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Toward a Discourse Community for Telemedicine: A Domain Analytic View of Published Scholarship

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Toward a Discourse Community for Telemedicine:

A Domain Analytic View of Published Scholarship

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Abstract

In the past 20 years, the use of telemedicine has increased, with telemedicine programs increasingly being conducted through the Internet and ISDN technologies. The purpose of this dissertation is to examine the discourse community of telemedicine. This study examined the published literature on telemedicine as it pertains to quality of care, defined as correct diagnosis and treatment (Bynum and Irwin 2011). Content analysis and bibliometrics were conducted on the scholarly discourse, and the most prominent authors and journals were documented to paint and depict the epistemological map of the discourse community of telemedicine. A taxonomy based on grounded research of scholarly literature was developed and validated against other existing taxonomies.

Telemedicine has been found to increase the quality and access of health care and decrease health care costs (Heinzelmann, Williams, Lugn and Kvedar 2005 and Wootton and Craig 1999). Patients in rural areas where there is no specialist or patients who find it difficult to get to a doctor's office benefit from telemedicine.

Little research thus far has examined scholarly journals in order to aggregate and analyze the prevalent issues in the discourse community of telemedicine. The purpose of this dissertation is to empiricallydocument the prominent topics and issues in telemedicine by examining the related published scholarly discourse of telemedicine during a snapshot in time. This study contributes to the field of telemedicine by offering a comprehensive taxonomy of the leading authors and journals in telemedicine, and informs clinicians, librarians and other stakeholders, including those who may want to implement telemedicine in their institution, about issues telemedicine.

Chapter 1 Introduction

Medical information is critical in the diagnosis and treatment of disease and in the accumulation of scientific knowledge that leads to cures. Falconer (in Wootton, 1999) wrote that medicine has relied on communication systems between and among patients, doctors, and other health care professionals to deliver health care to the patient for years. In the past 20 years or so, the Internet has become an integral part of this communication. An important part of telemedicine is the communication and technology components that relay medical information among clinicians, patients, technologists and stakeholders.

1.1 Telemedicine as a Topic in Information Science

Telemedicine is classified in three ways in the MEDLINE® thesaurus. MEDLINE® (Medical Literature Analysis and Retrieval System Online, or MEDLARS Online) is a bibliographic database of life sciences and biomedical information that includes articles from academic journals in the areas of medicine, nursing, pharmacy, dentistry, veterinary medicine, and health care, and some literature on biology, biochemistry and molecular biology (https://www.nlm.nih.gov/bsd/pmresources.html). MEDLINE® is compiled by the United States National Library of Medicine (NLM), an authoritative source of health care information and is freely available on the Internet and searchable via PubMed and NLM's National Center for Biotechnology Information's Entrez system.

In one such instance, it places telemedicine under the taxonomic category of information science, which is the key focus of this dissertation. The following excerpt illustrate telemedicine's inclusion in the MEDLINE® (2014) thesaurus:

Information Science [L01]
Communications Media [L01.178]
Telecommunications [L01.178.847]
Electronic Mail [L01.178.847.249]
Radar [L01.178.847.500]
Radio [L01.178.847.514]
Satellite Communications [L01.178.847.550]
Telefacsimile [L01.178.847.606]
Telemedicine [L01.178.847.652]
Remote Consultation [L01.178.847.652.550]
Telepathology [L01.178.847.652.600]
Teleradiology [L01.178.847.652.700]
Telerehabilitation [L01.178.847.652.850]
Telemetry [L01.178.847.675]
Telephone [L01.178.847.698]
Television [L01.178.847.823]
Videoconferencing [L01.178.847.900]
Wireless Technology [L01.178.847.950]

Bashshur, Shannon, Krupinski, and Grigsby (2011) wrote that telemedicine embodies the electronic acquisition, processing, dissemination, storage, retrieval, and exchange of information to promote health, prevent disease, treating the sick, manage chronic illness, rehabilitate the disabled, and protect public health and safety. Telemedicine systems promote collaboration among health networks, facilities, and organizations. Although public health is mentioned (promoting health and preventing disease), the emphasis is on information at a distance for the purposes of curing and managing disease.

1.2 Prominent Topics in the Discourse Community of Telemedicine

While telemedicine does not easily fit the framework of a domain (see, for example, Jank 2010, Tennis 2003 and Hjørland 2002), it easily can be viewed as a discourse community given its parameters, its discourse, and its consistent appearance in the literature (see, for example, Jank

2010, Hjørland 2002, White and McCain 1998).   Hjørland and Albrechtsen (1995) defined

domain as thought or discourse communities that are parts of society's division of labor.

During preliminary research in preparation for this study, the major topics in the discourse

community of telemedicine were determined to be the following:

• effectiveness

• clinical outcomes evaluation

• access to care

• quality of care

• technology

• implementation

• privacy

• organization

• regulatory laws

• training

• physician acceptance

• patient opinions

• synchronous (video conferencing and real-time (RT)) versus asynchronous (store-and-

forward) telemedicine

• ethical issues

• the physician-patient relationship

• cost

Such an approach allows for the consideration of a domain or community of discourse

(Hjørland 2002). I used these techniques to analyze the prominent topics in telemedicine

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discourse, while also documenting both the taxonomic and ontological attributes of telemedicine scholarship.

1.3 Main Areas of Telemedicine

Teleradiology, telesurgery, telepathology, telepsychiatry and telecardiology are the most developed application areas of telemedicine (Misra 2009; McGowan 2008; Roine, Ohinmaa and Halley 2001). Teleradiology and telepathology are listed under telemedicine in the MeSH thesaurus. Roine, Ohinmaa and Halley (2001) wrote that the primary uses of telemedicine are teleradiology, teleneurosurgery, telepsychiatry, transmission of echocardiographic images and electronic referrals enabling consultations between primary and secondary physicians. In a study of MEDLINE® literature, Misra, Kalita, Mishra, and Yadav (2005) wrote that telemedicine is not used widely in teleneurology, where only 11 relevant articles were found. Demiris and Tao (2005) reviewed MEDLINE® telemedicine articles and found teleradiology to be one of the most developed application areas.

According to Franken, Allen, Budig, and Allen (1995), teleradiology was booming years before telemedicine was widely used outside the military. Images used such as X-rays can easily be relayed through the Internet. Wakefield, Kienzle, Zollo, Kash, et al. (1997), wrote that teleradiology was the most used because it had been tested for efficacy the most. DeBakey (1995) wrote that telemedicine has been shown to increase the access and quality of care. He wrote that "interest in telemedicine has intensified, and its application greatly expanded both for purposes of continuing medical education and for patient consultation." He further wrote about telemedicine: "Having now come of age, telemedicine has the potential of having a greater impact on the future of medicine than any other modality." He mentioned its usefulness in standardizing the quality of

global medical care, natural disasters and home monitoring, and wrote that it is the most cost-effective means for continuing medical education.

The topics revealed in this dissertation in the discourse community of telemedicine shed light on what is important to health professionals, stakeholders and patients. According to Tennis (2003, 191), a domain can be thought of as a type of discourse community, but the definition is "muddied." He wrote that domain analysis is what is important. He wrote that domain is like "an area of expertise, a body of literature, or even a system of people and practices working with a common language," but this does not lend itself to a definition, but rather to an operationalization, or "definition within the context of one research study."

1.4 History of Telemedicine

Early scholarship dates telemedicine back to the late 1800s, when telegraphs on ships were used to communicate health problems of crew to physicians on land. Radio, telephone and television followed as a means of conducting services in telemedicine, while the Internet has been the leading provider of telemedicine for more than 15 years (Zundel 1996). David Brennan provided a linear graph of telemedicine history beginning in 1900, prior to which he wrote no technology was used in medicine. He considered the telephone and electrocardiogram before 1920 to be the beginning of telemedicine. Between 1920 and 1940, the new technologies introduced were the radio and telegraph. "The Radio Doctor" was on the cover of *Radio News* in 1924. Between 1940 and 1960, closed-circuit television was used. Around 1960, video-conferencing and satellite technology were used in telemedicine. Between 1980 and 2000, email and the Internet comprised the largest means of telemedicine information transmission. After 2000, high-speed wireless service for computers and cell phones took on a major role in telemedicine.

Bashsur, Krupinski and Grigsby (2011) wrote that the first instance of telemedicine was in 1905 when the Dutch physician Willem Einthoven demonstrated the feasibility of telephonic transmission of heart sounds over a one-mile distance. Einthoven, a Dutch physician and inventor, first used the prefix ''tele'' in a medical context when he referred to a successful telephonic transmission of electrocardiographic images as the telecardiogram. James and Williams (1910) recognized the first instance of telemedicine to be when two American physicians in New York City in 1910 transmitted electrocardiograms of ventricular hypertrophy, atrial and ventricular ectopic beats and atrial and ventricular fibrillation.

In 1950, inventor Cooley and radiologist Gershon-Cohen coined the term ''telognosis," an abbreviation of the terms: teleo, roentgen, and diagnosis, for the transmission of radiographs over wire or radio circuits. The transmission of images happened by telephone between West

Chester and Philadelphia, Pennsylvania, a distance of 24 miles. Jutras and Duckett followed in 1957, introducing the term ''telefluoroscopy.'' The terms telediagnosis and telemedicine were used in 1967 and 1969, respectively, by Bird and associates regarding medical care at a distance. According to Gambadauro and Torrejo (2013), Kim (2004), and Perednia and Allen (1995) the first form of telemedicine was used in 1959 when a circuit microwave television system provided successful telemedicine communication, training, and research between the Nebraska Psychiatric Institute and Norfolk State Hospital in Nebraska. Professionals in the nursing and military sectors use telemedicine extensively.

Kim (2004) wrote that in April 1968 the Massachusetts General Hospital (MGH) established a microwave video link between the hospital and Boston's Logan Airport for cardiology, dermatology and radiology examinations. A review of this early service showed that it improved patient access to health care and diminished travel time.

According to the World Health Organization (2010), the term telemedicine was coined in the 1970s to mean healing at a distance. Kim (2004) wrote that a pioneering telemedicine program by NASA was called the Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) from 1972 to 1975. This program was designed to deliver health care to the Papago Indian Reservation in Arizona via a van with a variety of medical instruments, including an electrocardiograph and x-ray machine, staffed by two Indian paramedics. They were linked to specialists at the Public Health Service Hospital by a bilateral microwave transmission and medical information could be communicated from one site to the other.

The government has used telemedicine in The National Aeronautics and Space Administration (NASA) and Veterans Administration (VA) hospitals since the 1960s. (McLaren 1995). NASA conducted the first international telemedicine program, Space Bridge to Armenia/Ufa, after an earthquake struck the Soviet Republic of Armenia in December 1988. In 1993, the University of Washington joined the Lewis Research Center and the Jet Propulsion Laboratory on a teleradiology project that used an Advanced Communications Technology Satellite. In 1994, NASA collaborated with the University of Pittsburgh, WHO (World Health Organization), PAHO (Pan American Health Organization), USAID (US Agency for International Development) and the World Bank, to organize Global Health Network for preventative telemedicine service. Other U.S. departments that use telemedicine are: U.S. Department of Defense (DOD), the VA and the Army's Telemedicine and Advanced Technology Research Center (TATRC).

1.5 Definition of Telemedicine and Related Terms

There is no conclusive definition of telemedicine by all those involved in the field.

Telemedicine literally means "distance healing": "tele" in Greek means "distance" and "mederi" in Latin means healing. A review of the literature was conducted to arrive at the meaning of telemedicine for the purposes of this dissertation. Vassallo (2000) wrote that telemedicine transcends temporal and geographical boundaries. Medical information transcends geographical boundaries where specialists may not be available in an area, or where some patients, such as the elderly or physically challenged, cannot make it to their physician.

Bashshur, Shannon, Krupinski and Grigsby (2011) wrote that "The current confusion in the nomenclature and classification hinder telemedicine research and implementation." They explained that this lack of clarity "impedes progress toward development and implementation of a research agenda geared toward reaching answers to questions regarding the true benefits and costs of telemedicine" and "interferes with informed and prudent decision making by policymakers, payers, program developers and providers" in implementation. This study would enhance the body of knowledge in patient-driven health care, and be informative for physicians who want to start using telemedicine.

Bashshur, Shannon, Krupinski and Grigsby wrote that the terminology in telemedicine suffers from a lack of clarity and an absence of agreement about its concepts. This suggests that, as a domain, telemedicine lack a mature vocabulary.

A taxonomy of telemedicine may help in dealing with this confusion. Fatehi and Wootton (2012) conducted a bibliometric analysis of the trends in the use of the terms telemedicine, telehealth, and e-Health. Hjørland (1998) wrote that the decisions a designer of controlled vocabularies are informed by the designer's epistemological stance. A domain can be organized in several valid ways, depending on the particular epistemological stance taken. Hjørland's four basic epistemological approaches or contexts are (Mai 2008; Hjørland 1998):

1. Empiricist — based on statistical analysis of resemblance and favoring perception and experiences;

2. Rationalist — based on logical division and/or eternal and unchangeable categories and emphasizing reasoning and a priori theorizing;

3. Historicist — based on a notion of development or evolution and emphasizing that perception and thinking are influenced by culture and language; and

4. Pragmatic — based on an analysis of goals and usage.

In 1995, Hjørland and Albrechtsen wrote that the positivist and rationalist view of science had a nominalistic understanding of language as labels for knowledge. Language did not contribute to the perception of reality and was limited to communication. Individual perception was important. Epistemology is moving toward a more holistic approach which takes into account the importance of language in the perception of reality and introduces historical, cultural and social dimension to the theory of knowledge and science. This is reflected in the definitions of telemedicine and other related terms, although they are not mature. The evolution of technology and goals of the health care programs, used mostly to define the terms, as well as the holistic view of different aspects such as delivery methods, type of medicine, type of technology, application and more, taken on by the taxonomies, reflect more of a historicist and pragmatic hermeneutic view on naming and defining terms.

Knowing what telemedicine professionals mean when they use different terms, such as telemedicine or telehealth, makes it easier for professionals, patients and stakeholders to look for and retrieve health care information. There is a great deal of crossover, however, in the meaning of the definitions or what each one entails because the terms are not mature.

Telemedicine can be as simple as using the telephone or radio to diagnose and treat disease, which has been in place in the military and other services for years. Telemedicine always involves the exchange of information from a sender to one or more receivers, which falls into the Shannon communication model of 1948 (Shannon 1948).

Sood, Mbarika, Jugoo, and Dookhy (2007) found 104 definitions of telemedicine in journal articles, books, and conference proceedings published between 1970 and 2006. Their consensus definition takes into account the four major elements of telemedicine: medical care, use of technology, mitigation of issues of distance, and provision of benefits. This definition is mostly pragmatic, based on goals of the telemedicine programs and usage. It is also historical, based on the evolution of techniques and technology. If statistical analysis is involved in the definition, empiricism is involved. The definitions of mhealth and e-Health (See Glossary) are pragmatic, and also historical, showing technological advances through the years.

Other definitions of telemedicine have been more general. In the editorial "A New Journal for a New Age" on the first page of *Telemedicine Journal* in 1995, Mark Goldberg included medical education, home care, emerging applications like surgery and medical informatics under the umbrella of telemedicine. Technology of the day influenced definitions of telemedicine at the time. With other technologies developing through time, other terms such as e-Health began to be used. For instance, Franken, Allen, Budig, and Allen (1995), wrote that telemedicine is the delivery of patient care using interactive television, with the physician and patient at different locations. The amount of literature and, of course, instantiations of telemedicine have increased since then.

The Institute of Medicine in 1996 defined telemedicine as "the use of electronic information and communications technologies to provide and support health care when distance

separates the participants." In 1997 the Telemedicine Information Exchange (TIE) defined

telemedicine as the use of electronic signals to transfer medical data from one site to another by

the Internet, Intranets, PCs, satellites, or videoconferencing telephone equipment, in order to

improve health care access. Kim included telemonitoring in the definition, writing that this is a

rapidly-growing area due to the increase in age of the population and to the lack of home-care

physicians. Grigsby and Sanders (1998, 123) defined telemedicine as the use of

telecommunications and information technology to provide health care services to persons at a

distance from the provider. Again, exchange of information at a distance is of importance.

The terms telemedicine, telehealth and telecare are not fully mature. Barlow, Singh, Bayer

and Curry (2007), and Botsis and Hartvigsen (2008) have commented that telehealth, telecare and

telemedicine have been used interchangeably. For scholarly and policy issues, arriving at a

definition is important. While no definitive answers have been found, scholars are moving toward

maturity of the term.

1.5.1 Telemedicine and Telehealth

Telehealth encompasses patient-physician interaction through email; patient and health

care professional education through health Web sites; using mobile phones to monitor, diagnose

and treat disease; using telemonitoring or using mobile phones, computers and other technology

to monitor patients at home; and using mainly the Internet to diagnose and treat disease (Health

Resources and Services Administration 2013). Norman and Skinner, in their 2006 study on health

literacy, linked telehealth to public health in mentioning health literacy as being in the public

health arena. Nuccio (2007) defined telemedicine as the use of medical information exchanged

from one site to another electronically for the health and education of the patient or health care

provider and to improve health care.

Matusitz and Breen (2007) defined telemedicine as the use of distant health care communication technologies and the effects this has on health communication. They indicated that it is used in patient care, research, training, diagnostics, health care administration, exchange of information, analysis of noninvasive film, and education of patients and health professionals. This has usually been defined as telehealth, telemedicine being a more specific term referring in recent years to using the Internet to exchange information for the diagnosis and treatment of disease. They explained that an understanding of telemedicine as an interpersonal channel and a resource to facilitate interpersonal communication when face-to-face meetings are less feasible can lead the way to better provider service and behavior, as well as developed technology to help telemedicine will be less impersonal in cases where it is. After all, there is often no meeting in telemedicine so that players can get a sense of each other's personalities, attributes, tendencies and predictabilities. Depending on the context of the patient-physician relationship, email can be impersonal.

Bashshur, Shannon, Krupinski and Grigsby (2011) claimed: "It is not clear what constitutes telemedicine vis-à-vis telehealth; whether the two terms can be used interchangeably" and what their differences are. According to the authors (2011), "the introduction of more terms complicates the situation further." They suggested that telemedicine is to telehealth what medicine is to public health. According to the authors, there is an overlap between medicine and public health. The health of individuals and the population is not only attributable to medical intervention. The success of public health in identifying risk factors can work with medicine for health prevention, disease promotion and environmental quality improvement. Health services research can explain "the effects of structural, organizational, financial, and administrative arrangements in health care as well as providing effective tools for health policy analysis and

health management" (2011). They indicated that the areas that comprise telehealth comprise public health: disease epidemiology; health behavior and health education; health services management and policy; environmental and industrial health; and biostatistics.

Bashshur, Shannon, Krupinski, and Grigsby (2011) wrote that "telemedicine technology embodies the electronic acquisition, processing, dissemination, storage, retrieval, and exchange of information for the purpose of promoting health, preventing disease, treating the sick, managing chronic illness, rehabilitating the disabled, and protecting public health and safety."

Fatehi and Wootton (2012) conducted a bibliometric analysis of the trends in the use of the terms telemedicine, telehealth and e-Health. They offered that telemedicine was used first to refer to medicine at a distance, and telehealth then was used as a broader term to include a "broader scope of health-related functions such as education and administration." They explained that the terms telemedicine, telehealth and e-Health are often used interchangeably by health care providers and consumers. They set off to discover how consistently the terms in this field have been used in the literature prior to 2012, to determine their trends over the past few years, and to identify any differences in their usage among different countries. They searched the Scopus database for telemedicine, telehealth and e-Health in Title, Abstract, and Title/Abstract of journal articles, conference papers, editorials, reviews and other documents. The term e-Health was spelled in three different ways: e-Health, e-Health and e health. They found documents using telemedicine as early as 1972. There was an increase in telemedicine articles in 1994 and a slight decrease after 2000. The authors could not explain why. Articles containing e-Health appeared later than those using the other terms. The 2000 dip of articles containing e-Health was less pronounced than those containing the other two terms. A total of 11,644 documents contained at least one of the three terms in the title or abstract. The number of articles per term were:

telemedicine (8028), e-Health (273) and telehealth (1679). The term telemedicine was used in articles from126 different countries, while telehealth was used in articles from 55 different countries and e-Health was used in articles from 96 different countries. Articles from the United States and the United Kingdom used "telemedicine" the most. The term "telehealth" was most popular in countries with English as the official language, and Canada used the term the most. High income countries accounted for 85% of the articles. The number of documents using telemedicine and e-Health has been increasing faster than those using telehealth. In 2011 there were 1960 articles with the terms telemedicine, telehealth or e-Health appearing in the title or abstract, or being assigned as the keyword.

The pragmatic definition of telemedicine from the University of Tennessee Health Science Center is also more specific than that of telehealth. Telemedicine is "the use of medical information exchanged from one site to another via electronic communications to support medical diagnosis" while telehealth is the "ongoing patient care and remote patient monitoring." Telehealth encompasses a broader definition of remote health care than telemedicine that does not always involve clinical services and health-related distance learning.

1.5.2 Telemedicine and Telecare

Demiris, Speedie, and Finkelstein (2000) provided the distinction between telemedicine and telecare in writing that telecare "allows patients to conduct their interactions with the health care provider in their own home." This is telemonitoring. Tang and Venables (2000) wrote that telecare is the: "care, support, or monitoring delivered in the home that enables either rapid emergency or ongoing medical advice." This is akin to telemonitoring as well. Likewise,

Percival and Hanson (2006) wrote that telecare is a means of effectively and economically delivering health and social care and monitoring services to people in their homes via technology,

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using technology. The use of telecare gives the opportunity for delivering medical and social support, education, treatment and care from health care providers to homebound patients. They differentiated this from telemedicine, which uses ICT systems for diagnosis and referral.

Solli, Bjørk, Hvalvik, and Hellesø (2012) analyzed 44 English-language articles from MEDLINE® and Cinahl between 1995 and 2011 to come up with a conceptual definition of telecare to contribute to the research, theory development, and practice of telecare through a principle-based concept analysis of the research literature. Definitions were found in 32 out of 44 articles. They explained that the difference between telehealth and e-Health has to be fully delineated before the concept of telecare is mature. The authors concluded that they moved the definition of telecare to an epistemological maturity. Their conclusion showed that telecare encompasses a broader field than telemedicine, including online education, home monitoring, and social care (2012, 2813): "Telecare is the use of information, communication, and monitoring technologies which allow health care providers to remotely evaluate health status, give educational intervention, or deliver health and social care to patients in their homes." Telemedicine is a more specific term that focuses on diagnosis and treatment.

Solli, Bjørk, Hvalvik, and Hellesø wrote (2012): "There are linkages to the concept of telemedicine and telehealth, although boundaries to the concept of telemedicine are more clarified." They found the pragmatic and linguistic principles mature and the logical and epistemological principles immature. The principle-based analysis of telecare revealed that the definition of the concept is not well differentiated. There are the blurred boundaries between telecare, telemedicine, telehealth and e-Health, and the concept demonstrates a lack of delineation. Regarding the epistemological principle, the definitions were used broadly and overlapped other concepts. The authors provided a table of others' definitions of telecare. All

definitions involve technology and health care at a distance, and most involve a continuous monitoring of patients who are at home.

