologist Knowledge and Satisfaction Survey

EDWARD VIA VIRGINIA COLLEGE OF OSTEOPATHIC MEDICINE

Application and Evaluation of Teledermatology In An Underserved Area of Honduras

Please rate the following:

1. Your knowledge level regarding the practice of Store-and-Forward (S&F) teledermatology prior to this study

1. None
2. Some knowledge
3. Knowledgeable
4. Very knowledgeable
5. Expert

2. Your knowledge level regarding the practice of S&F teledermatology after this study

1. None
2. Some knowledge
3. Knowledgeable
4. Very knowledgeable
5. Expert

3. Utility of teledermatology as a means of providing dermatologic care to those without access to a dermatologist

1. Very poor
2. Poor
3. Barely
4. Good
5. Very good

4. Utility of using teledermatology as a learning modality for dermatology residents?

1. Strongly unfavorable to the concept
2. Unfavorable to the concept
3. Undecided
4. Favorable to the concept
5. Strongly favorable to the concept

5. Your interest to participate in a future S&F teledermatology study

A. Strongly unfavorable to the concept
B. Unfavorable to the concept
C. Undecided
D. Favorable to the concept
E. Strongly favorable to the concept

6. Integration of S&F teledermatology into your current practice model

A. Strongly unfavorable to the concept
B. Unfavorable to the concept
C. Undecided
D. Favorable to the concept
E. Strongly favorable to the concept

From your experience with this S&F study, please rate:

1. Your satisfaction with the quality of image and information transfer

1. Very Dissatisfied
2. Dissatisfied
3. Indifferent
4. Satisfied
5. Very Satisfied

2. How helpful was the clinical information given for each patient in reaching your diagnosis

A. Not helpful
B. Minimally helpful
C. Helpful
D. Very helpful
E. Could not have made diagnosis without it

3. Average time needed to review the clinical information and photographs, then render your diagnosis and treatment recommendations

A. 1 – 5 minutes
B. 6 – 10 minutes
C. 11 – 15 minutes
D. 16 – 20 minutes
E. 21 minutes or greater

4. Your overall diagnostic confidence

1. Very poor

2. Poor
3. Barely
4. Good
5. Very good

5. Your overall therapeutic management recommendation confidence

1. Very poor
2. Poor
3. Barely
4. Good
5. Very good

6. Your satisfaction of the time requirement needed for this study

1. Very Dissatisfied
2. Dissatisfied
3. Indifferent
4. Satisfied
5. Very Satisfied

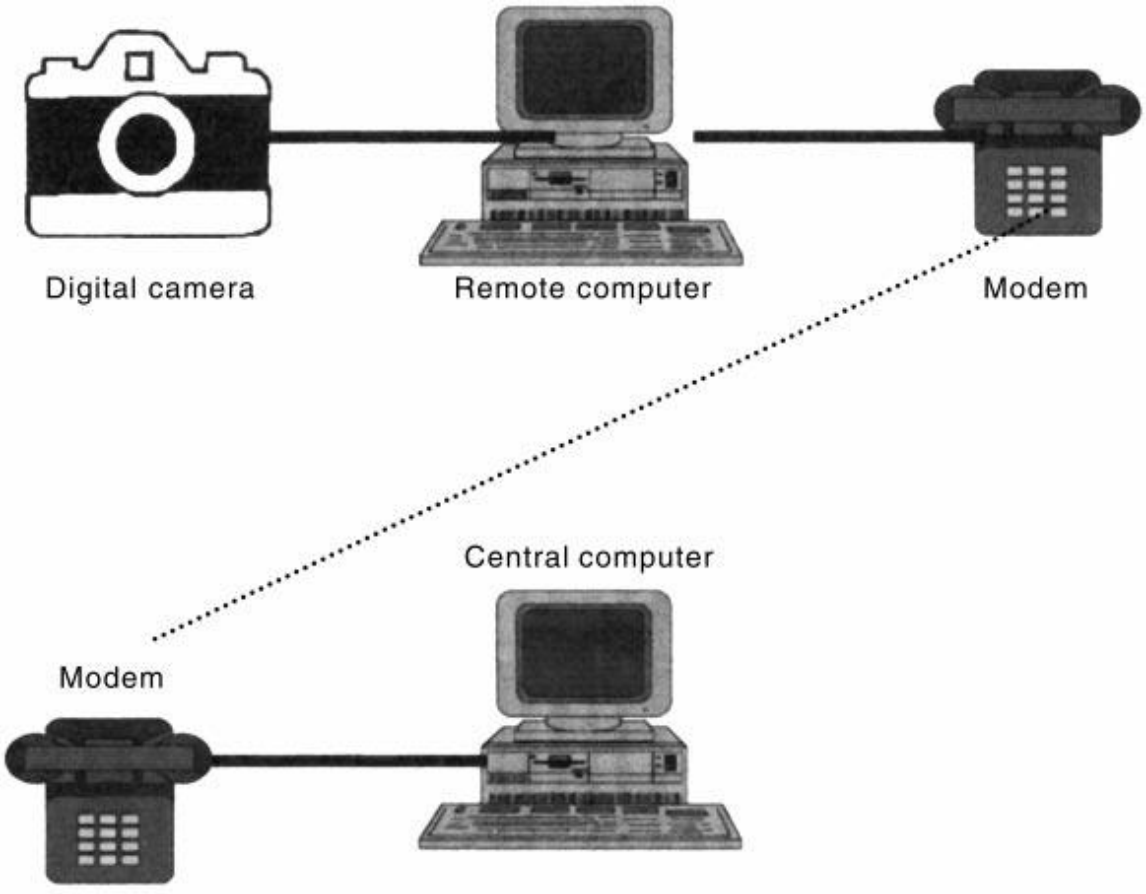
7. Your overall satisfaction

1. Very Dissatisfied
2. Dissatisfied
3. Indifferent
4. Satisfied
5. Very Satisfied

Please provide below your recommendations for replication of this study or future research. You are also welcome to make general comments in reference to the questions above.

Appendix G

Study Design Illustration



Appendix H

Teledermatology Clinic Patient Information Sheet

Teledermatology Clinic Patient Information Sheet

EDWARD VIA VIRGINIA COLLEGE OF OSTEOPATHIC MEDICINE

Application and Evaluation of Teledermatology In An Underserved Area of Honduras

Patient ID:	**Date:**	**Time:**
Gender: M / F	**Age:**	**Pregnant:** Y / N / NA
Annual household income:	**Department & Municipality:**	
Distance traveled to clinic:	**Can patient return for follow-up:** Y / N	

Chief Dermatologic Complaint:

History of Present Illness (onset, location [distribution], duration, symptoms, localized/systemic symptoms, aggravating/alleviating factors, affected family members, new medications/soaps, attempted therapy:

Patient Dermatologic History:

- Ever been to a dermatologist: Y / N
- Do you use sunscreen: Y / N
  - How often: Daily / Weekly / Monthly / Yearly

Family Dermatologic History:

Medical History:

Allergies:

Current Meds:

Social History:

- Occupation & Exposures (chemicals, dust, sun):
- Lifestyle:

- Number of people in household:
- Water Source: Well / Municipal; Treated / Untreated / Unknown
- Sanitation system: Modern sewer system / Latrine
- Cooking material: Wood / Charcoal
- Animal exposure: Y / N (If yes indicate home or work and what type of animal.)
- Substance Use: Tobacco / EtOH

Physical Exam Findings (skin, hair, nails, buccal mucosa):