The dimensions found in the definition were deemed pragmatic by Solli, Bjørk, Hvalvik, and Hellesø wrote (2012) and encompassed four dimensions: the use of technology, such as for diabetes or respiratory or emergency care; activity of caring, such as for management, nursing, medical treatment, monitoring, and so on; the patient and type of disease and type of health care professional; and accessibility and delivery. The authors explored the concepts of measurement, monitoring, and information and their overlap. They indicated that the concept of information comprises three attributes, which are data, information, and knowledge. They referred to Graves and Corcoran (1989), writing that when data are analyzed, organized, and structured in a meaningful way, they can be called information, and that, when information is structured in a way that describes coherences, it can be characterized as knowledge. They referred to Wilde and Garvin (2007) that monitoring or self-monitoring is defined as "awareness of symptoms or bodily sensations that is enhanced through periodic measurement, recordings and observations to provide information for improved self-management."

According to the American Telemedicine Association (ATA) (http://www.americantelemed.org/main/about/telehealth-faqs-), formally defined, telemedicine is the remote delivery of health care services and clinical information using telecommunications technology. The ATA has begun to use the terms telemedicine and telehealth interchangeably. Telemedicine includes applications and services such as two-way video, email, smart phones, wireless tools and other forms of telecommunications technology. While the term telehealth is sometimes used to refer to a broader definition of remote health

care that does not always involve clinical services, ATA uses the terms in the same way one would refer to medicine or health in the common vernacular.

There are other pragmatic definitions of telemedicine include: The World Health Organization (2010) defined telemedicine as "the delivery of health care services, where distances a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities." Sridhar and Prasad (2013) defined telemedicine as using the Internet applications which include, clinical consultation and home care monitoring and management to deliver medical care in underserved areas. Wikipedia defined telemedicine as "the use of telecommunication and information technologies to provide clinical health care at a distance." It helps eliminate distance barriers and can improve access to medical services to rural communities. The European Commission defined telemedicine as the "rapid access to shared and remote medical expertise by means of telecommunications and information technologies, no matter where the patient or relevant information is located."

1.5.3 E-Health

Della Mia (2001) wrote that e-Health would be the death of telemedicine because it incorporates everything from electronic health records to information systems. Telemedicine is more specific and hardware-centric while e-Health, the "e-thing," is more open and is based on the services model whereas telemedicine is based on an old sales model. He wrote that telemedicine is linked to professionals, while e-Health is linked to patients. E-Health, he wrote, is a patient-driven approach. The World Health Organization (2005) defined it as "the costeffective

and secure use of information and communication technologies (ICT) in support of health and health-related fields, including health care services, health surveillance, health literature, and health education, knowledge, and research'' (Bashshur, Shannon G, Krupinski, and Grigsby 2011).

Eysenbach (2001) listed the "e's" in health (discussed in Table 1): efficiency; enhancing quality of care; evidence-based; empowerment of consumers and patients; encouragement of a new relationship between the patient and provider; education of patients and physicians; enabling information exchange and communication in a standardized way between health care establishments; extending health care's scope beyond conventional boundaries; ethics; and equity. He added easy-to-use and entertaining. He wrote that e-Health is a field in the intersection of medical informatics, public health and business and involves information enhanced by or delivered through the Internet and related technologies. He wrote that it reflects technology, as well as a way of thinking and a commitment for networked, global thinking.

Table 1 The "E" in E-Health

1. Efficiency – one of the promises of e-Health is to increase efficiency in health care, thereby decreasing costs. One possible way of decreasing costs would be by avoiding duplicative or unnecessary diagnostic or therapeutic interventions, through enhanced communication possibilities between health care establishments, and through patient involvement.
2. **Enhancing quality of care** – increasing efficiency involves not only reducing costs, but at the same time improving quality. E-Health may enhance the quality of health care for example by allowing comparisons between different providers, involving consumers as additional power for quality assurance, and directing patient streams to the best quality providers.

3. **Evidence based** – E-Health interventions should be evidence–based in a sense that their effectiveness and efficiency should not be assumed but proven by rigorous scientific evaluation. Much work still has to be done in this area.
4. **Empowerment** of consumers and patients – by making the knowledge bases of medicine and personal electronic records accessible to consumers over the Internet, e-Health opens new avenues for patient-centered medicine, and enables evidence-based patient choice.
5. **Encouragement** of a new relationship between the patient and health professional, towards a true partnership, where decisions are made in a shared manner.
6. **Education** of physicians through online sources (continuing medical education) and consumers (health education, tailored preventive information for consumers)
7. **Enabling** information exchange and communication in a standardized way between health care establishments.
8. **Extending** the scope of health care beyond its conventional boundaries. This is meant in both a geographical sense as well as in a conceptual sense. E-Health enables consumers to easily obtain health services online from global providers. These services can range from simple advice to more complex interventions or products such as pharmaceuticals.
9. **Ethics** – E-Health involves new forms of patient-physician interaction and poses new challenges and threats to ethical issues such as online professional practice, informed consent, privacy and equity issues.

Above excerpted from Eysenbach 2011

According to Eysenbach (2001), e-Health encompasses: (1) consumers interacting with their systems online (B2C = "business to consumer"); (2) institution-to-institution transmissions of data (B2B = "business to business"); and (3) peer-to-peer communication of consumers (C2C = "consumer to consumer").

Silverman (2003) defined telemedicine as the use of electronic communication to provide clinical care from distant sites and e-medicine as using the Internet to provide patient services. So, how can we define e-Health in the academic environment? Oh, Rizo, Enkin and Jadad in 2005 searched the following databases: PreMedline and MEDLINE® (1966 to 2004); EMBASE (1980-May 2004), International Pharmaceutical Abstracts (1970-May 2004), Web of Science (all years), Information Sciences Abstracts (1966-May 2004), Library Information Sciences Abstracts (1969-May 2004), and Wilson Business Abstracts (1982-March 2004), as well as some dictionaries and an Internet search engine. They found 51 definitions (discussed in Table 2), two universal themes and six less generally mentioned themes. Definitions were based on pragmatism and historicism. Health and technology were mentioned in each of them, while the Internet was mentioned in 27. Specific technologies were often noted, and they were not exclusive to the Internet. Most of the definitions concentrated on the process of care, rather than diagnosis or treatment, and about a quarter focused on the outcomes, such as improving and increasing the cost-effectiveness of health care by lowering cost, making it more efficient, and increasing access. Location and attitude were also often mentioned. Most definitions referred to technology as both a tool to enable a process/function/service and as the embodiment of e-Health like a health data Web site, and most referred to technology as augmenting, rather than replacing office visits (OV). All definitions showed positive connotations, using words such as benefits, improvement, enhancing, efficiency, and enabling. The authors did not attempt a definition, writing it is an important, evolving concept.

Table 2 Definitions of E-Health

1	1999	Mitchell	A new term needed to describe the combined use of electronic communication and information technology in the health sector. The use in the health sector of digital data – transmitted, stored and retrieved electronically – for clinical, educational and administrative purposes, both at the local site and at a distance.
2	1999	Loman - First Consulting Group	E-Health – the application of e-commerce to health care and pharmaceuticals
3	2000	JHITA	Internet-related health care activities
4	2000	McLendon	E-Health refers to all forms of electronic health care delivered over the Internet, ranging from informational, educational and commercial "products" to direct services offered by professionals, non-professionals, businesses or consumers themselves. E-Health includes a wide variety of the clinical activities that have traditionally characterized telehealth, but delivered through the Internet. Simply stated, Ehealth is making health care more efficient, while allowing patients and professionals to do the previously impossible.

5	2000	Medical Business News	E-Health is a convergence between the Internet and the health care industry to provide consumers with a wide variety of information relating to the health care field
6	2000	GJW Government Relations	A wide-ranging area of social policy that uses new media technologies to deliver both new and existing health outcomes
7	2000	Oracle Corporation	Health care transactions, encounters, messaging, or care provision occurring electronically.
8	2000	DeLuca, Enmark - Frontiers of Medicine	E-Health is the embryonic convergence of widereaching technologies like the Internet, computer telephony/interactive voice response, wireless communications, and direct access to health care providers, care management, education, and wellness.
9	2000	Pretlow	E-Health is the process of providing health care via electronic means, in particular over the Internet. It can include teaching, monitoring (e.g. physiologic data), and interaction with health care providers, as well as interaction with other patients afflicted with the same conditions.

10	2001	Baur, Deering and Hsu	The broadest term is e-Health, with refers to the use of electronic technologies in health, health care and public health. The various functions of ehealth [are]: reference (electronic publishing, catalogues, databases); self-help/selfcare (online health information, support groups, health risk assessment, personal health records), plan/provider convenience services (online scheduling, test and lab results, benefit summaries); consultation and referral (doctor patient or doctor-doctor consultation via telemedicine systems, remote readings of digital image and pathology samples); e-Health commerce (sales of health related product and services) [and] public health services (automated data collection, data warehouses, online access to population survey data and registries, advance detection and warning systems for public health threats).This chapter uses the term ehealth to refer to the broadest possible range of interactive technologies applied to health and health care.
11	2001	Orlikoff & Totten	The use of the Internet and related information systems and technology in all aspects of health care.
12	2001	Eysenbach	E-Health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term

			characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology
13	2001	Blake	The combined use of electronic communication and information technology in the health sector. It is important to note that e-Health is much more than business transactions. It encompasses everything from digital data transmission to purchase orders, lab reports, patient histories and insurance claims.
14	2001	Strategic Health Innovations	The use of information technology in the delivery of health care.
15	2001	Robert Wood Johnson Foundation	E-Health is the use of emerging information and communication technology, especially the Internet, to improve or enable health and health care.
16	2001	Wysocki	E-Health refers to all forms of electronic health care delivered over the Internet, ranging from informational, educational and commercial "products" to direct services offered by professionals, non-professionals, businesses or consumers themselves
17	2001	JP Morgan Partners	The health care industry's component of business over the Internet

18	2001	Ontario Hospital eHealth Council	E-Health is a consumer-centered model of health care where stakeholders collaborate utilizing ICTs including Internet technologies to manage health, arrange, deliver, and account for care, and manage the health care system
19	2001	Tieman	E-Health is all that's digital or electronic in the health care industry
20	2001	DeLuca, Enmark	E-Health is the electronic exchange of health related data across organizations, although every health care constituent approaches e-Health differently.
21	2001	Ball – HIMSS	Internet technologies applied to the health care industry
22	2002	Health e-Technologies Initiative	The use of emerging interactive technologies (i.e., Internet, interactive TV, interactive voice response systems, kiosks, personal digital assistants, CDROMs, DVD-ROMs) to enable health improvement and health care services.
23	2002	Grant makers in Health	Use of ICT, especially (but not only) the Internet to enable health and health care.

| 24 | 2002 | Kirshbaum | There are many different definitions of eHealth

Electronic connectivity vehicle for improving the efficiency and effectiveness of health care delivery
Enabling consumers/patients to be better informed about their health care
Enabling providers to deliver better care in more efficient ways |
|----|------|-----------|---|
| 25 | 2002 | Wyatt and Liu | The use of Internet technology by the public, health workers, and others to access health and lifestyle information, services and support; it encompasses *telemedicine, telecare*, etc. |
| 26 | 2003 | Staudenmeir - Arthur Anderson | Any use of the Internet or related technology to improve: the health and wellness of the population; the quality of health care services and outcomes; efficiencies in health care services or administration |
| 27 | 2003 | COACH | The leveraging of the information and communication technology (ICT) to connect provider and patients and governments; to educate and inform health care professionals, managers and consumers; to stimulate innovation in care delivery and health system management; and, to improve our health care system. |

28	2003	Rx2000	E-Health signifies a concerted effort undertaken by some leaders in health care and hi-tech industries to harness the benefits available through convergence of the Internet and health care. Access, cost, quality and portability have been concerns in the health care arena. It's evident from many recent surveys that both health consumers and health care professionals are frustrated with the maze of health care delivery. Some, therefore, are turning to the Internet for answers and cost effective solutions.
29	2003	Beaulieu & Beinlich - First Consulting Group	E-Health (eHealth), n. 1. The application of Internet principles, techniques and technologies to improve health care. 2. New way of conducting the business of health care enabling stronger and more effective connections among patients, doctors, hospitals, employers, brokers, payers, laboratories, pharmacies, and suppliers. 3. The "customer facing" e-revolution in health care. [1999]
30	2003	eEurope - eHealth	The application of information and communication technologies (ICT) across the whole range of functions which one way or another, affect the health of citizens and patients.
31	2003	Decker – HealthVision	Corporate strategy and using the power of the Internet and emerging technology to redefine the delivery of health care.
32	2003	Miller - athealth.com	E-Health means any form of health care information made available over the Internet.

33	2003	Telehealth Victoria	Term that is used to describe most aspects of health care delivery or management that is enabled by information technology or communications
34	2003	Ebrunel.com	The provision of health care services available through the Internet, and particularly health related web sites.
35	2003	Regional Office for the Eastern Mediterranean - World Health Organization	E-Health is a new term used to describe the combined use of electronic communication and information technology in the health sector OR is the use, in the health sector, of digital data transmitted, stored and retrieved electronically-for clinical, educational and administrative purposes, both at the local site and at a distance
36	2003	www.avienda.co.uk	A generic field of information and communications technologies used in medicine and health care.
37	2003	Brommey	The use of electronic information and communications technologies to provide and support health care wherever the participants are located
38	2003	Southwest Medical Group	E-Health is an emerging field focused on medical information and health care services delivered or enhanced through advanced Internet or related technologies. In a broader sense, the term extends the scope of health care beyond its conventional boundaries. Conceptually, e-Health enables patients to easily obtain medical related services online from health care providers

39	2003	HMS Europe	The practice of leveraging the Internet to connect caregivers, health care systems and hospitals with consumers
40	2003	Nova Scotia Telehealth Network	E-Health is a broad term to describe the accessing of information, products and services on "eHealth" sites
41	2003	Strengthening Support for Women with Breast Cancer	The use of information and communication technology (ICT) to enhance health care.
42	2003	Vigneault	The development and evolution of technical tools to support program delivery
43	2003	Policy on ICT Security	Using the Internet and other electronic channels to access and delivery health and lifestyle information and services
44	2003	Health systems group	E-Health is health promotion delivered and managed over the Internet
45	2003	Marcus and Fabius	E-Health is connectivity
46	2003	Silber	E-Health is the application of information and communications technologies (ICT) across the whole range of functions that affect health.

47	2003	Ehealth Technologies	The use of emerging information and communication technology, especially the Internet, to improve or enable health and health care thereby enabling stronger and more effective connections among patients, doctors, hospitals, payers, laboratories, pharmacies, and suppliers
48	2003	International Telecommunication Union	Encompasses all of the information and communication technologies (ICT) necessary to make the health system work
49	2003	Baker Modified from Gott (1993)	The promotion and facilitation of health and wellbeing with individuals and families and the enhancement of professional practice by the use of information and communication technology
50	2004	Sternberg	New business models using technology to assist health care providers in caring for patients and providing services.
51	2004	Watson	The integration of the internet into health care.

Chan, Matthews, and Kaufman (2009) placed e-Health as an "emerging subfield" of

health informatics. According to Wikipedia, health informatics "is a discipline at the intersection

of information science, computer science, and health care. It deals with the resources, devices,

and methods required to optimize the acquisition, storage, retrieval, and use of information in

health and biomedicine." This would include Electronic Medical Records (EMR) and systems to

store, file, and disseminate information. The focus is more technical than that in telemedicine,

dealing often with data mining, signal processing, imaging and visualization, computational

modeling, signal processing, coding, text, graphics, imaging, knowledge representations and systems architecture (Maojo and Kulikowski 2003). According to Bashshur, Shannon, Krupinski and Grigsby (2011), informatics is "the science of collection, classification, storage, retrieval, and dissemination of information." Storage and retrieval of information may or may not involve medical care, as telemedicine does. The emphasis is on information at a distance for the purposes of curing and managing disease.

Bashshur, Shannon, Krupinski and Grigsby (2011) wrote that the term e-Health started to be used in the 1990s, mostly by business and commercial interest and that "to date, no consensus has emerged as to a uniform, let-alone unique or non-overlapping, definition of eHealth that differentiates it from similar domains. Some in the field use the term to refer to health applications that rely on electronic processing and the Internet, whereas others prefer to use it as an even more inclusive reference to any computer usage in health care."

1.5.4 Mobile Health

About 6 billion people in the world have cell phones, according to U.N. Deputy Secretary-General Jan Eliasson, reported Wang, Time Newsfeed (2013). Mobile phones have been used increasingly to provide telemedicine services. Whitten and Love (2005) wrote that the use of innovative mobile technology can improve prevention and reach young people. Rodgers, Soyer, Lossi, DiStefani in 2005 conducted a study in which text messages to assist in smoking cessation were sent to participants, but not to those in the control group. At six weeks, more participants had quit in the intervention compared to the control group: 239 (28%) *v* 109 (13%).

Massone, Brunasso, Campbell, and Soyer (2008) investigated the feasibility of teleconsultation for pigmented skin lesions using a new generation of cellular phones. Face-face consultations were done, and clinical and dermoscopic images were taken. Two teleconsultants

reviewed the images on a specific web application. Compared to the face-to-face diagnoses, they obtained a score of correct telediagnoses of 89% and of 91.5%, reporting the clinical and dermoscopic images, respectively. However, in their 2007 study of a virtual slide system (VSS) in teledermatopathology, the average agreement of telediagnosis with gold standard diagnosis and conventional diagnosis decreased to 65% and 66%, so the system was not deemed feasible for diagnosis.

In 2008, Koshy, Car and Majeed conducted a study where ophthalmology patients received doctor appointment reminders. A total of 11.2% (50/447) of patients who received an SMS appointment reminder were non-attenders, compared to 18.1% (1720/9512) who did not receive a reminder. Therefore, the non-attendance rate of the SMS group was 38% lower than that of the control group.

In 2009, Armstrong, Watson, Makredes, Frangos et al. conducted a randomized, controlled trial of the effect of an electronic text-message reminder system for sunscreen application adherence. There were two groups of participants: those that received daily reminders to put on sunscreen for six weeks, and those who did not. Those who did not receive reminders had a mean daily adherence rate of 30.0%, while those who did receive reminders had a mean daily adherence rate of 56.15%.

Allen (2012), covering the Arizona Telemedicine Program, wrote how telemedicine was relying more and more on mobile phones, Skype and iPads. Physicians were the biggest impediment to its implementation, since they seldom studied it in medical school.

"Someday a smartphone will be as common as a stethoscope," Dr. Bart Demaerschalk, a neurologist at Mayo Clinic Hospital, said. He did add: "I'm convinced the doctor of tomorrow may not even regard telemedicine as telemedicine. They may regard it as medicine and not be so

fixated on technology "It won't be long before physicians will accept telemedicine as a natural extension of their practice."

One medical condition for which mobile phones are used extensively is strokes. According to Bergrath, Rossaint, Reich, Rörtgen et al. (2012) stroke is the third leading cause of death in the U.S. and about one-third of stroke survivors remain permanently disabled. A person who experiences a stroke has an hour to get medical help. This is one factor that makes stroke the fourth leading cause of the death in the United States. In a new study Brendan Carr, MD, and colleagues showed that only 54% of residents in Oregon could reach a stroke center by ground in this critical 60 minutes and 20% had no access to a telemedicine network or a stroke center at all. Telemedicine could reach people in rural areas with no cars and where it takes an ambulance a long time to get to a medical professional. They found that telestroke programs increased access to stroke care in this critical hour by 40%. Officials said a major benefit of the collaboration was that patients with stroke symptoms who meet the criteria can often be administered clot-busting medications within the narrow window of time necessary to minimize permanent injury to the brain.

Mobile phones also are used to treat asthma. Yanhua, Zhao, Liang, Dong et al. (2012), conducted a study of 150 outpatients with asthma who were randomly assigned to control, traditional, and short message system (SMS) groups. Patients in all groups received verbal asthma education. Patients in the traditional group received additional individualized asthma action plans for self-management and patients in the SMS group received additional daily SMS reminders on their mobile phones. They found that SMS can improve patients' perceived control of asthma (PCA), and has a greater advantage than traditional care in improving follow-up rate, medical compliance and asthma-specific quality of life. Patients' PCA is associated with better physical

and mental health (Katz, Yelin, Eisner and Black 2002), and is related to the general theories of self-efficacy, locus of control, and learned helplessness. Past studies (Liu, Huang, Wang, Lee et al. 2011) had shown that SMS could increase the asthma control rate, the quality of life and the adherence to asthma treatment, while decreasing episodes of exacerbation and unscheduled visits.

Yun and Arriaga (2013) conducted a study with 30 children with asthma, ages 10 to 17, who owned a mobile phone and could read at a fifth-grade level or higher. The children were divided into three groups: a control group that did not receive text messages; a group that received text messages every other day; and a group that received text messages every day. The text messages contained information about asthma or asked children about their symptoms. After four months, researchers found that children who received the daily text messages had improved clinical outcomes compared with children in the other two groups.

Mobile phones also are useful in medical conditions that need to be assessed before a patient can get to a medical center. Van Dillen, Silvestri, Haney, Ralls et al. (2013) evaluated the agreement between a real-time telemedicine evaluation and a bedside evaluation in the management of acute traumatic wounds in an emergency department.

Adult and pediatric patients with 173 acute wounds in varying parts of their bodies were first assessed via telemedicine and then by bedside care. The primary outcome measure was wound length and depth, and management decision-making was also assessed. The authors found that wound management would have been the same in 94% of cases. The agreement on wound characteristics and wound management ranged from 84 % to 100%. They concluded that the ability of video images to distinguish between a minor and non-minor wound, and predicting the need for hospital management, had high degrees of sensitivity and specificity. Wound

characteristics and management decisions appeared to correlate well between video and bedside evaluations.

Bastawrous and Armstrong (2013) conducted a review of peer-reviewed literature, published between 1 August 2006 and 1 August 2011, for the application of mobile devices (from basic text-messaging systems to smartphones) in health care in developed and developing countries. They noted the uses of mobile phones in health care, including infection outbreak reporting, anti-HIV therapy adherence, gait analysis, resuscitation training and radiological imaging and wrote that "the current uses and future possibilities of mobile phone technology in health care are endless." As other authors have concluded about telemedicine evaluation, Bastawrous and Armstrong concluded that more rigorous research is needed to ensure evidence-based applications for the best possible patient benefit, and that regulation and guidelines for mobile home health care uses would be beneficial, as would more well-designed prospective studies that would enable the validation of these promising advances in mobile telemedicine According to the authors, this is difficult because mhealth is innovating at a rate that is quicker than the process of designing, completing and publishing scientific evidence for its effectiveness.

The director of the NIH, Dr. Francis Collins, addressed health care professionals at the 2012 mHealth Summit, saying that only about 20 randomized clinical trials involving mHealth tools or services had been conducted in the United States since 2008 under the NIH and more than half of them have failed to document clear evidence of improved outcomes (Wicklund 2012). He said that, while mHealth technology is needed by the health care industry, the small amount of trial-based evidence is hindering its acceptance. He noted that 200 NIH-funded projects were then underway on mobile phone-related research. He also noted that mHealth technology was evolving so rapidly that trial results were outdated by the time the trials were

completed. He recommended that more appropriated, speedier trials be conducted. He said that going forth with mHealth without clinical evidence would be "unfortunate" and he also recommended that national research network of millions of people, linked through electronic medical records platforms be created to have real data available to physicians and to produce "quick and compelling clinical results."

According to the *Health Care Information and Management Systems Society (HIMSS 2012)*, about 68% of 180 surveyed health care organizations were implementing a policy on the use of mobile technology, about 27% of surveyed health care organizations were developing a policy on the use of mobile technology and about 4% said they had no plans to develop such a policy. About 2% of respondents selected "other" or "don't know" regarding their mobile policy. According to the Second Annual HIMSS Mobile Technology Survey, 93% of physicians use mobile health technology in their day-to-day activities, and 80% use it to provide patient care. Clinicians using mobile technology to collect data at the bedside rose from 30% in 2011 to 45% in 2012 (Health Care Information and Management Leadership Society 2013).

Clinicians using mobile technology for monitoring medical-device data increased from 27% to 34%. Dr. Jeffrey Sachs (mHIMSS 2012) said that the U.S. should look to Africa for mobile breakthroughs: "Those breakthroughs will eventually become breakthroughs in the U.S. when it addresses the high costs of its health care system and frees up $750 billion a year in waste." He wrote that mobile technology empowers patients and community health workers. Especially in developing countries. It also improves diagnostics (for instance, malaria can be diagnosed with just a drop of blood); emergency response (whereby patients can call an ambulance); and epidemic surveillance.

According to a 2012 comScore study, which looked at 300 physicians, computers were the most used electronic device but mobile phones were gaining in importance. About 60% of physicians surveyed reported using mobile phones daily.

A Research2guidance Global Mobile Health Market Report anticipated that the global market revenue for mobile health technology would reach $26 billion by 2017. In that, same year, 3.4 billion people worldwide would have smartphones or tablet computers with access to mobile health apps (https://research2guidance.com/the-market-for-mhealth-app-services-will-reach-26-billion-by-2017/). Furthermore, the report predicted that 50% of those people would have downloaded such apps.

According to the report, there are phases of using mobile phones for health: an initial trial phase; a commercialization phase; and an integration phase. We are now in the second phase, which is characterized by many new products, business models and solutions focused on individuals and companies. For the second phase to move fully into the third phase, regulation and policies must be in place.

Stacy Lu (2013) wrote in the *Huffington Post* that the days of using a mobile phone for an annual physical are close. Since measurements such as blood pressure can vary daily, having a mobile phone to check them can be valuable. Physicians and medical schools are using mobile phone features such as the body analysis scale, blood pressure cuff, pulse oximeter and ECG.

1.5.5 Telemonitoring

Telemonitoring is a way for patients to have a continuous flow of useful information about their biological statistics and disease state, and to convey it to their doctor or medical center. Mair's 2008 definition described telemonitoring: "used for monitoring people with relatively stable but long-term conditions." As discussed in the definitions section, some

researchers consider telemonitoring to be an aspect of telecare and telehealth, but not telemedicine.

A report conducted by Kalorama Information, a leading publisher of market research, said that the U.S. remote patient monitoring market, almost $4 billion in 2007, more than doubled to $8.9 billion in 2011. The 2012 market was $10.6 billion. Kalorama officials expected market value to almost double to $20.9 billion by 2016 (McCann 2013).

Paré, Jaana and Sicotte (2007) defined telemonitoring in their literature review study as "an automated process for the transmission of data on a patient's health status from home to the respective health care setting." The authors concluded that the reviewed studies confirming the accuracy and reliability of telemonitoring. Few errors and technical problems were found in the projects studied. This is an important indicator of the success of home telemonitoring in ensuring the timely availability of quality data for clinical decision-making. With the continuous development in telemonitoring technologies, the authors wrote, the data transferred by telemonitoring will become as reliable as those collected through face-to-face patient examination.

The studies also presented consistent findings related to the effects of home telemonitoring on patients' attitudes and behaviors. Telemonitoring was well accepted by patients. With it, they could actively participate in the process of health care, with heightened awareness and feelings of security and empowerment. More studies need to be done to find out the conditions that would support the development of patients' empowerment and enhance their participation in the telemonitoring process. One issue to be studied further is the decreased use of telemonitoring with time. This is important, especially in the case of chronic illnesses that require long-term follow-up and monitoring. They wrote that more studies are needed to learn about its

clinical effects, cost effectiveness, impact on the utilization of health services, and acceptance by health care providers. This would lead to changes in legal policy and insurance coverage.

AbuDagga, Alwan and Reznick (2010) reviewed 15 studies to study the impact of telemonitoring of blood pressure. Blood pressure telemonitoring reduced blood pressure in all but two studies. Furthermore, they indicated that the magnitude of blood pressure reduction was comparable to that obtained in randomized control trials that compared the effects of certain antihypertensive drugs with a placebo. They concluded that telemonitoring was one effective intervention for management of hypertension, which should involve identification, follow-up, and treatment with antihypertensive drugs. Some of the reviewed studies suggested that telemonitoring can facilitate the control of blood pressure by managing medications and increasing patient self-confidence, knowledge, and involvement in their health. Using telemonitoring, health care providers have access to reliable, frequent blood pressure information, which offers opportunities for timely interventions not linked to routine office visits.

In a cluster randomized control trial, Kerby, Asche, Maciosek, O'Connor et al. (2012) asked patients with hypertension to measure their blood pressure six times a week and to "attend" phone visits with health care professionals about their condition. Adherence was high: 73% took at least six blood pressure readings per week and 88% of expected phone visits were attended. The two measures were correlated. Demographically, white race and male gender predicted a better adherence rate. One limitation was that the participants may have been more likely to adhere to the intervention because they agreed to participate in a clinical trial. According to recent systematic reviews, telemonitoring interventions for patients with heart failure reduce the risk of all-cause mortality, heart failure-related hospitalizations and emergency department visits (Inglis, Clark, McAlister, and Ball 2010; and Polisena 2010; Tran, Polisena, Coyle, and Coyle et al. 2008;

Clark, Inglis, McAlister, and Cleland 2007). Quality of life, selfcare and evidence-based prescribing were improved for heart failure patients. Moreover, the use of home telemonitoring for patients with heart failure improved quality of life, patient self-care and evidence-based prescribing (Inglis, Clark, McAlister, Ball 2010; Polisena, Tran, Cimon, Hutton et al. 2010; Clark, Inglis, McAlister, Cleland et al. 2007). As in other telemedicine areas, further studies of high methodological quality are required to give more precise information about the potential clinical benefits of home telemonitoring.

Klersy, De Silverstri, Gabutti, Regoli et al. (2009) reviewed 96 journal articles between 2000 and 2008 regarding heart failure treatment via traditional care or telemonitoring, including 20 journal articles about randomized clinical trials. They concluded that telemonitoring confers a significant protective clinical effect in patients with chronic heart failure compared with traditional care. Meta-analysis showed that telemonitoring significantly reduced the risk of death and hospitalization for any cause.

In the Clarke, Shah and Sharma study (2011), two people independently reviewed 125 articles and selected 13 articles for final review. Studies contained a control group, where patients received usual care and; physicians or nurse specialists saw them in person. The studies included 3,480 patients with congestive heart failure. Results showed that there was an overall reduction in all-cause mortality ($P = 0.02$), a reduction in heart failure hospital admission ($P = 0.0004$), no overall reduction in all-cause hospital admission ($P = 0.84$), and no reduction in all-cause emergency admission ($P = 0.67$). Although there was no significant difference in length of stay in hospital, medication adherence or cost, the authors concluded that telemonitoring, in conjunction with nurse home visiting and specialist unit support, can be effective in the clinical management and improvement of quality of life of heart failure patients. The reassurance of having the

telemonitoring system allowed patients to return home faster. The feedback gained by patients often promoted self-management. For the nurses, tele-education decreased travel time, workload, and reliance on the nurse.

Anker, Koehler, and Abraham (2011) also wrote that telemonitoring is useful in monitoring heart failure patients, and noted that cardiologists were increasingly scarce. They explained that telemedicine can be self-empowering and provide the patient with early detection, structured disease management, and prompt medical intervention. They claimed that health professionals can detect patient depression through telemedicine.

After a meta-analysis of heart failure telemonitoring systems, they concluded that most systems in the future will combine non-invasive and invasive approaches with daily monitoring and management. They recommend that telemedical management in heart failure should incorporate the monitoring and management of comorbidities and a partnership between patients and physicians, and make use of the self-care abilities of patients. They predicted that future systems will probably enable patients to interpret and respond to some of their physiological information.

Kulshreshtha, Kvedar, Goyal, Halpern et al. (2010) reviewed remote monitoring (RM) of vital signs for ambulatory, non-homebound heart failure patients to see if RM would reduce hospital admissions. Heart failure affects about 5 million people in the United States. Participants in the RM program had a lower all-cause per person readmission rate compared to the office visit. The difference was not statistically significant. The participants were mostly satisfied; 93% said the equipment was easy-to-use.

It is estimated that by 2020, chronic diseases will constitute more than 60% of illnesses requiring treatment (Martín-Lesende, Iñaki, Cairo, Bilbao et al. 2011). Often, several chronic

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diseases occur at the same time in the same patients. This is often the case for elderly patients, whose patient size is growing and is characterized by a high use of health care resources, elevated rates of hospitalizations and a high prevalence of disability and dependence during the course of the disease (Martín-Lesende, Iñaki, Cairo, Bilbao et al. 2011). These elderly chronic disease patients frequently experience multiple hospital admissions which can decrease their quality of life. Telemetric-supported self-monitoring of heart conditions and lung conditions has the potential to promote self-care, improve compliance, enable timely response to deterioration and improve the follow-up after hospital discharge (Martín-Lesende, Iñaki, Cairo, Bilbao et al. 2011).

Telemonitoring has been used to monitor and treat diabetes. In 2007, the American Diabetes Association estimated the annual economic cost of treating diabetes to be $174 billion. The lack of coordinated care among the various providers involved in treatment partly contributed to the cost. Telemedicine gives another means for providers to manage and/or share vital information for disease management and to increase patients' ability to make decisions about their condition. Carter, Nunlee-Bland and Callender (2011) randomly assigned inner city African-Americans with diabetes to the treatment (26) and control (21) conditions. Their study tested a telemonitoring-coordinated service delivery model that integrated provider-patient communication with patient self-management and education. Patients who received telemonitoring had access to online education, physician appointment reminders, and ways to monitor their statistics. They were included in a social networking site where they exchanged information and had biweekly virtual nurse visits. According to the Centers for Disease Control (CDC) in 2007, 7.8 % of the U.S. population, or 23.6 million persons, had diabetes, predominately type 2 diabetes. The rate of African Americans with the disease was 11.8 %

compared to the overall national rate of 7.7 % (Brennan, Spettell, Villagra, Ofili et al. 2010; Lowe and Cummin 2010). The telemedicine participants in the 2011 study achieved positive outcomes in terms of lowered hemoglobin A1c and body mass index (BMI) than control group members. The primary dependent variable was hemoglobin A1c, and more participants who received telemonitoring achieved a measure of 7% or below. Telemonitoring participants were 4.58 times more likely to reach the desired hemoglobin A1c target than the participants who received traditional care. Blood pressure below 130/80 during the last month or longer of enrollment and a BMI of between 18.5 and 24.9 during the last month or longer of enrollment were the secondary dependent variables. Patients who received telemonitoring were more likely to have lower BMI than those who received traditional care, but no such correlation was found with blood pressure. Patients who received telemonitoring were more likely to report feeling better mentally and physically and to keep their physician appointments. Limitations were that the sample size was small, predominantly female, and had a mean age of 56. The study was restricted to participants with an eighth grade or higher reading level and many inner city residents have a lower level of education.

Lowe and Cummin (2010) think that telemedicine may reduce costs of taking care of people with diabetes. The authors mentioned a study that found that the use of community-based telehealth kiosks and clinician-supported patient self-management reduced costs to treat diabetes by increasing coordination and reducing service delivery time.

Molero, Domínguez-López, Guerrero, Carreira et al. (2012) evaluated a telemedicine system in 15 patients with type 1 diabetes who had optimized treatment with an insulin pump and a real-time continuous glucose monitoring system for one year. Three medical visits took place at pre-baseline, baseline and at 6 months. Information was gathered from the glucose meter, glucose

sensor and insulin pump. Variables evaluated included HbA1c, hypoglycaemia, hyperglycaemia and glucose variability. Results were: a significant reduction in HbA1c (7.50% to 6.97%) at 6 months, a significant increase in the number of self-monitoring blood glucose checks per day (5.2% to 6.2%), and significant improvements in variability, significant improvements in quality of life (92% to 87%), satisfaction with the treatment (34% to 32%) and less fear of hypoglycaemia (36% to 32%). The authors concluded that adult subjects with type 1 diabetes on treatment with a continuous insulin infusion system and a real-time glucose sensor and who have acceptable metabolic control and optimized treatment can benefit from the addition of telemonitoring to outpatient care. Limitations included the lack of a control group and the reduced sample size

According to Berenson, Paulus and Kalman (2012), hospitals with high readmission rates faced up to a 1% cut in Medicare beginning in October 2012, and about 20% of Medicare patients were rehospitalized within 30 days. Some studies show that telemonitoring of chronic disease reduced readmission rates. For example, Cordisco, Benjaminovitz, Hammond and Mancine (1999) showed that there was a drop in readmissions for patients with congestive heart failure when they were monitored at home. Other studies show that telemonitoring did not reduce readmissions. For example, in a study by Takahashi, Hanson, Thorsteinsdottir, Van Houten et al. (2012), telemonitored patients showed no drop in readmissions and emergency room visits. Researchers compared two groups of Mayo Clinic patients 60 years and older with comorbid conditions such as heart disease, diabetes and chronic obstructive pulmonary disease who were at high risk of rehospitalization. One group of 102 patients received telemonitoring that had real-time videoconferencing capability. The system measured patients' weight, blood glucose and blood pressure for nurse and physician review. The second group of 103 patients received no

telehealth services. In comparison, 44% of usual care patients compared to 52% of telemonitoring patients were readmitted. About 28% of usual-care patients visited the emergency department (ED), while 35% of telemonitoring patients visited the ED. But these results were not significant; telemonitoring had no effect. Forty-four % of the usual-care patients were rehospitalized within the following year, while 52% of the telemonitoring patients were admitted to the hospital. Meanwhile, 28% of the usual-care patients visited the ED, compared with 35% of the telemonitored patients. The differences were not statistically significant, meaning the intervention had no effect, according to the study published online on April 16 in the *Archives of Internal Medicine*.

Telemonitoring is being used in the United Kingdom. For example, according to Hirschler (2012), the United Kingdom, second only to the United States in telehealth programs, was looking to invest in telemonitoring, aiming to reduce hospitalizations and to save money for patients and the state. The Department of Health in the United Kingdom claimed it could save up to 1.2 billion pounds ($1.9 billion) in the next five years.

Telemonitoring can help many people with diabetes monitor their insulin and blood sugar levels. According to the American Diabetes Association (2014), a total of 25.8 million children and adults in the United States, (or about 8.3% of the total population), had diabetes in 2011. For instance, Leichter, Bowman, Adkins and Jelsovsky analyzed 100 diabetes patients in a randomized clinical trial and found that the use of a telemedicine-based treatment protocol in diabetes patients is feasible and efficient, and comparable with traditional, clinic-based protocols when it comes to clinical outcomes. No significant differences between control group and study group (telemedicine) participants were found, and no significant between-group differences in

blood sugar, blood pressure, lipids, or BMI at 12 months were found. In addition, study group participants showed a significantly larger drop in weight.

1.6 Importance of Telemedicine

As early as 1995, Grigsby, Schlenker, Kaehny, and Shaughnessy et al. (1995) proposed these uses of telemedicine:

1. Initial urgent evaluation of patients, triage decisions and pretransfer arrangements. These include emergency treatment, one-time specialist consults, and disaster relief;

2. Medical and surgical follow-up and medication checks. Examples are postsurgical encounters between specialist and patient, with or without the primary provider;

3. Supervision and consultation for primary care encounters in sites where a physician is not available. A physician communicates with a nurse or other non-physician health professional with the patient a distance away;

4. Routine consultations and second opinions based on history, physical examination findings, and available test data. These may or may not involve a physician at the remote

    site;

5. Transmission of diagnostic images. These images can be radiologic, pathologic, dermatologic or other;

6. Extended diagnostic work-ups or short-term management of self-limited conditions. Certain conditions, such as chronic headaches, may take several visits;

7. Management of chronic diseases and conditions requiring a specialist not available locally. Examples of these are oncology, disability, and dialysis;

8. Transmission of medical data. This could involve electrocardiogram data, patient history, laboratory results and other clinical data;

9. Public health, preventive medicine, and patient education. Patients are provided with information. Examples are pregnancy or disaster relief education and information.

Wootton (1996) foresaw that constraints in time and resources would make face-to-face consultations increasingly expensive and telemedicine would produce "major efficacies in diagnostic progress." He wrote that telemedicine would do for health care what the personal computer did for the office. He wrote that telemedicine is a process, not just technology.

Telemedicine via the Internet has been popular in the past 21 years (Gambadauro and Torrejo 2013). Figure 1 shows that there was a spike in PubMed articles with the keyword "telemedicine" in 1991 and a parallel trend in the absolute and relative number of publications retrieved, respectively, with the keywords ''telemedicine'' and ''Internet.'' Figures 2 and 3 show a parallel increase in the articles retrieved after 1991 using the terms "telemedicine" and "Internet." Organizations in the forefront who use telemedicine include Veterans Association (VA) hospitals and the National Aeronautics and Space Association (NASA) (Klonoff 2009). McGowan (2008) wrote that telemedicine is the telephone of tomorrow; just as the telephone was not designed for health care but added to it, the same can be said about the Internet and World Wide Web. However, the field has not matured yet. Demiris and Tao (2005) found that publications in telemedicine cover a wide range, geographically and in terms of clinical disciplines, suggesting that the field of telemedicine is maturing. This study will aid in understanding telemedicine by revealing the most important topics in the field and the scholarly (author and journal) sources of information in the field.

Figure 1. Spike in Telemedicine Publications
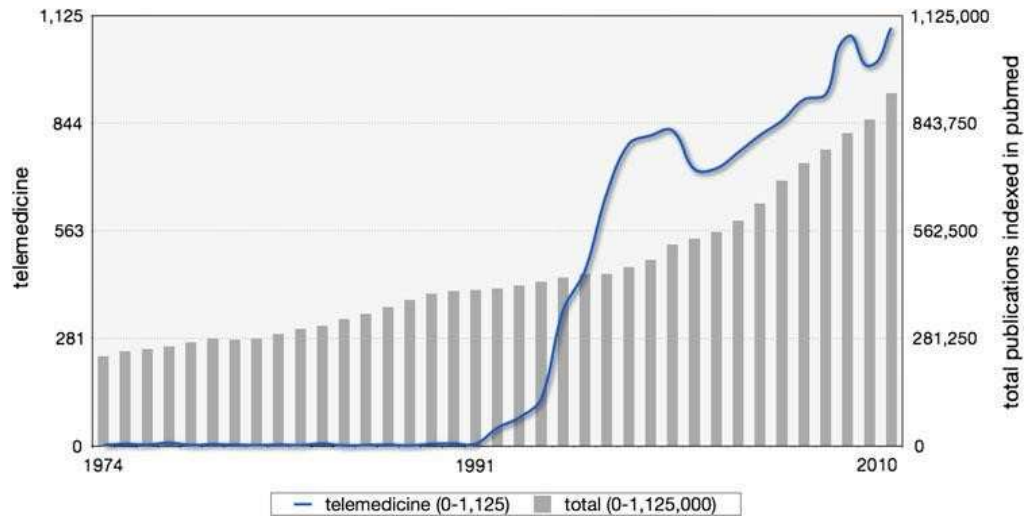
Above excerpted from Gambadauro and Torrejo 2013

Spike in the absolute and relative number of publications retrieved with the keyword ''telemedicine'' following the advent of the World Wide Web, 1991 as of October 7, 2011.

Figures 2 and 3: Parallel Increase in Articles Retrieved Using "Telemedicine" and "Internet"
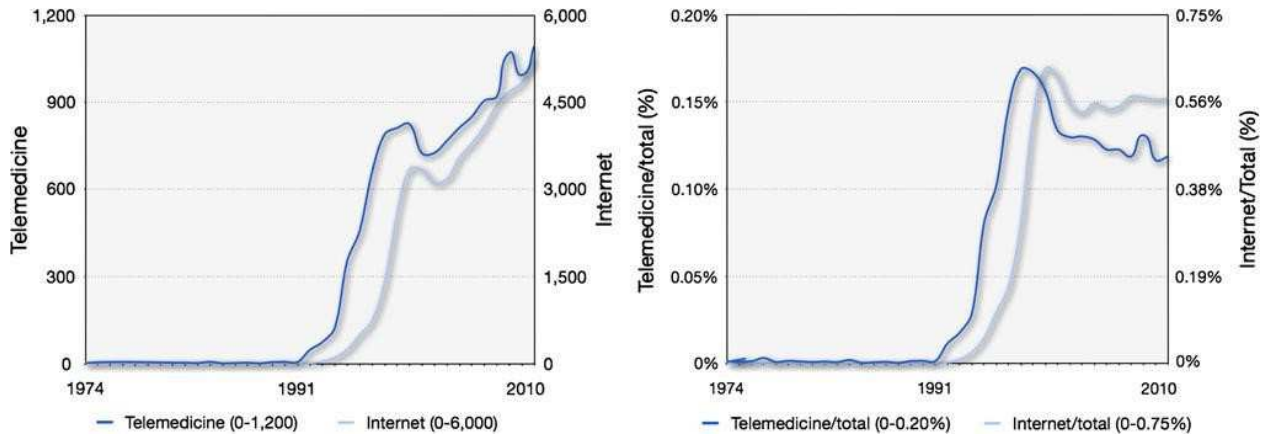
Above excerpted from Gambadauro and Torrejo 2013

Jonathan Linkous, CEO of the American Telemedicine Association (ATA), which is at the cutting edge of telehealth, holding annual meetings that bring together health and IT professionals to discuss telehealth, said in a 2012 interview with Diane of Health Care IT News that support for telemedicine was growing: "The time is right" for telehealth to grow. Linkous (2012) added: "Over the next year, you are going to see some very important people joining the telehealth bandwagon." He went on to say that remote monitoring was used by 200,000 patients nationwide, and a million cardiac patients a year, and provided 400,000 virtual visits in 2012 to mental health patients.

Veteran telemedicine author Rashid Bashshur (2013) believed that telemedicine should be established as "an integral component of a more rational health care organization" and "…we are at the threshold of a new environment in which telemedicine, broadly defined, must be an essential a part of mainstream health care if patients are to receive the appropriate care (based on clinical need and evidence-based medicine), at the appropriate site (closest to where they live and work aided by electronic links), by the appropriate provider (based on explicit and rational triage criteria), while avoiding duplication and waste (using protocols for diagnostics and procedures)." He maintained that EHR was necessary but not sufficient for "the integration of primary care and prevention, acute care, chronic disease management, and rehabilitations, specialty and end-of life."

A leading example of using telemedicine for professional medical information sharing is Mercy, in St. Louis, Missouri, the sixth largest Catholic health care system in the U.S. It serves more than 3 million people annually. Mercy is building $90 million virtual care center along with a new specialty hospital and corporate offices to consolidate various telemedicine services at one site. Besides the vital role of information sharing, Mercy estimated that the center can reduce the cost of an emergency room visit by $4,000 per patient.

Mayo Clinic's CEO, John Noseworthy has set goal of the clinic touching the lives of 200 million patients by the year 2020. Mayo Clinic's "Care Network" is another example of a center that seeks to affiliate and provide "e-consults" to patients in affiliated hospitals.

Noseworthy has stated: "Our model has been that the patients come to us. Increasingly, going forward … we also wish to extend the reach of the Mayo Clinic, taking our knowledge, taking our experience, and sharing it with others."

Erin McCann reported that telemedicine patient monitoring market grew from $4.2 billion in 2007 to more than $10 billion in 2012, a 237% increase. Although the market itself was considered small to moderate it, it had notable number of competitors. Reasons for growth include an aging population, increases in health care costs, advancing technologies and the often cost effectiveness of patient monitoring. McCann wrote that growth will increase as compatibility, privacy and security issues continue to be resolved. Economic hardships in many European countries have led governments to review options such as telemedicine to control costs in health care. Rising health care costs in the United States have been attributed to doctor and hospital bills and rising chronic conditions such as obesity and diabetes (Goodman and Norbeck 2013; Leichter, Bowman, Adkins and Jelsovsky 2013).

Misra, Kalita, Mishra, and Yadav (2005) wrote that new technology in the past decades has allowed for easy information sharing of medical ideas and practices. Telemedicine via the Internet allows for the faster communication of larger qualities of information to one or more recipients. When patient history and disease history and statistics need to be analyzed by experts, telemedicine allows for information sharing and transfer among a large number of actors, if necessary, to provide for an accurate diagnosis of and treatment for disease. Second (or more) opinions are often needed and telemedicine is efficient for that. Telemedicine also allows for treatment (in one center or collaborative with information sharing) of rising health concerns such as obesity. According to the CDC, more than one-third of U.S. adults (35.7%) were obese in November 2015 (https://www.cdc.gov/nchs/data/databriefs/db219.pdf).

1.6.1 Telemedicine as Part of Health Care Reform

Bashshur, Shannon, Krupinski, and Grigsby (2011) wrote that telemedicine is central to the necessity of health care reform. They cited long-standing problems of health care in the United

States and the increasing telemedicine research that accounts for the benefits of telemedicine. While the

United States spends more on health care than any other developed country, the health status of Americans is relatively low compared to citizens of other developed countries. According to the authors, Americans suffer from health care inequities, inefficiencies in delivery of care, escalating costs, adverse lifestyles, discontinuity of care, and a system that is slow to grow. They stated that health is a combination of genetics, biology, lifestyle, health care, and environmental quality. They believe that the role of medical intervention is to enhance prevention of disease, and to provide diagnostic, therapeutic and support systems. They concluded that federal and state governments, as well and health professionals, have emphasized EHRs, but they only are a partial solution to the nation's health care problems.

The term "Big Med" was coined by Atul Gawande in the August 2012 edition of *The New Yorker*. It relates to the accelerating trend in mergers, acquisitions and affiliations in health care. New approaches to the delivery of care are adapting strategies used in retail and other sectors. Gawande wrote: "Our costs are soaring, the service is typically mediocre, and the quality is unreliable. Every clinician has his or her own way of doing things, and the rates of failure and complication (not to mention the costs) for a given service routinely vary by a factor of two or three, even within the same hospital." He wrote that perhaps consolidated health care centers can mirror chains such as Cheesecake Factories that "provide goods and services of greater variety, better quality, and lower cost than would otherwise be available." Their size gives "them buying power, lets them centralize common functions, and allows them to adopt and diffuse innovations faster than they could if they were a bunch of small, independent operations." A shift in Medicare and Blue Shield Blue Cross is that many insurers are paying for results, not just procedures. This is making health care centers focus on what can make their results better, including telemedicine. Gawande wrote that "good ideas in medicine take an appallingly long time to trickle down." For

instance, new medical guidelines from American Academy of Neurology and the American Headache Society have not become standard (as of 2012 when the article was written) even after they were introduced by others over a decade ago. Gawande predicted:

"Patients won't just look for the best specialist anymore; they'll look for the best system. Nurses and doctors will have to get used to delivering care in which our own convenience counts for less and the patients' experience counts for more. We'll also have to figure out how to reward people for taking the time and expense to teach the next generations of clinicians. All this will be an enormous upheaval, but it's long overdue, and many people recognize that."

Telemedicine can help transmit and sort information among physicians, health care professionals and health care centers, providing for collaboration in diagnosis, treatment and monitoring of disease.

1.6.2 Problems of Health Care in the United States

Bashshur, Shannon, Krupinski, and Grigsby (2011) wrote that some problems in health care are: inequality of care; limited access of some to health care, inefficiencies and limited coordination of complex systems of health care; a high degree of adherence to evidence-based care; unhealthy lifestyles; and uneven distribution of quality care. They wrote that IT has been adopted widely for billing, scheduling and communication, but not for second opinions, telemonitoring, triaging patients and coordinating care. They explained that reform in the cost of implementation and standard reimbursement policy would equate telemedicine to office care. In these economic times, it is especially hard for large systems to incorporate telemedicine without a clear expectation of return on investment.

Telemedicine allows people in both urban and rural areas with a low level of medical specialists, or patients who find it hard to move, such as many seniors, access to one or more

medical opinions. Usually, more than one opinion is optimal to pinpoint the correct diagnosis and treatment (Hersh, Helfand, Wallace, Kraemer et al. 2001, Bashshur, Shannon, Krupinski, and Grigsby (2011). Telemedicine has been used in developing countries where there are few doctors per thousand people and very few specialists.

Some groups such as the Veterans Administration, the Department of Defense and the Bureau of Prisons, have adopted the use of telemedicine. In order for both the insured and uninsured to benefit financially from telemedicine, explicit protocols for triage, referral, treatment and follow-up and enhanced patient self-management are needed. In addition, patients must also be informed and take responsibility for their own lifestyles.

Bashshur, Shannon, Krupinski, and Grigsby (2011) noted how hospitals became the main centers of health care since they were the places to obtain an X-ray, anesthesia, antisepsis and surgery. Although this is still often the case, there are new technologies and smaller centers available today and hospital costs have spiraled. Public health started to be underfunded and separated from clinical care, focusing on sanitation, communicable disease and environmentally-linked disease etiologies.

The authors cited ways in which legislation has tried to help, but was not sufficient to address underlying inefficiencies and unintended consequences. These ways were: Trying to improve resources in underserved areas; education and grants to attract health care providers to these areas; regional programs and health planning agencies trying to enhance integration and efficiency; and containing cost through reimbursement and managed care. They summed up the lessons to be learned from past reforms:

Table 3. What Was Learned from Past Health Care Reforms

Lack of sustained national health initiative	A system that favors the status quo and resists change
Lack of coordinated system of care	Wide variations of clinical practice, discrepancies in adherence to evidence-based standards, and wide variability
Systemwide approached viewed as quick fixes	Need a system wide approach where different initiatives are blended to achieve explicit goals

Above excerpted from Bashshur, Shannon, Krupinski, and Grigsby 2011

1.6.3 Shortage of Specialists

Telemedicine also may help with the shortage of physician specialists in many areas

(Huston and Huston 2000; Watson, Bergman, and Kvedar 2007; Schwamm, Audebert,

Amarenco, Chumbler et al. 2009). Rural areas usually have the highest shortages, but urban areas have a higher number of patients, which lowers the specialist to patient ratio. (Kim 2004; Fieleke, Edison and Dyer 2008) Global medical staff shortages, especially of specialists, make teleconsultations vital, according to some, for health care in the future (Desai, McKoy, and Kovarik 2010; Ferguson 2006; Pak 2005; Perednia and Allen 1995). Bashshur, Shannon, Krupinski and Grigsby (2011) wrote about the importance of telepsychiatry as well in reaching rural areas.

1.6.4 How Telemedicine Can Help

Bashshur, Shannon, Krupinski, and Grigsby (2011) believed that the increased cost of medical care (due to wasteful spending, new technologies and new procedures as in surgery) can be decreased by using telemedicine, especially for the needy. They also believed that telemedicine can help with the problem of the uninsured and underinsured, or those who lose work and therefore lose their health care. Health issues not addressed in time are exacerbated.

Telemedicine may offer a less costly and timelier option. They concluded that telemedicine is not a panacea, but can increase access and quality of care, lower costs for providers and patients, increase connectivity of health providers, and lead to an integrated, electronically-connected health care landscape.

The authors cited the benefits of telemedicine implementation it in the past few years: improved access to primary, secondary and tertiary health care; the avoidance of duplication and waste in diagnostic services and clinical procedures; the promotion of patient-centered care at a lower cost and in localities that contribute to stabilizing local health care and economies; enhanced efficiency in clinical making decisions, prescription ordering and mentoring; increased effectiveness of long-term care at hospitals and at home; increasing patient access to specialists;

enlarging specialists' reach; ending the need for unnecessary patient travel; integrating services across delivery sites, including connectivity and collaboration between centers for primary, secondary and tertiary care; providing better triage of patients; minimizing the repetition of tests and services; reducing cost; and increasing safety.

Harvard business professor Regina E. Herzlinger (2013) wrote that health care is fragmented: Many physicians practice alone or in small groups, many medical device and other companies exist, and a quarter of the nation's 5,000 community hospitals and nearly 50% of its 17,000 nursing homes are independent. She believes that "IT innovations that connect the many islands of information in the health care system can both vastly improve quality and lower costs by, for example, keeping a patient's various providers informed and thereby reducing errors of omission or commission."

1.6.5 Two Examples of Telemedicine Areas

1.6.5.1 Telepsychiatry

Telepsychiatry is one of the most developed areas of telemedicine (Roine, Ohimnaa and Misra 2008; Halley 2001). In 2000, Whitten and Mair studied 16 telepsychiatry programs from an organization perspective. They found a dearth of strategic business plans for telepsychiatry services; a primary focus on patient services; and the potential for telepscyhiatry to become more common in psychiatry and psychologist practices. Seventy-five percent of participants wanted to gain new clients or develop new services, but they did not know exactly what new services they would like to offer. Participants identified improvement in care (63%), convenience for providers and patients (38%), community cooperation and collaboration (31%) and internal support (19%). The improvements that most participants (51%) wanted to make regarded costs. The rest mentioned unique problems, as well as the standardization of assessment reports and the need to

improve administrative support. The focus was more on patients than profit. About half the programs were free-standing while half were integrated into psychiatry departments. Much of the telemedicine approach was "seat-of-the-pants," mostly because many telepsychiatry programs were directed by universities. Both types of programs needed less telemedicine support staff as time passed; the service moved down to the level of the provider.

Hailey, Roine and Ohinmaa (2008) reviewed articles that described controlled studies, comparing telemental and non-telemental care, and uncontrolled studies that had at least 20 participants. The articles described 65 clinical studies and 32 (49%) were of high or good quality. Seventeen of the studies were large randomized control trials and 25 studies were small randomized control trials. Eight of the studies were prospective comparative studies and nine studies were retrospective comparative studies and 13 were noncomparative studies.

Most studies of high or good quality involved Internet or telephone telemental health programs. Only in 18% of the studies was there enough evidence to say that a telemental health application for a particular area was successful. In 62% of studies, further evidence was needed to be of benefit. Follow-up work was desirable for 20% of studies. In 12% of the studies, it was unclear if telemental health applications were successful, and in 5% of the studies, it was judged unsuccessful. Quality of the evidence was assessed by considering both study performance and study design. The researchers made judgments on whether further data were needed to establish each TMH application as suitable for routine clinical use. Quality of evidence was higher for Internet- and telephone-based interventions than for video conferencing programs. Telemental health was found to be successful in the areas of child psychiatry, depression, dementia, schizophrenia, suicide prevention, post-traumatic stress, panic disorders, substance abuse, eating disorders, and smoking prevention. For general telemental health programs, as well as for

obsessive–compulsive disorder, evidence of success was less convincing. Authors of 53 studies (82%) concluded that further study was necessary or desirable. Hailey, Roine and Ohinmaa concluded that evidence of benefit from telemental health applications is encouraging but more telemental health applications in routine care is needed. The authors concluded that more detailed studies to show the effectiveness of telemental health applications in various subspecialties of mental health and using different types of available technology are needed.

Yellowlees, Burke, Marks, Hilty et al. (2008) studied several telepsychiatry case studies and concluded that telepsychiatry is safe and effective for most mental health services. These mental health services are either emergency room consultations dealing with an immediate situation or public health emergencies, where several people or communities are affected. They concluded that telepsychiatry improves diagnosis precision and appropriateness of admissions.

Both emergency department staff and patients were satisfied with telepsychiatry services. However, standardized guidelines are needed. Emergency telepsychiatry, they concluded, can reduce emergency department overcrowding (at nearly 50% capacity), and provide needed care and increased access to rural mental health patients. They claimed that many emergency departments are not equipped to handle patients with psychiatric problems, and that this often leads to a prolonged length of hospital stay. They pointed out that through telepsychiatry specialists can aid first responders, who often have post-traumatic stress disorder and depression. The case studies included psychosis, mood disorder, substance abuse disorder and childhood behavior disorder. The authors believe that telepsychiatry would not work with violent or self harm patients who need to be physically restrained.

Szeftel, Federico, Hakak, Szeftel et al. (2012) reviewed patient characteristics, clinical care, symptom severity and diagnostic outcomes at the Cedars Sinai Telepsychiatry Clinic.

Forty-five patients were seen at initial evaluation, year one and year three. The telepsychiatrist recommended a change of medication for 82% of patients at initial assessment, 41% of patients at year one, and 46% of patients at year three. The researchers concluded that telepsychiatry can be used for other types of patients, such as people with developmental disabilities and severe communication barriers. Their observations were: patients improved over time, required fewer visits as treatment progressed, and had fewer medication changes. In addition, internalizing disorders were detected for the first time in some patients.

Shore, Savin, Novins and Manson (2013) reviewed five years of telepsychiatry at the American Indian and Alaska Native Programs (AIANP) at the University of Colorado at Denver Health Sciences Center (UCDHSC) and the Veterans Administration (VA). They believed that telepsychiatry has no known exclusion criteria or contraindications for certain diagnoses, treatments or populations. The authors also wrote that telepsychiatry brings care closer to patients and increases the range and quality of available mental health services and that telepsychiatry has been shown to be feasible in a wide range of settings and in different ethnic groups and populations. According to the authors, some patients prefer telepsychiatry because of feelings of safety, control and distance. The psychiatrists should engage in small talk to get to know the patient first, and make sure the background is warm and not too "noisy." The professional should also make sure the patient is not drunk or violent, which may be more difficult through videoconferencing. The psychiatrist's style may have to change for video work; they may have to be more expressive, etc. Shore, Savin, Novins and Manson wrote that physicians using telepsychiatry must be trained and especially careful to keep patient records private. Videoconferencing equipment must meet HIPAA standards.

But Slabodkin (2013) wrote that barriers to telemental health implementation include personal and technological barriers, workflow, and credentialing/licensing/reimbursement. Personal barriers involve many telemental health care practitioners who think that care may suffer if the patient and health care practitioner are not in proximity. Telemental health leads to added processes for providers, including travel to a special room, making the appropriate technical arrangements, and scheduling and documenting. High-quality videoconferencing may ease their concerns, and alternating between office and telemedicine visits may work. Other obstacles to telemental care are licensing (physicians need to be licensed in the states where they practice in office) and telemedicine care. This is time-consuming and expensive. Clinical training for health care providers also is a concern.

According to the study by Brooks, Turvey and Augusterfer (2013), videoconferencing and may alleviate concerns by allowing health care providers to be flexible. The authors wrote that transformations in technologies that improve provider convenience and transmission quality, dissemination of data underscoring the promise and effectiveness of telemental health, integration of videoconferencing with sufficient bandwidth capabilities into electronic medical record platforms, expanding reimbursement, and modifying licensure standards may help to increase telemental health implementation and quality of care. The authors also wrote that more randomized control trials are needed to provide positive evidence of telemental effects and encourage practitioners to adopt telemental health programs.

1.6.5.2 Telesurgery

Telesurgery is remote surgery with robotic or video tools. Telesurgery has its own discourse community and distinct authors and journals, such as *Telesurgery*, published by Springer Scientific. In 2001, Broderick, Harnett, Doarn, Rodas, et al. wrote about the successful

use of even low-bandwidth technology for laparoscopy. Remote surgeons correctly identified biliary and arterial anatomy during cholecystectomy operations. Using Web-based questionnaires, 15 surgeons correctly distinguished the quality of remote and local laparoscopic images. Surprisingly, 68% of the surgeons said they would not feel comfortable in the future proctoring surgeons using images. This may have had to do with image context.

Telesurgery is minimally invasive surgery (MIS), according to van Wynsberghe and Gastmans (2008) and Hanly and Broderick (2005) and so there is a significant decrease in risk of infection, recovery, time, pain and scarring for the with telesurgery. The question of responsibility, however, gets complicated when an on-site surgeon or physician is not overseeing the patient while telesurgery is performed. Legal issues ensue. At the very least, a medical professional such as a nurse, should be present with the patient. There is always the chance of a power outage or technology malfunction.

Kim (2004) wrote that the benefits of applying video-conferencing to surgery are preoperative, intra-operative, and post-operative. In the preoperative stage, it can be used to screen surgical candidates without having them travel to the surgical center. Surgical nurses can utilize the same technology to prepare the patient for surgery. During surgery, telemedicine can be used to connect with a colleague or mentor during an operation (telementoring) or to demonstrate the procedure to medical and surgical students, (tele-education). During postoperative follow-up, surgeons can monitor the process of healing and recovery after surgery.

Two telesurgery robotic systems for minimally invasive surgery, which can be controlled at a distance, were developed by the 1970s: da Vinci by Intuitive Surgical Inc. in 2000 and ZEUS® by Computer Motion Inc. (Marescaux and Wall, 2012). In addition, with a robotic telecollaboration system for tele-mentoring (SOCRATES by Computer Motion Inc.), those

robotically assisted technologies are becoming a paradigm shift in clinical applications of telemedicine for remote telesurgery (Distance-Educator, 2001).

Holt, Zadi, Abramson, and Somogyi (2004) wrote that telepresence or telerobotic surgery is the most advanced form of telemedicine. Sensors provide real-time tactile, visual and auditory information from the operating site and providing the surgeon with 3-D vision, stereophonic sound, tactile and force feedback. The computer translates the motions of a surgeon's hands into robotic movement. The robot "holds" a camera and one or more surgical instruments. This is ideal for emergencies, at times when, there is no specialist surgeon present, or in developing countries.

Telerobotic surgery was first developed by the U.S. Department of Defense to allow surgeons to operate on the wounded before they can reach a hospital. Usually, the soldiers are placed in vehicles equipped with the required robotics and communications equipment. Because of a high-bandwidth fiber-optic service running at 10 Mbits per second, the delay from surgeon to robot was less than 200 milliseconds. This time is a limiting factor to what is possible. Legal issues, costs and available technology are important in consideration for professionals that want to implement telemedicine. Robots may not have the full degree of freedom (DOF) needed in their arm/hand movement that surgeons need during specific procedure.

In 2008, van Wynsberghe and Gastmans wrote that, if the inherent danger of technology in health care is reducing the patient to an object, then the way to overcome this is care. In telesurgery, this can be managed by an onsite physician or surgeon providing the care, while the distant surgeon provides the patient's clinical good, which is defined by the authors as "The process of care combined with the moral aim of medicine" which "provides the ethical foundation for assessing telesurgery." This reduces the risk of patient objectification. They explained that

the purpose of surgery, and thus telesurgery, is to maintain the physical integrity of the patient (non-maleficence) as well as to treat the patient (beneficence), and that telesurgery achieves this. They also wrote, however, that the physician must learn new skills and experiences a reduced dexterity because of a limitation in instrumentation.

1.7 Future

Wootton (1999) wrote that telemedicine will have come of age when the term telemedicine is no longer perceived as representing a distinct method for delivering health care. In an interview with Health CareITNews, Linkous shared seven future trends of telemedicine: 1. A shift away from reimbursement models; 2. Telemedicine as a standard of care; 3. An increase in private remote clinical enterprises; 4. A rise in virtual medical centers; 5. Growth in mHealth; 6. Increase in telemedicine programs rather than networks; and 7. Telemedicine as a source of international trade.

Nuccio (2007) wrote that telemedicine's presence will be more prominent in the future in his article "The Future Is Now." He referred to1982 study by Grundy, Hones and Lovitt in which two-way television decreased morbidity and mortality rates (when caregivers took the long-distance advice of intensivists). He cited other studies that showed that telemedicine was successful. The Smith, Kimble, Mill, Baily, O'Rourke, and Wootton (2004), showed that videoconferencing can provide quality of information comparable to that of traditional consultation for follow-up on pediatric burn patients. The Saffle, Edelman and Morris's study (2004) that showed that telemedicine was successful for the evaluation of burn patients, assisted with decisions regarding patient transfer, reduced errors in initial care, and reduced costs. According to Dr. Andrew Watson (2012), Director for the Center of Connected Health in Pittsburgh, the three biggest barriers for the future of telehealth are mindsets, the

disconnectedness of medical information and reimbursement: According to Dr. Watson, the industry mindset is focused on face-to-face care and "the coordination of care among diagnostic and therapeutic entities, inpatient and outpatient facilities and home care environments is unacceptably low". Real-time telemedicine can take the place of many face-to-face visits. He believes that telemedicine increases access and lowers costs and "telehealth is a more humane approach to care and a model that reflects what patients actually want – care based in their communities."

Regarding disconnectedness, no technology and infrastructure exists for a national environment for connected health. The lack of standards and interoperability among systems enhances the disconnection and impedes clinician access to real-time data for medical decision-making. Often, documentation from other hospitals and care centers is not accepted, and care may have to start from the beginning if a patient goes to a different health center for care. Electronic health records and other systems enhance information sharing between different health centers. But culture has to change. The government can help with incentives such as meaningful use (see Glossary). According to SearchHealthIT, this defines the use of EHR and related technology. Achieving meaningful use helps determine whether a health care group or center will receive payments from the federal government under the Medicare EHR Incentive Program or the Medicaid EHR Incentive Program. Dr. Watson wrote that reimbursement models need to be retooled with less focus on fee-for-service and face-to-face visits and more focus on telehealth services. Only a limited number of patient encounters are eligible for reimbursement by Centers for Medicare and Medicaid Service (CMS). Usually this is in areas that the CMS designates as rural Health Professional Shortage Areas (HPSA) Blanket coverage does not exist. Many payers believe that supply-induced demand may drive up costs, and do not see how telemonitoring and

second opinions from specialists can drive down costs. Dr. Watson wrote that, instead of focusing on the method of care delivery, payers and regulatory agencies should focus on the value and quality that is now available in the cloud using telemedicine.

According to market firm InMedica, 308,000 patients were monitored in 2012 via telehealth technology. Telehealth technology will be used by 2017 by an estimated 1.8 million patients with heart failure, chronic obstructive pulmonary disease; diabetes; hypertension; and mental health conditions. The firm estimated that, by 2017, 1.8 million people would be monitored by telehealth technology (iHealthbeat, January 23, 2013).

InMedica predicted that diabetes would overtake COPD as the second-largest group of telehealth patients in 2017 with the increased use of personal glucose monitors. The firm stated that drivers increasing the use of telehealth are:

- Federal policies which do not favor readmission rates;
- Health care providers who want to improve care quality;
- Insurers that want to increase their competitiveness and reduce inpatient fees; and
- Patients who demand telehealth technology.

In the same report, IMS Research stated that the U.S. health care costs accounted for nearly 18% of gross domestic product (GDP) in 2012, and that figure would rise to 18.4% of GDP by 2017.

1.8 Summary

Telemedicine, a topic of information studies embodies the electronic acquisition, processing, dissemination, storage, retrieval, and exchange of information and promotes collaboration. The main types of telemedicine that have been most developed are teleradiology, telesurgery, telepathology, telepsychiatry and telecardiology. Telemedicine can play a key role in

health care reform by assistance toward a better access and quality of care, disease control through sharing of information and second opinions, collaboration among health care leaders and centers, and a decrease in the cost of care for patients. Prominent topics in telemedicine include diagnosis, treatment, privacy, security, technology, costs and legislation. Content analytical techniques will be used to find topics in telemedicine from a randomly selected sample of journal articles to more clearly gain a picture of a taxonomy and ontology of telemedicine.

Several authors date the history of telemedicine to the 1800s when telegraphs on ships were used to convey medical information. Telemedicine has come a long way since then, with the Internet and new video, robotic and bandwidth technologies constantly shifting the field forward. History in telemedicine happens every year. Some groups that are instrumental in using and advancing telemedicine technology are NASA and the Veterans Administration.

All the definitions of telemedicine involve providing health care at a distance, increasing access to care, information and technology. The ATA uses the terms interchangeably, but choosing telemedicine in its name may indicate the thoroughness or maturity of the term as compared to telehealth. The terms telemedicine, telehealth, and telecare are not mature yet. Study results may lead to a clarification of their definition. Telemedicine is the most precise term, and is recognized in the MeSH thesaurus. It refers to medical care at a distance. Telehealth is in the realm of public health, and is more likely to include telephone and other technology besides computers, as well as online health information, telemonitoring and health education. The same can be said for telecare. E-Health encompasses even more – computer applications, electronic health records, etc. However, some use telemedicine to encompass the same. Mobile health refers to using mobile phones as a way to transmit medical information for telemedicine.

While telemedicine, like e-Health, relies on technology, the focus of telemedicine is more on the information exchanged for the purposes of medical treatment. Medical informatics involves e-Health, focuses more on the information exchanged, and is always Internet-based. Mobile phones are being used increasingly in telemedicine, including stroke and asthma. Although several studies have shown the advantages of using mobile phones in telemedicine, more comprehensive studies, including randomized clinical trials, are needed.

Telemonitoring has been used increasingly to manage people with chronic diseases such as diabetes and has been found to be effective for conditions such as heart failure. It is especially useful for the growing senior population to view their daily medical statistics and may find it difficult to get to a health care provider frequently.

Problems of health care in the United States include inequality of care; limited access of some to health care; inefficiencies and limited coordination of complex systems of health care; a high degree of adherence to evidence-based care; unhealthy lifestyles; and uneven distribution of quality care. Telemedicine can help by increasing quality of care and access of care, making specialists available, especially in rural areas and for the elderly, and in some cases lowering the cost of medical care.

Telepsychiatry is one of the most developed areas of telemedicine. Several studies have found telepsychiatry to be effective and to increase access, range and quality of care. Procedures can be put in place to make the patients comfortable. Concerns include: Physicians committing to implementing telepsychiatry programs; patient trust and comfort with telemedicine equipment; and reimbursement for physicians. Telesurgery is also a growing area of telemedicine. Surgeons can monitor other surgeons or robots and can at times move robot arms with their own motions at a different location.

Experts predict that telemedicine will play a greater role in the future of health care. Laws are being passed to make telemedicine implementation easier and affordable for providers and patients and more investments are paving the way for implementation.

Chapter 2

Benefits and Drawbacks of Telemedicine

Several studies have been conducted to determine the benefits and drawbacks of telemedicine. Many studies show that the benefits of telemedicine include increased access and quality of health care, the sharing of meidcal information amongst professionals, and lowered cost to the patient. Yet some physicians and patients prefer face-to-face contact in office visits. There can also be complications in telemedicine implementation, privacy, security, cost, and reimbursement.

2.1 Benefits of Telemedicine

Benefits of telemedicine include increased access and quality of care, ability to get a second opinion easily, health information exchange and cost effectiveness. As early as 1995, Grigsby, Schlenker, Kaehny, Shaughnessy et al. predicted that telemedicine would be integrated into the overall health care delivery system. Teledermatology has been viewed as providing accurate triage of patients (Desai, Patil, Chinoy, Kothari, et al. 2004; Harrison, Clayton and Wallace 1998; Pak 2005). This helps with unneeded hospital visits or procedures, often in areas with a dearth of specialists (Fieleke, Edison and Dyer 2008). Telemedicine is crucial in rural areas where there are no specialists or where old or frail patients cannot get to the specialist on time. Wootton (1996) wrote the introduction of telemedicine, even in urban areas, has sped up the referral process, reduced unnecessary referrals, and improved the consistency and quality of health care. Wootton wrote that telemedicine is a process and that its proponents think that telemedicine will do for health care what the personal computer has done for the office. Some opponents think that it is a threat to the doctor-patient relationship and unsafe. He wrote that

telemedicine improves communication between periphery and the tertiary hospitals, and so facilitates higher quality medicine. For example, Schwamm, Audebert, and Amarenco, Chumbler, et al. (2009) also wrote about the ability of telemedicine in stroke cases to identify and facilitate the transfer of patients in the community for specific tertiary care interventions such as neurointensive care; decompressive surgery for life-threatening disease.

Hjelm (in Wootton and Craig, 1999) wrote that benefits of telemedicine include: improved access to information and services; provision of previously unavailable care; professional education; quality control; faster access to health care professionals; increased convenience and time savings for patients; interhospital access for health care professionals; and reduced health care costs. According to Heinzelmann, Williams, Lugn and Kvedar (2005), telemedicine has been found to improve the quality of health care, increase access and equity, improve health outcomes, enhance educational opportunities, decrease health care costs for patients.

2.1.1 Quality of Care

Quality of care is defined as correct diagnosis and treatment (Bynum and Irwin 2011). It is also defined as suggesting that there are two principal dimensions of quality of care: access and effectiveness. Within effectiveness Bynum and Irwin distinguished two main components — effectiveness of clinical care and effectiveness of inter-personal care.

According to van Wynsberghe and Gastmans (2008), care is difficult to define. It can be divided into the idea of caring about, or the attitude, and caring for, or the exercise of a skill with or without a particular attitude toward the object upon which this skill is exercised. Tronto (1993) wrote that caring includes everything done to maintain, continue, and repair our bodies, ourselves, and our environment so that we can live in it as well as possible. The recipient of care is expected

to pay. According to Tronto, he or she is vulnerable, but not passive. The physician assumes the role of being responsible, competent, attentive and responsive.

Pellegrino (2002) wrote that the ultimate goal of medicine is to fulfill the good of the patient: clinical/biomedical good, or the ability of the person to return to their life plan; the good as perceived by the patient; the good of the patient as a human being; and the Good, or spiritual good. If telemedicine contributes to that goal, it contributes to enhancing health care or even taking the place, in some instances, of traditional care.

In the 2005 Marcin, Nesbitt, Cole, and Knotted et al. study, telemedicine did improve the quality of care. Changes in diagnosis and treatment after outpatient telemedicine specialty consultations in dermatology, psychiatry, and endocrinology were associated with improved quality of care. The three indicators used to measure changes in the processes of care and clinical outcomes were change in diagnosis, change in treatment, and patient clinical improvement. The researchers conducted a review of 223 individual telemedicine patient medical records. The specialty telemedicine consultations resulted in changes in diagnoses in 48% of the cases, changes in treatment therapy in 81.6% of the cases, and clinical improvement in 60.1%.

A telepsychiatry counseling service for youths resulted in the higher attainment of behavioral goals for each adolescent (Fox, Connor, McCullers, Waters 2008). In a pediatric telemedicine weight management clinic, teleconsultations resulted in changes to diagnoses in 78% of patients, while 81% demonstrated improvement in clinical outcomes, often associated with changes to treatment due to telemedicine (Shaikh, Cole, Marcin, and Nesbitt 2008).

According to Bynum and Irwin (2011), several studies have concluded that changes in the patient's diagnosis and treatment plan after telemedicine consultation can have an impact on clinical outcomes and patients' costs for medical care. The researchers reported that changes in

diagnoses and treatment plans through 454 telemedicine consultations in rural Arkansas many times avoided morbidity, costly or inappropriate treatment, patient transfers, and patients' travel costs. Bynum and Irwin (2011) examined the effects that teleconsultants' characteristics have on rural patients' diagnoses and treatment plans and how those diagnoses and treatment plans change depending on individual consultant characteristics. They found that changes in the patients' diagnoses and treatment plans are not direct measures of quality. They interpreted the results to imply that the patients' diagnoses and treatment plans were upgraded as a result of the teleconsultations. The accuracy of the consultants' diagnoses and treatment plans could have an effect on the quality of the patient's health care, so future studies would be needed to assess the accuracy of the consultants' diagnoses and to assess the association between changes in the patient's diagnosis and treatment plan and the likelihood of clinical improvement. They recommended comparing telemedicine consultations and face-to-face medical care on the patient's diagnosis and treatment plan in remote, rural communities and assess the impact of telemedicine on improvement in clinical outcomes via changes in diagnosis and treatment.

Teleconsultant characteristics that may affect changes in diagnosis and treatment include specialty and chances to profit monetarily. The most frequently used specialties for teleconsultation were obstetrics/gynecology, genetic counseling, psychiatry and psychology, nutrition and dietetics, dermatology, primary care, and pharmacy. The researchers wrote that these may require a higher rate of change in diagnosis and treatment. Teleconsultants who wanted to increase access to care or to profit from changes in diagnosis and treatment, were more likely to make the changes. More research is needed to account for the last motive. The ethics of the teleconsultants comes into play.

2.1.2 Access

Bashshur, Shannon, Krupinski, and Grigsby (2011) also expounded the benefits of telemedicine for access of care. By sharing and disseminating information through telemedicine, patients such as rural patients can receive health care, specialist care, and a second opinion, while physicians can share patient information and make diagnostic and treatment decisions for patients who may not have the financial and transportation means to get to a medical office whenever needed.

Sarhan, Weatherburn, Graham, and Saeed et al. (2010), working in a North Carolina telepsychiatry hub, showed that the benefits of telepsychiatry included improved patient convenience and satisfaction, reduced travel time and thus less time away from school and work, and decreased waiting time for specialist referrals. They found that telepsychiatry leads to reduced geographic and socioeconomic health disparities through improved access and convenience and, consequently, greater likelihood of compliance with therapy. The authors found that mental illness often had comorbities present and that it was more convenient to address these, using different specialists, with telemedicine. The authors observed that, after 3.5 years and 185 telepsychiatric consultations, less than 3% of the consultations were problematic, and an enhanced ability to facilitate appropriate primary care diagnosis, care of mental health disorders, and referral to specialists when needed. They concluded that limitations and findings suggest that telepsychiatric services are comparable to those delivered face to face.

They uncovered with benefits and outcomes of teleconsultation at East Carolina University:

• High patient satisfaction

• Improved patient convenience

- Reduced travel

- Less time away from work and school

- Decreased waiting time for specialist referrals

- Improved patient compliance with therapy

- Higher attendance rates for telehealth visits

- Lower frequency of missed appointments, compared with traditional outpatient clinic (35%-42%)

- Improved continuity of care

- Referring physician remains informed of the patient's condition

- Faster receipt of consultant's findings

In a randomized clinical trial involving 20 participants, Dorsey, Venkataraman, Grana, and Bull, et al. (2013), in a randomized clinical trial involving 20 participants, showed that telemedicine increased access to health care by saving participants about 100 miles of travel, three hours of time, and financial cost during the study. The primary outcome was feasibility, measured by completed visits as scheduled, and the secondary outcome measure was clinical benefit. Their tertiary outcome measure was economic benefit, which included time spent for travel. Most common problems with telemedicine were not feeling that there was a deep connection with the physician, fear the physician would not obtain all of the relevant information, and technical difficulties.

Hilty, Ferrer, Parish, Johnston, et al. (2013) reviewed telemental health literature since 2013 and concluded that it has increased access to care. Telemental health in the studies reviewed was effective for diagnosis and assessment for adults, children, geriatric patients and for disorders in many settings such as emergency and home health. Telemental health was comparable to in-

person care. New models of care such a collaborative care, asynchronous, and mobile had equally positive outcomes to traditional office care. Leichter, Bowman, Adkins and Jelsovsky (2013) found that telemedicine applications can expand access to care for patients and may reduce costs for patients, providers, and payers. Seventy diabetes patients completed a 12-month, randomized, controlled study. The control group participated in quarterly office visits and the telemedicine subjects participated in two office visits and two telemedicine interactions. The researchers found no significant between-group differences in HbA1c, blood pressure, lipids, or BMI at 12 months. Telemedicine subjects showed significantly greater reductions in mean body weight, -5.2 (1.6) pounds versus -0.7 (1.5) pounds, respectively (P=0.04). The researchers concluded that the use of a telemedicine-based treatment protocol in diabetes patients "is feasible and efficient and yields similar clinical outcomes compared with traditional, clinic-based protocols." Telemedicine applications of computer software can expand access to care for patients and may reduce costs for all stakeholders: patients, providers, and payers.

2.1.3 Equity of Health Care

Freedman (2009) emphasized that telemedicine is a type of patient-driven health care, where an emphasis is placed on needs and quality of care for patients. Since the Internet's earliest days, patients have used online resources to share experiences, learn about diseases and treatments, and become advocates. A newer phenomenon has seen a growing number of online communities evolve into centers of patient-driven research (PDR)—especially for orphan diseases (diseases that affect fewer than 200,00 people worldwide.) Thanks to Health 2.0 capabilities, various models of PDR are being developed, usually involving methods of data collection and aggregation that can eclipse randomized control trials (RCTs) as meaningful evidence. A radical shift from the classical research model, this may result in accelerated findings

and dissemination. According to Swan (2009), patient-driven care is characterized by "an increased level of information flow, transparency, customization, collaboration and patient choice and responsibility-taking, as well as quantitative, predictive and preventive aspects."

Telemedicine can increase access to care for those that cannot easily get to a specialist physician due to travel cost and for those who cannot afford costlier office visits. Racial/ethnic minorities and socioeconomically disadvantaged individuals face barriers to receiving basic health care. This is may be due to lower income, language barriers and lack of area specialists leading to untimely access (Nelson 2002).

George, Hamilton, and Baker 2012 found that the two groups most affected are Latin Americans and African Americans. Many of them are in areas like the inner city, where there are few specialists, are illiterate or distrust technology. Latin Americans tended to trust the computer more, saying it would be less likely to make a misdiagnosis because it was precise and gave exact data. Latina Americans were more likely to think that telemedicine was comparable to past experiences, and noted the efficiency of being able to have many family members seen at one time using telemedicine. Latin Americans were less concerned on the absence of a physician, even preferring it due to perceived gender, age and class differences between themselves and the doctor.

Jaglal, Haroun, Salbach, Hawker et al. (2013) reviewed telemedicine care for patients with heart disease, stroke, lung disease, or arthritis and concluded that access to self-management programs showed improvements in self-efficacy, health status, and health behaviors. Self-efficacy included "exercise behavior, cognitive symptom management, communication with physicians, role function, psychological well-being, energy, health distress, and self-rated health."

2.1.4 Time Element

Some researchers have written that telemedicine decreases the time it takes for patients to receive a diagnosis. First, there is the time it takes to visit a physician. There is also the speed in communicating about a diagnosis or communication about diagnosis and treatment among different physicians such as general practitioners and specialists. Harrison, Clayton and Wallace (1998) reported that the four days it took for patients to hear their diagnoses through store-and-forward teleconsultation were very satisfactory to them. Wootton, Bloomer, Corbett, Eedy, et al. 2000 wrote that real-time teledermatology is less time consuming for patients than office visit care. The real-time patients they studied made fewer return general practitioner and hospital visits. Patients do not have to wait to be seen, losing valuable time from work.

In a study of store-and-forward teledermatology in the United States Department of Veterans Affairs (Whited, Datta, Hall, Foy et al. (2003), wrote that the average store-and-forward consultation takes 7.2 minutes, while the average office visits takes 24.4 minutes. This time savings translated into cost effectiveness.

McGowan (2008) wrote that teledermatology can reduce time to diagnosis and/or treatment. Hsiao and Oh (2008) found that store-and-forward teleconsultations were similar to or quicker than office visits in terms of diagnosis and surgery. A limitation was that most patients from the VA hospital were white males. Patients referred for either type of diagnosis did not have significant differences in: age, gender, skin type, tumor location, final diagnosis or number of tumors. Time to biopsy was longer for teledermatology patients because most patients had a biopsy in the same place as their office visits. Time from biopsy to surgery was similar in both groups, since the procedures took place in the same hospital.

2.1.5 Length of Hospital Stay

Length of hospital stay is often reduced when telemedicine is used. For instance, Seamus Watson, Head of Public Health Programmes and Public Health Workforce National Health Service (NHS) South of England told British reporter April Cashin-Garbutt of News-Medical.net that the previously 24-day hospital stay of stroke patients has now been reduced to around 12 days. Telemedicine was especially useful, he said, because of the often dearth of available stroke specialists, especially on weekends.

According to RN Case Manager (2007), a British telemedicine-telemonitoring project has halved the time that COPD patients at the Carlisle Housing Association and the Carlisle and District Primary Care spend in the hospital by enabling physicians to monitor their condition remotely.

2.1.6 Referrals and Outpatient Care

In the 2000 Loane, Bloomer, Corbett, Eedy et al. study, physicians said that hospital referrals after real-time consultation were reduced 20%, thus saving 20% of the physician's time, 20% of the patient's time, and 20% of travel costs. They claimed that teledermatology can be used for management and referral care. Mahendran, Goodfield, and Sheehan-Dare (2005) wrote that teledermatology may be of value to reduce outpatient visits. They concluded that store-and-forward was safe and that no malignant lesions were misdiagnosed with store-and-forward consultations. Telemedicine can be used as a triage tool (Desai, McKoy, and Kovarik, 2010), which would reduce the number of patients who need to be seen as outpatients, cost for the patient, and possibly cost to the health service.

2.1.7 Medical Education

Telemedicine under certain definitions is used for education: physicians can take some courses online and patients can use the Internet to learn about their health or to ask questions about a condition. Mahadevan, Muralidhar, and Shetty (2012) reviewed a telemedicine medical school program of classes that took place twice a week in India. Analysis included satisfaction of student, infrastructure difficulties (if any) and overall outcome of the program. The authors reviewed 1,000 responses for 243 academic sessions. The participants were undergoing postgraduate training. Of the 84.4% attendees, 48.4% said the teaching was good and 37% said the teaching was excellent. Attendance was 84.4%. Variables used to judge the video presenter and presentation were: technical content; presentation; quality; overall usefulness; enthusiasm; clarity; iteration; task orientation; rapport and organization. The authors concluded that teleeducation is a good way to keep up with changing medical rules and regulations. They cited advantages of telemedicine to be: sharing of knowledge and faculty; enthusiasm and satisfaction. Disadvantages were 1. Getting commitment from both sides; 2. costly multipoint equipment; 3. technical difficulties. 4. planning and scheduling needed; and 5. need for technical support.

Commitment must be secured first and cost issues and technical difficulties must be overcome to implement telemedicine. Planning, scheduling and technical support are needed. Citing Masic, Panda, Kulasin, Masic et al. (2009), Mahedevan wrote that telemedicine encompasses e-Health, telehealth, telematics and teleeducation. The authors concluded that telemedicine offers a way for medical professionals to continue education and to maintain their qualifications and certifications.

Another telemedicine education example is a 2003 study by Izquierdo, Knudson, Meyer, Kearns, et al. The authors wrote about the growing problem of diabetes. They found that diabetes

education with a diabetes nurse educator and dietitian via telemedicine and in person was equally effective for controlling glycemic control. For both groups, the consultations consisted of an initial one-hour consultation and then two 30-minute follow-up appointments at 4–6 weeks (visit 2) and 8–12 weeks (visit 3) after the initial visit. Both methods were well accepted by patients, who experienced less stress by both methods. The study suggested that telemedicine can be successfully used for patient diabetes education. According to the authors, diabetes self-management education (DSME) is essential in the care of the person with diabetes and can help improve glycemic control, self-care, and even emotional well-being while decreasing the cost of health care.

Each study participant formulated individual nutritional and diabetes management goals, which were reviewed at visit 3 to determine how well the participant met them. A χ^2 analysis of the proportion of the participants who fully achieved their goals showed no differences between the two groups. Limitations included the lack of a control group without intervention, BMI and age differences, and the limited size of the study group. The power calculations done before the commencement of the study were aimed at detecting large group differences.

Shopf and Flytkjær (2012) conducted a randomized controlled educational trial with general practitioners from Norway for six months. Physicians in the intervention group participated by choice in a Web-based course on the management of atopic dermatitis. Additional guidance included email or multimedia messaging service (MMS) through mobile phones from a dermatologist. No education or guidance was offered in the control group. Outcome measures included: the duration of topical steroid treatment prescribed to patients (primary outcome), number of treatment modalities, and number of referred patients. Twenty-four physicians were allocated to the intervention group and 22 physicians to the control group. A total of 190 patient

treatments were reported. No statistically significant differences were noted in the duration of topical steroid treatment or number of treatment modalities between the groups. Physicians in the intervention group referred fewer patients to secondary health care. The main reasons for referral were treatment failure and flare. The researchers concluded that the Web-based educational intervention aimed at general practitioners combined with personal support can reduce the number of atopic dermatitis patient referrals to specialists. Limitations included a small sample size of physicians and a short (six month) duration of the study. Long-term effects are not known. Physicians who signed up for the online education had a better attitude toward or previous experience with online education.

2.1.8 Information Sharing and Second Opinion

Information is becoming increasingly important in all areas—business, technology, law—and medicine is no exception. Telemedicine allows physicians to share information and ideas (Desai, McKoy, and Kovarik 2010; Stronge, Nichols, Rogers, and Fisk 2008; Pak 2005). This education may be more effective than continuing medical education where real patients are usually not used (Wootton 2000). It can be part of medical or continuing medical education (Fieleke, Edison and Dyer 2008). Telemedicine allows for an ongoing support and education for primary care physicians, as well as for dermatologists. Physicians use it to share information and ideas (Wootton, Bloomer, Corbett, and Eedy 2000; Heinzelmann, Williams, Lugn and Kvedar 2005; Stronge, Nichols, Rogers, and Fisk 2008). It can be part of medical or continuing medical education (Fieleke, Edison and Dyer 2008). Diagnosis and treatment are often changed after this information sharing. Nancy A. Brown mentioned in her chapter in Wootton (1999), John

Naisbitt's quote from *Megatrends*: "We are drowning in information but starved for knowledge." The use and interpretation of telemedicine-generated information is up to researchers, providers and patients and will determine new knowledge. Research and experience will allow this information to be of value for patient health, and a big way that can happen is through physician and other health professionals' sharing of information to make sense of and reach the best conclusions from patient medical data and increase quality of life."

Kanthraj (2009) wrote that second-opinion teledermatology is especially valuable for difficult to manage (DMC) cases. He proposes author-based second-opinion teledermatology (AST) or online reprint-request-led teledermatology, where teledermatologists perform reviews of studies and cases of DMC, and pool constructive suggestions and second opinions by sending clinical data to deliver quality care. He wrote that this can be an alternative to online discussion groups. Some authors, however, were unwilling to offer second opinions due to legal issues. Pak (2005) wrote that real-time teledermatology is especially effective in physician to physician education and information sharing. It can shift the model of care from that of traditional referral to a co-management model where the teledermatologist is a consultant.

Telemedicine allows for collaboration and teamwork among physicians (Gambadauro and Torrejo 2013). According to Gambadauro, the multimedia capabilities of the Internet, with new applications such as wikis, blogs or podcasts, represent powerful collaborative tools for anyone, anywhere and are not as expensive as telephone calls.

Bergrath, Reich, Rossain, Rörtgent (2012) investigated real-time and store-and-forward telemedicine information sharing between emergency medical services (EMS) and the hospital before stroke patients arrived to the emergency room. A stroke checklist was filled out by EMS personnel and the researchers concluded that the technical performance has to be improved and

that multifunctional prehospital teleconsultation in acute stroke was feasible. Telemedicine resulted in a better transfer of stroke-specific information to the hospital. Shortened clinical time intervals and improved diagnostic accuracy were not found, but the researchers believe that transmission of stroke history checklists exhibits a possibility for improved work processes in the initial in-hospital phase. Emergency rooms are notoriously overcrowded. Often, one overworked nurse collects and analyzes information from EMS workers to determine the care department for each patient. Having computer information from EMS before the patient arrives can be useful for the nurse and other health care professionals to channel the patients. The researchers found no negative effects of the telemedicine. The authors also concluded that training is essential: All physicians of the telemedicine group were shown how to use the stroke history checklist, but pre-arrival notification with the checklist was realized only in 78% of the time and video transmission was not performed in four cases. Also, some explanatory documentation was missing. The introduction of new, complex technical devices and workflows require intensive training, even among physicians. Only one patient refused consent for video transmission, and the authors concluded that most patients were not biased against this new technology.

The importance of telemedicine in providing a means to share information among health care professionals and to receive a second opinion was shown in a 2013 study by researchers (Rudansky 2013) who found that telemedicine consultations significantly improved outcomes in rural pediatric patients in emergency departments without specialists. According to Rudansky, 21% of U.S. children live in rural areas and are served by only 3% of pediatric critical care specialists. Physicians were more likely to adjust the patient's diagnosis and course of treatment after consulting with a specialist via real-time telemedicine video. The researchers examined data collected from five rural California pediatric emergency departments from 2003 to 2007 and

covering 320 patients presenting in the highest triage category to five rural emergency departments. The patients had access to pediatric critical care consultations from an academic children's hospital.

2.2 Drawbacks of Telemedicine

Among the drawbacks of telemedicine are organizational problems include: infrastructure planning and development; telecommunications regulations; reimbursement; licensure; malpractice liability; and privacy. Other problems include lack of consideration of knowledge and skills of users and lack of agreed-upon standards. Technology failure or malfunction is always a risk (McGowan 2008).

Technology failure that leads to a wrong diagnosis or the inability of the provider to manage the technology could cause injury. According to Stanberry (in Wootton 1999), problems may occur if the general practitioner does not agree with the specialist and diagnosis, or vice versa. But this problem can occur in traditional health care as well. Mahadevan, Muralidhar, and Shetty (2012) wrote that possible disadvantages of telemedicine include technical difficulties, needing technical support, and costly equipment.

Demiris, Patrick, Mitchell and Waldren (2004) reviewed studies on telemedicine safety and wrote that, although telemedicine can increase productivity and provide access to care for urban and rural underserved populations, drawbacks need to be assessed. Technology's limitations and the care providers' training level can affect diagnostic accuracy. They found that telemedicine could increase the risk of patient-provider communication failure and that it can also introduce the possibility of cumulative errors. Privacy is also an issue to be dealt with in telemedicine. They believe that more studies should be done on patient safety and telemedical error. The authors did not conclude that telemedicine is more or less safe than traditional care

because telemedicine does not refer to a specific clinical procedure or device and sometimes enhances traditional care. Technology factors such as bandwidth and level of data compression can impair the audiovisual assessment of a patient and affect physician performance. Health care providers must be well trained in the technology and confident in using it. Patients may be uncomfortable with technological aspects, such as an audio or video recording.

According to the authors, threats to patient privacy, include: 1. the breach of privacy and confidentiality of medical data and 2. a possible barrier to communication due to fear of this breach. In telemonitoring, patients and family members must be trained in equipment use, and equipment must be regularly maintained and tested. Guidelines and policies for telemonitoring should define (2004): "1. procedures for care providers to review and respond to the monitored data, 2. standards of response timeliness, and 3. mechanisms for handling emergency or other critical events." Studies have shown that some patients are concerned with store-and-forward telemedicine because of lack of patient and physician interaction. Telemedicine guidelines should include "Development of design and maintenance guidelines for telemedicine hardware, applications, and networks and development of evaluation frameworks for telemedicine applications and networks which address patient safety." Internal and external benchmarking should take place. Usability testing, and ways to report it and track it are important. They proposed that all stakeholders in all phases of implementation should be involved in recommendations in these categories: "Development and diffusion of standards for telemedical care; 2. Risk management and reduction; and 3. Continuous quality improvement."

Hjelm (2005) wrote that drawbacks of telemedicine may be: a breakdown in the relationship between health professional and patient or between health professionals; issues concerning the quality of health information; and organizational and bureaucratic difficulties.

He concluded that the benefits are substantial, if future "research will reduce or eliminate the obvious drawbacks." A breakdown in the relationship between patient and physician may include: depersonalization; inability to perform the whole consultation (especially in the case of palpation, where another health professionalism present on the other end of the video as the specialist); reduced confidence of patients and health professionals and training issues. Although most studies show patient and health professional satisfaction and confidence, some health professionals are apprehensive to adopt telemedicine. Future studies may contribute to their changing their minds. Hjelm surmised that some health professionals may be threatened by telemedicine, or fear they will become less than technicians for the specialist, who will receive all the credit for performing a consultation. Lastly, health professionals using telemedicine need to be trained and some are reluctant to learn new skills, at least until they are sure of the effectiveness of telemedicine. In addition, some patients with eye and ear disabilities may find it difficult to use telemedicine technology. If health professionals are present (as they usually are excepting in telemonitoring from home), figuring out how to use telemedicine equipment may not be a problem.

2.3 Summary

Problems of health care in the United States include limited access to health care, inequality of care; cost of care; and uneven distribution of quality care. Several studies have shown the following benefits to implementing telemedicine programs: increased quality of care; increased access to care, especially for those for whom travel to medical facilities is difficult due to disability, age or budget; decreased time to get health care; increased information sharing and ease to get a second opinion; lowered cost for health care and/or travel to obtain health care; access to specialists; and the ability to monitor chronic disease and vital signs at home.

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Telemedicine is also useful for physician education and information sharing online via Web sites, communities of practice and emailing.

Possible drawbacks of telemedicine include: privacy issues; technology breakdowns; untrained personnel; and a breakdown of communication or intimacy between patient and physician.

Chapter 3

Past Evaluation Studies

Most evaluation studies from the literature review were about diagnosis and treatment, as is logical given that telemedicine is in the area of medicine which encompasses the care of patients. Other studies involved cost and reimbursement. Several authors claimed there is a derth of randomized clinical trials.

3.1 State of Evaluation

Telemedicine evaluation research has been somewhat limited, especially with outcome data (Zanni 2011; Desai, McKoy, and Kovarik 2010; Lesher, Davis, Gourdin, English et al. 1998; Perednia and Allen 1995). Demiris (2003) wrote that what telemedicine literature lacks are controlled clinical trials, reliability and validity studies, and sound statistical methods. Demiris and Tao (2005), after searching for telemedicine articles in MEDLINE®, found that only 4.7% of 1321 reported on randomized control trials. The authors compared this to the finding by Solomon and McLeod (1993) that 72% of all articles reviewed in surgical journals were clinical trials. They indicated that "the lack of clinical trials limits the application of evidence-based medicine in the domain of telemedicine."

In addition, more large-scale studies are needed in the future (Mahendran, Goodfield, and Sheehan-Dare 2005). According to Zanni (2011), positive study results are tempered because of methodological problems such as small sample size. Bashshur, Shannon, Krupinski and Grigsby (2011) wrote that, although telemedicine's feasibility and acceptability to patients and providers, and its ability to improve access to health care are no longer in doubt, evidence regarding its effectiveness and efficiency is lacking. Although money from the Obama administration, UN

agencies, and private groups has been forthcoming, to ensure continued investment, results of current telemedicine programs must be shown.

Bashshur (1995[1]) wrote that the evaluation of telemedicine must consider contexts, and the full range of effects, short and long term, intended and unintended, direct and indirect. For evaluation, according to Bashshur, you need these three elements: 1. identification of appropriate environments and specific health care needs of communities and providers; 2. the specification of information requirements necessary for remote diagnosis, treatment and follow-up; and 3. the attempt to exploit to the extent possible the technology capabilities. He wrote in 1995 what he and major authors still write, which is that more valid evaluation studies, such as randomized controlled trials, are needed in telemedicine (Schwamm, Audebert, and Amarenco, Chumbler et al. 2009; Currell, Urquhart, Wainwright and Lewis 2010).

Bashshur (1995[1]) wrote that telemedicine systems are innovation "bundles" that evolve according to context, technology, organization configuration, patient needs and references, and more. According to Bashshur, two types of research questions are appropriate for telemedicine evaluation. One type involves biomedical research, which encompasses issues of clinical effectiveness and safety and deals with accuracy, precision, reliability, sensitivity, safety, and meeting clinical standards of performance. The second type of question pertains to health services research, which focuses on health care delivery and acceptance by providers and clients.

Bashshur (1995[1]) distinguished three periods of telemedicine evaluation, beginning in the 1970s. He wrote that during this period, telemedicine systems did not fully exploit their capabilities, even after accounting for the technological limitations back then. Funding was usually short-term and institutional commitment was limited, both of which, according to Bashshur, contributed to underutilization. In addition, almost all telemedicine projects had

narrowly defined functions or special target groups to service. The specific area of telemedicine was not defined by most projects. Some evidence of the efficacy of telemedicine by health professionals was already available.

The three parts of health services research evaluation, according to Bashshur, are evaluability assessment, formative evaluation and summative evaluation. Evaluability assessment provides attributes, characteristics and attributions, and problems of telemedicine. Inputs, outputs and relationships must be identified. Objectives are specified. It sets the stage for the next two evaluations. A matrix may be involved, indicating the four perspectives of clients, providers, institutions and society on one axis and three types of effects – access, cost, and care—on the other. Bashshur, Shannon, Krupinski, and Grigsby wrote further about this access in the 2011 article. Formative evaluation focuses on system decision and implementation, and the assessment of intermediate- or short-term effects on process and content of care. This leads to adjustments and refinements. Summative evaluation seeks to determine the ultimate effect of telemedicine systems on health outcomes that can be measured by objective and subjective measures, problem resolution and functional performance.

Bashshur, Shannon, Krupinski, and Grigsby (2011) wrote that one problem is that technology precedes telemedicine, i.e., if the technology is available, it will be used before evaluation studies have taken place. He called this the technological imperative; if the technology exists, it will be used. He stressed the need for evaluation studies to precede the technology. Clinical and health care needs must be identified first. Funding for this may be a problem. Evaluation may have problems involving requisites for valid scientific evaluation and then linking the evaluation to health policy. Program objectives must be clearly described, program

outputs may take a long time, program effects may be conflicting, effect size may be too small or the program may not achieve a steady state of operation to the desired strength and fidelity.

3.2 Evaluation Studies

Gelber and Alexander (1999) reported improved general communication, improved access to others and reduced isolation after telemedicine evaluations with a user satisfaction survey of videoconferencing services for child and adolescent mental telemedicine treatment. They aimed to evaluate key utilization areas, effect on professional practice, and advantages and disadvantages of the videoconferencing service. Uses of videoconferencing were: Consultations (62%), followed by clinical use (59%), supervision (36%), teaching (19%) and administration (14%). Users listed cost savings as an advantage and technical problems as the biggest disadvantage. The findings show the benefits of videoconferencing for improving the delivery of mental health care in rural Australia.

Whitlock, Brown, Moore, and Pavliscsak et al. (2000) monitored 28 patients who entered a study comparing home telemedicine consultation with standard outpatient care. A nurse case manager contacted patients in the telemedicine gro up once a week under the direction of a primary care physician. The physician contacted the patients in the telemedicine group once a month. The hemoglobin A1c (HbA1c) and body weight improved significantly in the intervention (telemedicine) group, which had a 16% reduction in mean HbA1c level (from 9.5 to 8.2%) and a 4% mean weight reduction (from 214.3 to 206.7 pounds).

The same year, Demartines, Otto, Muttler and Labler et al. (2000) investigated the value of teleconferencing for patient care and surgical education. They evaluated the technical feasibility of real-time telesurgery system, physician participant satisfaction, and the feasibility of

telesurgical network. Telemedicine was used in 50 "state of the art" lectures and 271 clinical case presentations. They concluded that most of the surgeons were satisfied with telesurgery and the transmission of clinical documents was accurate. Surgeons and residents were queried, and 83% of surgeons were satisfied with the contribution of telemedicine to medical education and patient care, rating it good or excellent.

One of the few telemedicine randomized control trials that has been conducted was the multicenter trial conducted by Wootton, Bloomer, Corbett, and Eedy et al. in 2000 to compare real-time teledermatology with conventional outpatient dermatological care. Of a total of 204 general practice patients requiring referral to dermatology services in four health centers (two urban and two regional) and two hospitals, 102 were randomized to teledermatology consultation and 102 to traditional outpatient consultation. The clinical outcome of the teledermatological care was found to be equal to that of the conventional care, with no major differences found. Of 102 patients randomized to teledermatology, 55 (54%) were managed within primary care and 47 (46%) of patients needed at least one hospital appointment. Of 71 patients randomized to the conventional hospital outpatient consultation, 46 (45%) needed at least one further hospital appointment, 15 (15%) needed general practice review, and 40 (39%) did not require follow up visits. Clinical records showed that a similar amount of patients seen by teledermatology attended subsequent hospital appointments compared with patients under traditional care: 42 (41%) versus 41 (40%). The cost for initial teledermatology was higher than that for conventional consultation: £132.10 versus £48.73 per patient. Teledermatology would have been cost effective if each health center had allocated one morning session a week to teledermatology and the average round trip to hospital had been longer, 78 km instead of 26 km. The researchers concluded that real-time teledermatology was clinically feasible but not cost effective. They predicted that, if the

equipment were purchased at current prices and, as seen through sensitivity analysis, the travelling distances greater, teledermatology would be a cost effective.

A year later, Hersch, Helfand, Wallace, Kraemer, et al. (2001) wrote that the situation of a dearth of evaluation studies in telemedicine had continued since a *Journal of Medical Informatics* article indicated as such in 1996. Furthermore, they claimed that the quality of evaluation studies was poor. They evaluated one home care program and one hospital-based telemedicine program with a literature review. They concluded that telemedicine is comparable to face-to-face care in emergency medicine and is beneficial in surgical and neonatal intensive care units and in patient transfer in neurosurgery. They noted that the best efficacy evidence was from home-based care, especially in hypertension and diabetes. In office/hospital-based telemedicine, there is good evidence that telemedicine provides comparable care in emergency room, surgery and neonatal settings. They stressed the need for high-quality evaluation studies.

The same year, Miller (2001) also wrote that there is a dearth of evaluation studies in telemedicine. He wrote that evaluation needs to be technical and interpersonal. Technical aspects include diagnosis, treatment and follow-up, while interpersonal components include social and psychological aspects of care such as the physician-patient relationship, including trust, patient satisfaction and patient quality of life. Some authors, he pointed out, wrote that telemedicine may facilitate the movement to patient-centered and consumer-oriented patterns. Other authors wrote that it reinforces traditional, paternalistic patterns of care. The latter includes asking closed questions and giving directions. Patient-centered care is characterized by patients who bring knowledge of their own health, often taken from online sources, as well as knowledge of their psychosocial situations. Out of 38 studies that Miller reviewed, there were more than three times positive than negative results regarding telemedicine. The positive results did not outweigh the

negative results only in non-verbal communication and touch. He noted that there have been many telepsychiatry studies after 1994, and more studies in other telemedicine areas such as dermatology, cardiology, otolaryngology, oncology and orthopedics are needed. Miller wrote that future studies are needed if the nature and content of the communication process and the interpersonal dynamics of telemedicine are to be understood completed. Miller wrote that patient distrust in medical care in the United States had decreased in the 20 years prior to his study's publication, with increasing privatization and proliferation of managed care. Patient-centered care is characterized by patients asking questions, physicians listening to patient stories, eye contact, and physician feedback.

In 2001, Roine, Ohinmaa and Halley wrote that evidence regarding the effectiveness or cost-effectiveness of telemedicine is limited. They claimed that the most convincing evidence is in these areas: teleradiology, teleneurosurgery, telepsychiatry, transmission of echocardiographic images and use of electronic referrals for email consultations. For most of these, pilot or short projects were evaluated, and only efficacy, rather than effectiveness, was shown.

In 2004, Hailey, Ohinmaa and Roine carried out a systematic review of recent telemedicine assessments to identify scientifically credible studies that compared telemedicine with a non-telemedicine alternative. Selection criteria included that the authors of the studies reported administrative changes, patient outcomes or the results of an economic assessment. Forty-four out of 605 publications identified in the literature search were included in the review, and four other publications were identified through references cited in one of the retrieved papers for a total of 48 papers, which referred to 42 telemedicine programs and 46 studies. Study design and study performance were considered when analyzing the research. The authors concluded that 24 studies were judged to be of high or good quality and 11 of fair to good quality with some

limitations. Seven studies were judged to have limited validity and a further four were unacceptable for decision makers. The studies revealed new evidence on the efficacy and effectiveness of telemedicine in the areas of geriatric care, intensive care and some of those on home care. The authors concluded that good-quality studies in telemedicine effectiveness, efficacy and cost-effectiveness are still scarce. Only 8% of the studies involved a controlled comparison of telemedicine versus traditional care. The authors wrote that in many cases, evidence of telemedicine benefits is only provided in preliminary studies. The implementation of telemedicine affecting organization and the health care process was barely discussed, according to the authors. Of the 46 reviewed studies, seven were based on large randomized-control trials, 15 were based on small randomized-control trials, seven were prospective, non-randomized trials and 17 were retrospective. (The authors proposed an arbitrary cutoff of 50 subjects to determine a large randomized control trial.) Thirty-five of 46 (76%) studies concluded that telemedicine had advantages over office visits, although many studies pointed to disadvantages of telemedicine as well. More weight was placed on study performance than on study design (two-thirds versus one-third, respectively). Few studies considered long-term use or routine care of telemedicine. The authors wrote that the lack of good quality outcome measurement and economic studies is a weakness in telemedicine.

Kim (2004) wrote that telemedicine lacks an objective validation and evaluation program, and definitive standards for the exact assessment of a telemedicine system. Heinzelmann, Williams, Lugn and Kvedar (2005) conducted a literature review of 160 studies, including randomized control trials, involving telemedicine. Half of the studies concentrated on asynchronous, and half concentrated on synchronous telemedicine. They concluded that there is a lack of hard evidence of the merits of telemedicine and that such studies must compare

telemedicine with conventional care as the gold standard, and should be based on randomized control trials. In the review, 23 out of 61 or 38% of studies that investigated clinical management or clinical outcomes were based on randomized control trials. They also wrote that there "may not be a single optimal design, and methodological rigor needs to be balanced with the practicalities of clinical workflow, resource availability, and legal/ethical requirements." They found that the majority of comparative studies in telemedicine have focused on patient satisfaction and diagnostic accuracy, and noted a lack of studies on clinical management and clinical outcomes. Applications in radiology appear to be both accurate in diagnosis and well- integrated into the mainstream of health care delivery. They also found that (2005), "among specialties with both diagnostic and clinical management functions, dermatology appears to have the most evidence of diagnostic accuracy." Like pathology, further research into real-time applications, including those comparing them to store-and-forward applications, are needed. Among real-time applications, the diagnostic accuracy of transmitted echocardiograms and mental health application was found to be well-supported, but sample sizes were usually small.

In the area of clinical management and clinical outcomes, most evidence for impact was with home/institution–based applications for congestive heart failure, diabetes, and blood pressure monitoring. For hospital–based clinical applications, dermatology, cardiology (i.e., echocardiography), and intensive care and emergency care/trauma had the strongest evidence for benefit compared with other areas. Patient satisfaction was well demonstrated, especially in psychiatry, dermatology, and multispecialty applications.

Griffiths, Lindenmeyer, Powell, and Low et al. (2006) reviewed peer-reviewed scientific articles evaluating the use of the Internet for health care delivery. The Internet was used to lower costs, treat rural patients, enhance equity of care, reach stigmatized groups, and research reasons.

They concluded that more comparative evaluation studies must be conducted comparing telemedicine to in-office care.

Bowns, Collins, Walters, and McDonah et al. (2006) conducted one of the few randomized control trials in telemedicine. They compared the clinical equivalence, patient and clinician opinion of store-and forward teledermatology with conventional face-to-face consultation. Face-to-face visits or digital photography and dermoscopy were used to treat malignant melanoma or squamous cell carcinoma. There were difficulties in recruitment and patient loss so no conclusions could be drawn. This shows that more studies need to be done. Chiang, Keenan, Staren, Du et al. (2006) determined the accuracy and reliability of retinopathy of prematurity (ROP) diagnosis via telemedicine. They concluded that the accuracy and reliability were substantial. Images captured by a remote camera were interpreted with high accuracy, interreader reliability, and intrareader reliability. Careful selection and training of readers were considered important.

Verhoeven, van Gemert-Pijnen, Dijkstra, Nijland et al. (2007) reviewed publications from May 2005 to December 2007 on teleconsultation and videoconferencing in diabetes. They concluded that they are practical, cost-effective, and reliable ways of delivering a worthwhile health care service to diabetes and that future systems should integrate monitoring. More rigorous studies are needed to measure the effects of telemedicine on quality of life, well-being and organizational issues in order to make better decisions and to encourage better care coordination. Future research on telemedicine for self-efficacy of diabetics should take place. The process of implementation should also be evaluated.

Obstfelder, Engeseth and Wynn (2007) reviewed articles to find characteristics of successful telemedicine programs. The characteristics they found were: 1. Telemedicine was seen

as a benefit; 2. Telemedicine had been seen as a medical and political solution; 3. There was collaboration between promotors and users; 4. Organizational and technological issues had been addressed; 5. The future operation had been considered. The interplay between social and technical factors produced a final successful outcome.

Jackson and McLean (2012) performed a literature review in July 2009 of 526 telemedicine evaluations reporting quantitative assessments of performance in PubMed and Web of Knowledge. They reviewed evaluation articles on store-and-forward, real-time and telecare, which they defined to mean telemonitoring. They explained that systematic reviews of telemedicine have focused on identifying deficiencies in studies, measuring the quality of the best, as a means of determining the success of telemedicine, and on identifying well-designed studies reporting criteria commonly considered as useful in a full assessment of the new technology in a clinical context. Few studies meet such stringent criteria, because of financial constraints of research. They found that clinical outcomes such as diagnostic accuracy, clinical effectiveness and patient satisfaction were frequently reported. They suggested that more cost analysis and professional satisfaction measures should be conducted. They claimed that cost effectiveness is essential to predict the success of telemedicine programs and that patient and professional satisfaction ratings provide an essential predictor of the likely retention of telemedicine services. Patient quality and cost measures were not reported on as frequently as clinical outcomes and patient satisfaction. Patient quality measures include access to care, cost to patient, quality of service, including waiting time, hospital attendance required, including for follow-up visits, and patient view of health care impact. Different measures were used for different types of telemedicine. For instance, for store-and-forward and real-time telemedicine, diagnostic accuracy was measured.

Weatherburn (2010) evaluated two teledermatology systems in two different United Kingdom hospital systems. She concluded that the teledermatology teleconferencing services met the needs of the patients. Sarhan, Weatherburn, Graham, and Thiyagarajan (2010) evaluated the results of nurses viewing spinal injury digital images. Most uses had a positive opinion of the images. Their diagnosis had a high level of agreement of more than 80% for most types of injuries. The nurses concluded that the digital image quality was good enough to negate the need for hospital visits for digital exams.

In a systematic review of 1593 titles and abstracts, Ekeland, Bowes, Flottorp (2010) concluded that telemedicine is effective, 18 of the titles and abstracts found that evidence it to be promising and incomplete and others that evidence is limited and inconsistent. Issues included the nature of economic analysis, the benefits for patients, and telemedicine as a complex and ongoing collaborative achievement in unpredictable processes. New issue areas emerged. The authors concluded, as others have done, that larger studies of telemedicine as controlled interventions are needed, as are a larger focus on patients' perspectives, economic analyses and on telemedicine innovations as complex processes and ongoing collaborative achievements. Formative assessments are emerging as an area of interest. These may guide policy makers to make decisions on how best to use telemedicine. Issues included: Finding the appropriate research methodologies; economic analysis of telemedicine has not yet met accepted standards; a relative lack of exploration of the socioeconomic impact of telemedicine; lacking evidence on factors promoting the uptake of telemedicine; an undeveloped use of qualitative methods; and studies that are not well-designed. Promising areas of telemedicine include psychotherapy using remote communication technologies; virtual reality in stroke rehabilitation, mental disorders and related

conditions; diabetes management; stroke therapy; and alcohol abuse. What makes things more complicated and shows the need for future studies is that lack of evidence does not imply lack of effectiveness. The issues of technical, ethical, legal, clinical, economical and organizational implications and challenges need to be explored in smart homes.

Ríos-Yuil (2012) conducted a study to compare office visits and teledermatology cases in Panama, where weekly case conferences are held in which dermatologists throughout the country agree on a second opinion for the diagnosis of complicated cases. In a quasi-experimental nonblinded analysis of correlation, dermatologists were randomly assigned to two office visits or telemedicine examinations for 30 cases. The degree of correlation (Cohen coefficient) between the diagnoses made by each group was assessed. Ríos-Yuil concluded that, while office visits remain the gold standard, teledermatology can be used effectively to facilitate diagnosis in case conferences. The diagnostic agreement between the two groups was 83.33%.

Telemedicine allows for collaboration and teamwork among physicians (Gambadauro and Torrejo 2013). According to Gambadauro, the multimedia capabilities of the Internet, with new applications such as wikis, blogs or podcasts, represent powerful collaborative tools for anyone, anywhere and are not as expensive as telephone calls.

In another evaluation study review, Gardiner and Hartwell (2012) reviewed 29 manuscripts, of which 15 reported on telemedicine complications that the authors grouped into six groups: misdiagnosis, time consumption, training, technical issues, dissatisfied users and cost. In the articles, the success of telemedicine in plastic surgery was shown in the areas of wound care, free flap monitoring, wound care, maxillofacial injuries, and replantation potential of amputated digits.

The articles contained other telemedicine plastic surgery issues, such as security and privacy protection. Gardiner and Hartwell (2012) have proposed the need for strong authentication, data encryption, non-repudiation services, a common security policy, and controlled contracts between partners.

Emails can be sent securely if the sender's and recipient's systems are both secure. The authors concluded that telemedicine is used in plastic surgery, between junior and senior physicians, nursing staff and patients, but there is little information on its security, cost benefits, and privacy. Issues that Gardiner and Hartzell found include: the inability to accurately interpret 2D imagery; delays in diagnosis; misdiagnosis; the wasting of specialists' time due to poor preparation of patients prior to teleconsultations; data protection; data resolution; quality of care; confidentiality; and privacy.

Telemedicine is used in stroke care. Lamonte, Bahouth, Hu, Pathan, et al. (2003) evaluated real-time telemedicine and stroke. The University of Maryland Medical Center uses triplexed integrated services digital network such as providing a 30-frames-per-second video to St. Mary's Hospital over 100 miles away. They evaluated 21 patient telemedicine cases and concluded that telemedicine had a valuable role in emergency stroke consultation. Further studies of patient outcomes, effects on hospital cost and quality of control are needed.

The Scottsdale, Arizona-based Mayo Clinic in conjunction with Tuba City Regional Health Care extended its telestroke program to residents of the largest Navajo Nation city (McCann[1] 2013). The Mayo stroke neurologist consults via computer screen with emergency room physicians in Tuba City to examine patients that show signs of stroke. Views of the patients' brains are examined to detect possible damage from a hemorrhage or blocked artery and to prescribe emergency clot-busting medications accordingly and within the narrow window of

time necessary to minimize permanent injury to the brain. Bart Demaerschalk, MD, professor of neurology, and medical director of Mayo Clinic Telestroke said: "Urgent and immediate virtual care can be provided to patients — collaboration between stroke neurologists and physicians at the remote sites has resulted in 96% accuracy in diagnosing stroke."

Van Hooff, De Smedt, De Raedt, and Moens et al. (2013), aimed to develop a novel scale for assessing severity through telemedicine without assistance from a third party, the Unassisted TeleStroke Scale (UTSS). Stroke severity was assessed in 45 patients by bedside examination using the National Institutes of Health Stroke Scale (NIHSS) and by teleconsultation using the UTSS. Reliability was measured by intrarater and interrater variability, internal consistency, and rater agreement. The mean examination time for the UTSS was less than that for the NIHSS model: 3.1 minutes (SD, 1.1) versus 8.5 minutes (SD, 2.6; $P<0.001$). Both scales showed excellent intrarater variability ($r=0.97$ and 0.98; $P<0.001$) and interrater variability ($r=0.96$ and 0.98; $P<0.001$), and excellent internal consistency and rater agreement. The UTSS was an independent predictor of stroke outcome in logistic regression analysis. The authors concluded that "UTSS is a rapid, reliable, and valid tool for unassisted assessment of stroke severity."

In 2013, Shah, Morris, Jones, Gillespie et al. evaluated telemedicine-enhanced emergency care program for older adults by field notes and 34 semistructured interviews of 21 participants after 10 telemedicine visits. They believe that this is the first study to evaluate stakeholders' experience and perceive barriers and facilitators to a telemedicine-enhanced emergency program for older adults. Providers and participants were overall happy with the telemedicine care, although providers did not prefer it over in-person care. Before the program, a nurse would receive an emergency call and direct a patient to an appropriate emergency department. In the study, the nurse would dispatch a certified telemedicine assistant (CTA) to perform tests such as

blood pressure testing and contacted a telemedicine provider, who reviewed findings by telephone or videoconferencing to determine if further evaluation or testing such as mobile imaging was necessary. Treatment was initiated. If appropriate, the telemedicine provider completed discharge instructions for the CTA. Participants believed that the telemedicine evaluations were thorough and liked that they made it possible for them to get medical care without travel. They believed that telemedicine care was superior to telephone care, but more time-consuming and clinically inferior to traditional office visits. The major complaints involved inadequate telemedicine technician training, which led to low confidence and performance difficulties, and problems with reliability, performance and weight of equipment, which led to frustration for both participants and providers. Some participants and family members reported that the CTAs did not know how to communicate well with older adults. Several CTAs complained that the technology was heavy to carry and often included pieces that did not work. Common technology problems included broadband card failures, computer medical device interface failures, and software problems. The authors do not believe that using telemedicine is needed when telephone emergency care suffices and believe that future studies to evaluate telemedicine in emergency care are needed.

Working in the area of psychotherapy, Wagner, Horn and Maercker (2013) randomly assigned a total of 62 participants suffering from depression to a therapist-supported internet based intervention group (n=32) and to traditional face-to-face intervention (n=30). Both modalities were based on cognitive-behavioral therapy principles. The health care professionals were six psychologists and psychotherapists. Online care was equally beneficial to regular face-to-face therapy. However, long-term efficacy, shown by continued symptom reduction three months after treatment, could be found for the online group, where results remained stable. Participants who had received in office care showed significantly worsened depressive symptoms.

The authors speculated that this may have occurred because the online group had a stronger focus on responsibility to conduct treatment modules and homework, and led to a longer-lasting sense of self-efficacy. Seven participants in the online group dropped out as opposed to two participants in the face-to-face group. This may show that it is easier to drop out in an anonymous online group, and thus the therapeutic relationship may be less stable than it is in the face-to-face group. The sample size was small, most participants were well-educated and all had previous therapy experience. The authors recommend a similar future study with more participants.

In 2013, Poropatich, Lai, McVeigh and Bashshur reviewed telemedicine in the military. Secure telemedicine is used in all echelons of care. For instance, the E-mail Teleconsultation Program, also called the US Army AKO Teleconsultation System, started in 2004 and provides continuum of care and second opinions and can result in avoiding unnecessary medical evacuation of some patients form the battlefield. Often teleconsultations facilitated timely needed evacuations. About 43% of these consultations were in dermatology, then infectious disease and after that orthopedics and neurology. The program is used in many places in the world, from Afghanistan to Honduras and on ships. The deployable military teleradiology system consists of the Theater Image Repository. Telebehavioral health is also a key component in military telemedicine. It consists of simple and inexpensive equipment, usually of a video nature. Surveys have shown a high satisfaction rate for users. Mobile telemonitoring is also a huge component of military telemedicine. The authors concluded that there is a need to integrate capability with the electronic health record.

Ajami and Arzani-Birgani (2014) conducted a review of data published on burn victims in Iran and concluded that the acute evaluation of burn patients can be performed by telemedicine. Telemedicine plays an important role in improving access to medical expertise, and raises

physician confidence in treating burn patients. Telemedicine can reduce under-triage or over-triage for air transport and lead to saving time and cost.

Parmar, Mackie, Varghese and Cooper (2014) conducted a literature review to assess telemedicine technologies that are increasingly becoming incorporated into infectious diseases practices. They found that patients consistently report high levels of satisfaction with telemedicine. Infectious diseases treated with telemedicine include respiratory, urinary tract, skin and soft tissue, HIV, HCV, and tuberculosis. Key telemedicine advantages are increased access to health care for isolated populations and cost-effectiveness, although more studies are needed to assess the latter. Impediments to telemedicine include immature policy, licensing and reimbursement laws. Security issues and lack of the ability for a full physical examination are also impediments. Telemedicine technology can also successfully deliver continuing education to primary health care professionals. The authors recommend more telemedicine evaluation studies.

Agua Peris, Del Hoyo, Bebia, Faubel et al. (2015) wrote a review article that summarizes the evidence about telemedicine, telemonitoring, teleconsulting, and tele-education for the management of inflammatory bowel disease. Factors studied include the acceptance of these systems, adherence to treatment, quality of life, patient knowledge, patients' empowerment, health care costs, and safety of telemonitoring. The authors concluded that the telemedicine applications were safe and well accepted by the patient, and improved adherence to treatment, quality of life, and disease knowledge.

 In 2016 Bashshur and Krupinski published a paper in which they reviewed 52 teleradiology articles from 25 countries between 2005 and 2015. Some of the studies they reviewed are as follows. An analysis of a six-year experience with clinical teleradiology sessions was conducted in Spain. Most participants indicated acceptance and ease-of-use of the tools. A

2003 Swedish study concluded that telemedicine conferences, including the remote viewing of radiographic and real-time images, had a significant impact on the competence of clinicians to treat children with cancer. Some clinicians did complain about audio quality, which was subsequently fixed. A 2005 UK study investigated the accuracy of mobile phones in radiological investigations for diagnosing ear, nose and throat (ENT) problems presenting in the emergency department. In 154 cases, mobile phone versus conventional X-ray film viewing were assessed. Physicians always made the right diagnosis, but they had more confidence with the X-ray film. Since the mobile phones are not expensive, the authors concluded that tin time practitioners would have more confidence with the mobile phones.

A 2007 report of a teleradiology collaboration between Greece and Germany showed the feasibility of advanced collaboration via a hybrid satellite-terrestrial network. A 2007 US report was about the implementation of an automated wireless network for the transmission of prehospital electrocardiograms (ECGs) as a way to reduce door-to-balloon times in acute ST-segment elevation myocardial infarctions (STEMIs) which are the most severe type of heart attack. The system included Bluetooth devices, preprogrammed transmitting receiving stations, dedicated email servers, and smartphones. The teleradiology system resulted in early evaluation and triage of patients with STEMI and it reduced door-to-balloon times by more than 90 minutes. A 2008 Israeli report showed the risibility of using a centralized medical imaging system based on mobile phone technology as a replacement for conventional imaging devices for breast cancer detection in developing countries with a high disrepair rate for sophisticated imaging equipment. A 2009 Croatian study reported on telemedicine in neurosurgery in a system that connected CT, MRI and digital subtraction angiography which is a type of fluoroscopy used to visualize blood vessels in bone or dense soft tissue. Patient information was made available to surgeons in seven

Croatian cities. In just the first seven years of the projects, 25, 366 expert opinions were rendered. Teleradiology was valuable in determining effective treatment. A 2006 teledermatology study with 1,003 patients showed that remote management can reduce the number of women who need to return physically to the clinic for additional procedures by half. A downside was that there was one unnecessary imaging procedure for every recall avoided. Bashshur and Krupinski also wrote about a 2007 Italian study in which assessed the impact of digital radiology department in a regional hospital on the process of care in terms of quality and efficiency. The researchers noted the turnaround time, number of procedures and hospital length of stay. After a year, turnaround time was reduced by 60%, productivity was increased by 12%, and length of stay for neurology patients decreased by 12%. The wait time for outpatients was reduced from 90 to 40 days for nonurgent CT scans and from 90 to 180 days for nonurgent ultrasounds. Bashshur and Krupinski (2016) also mentioned a 2008 US study in which intermediate outcomes were selected to investigate discrepancies between teleradiology and in-house radiology interpretations of CT scans in an emergency department. In three months, CT scans of the head, cervical spine, chest and pelvis were assessed. Most discrepancies involved an office radiologist finding an abnormality that a teleradiologist did not find. Eight of 32 were due to misinterpretation by teleradiology and one case led to an adverse event. Nine were attributed to misinterpretations by the in-house radiologists while eight were attributed to teleradiologist misinterpretation. Discrepant interpretations were common for certain pathologies. So both in- office and teleradiologists had discrepancies at similar rates.

A 2009 Serbian study with 432 patients investigated the diagnostic agreement in store-and-forward images between teledentists and in office dentists were assessed in terms of sensitivity, specificity and effectiveness. There was almost total diagnostic agreement in terms of

all three measures. A NASA study evaluated the diagnostic capability of ultrasound at MACH 20 as a means of diagnosing, monitoring and treating medical or surgical conditions during spaceflight. The results showed that microgravity ultrasound imaging can provide diagnostic images for onboard emergencies.

In a Norwegian study, after a year of telemedicine diagnostic imaging implementation, there was a reduction in length of stay from 5.3 to 3.9 days, but it was not statistically significant. In a 2012 study, more than 11,000 young men with suspected appendicitis were selected and assessed using an abdominal CT scan. Almost 2,000 did not receive the CT scan. The ones undergoing the CT scan had less morbidity and fewer 30-day readmissions. The CT scan was associated with improved immediate postoperative complications. However, the CT scan was associated with increased cost of care. A 2012 study in the UK and Australia concluded that the use of after-hours outsourced teleradiology reporting service is substantiated. In 2012 in Italy, a retrospective review of medical records was studied to assess the effects of telemedicine intervention. Teleconsultations were used in the treatment of strokes. Patients with severe symptoms that were worsening were transferred to the hub. Telemedicine was useful for rapid time visualization of neurological and clinical data for treatment decisions. A study of 3,770 patients in Taiwan assessed teleradiology for use in the detection accuracy of osteoporosis. Sensitivity and specificity were 75%.

A 2013 Austrian study of 200 women studied digital mammograms that were sent to different institutions via teleradiology. Less than 10% of images were rated as poor. Reader agreement on the detection of masses and calcifications was high. A 2014 US veteran study also assessed the use of teleradiology in osteoporosis. An e-consult program served 444 veterans with osteoporosis. Treatment was recommended via this service. Before this service, the rate of

prescription for bisphosphonate was 4.8% and for vitamin D was 21.3%. The rates increased to 7.2% and 35.2% respectively. A Botswana study in the same year assessed the diagnostic accuracy of mobile phone teleradiology for evaluating chest X-rays. The authors concluded that diagnosis can be improved as the quality of digital cameras improves. The correct diagnosis was made in 82% of the light box cases and 76% of the digital camera cases. In a 2015 US study, the authors suggested that teleradiology can help in the amount of tertiary ED transfers for rural patients at institutions with no radiology service.

Bashshur and Krupinski concluded that, overall, participants in the studies benefitted from improved quality and enhanced efficiency, which included reduced transfer of trauma patients, reduced unnecessary trips for patients, reduced hospital length of stay, reduced rehospitalization, and reduced waiting time. Diagnosis from digital photographs was equivalent to conventional image viewing in select image and lesion applications.

Bashshur, Shannon and Smith in 2016 reviewed studies dealing with telemedicine and chronic disease management to assess some of the evidence that telemedicine improves access, quality and cost. The studies dealt with congestive heart failure (CHF), stroke and chronic obstructive pulmonary disease. The authors wrote that, while many people in rural areas do not have the medical resources or specialists they need, many people in urban areas are near the place and professionals they need but do not have the funds for health care. Telemedicine can help in both areas. Longer life expectancy has resulted in more people dealing with three of these chronic health conditions. The authors write that about 70% of all deaths in the US are from chronic diseases, which includes 50% of deaths from heart disease, cancer and stroke. Chronic diseases make up the largest part of health care costs. While telemedicine implementation costs can be high, the ability to provide diagnoses was normally available in tertiary care centers. In a 2008-

2009 Italian study, remote monitoring was significantly associated with a reduction of emergency department/in office visits for heart failure and quality of care increased. A 2011 study of Medicare patients reported savings for those who received telemedicine. After two years, these patients had a 15% reduction in mortality risk and an 18% reduction on hospital admissions per quarter. A 2012 Belgium study compared male patients with CHF who were released from hospitals and had telemonitoring versus those that did not. The telemonitoring devices reported on weight, blood pressure and heart rate each morning at a certain time. Both sets of patients were given an education on heart failure. The CHR patients in the study lost fewer days to hospitalization, death or dialysis.

In a 2012 US RCT, telemonitoring group experienced a higher rate of mortality than a control group. No difference between the two groups was observed in terms of hospitalization or emergency department visits. An example of a study in which telemedicine did not reduce hospital readmission was a 2010 Germany RCT in which patients with CHF were given telemonitoring equipment for ECG, blood pressure, weight. The patients in the telemedicine group experienced fewer rehospitalizations. Another such example was a 2010 US RCT in which some patients with heart failure received telemedicine while the control group did not. Both groups had educational materials. Since the participation of the first group dropped by more than 40% after the first week, telemedicine was not shown to benefit the patients. Overall, mortality was not reduced for those in the telemedicine group.

A 2012 English study with 3,230 participants investigated the impact of remote exchange of data with telemonitoring for CHF, COPD and diabetes patients. Patients who received telemedicine were less likely to be rehospitalized and less likely to die than controls. Groups were matched by size, disease and other characteristics. The researchers wrote that telemedicine can

help patients manage chronic disease and change their perceptions about needing to find more care, and assist professionals in referring or admitting patients. In a 2012 US RCT, mortality rates in the telemedicine group were higher than those in the control group. Patients' average age was 80 years old, and they suffered from complex health issues.

Stroke, compared to CHF, may require quicker assessment and decision-making. Regarding stroke, a 2006 Spain study showed that videoconferencing increased thrombolytic treatment and decreased interval between the onset of symptoms and thrombolytic treatment from 210 to 162 minutes. Authors of a 2006 Spain showed that telemedicine in COPD reduced hospital readmissions and was acceptable to professionals. In a 2009 non-randomized trial with 3.060 patients with ischemic or hemorrhagic stroke admitted between 2003 and 2005, death and dependency were significantly lower in the intervention group, including in two follow-up visits. A 2010 Canadian study showed that real-time video conferencing helped in thrombolysis treatment of stroke patients and reduced the need to transfer patients. In another 2012 study, i-Phones were used to assess stroke patients in their bedside. The study authors concluded that iPhones were reliable tools. In a 2011-2012 study in Georgia, telestroke shortened the time from emergency department arrival to thrombolysis. A Spanish 2012 study showed that telestroke saved time in the initiation of interventional therapy and the processing of informed consent and preparation of interventional team before patients' arrival at a stroke center.

A 2012 study was published about data of a seven-year period study on two hub-and-spoke centers, Georgia Health Sciences University and the Mayo Clinic, where costs were compared with and without telestroke. Cost savings increased with increases in the number of spoke hospitals.

A 2013 RCT among individuals with a history of rehospitalizations for COPD did not find that videoconferencing postponed hospital admissions or improved the quality of patients' lives. A 2013 RCT from Italy investigate telemonitoring in 100 patients with COPD. The authors found that the telemedicine system, which performed measurements every three hours, led to a lower rate of exacerbations requiring medication change and hospitalization. But the length of stay in the intervention group was longer. For four years, the mortality was lower for the intervention telemedicine group. Brazil studies in 2011 and 2012 showed that telemedicine use with CHF, stroke and/or COPD resulted in major savings in travel costs for patients, as well as reducing wage loss and actual health care costs. A 2013 RCT showed that patients in a remote monitoring group had fewer hospital admissions and shorter duration of follow-up visits. A 2013 study from Taiwan followed a single group of patients with cardiovascular disease

Bashshur, Shannon and Woodward (2015) reviewed telemedicine in diabetes. A 2005 to 2009 study of diabetes patients enrolled in the VHA Home-based Care Coordination Telehealth program consisted of reviewing the effects of the use of an electronic messaging device that queried patients daily about diabetic symptoms and which was linked to nurse coordinators by telephone. A 2010 US study showed significant decreases in A1c and LDL in the telemedicine education group where videoconferencing was used to disperse diabetes education. A 2011 Italian study of more than 1,000 diabetes patients showed that the SINERGIA telemedicine model led to a decrease in A1c from 10.5% to 4.3%, metabolic control improved and cardiovascular risk factors were lowered. One of the studies from the United States in 2011 was a feasibility study of patients with diabetes type 2 and the feasibility of incorporating a telediabetes system between two rural clinics in Montana. Feasibility was measured in terms of patient acceptance, patient self-management behaviors and diabetes knowledge. The authors concluded that telediabetes was

an effective mode for diabetes care to rural patients. A 2011 four-year control study assessed the effects of veteran care in a home telehealth program for patients with type I and II diabetes. The authors concluded that the intervention group had reduced inpatient and outpatient use. A 2010 Spain RCT of 100 subjects evaluated the feasibility of a telemonitoring system for gestational diabetes. The system was based on a message system and the Internet. The authors concluded that it reduced the need for outpatient visits by 62%.

A 2011 French study examined the effectiveness of a mobile Diabeo system consisting of a personalized bolus calculator and recommended insulin adjustments. Data was transmitted to a Web site for telemonitoring and teleconsultation. Diabeo improved glycemic control and resulted in cost and time savings due to patient traveling. A 2012 study reported a 44% reduction in rehospitalization for patients who received a combination of telemonitoring and case management. A 2012 German study used telemedicine to monitor movement in overweight and obese children and adolescents and resulted in significant weight reduction.

A 2013 United States RCT of 100 diabetes patients used both telephone and Internet links to connect providers with diabetes patients. Patients were assigned to experimental or control groups equally. No differences were seen between the office visit and telemedicine groups after a year. Another 2013 RCT was based in Italy. Patients used a carbohydrate calculator called the Diabetes Interactive Diary (DID) to calibrate the individual's appropriate insulin dose for each meal. Participants completed a quality of life questionnaire at the beginning and end of the program. Risk of hypoglycemia decreased and quality of life increased.

In the IDEATel RCT from 2002 to 2013 in New York City and upstate New York, participants in the telemedicine group received a home telemedicine unit made of a Web-enabled modem connected to a telephone line with videoconferencing, remote glucose monitoring and a

Web portal for patients with access to their own clinical data and to a nurse case manager as well as a Web site for diabetes education. Each subject had a case manager. Results showed that subjects were largely satisfied with the system and increased their knowledge of diabetes. Authors of one article concluded that the intervention group experienced a lower rate of physical activity decline.

3.3 Diagnostic Accuracy

Jackson and McLean (2012) defined diagnostic accuracy (DA) as: "the potential of a medical test for discriminating between the target condition and a healthy state." Metrics for measuring DA are typically sensitivity, specificity, predictive value, and likelihood ratio. Diagnostic accuracy measures are usually specific to the test being performed, and the population under study."

Several studies measuring diagnostic accuracy in telemedicine have been conducted, and many of them have been in the area of teledermatology. The telemedicine area of teledermatology had the highest amount of accuracy studies by Heinzelmann, Williams, Lugn, and Kvedar (2005). In the 2003 pilot study using telediagnosis for melanocytic skin neoplasms, the diagnostic accuracy reached 83% versus the gold standard of conventional histopathologic diagnosis (Ferrara, Argenziano, and Cerroni 2004). According to Oztas, Calikoglu, Baz, Birol et al. (2004), there was a 91% consensus between the face-to-face diagnosis and the telemedicine diagnosis. Reasons of lower confidence among teledermatologists were inability to palpate diseased regions, poor image quality and lack of ability to do a diagnostic procedure.

Sometimes, telemedicine care is less accurate than conventional care. As early as 1997, Kvedar, Edwards, Menn, Mofid et al. reported that physicians were less accurate using teledermatology than having patients come into the office. They conducted a study to investigate

the diagnostic accuracy of physicians viewing patients' history and store-and-forward images compared to those conducting office visits. Accuracy correlation between the two methods was 83%.

Several studies, however, showed that accuracy in telemedicine is comparable to that in conventional care. Oakley, Astwood, Loane, and Duffel, et al. (1997) conducted a study that showed that real-time teleconsultations were close in accuracy to office visit. Concordance between the two consultations was 82%. Harrison, Clayton and Wallace (1998) reported an accuracy of 71% for in store-and-forward teleconsultations with 210 patients. Confidence of physicians using real-time increased the more that they used.

In 1998, Lesher, Davis, Gourdin, English, and Thompson wrote that accuracy between teledermatology and office visits was comparable, but more diagnoses fell into the partial agreement category when the two physicians examined patients only through interactive television. Partial disagreement referred to similar differential diagnosis for lesions but no definite agreement on a single primary diagnosis. One dermatologist evaluated patients via interactive television and a second took them through office visits. The control group was investigators independently and in a blinded fashion recording diagnoses for a group of patients from a third dermatologist's clinic. A third dermatologist evaluated all the data and assigned categories of complete agreement, partial agreement, and disagreement.

Lowitt, Kessler, Kauffman, Hooper, et al. (1998) wrote that accuracy was 80% in 139 cases of both real-time and office visits consultations. Physicians, however, were satisfied with their ability to examine the skin well and visualize all necessary anatomical areas in 100% of the office visits but 80% of the real-time examinations. Most patients preferred a video examination by a dermatologist to an office visit with a non-dermatologist. Most patients would have preferred

to see the dermatologist by video close to home rather than travel to the office. Only a minority of patients would travel office visits using real-time consultation. Limitations included a large proportion of white male patients in the VA hospital study.

Whited, Hall, Smile, Foy et al. (1999) compared diagnosis and treatment in 168 skin lesions among 129 patients seen in the office and using telemedicine. Accuracy referred to whether the diagnostic test yields a correct or incorrect answer in comparison to the truth, represented by a reference standard. Reliability implied agreement in diagnosis if the test was performed on the same subject twice and the same answer was obtained. The lesions were independently examined by two clinic-based dermatologists and three different digital image dermatologist consultants. The reliability and accuracy of the diagnoses and the reliability of management recommendations were compared. They wrote that store-and-forward consultations resulted in comparable accuracy and reliability to office visits consultations. It is important to compare teledermatology findings to agreement (or not) between clinic-based examiners

Management recommendation agreement was variable. The authors suggest that this may be because the clinic-based dermatologists were VA-based and the teledermatologists were academic and private practice based. Their management styles may have differed. This was one study limitation. Others were: most patients were elderly white men and there is no accepted or widely adopted diagnostic rating scale for dermatologic disease. Thus, subjectivity enters into any study's diagnostic ratings. The authors chose a rating scale (see Tables 4 and 5) that they believed rated agreement conservatively and minimized subjectivity in diagnostic ratings.

Table 4 Agreement Rating Scale

1. Complete agreement: Evaluates agreement based on the single most likely diagnosis only.

Single most likely diagnoses that are identical are rated as complete agreement.

2. Partial agreement: Evaluates agreement based on diagnoses that appear as a single most likely diagnosis or as a differential diagnosis. Identical diagnoses that appear in one examiner's single most likely diagnosis and the differential diagnosis of the second examiner or identical diagnoses that appear in the differential diagnoses of both examiners are rated as partial agreement.

3. Disagreement: No identical diagnoses offered between examiners' single most likely diagnoses *or* differential diagnoses.

Above excerpted from Whited, Hall, Smile, Foy et al. 1999

Table 5 Management Agreement Scale

1. Complete agreement: All recommended medications/tests/therapies are identical.

2. Partial agreement: At least one medication/test/therapy of two or more is identical.

3. Disagreement: No medications/tests/therapies are identical.

Above excerpted from Whited, Hall, Smile, Foy et al. 1999

High, Houston, Calobrisi, Drage et al. (2000) assessed the accuracy of low-cost store-and-forward and concluded that it is comparable to office visits. Accuracy ranged between 81% and 89%, depending on the dermatologist involved. Furthermore, when there was disagreement between store-and-forward and office visits consultations, the discrepancy was clinically relevant about half the time. In fact, agreement was divided into cases of exact matches and

"differential" matches, where office visits diagnosis matched one of three mentioned in store-and-forward consultations. Disagreement cases were divided into non-clinically relevant cases, i.e., those that did not match but had little clinical consequences, and clinically relevant mismatches. The authors concluded that further studies must include clinical areas inappropriate for teledermatology.

Loane, Bloomer, Corbett, Eedy et al. (2000) stated the agreement between store-and-forward and office visits as ranging, in studies he reviewed, between 59% and 93%, while that between office visits and real-time was between 59% and 80%.

Many studies show that diagnosis via telemedicine is comparable to that via office visits. Bonvini, Caoduro, Menafoglio, Calanca, et al. (2002) evaluated 98 cases of coronary angiography telemedicine image transmission. The teletransmitted angiograms and original films were blindly evaluated and documented by the distant heart surgeon at a tertiary care center. These independent evaluations were compared for quality evaluation of images. Correct diagnosis and surgical approach was found in 89 of the 98 cases.

In 2004, Nordrum, Johansen, Amin, Isaksen et al. reviewed the accuracy of histology store-and-forward images sent for a second opinion. The still images were selected from glass slides from a 90 cases of mixed archival histological originally referred for extramural or at a distance second opinion. Samples were from varying organs and the most common diagnosis was melanocytic tumors of the skin and carcinomas. The authors analyzed results from a second group of second opinion pathologists reviewing images and found the accuracy to be sufficient and comparable to other telepathology second opinion image studies: The pathologists' Phase 1 and Phase 2 results measured against the original second opinion telepathologists were 67.8% (n = 61) and 68.9% (n = 62) complete agreement, respectively. Diagnoses were discordant in 29 cases

in Phase 1, 3 cases had incorrect benign diagnoses and 8 cases had incorrect malignant diagnoses. Clinical implications could have results from 11 of the 29 discordant diagnoses. False positives included: 8 false-negative diagnoses regarding malignancy; 6 false-positive diagnoses regarding malignancy; and 4 other discordant diagnoses. The authors concluded that the results supported the concept of using still images for second opinion diagnosis.

High-quality images increased diagnostic accuracy (Baba, Seçkin, and Kapdağli 2005; Oakley, Astwood, Loane, and Duffill et al. (1997). The Oakley, Astwood, Loane, and Duffill study involved nine teledermatologists diagnosing disease first without and then after looking at digital images of disease. They also increased physicians' diagnostic confidence. The more accurate the images, the less likely more diagnostic procedures such as biopsies are needed. Diagnosis is especially challenging without good images for residents versus experienced physicians.

Abdoh, Krousel-Wood and Re (2004) assessed the diagnostic accuracy of telemedicine among 62 hypertensive patients attending a hypertension clinic during a one-year period. Clinical data on blood pressure (BP) control as well as physician ordering patterns were collected for patients who received in-office or telemedicine care. The researchers found no difference in ordering diagnostic tests or therapeutics between the two encounter types and concluded that telemedicine was a valid means for detecting uncontrolled blood pressure among hypertensive patients.

Whited (2006) conducted a literature review of the diagnostic accuracy of teleophthalmology. He included studies that were the most methodologically sound and provided the most comprehensive data. He wrote that the sensitivity of teleophthalmology for detecting diabetic retinopathy has been shown to be comparable or better, than that of traditional

examinations. Specificity and diagnostic accuracy have been high and sensitivity values have ranged from 50% to 93%. He concluded that teleophthalmology appears to be an accurate and reliable test in the detection of diabetic retinopathy and macular edema. The sensitivity of ophthalmoscopy examinations varied widely, with point estimates ranging from 0% to 96%. Specificity was almost always high, approaching or achieving 100%. Whited concluded that a negative ophthalmoscopy test does not rule out disease, but a positive ophthalmoscopy test most likely rules in the disease.

Whited (2006) wrote that diagnostic reliability has been the most-studied aspect of teledermatology. A universal gold standard test, however, is needed. Accuracy, whether a diagnosis is correct or not, usually relies on a reference standard test. This, Whited (2006) wrote, can be challenging. Histopathology review of biopsied tissue is often used and its primary utility in dermatology accuracy assessments is for determining the presence or absence of malignancy (Oakley, Reeves, Bennett, and Holmes et al. 2006). Lowitt, Kessler, Kauffman, Hooper, et al.(1998) agreed with that office visits may not always be accurate as gold standards; physicians often disagree. They preferred histopathological analysis as the gold standard. In three cases in their 1998 study, either the real-time or the office visits diagnosis matched the histopathology. Ferguson (2006) wrote about the importance of having patient history, but also wrote that it is not always needed for correct diagnosis.

Some studies have not been so favorable for teledermatology. For instance, Mahendran, Goodfield, and Sheehan-Dare (2005) wrote that the management plan was appropriate in 55% of the total teledermatology referrals assessed by the consultants when compared with the conventional consultation.I. It was appropriate in 52% assessed of the total teledermatology referrals assessed by the trainee when compared with the conventional consultation. In the study,

45% of patients could not be managed using telemedicine alone. They concluded (2005) that this was a "limited diagnostic accuracy" for skin lesions. However, they found that it is suitable and safe for screening out benign lesions. He wrote that 45% of store-and-forward teleconsultations were not adequately managed.

Cox (2006) conducted a literature review and found store-and-forward accuracy rates in teledermatology to range from 55% to 90%, lower than in office visit accuracy rates. He wrote that and there is a higher rate of suggested need for skin biopsy by teledermatology consultation and that the important topic of palpation must be addressed. Palpation is not possible with teledermatology unless a health care professional is present during a real-time consultation and communicates results of palpation to a physician at a distance. He wrote (2006) that palpation "assesses quality of scale or keratosis, texture changes, and skin temperature or sweating differences" and that "for localized lesions, palpation identifies tenderness, consistency, induration, depth and fixation." Palpation also conveys empathy and reassures the patient that what they have is not contagious.

Bianconcini, Trindade, Wen, Neto, Escuder et al. (2008) reported an accuracy of 74% by telemedicine in diagnosing leprosy. They wrote that this was similar to other studies. The specificity was low. The study, however, dealt with leprosy, which is a polymorphic disease and so difficult to diagnose in initial stages. Warshaw, Lederle, Grill, Gravely, et al. (2009) studied veterans with neoplasms via a repeated measures equivalence trial. A clinic dermatologist and a teledermatologist generated primary diagnosis, up to two differential diagnoses and a management plan for each veteran patient. Limitations included that most patients were older Caucasian males. They found that the diagnostic accuracy of teledermatology was inferior to office visits, whereas management was equivalent. The severity of management problems in

teledermatology, however, was more severe than that in office visits. Up to a fifth of melanomas would have been mismanaged via teledermatology. However, for malignant pigmented lesions, management was also inferior. It would be useful to ask physicians if disease matters in the use and outcomes of teledermatology. The scientists concluded that more studies are needed. Participants knew this was a study, and it was limited to skin neoplasm.

Fabbrocini, Balato, Rescigno, Mariano, et al. (2008) found the following skin lesions to be detected by the same accuracy in face-to-face and teledermatology examinations: leaf-like areas, milia-like cysts/comedo-like openings, blue-white structures, and blotches. For others, teledermatology was better at diagnosis: pigment network, regression structures, and diffuse pigmentation. For certain skin conditions, face-to-face or teledermatology are most appropriate. For instance, teledermoscopy of hypopigmented or nonpigmented lesions cannot always significantly improve diagnostic accuracy. Vascular pattern, radial streaks, and dots/globules had lower detection frequency using teledermatology. A 2-step teledermatologic approach may be feasible for individuals with multiple pigmented skin lesions (Di Stefani, Zalaudek, Argenziano, Chimenti et al. 2007).

Tan, Yung, Jameson, Oakley, et al. (2010) took digital and dermoscopic photographs were taken of suspected skin lesions, and the patients were then seen independently face-to-face. Only 12.3% of lesions had disparate diagnoses (between face-to-face and teledermatology) of clinical significance. Only 12 of 491 lesions appeared to be underreported by teledermoscopy and only one malignant lesion had been missed by teledermoscopy. Teledermoscopy approximated 100% sensitivity and 90% specificity for detecting melanoma and nonmelanoma skin cancers, and 74% of all lesions were determined to be manageable by the general practitioner without face-to-face visits by a dermatologist.

After a teledermatology literature review, Fabbrocini, De Vita, Pastore, D'Arco et al. (2011) concluded that teledermatology can aid in the prevention and diagnosis of nonmelanoma and melanoma skin cancer, including while using experts by long distance when they are not available near the patient. The authors concluded that further studies can review cost effectiveness, intrinsic limits, and patient and clinician satisfaction. Overall, patients and physicians were satisfied with the results of teledermatology programs.

3.4 Technology

Technology is one of the most commonly discussed topics in telemedicine. This topic is based on a rationalist division of reasons that telemedicine is used. It is also based on a historical view, because technology transforms and evolves constantly, and on a pragmatic view based on different uses of technology. Falconer (in Wootton, 1999) wrote that technology is the most straightforward part of telemedicine systems. Reliability and trained personnel are important in the area of technology. He wrote that technological requirements include equipment to capture information, transmit information and display information. The nature of the information to be transmitted determines the choice of equipment and telecommunications network. Bandwidth, reliability and quality of service are important.

DeBakey (1995) wrote that telemedicine can enhance and standardize the quality of medical care in the world. Vidmar (1997) wrote about wrote that patient views and optimal hands-on techniques to acquire them were not standardized. This makes it more difficult to train users of telemedicine technology such as medical photographers. Images taken by less fully trained people are of lesser quality and reliability, he wrote, than those that are professionally taken. Quality of care is hindered by low quality photographs, and insufficient clinical history and laboratory data. Image crispness, coloration and lighting technique make a difference. The

camera can lie if the image is under- or over-illumined, has inadequate depth of field, lacks proper focus or does not employ appropriate lighting to define lesional color, topography, and texture. Standardization, Vidmar wrote, is the foundation of interaoperability, comparability of outcomes, and clinical success. He did not find ready available formal training manuals. Standards minimize the time and costs of image acquisition.

Franken, Allen, Budig, and Allen (1995) wrote about the importance of lighting, television equipment and know-how of the providers. Training of those who use telemedicine technology is very important to operate equipment and to have confidence in its operation, which may affect results (Currell, Urquhart, Wainwright and Lewis 2010, Bynum and Irwin 2011). Kvedar, Edwards, Menn, Mofid et al. (1997) and Mahendran, Goodfield, and Sheehan-Dare (2005) wrote that having trained medical photographers take images may yield higher diagnostic accuracy. Mencarelli, Marcolongo and Gasparetto (2008), in a study of telepathology, noted the importance of trained personnel, whether it is handling a microscope or telemedicine tools.

With vendors fragmented and a fair number of privately held companies, compatibility between devices and applications is of primary concern. Wootton and Craig (1999) wrote that technology outpaced the need of health care users, since much of telemedicine technology was an offshoot of business applications. He thinks that health care needs should prompt technology development and telemedicine programs should be built from the bottom up. Cornett, COO of Fused Solutions LLC, a provider of call center and business process outsourcing solutions, wrote that many health care providers are slow to take up new software and hardware, including EHRs. A stable technology infrastructure for interoperability, privacy and security is needed. Regional Extension Centers (REC) help providers implement and learn how to use EHR. Some companies, such as Polycom, provide instructional videos.

According Huston and Huston (2000), evolving digital technologies along with the development and national involvement in the information superhighway provide a potential for telemedicine. They wrote: "Also, there is an explosion of activity and competition among providers today with regard to cost, quality, and access to care on a regional basis." They believe (2000) that "technology certainly has the potential to soothe the growing pains and provide some solutions for the major challenges facing the business of health-care delivery."

Boriani, Diemberger, Martignai, and Biffi, et al. (2007) concluded that technology may race ahead of solutions to legal, privacy, regulatory and organizational issues. Yet technology has the power to mesmerize and telemedicine can be very effective. Evaluation studies such as this one are needed to link what works in telemedicine to needed technology and to the above issues that need to be resolved in a corresponding way. According to Lehoux, Williams-Jones, Hivon et al. (2012), studies have not been done to test the theory of use behind telemedicine, or the rationale and manner in which clinicians are to use it daily.

Whitten (2003) wrote that live video images can be transmitted through analog phone lines, but digital lines such as ISDN, T1 are usually faster and of greater quality. With increased bandwidth, motion handling is improved, decreasing the amount of motion artifacts. The size and resolution of images sent, required turnaround time, and expectations of peak use determine bandwidth requirements.

Kim (2004) wrote that technology is the most critical initiative of telemedicine because the telemedicine depends on the relationship of human-human (physician-patient) and/or human machine interaction through information-based technology. He wrote that
 transmission modes have various options, including ISDN, Tl, ATM, DSL, satellite, microwave, wireless, wireline, Internet, and Intranet among others. The choice affects the program's needs,

availabilities, costs and rapidly changing technology. Improvements in video display affect synchronous telemedicine. According to Kim, they included: the high resolution for dynamic/static variable; stereopsis avoidance; adaptable video communication delay; sickness reduction by long-time use of eyeglasses or head-mounted display; and standardized specifications. In audio display, improvements included: the spatial and qualitative presentation of audio input and the standardized specifications of audio compression and communication for the sound contained in a video conference.

For fast and stable connections, he recommended that the following are important: "signal quality improvement; latency reduction for signal processing high bandwidth requirements; traffic prioritization; encryption; network architecture optimization (scalability, reliability, redundancy); appropriate integration with hospital information systems using electronic patient records, billing, scheduling); increasing of connections for ease and reliability; interface standards; and transmission protocols for next generation communication or Internet (NGC/NGI)." He wrote that the following are needed for high image quality includes: sensory amplification, overlay of digital anatomic and physiologic date, color reliability, and avoidance of image deterioration.

Interoperability is important. Kim (2004) recommended that it can be improved in this way: Use an open system design for general purposes rather than a closed system for specific purposes and introduce the middleware (area between software and network engineering) concept in hardware and software. He wrote that middleware is the glue that renders incompatible standards interoperable.

Vinod Khosla (2012) wrote that patients are mostly informed by advertising and the physician's half-remembered and potentially obsolete lessons from medical school (which full of cognitive biases and other human errors). He continued to write that three physicians can give

you three different diagnoses. The writer maintained that computers are better at organizing and recalling complex information and integrating and balancing considerations of patient symptoms than the average physician. He also wrote that computers make fewer mistakes than human beings. He wrote that technology compensates for human deficiencies and will replace 80% of what physicians do in the future. Physicians will be quicker, more accurate, and more fact-based. He wrote that fewer physicians will be needed and technology will be relied upon more for triage, diagnosis, and decision-making.

Technology will capture more information at a reduced cost. He wrote that technology will not only avoid errors and allow for the study of larger volumes of information but will also increase affordable access to disadvantaged members of the population. Capital equipment will cost less as well. The move will happen in fits and starts and in different pathways with many failures, but also some successes that will power the forward momentum and change the health care system. According to a report from Dallas-based Health IT Market, the telemedicine market in North America will reach $31.3 billion by 2017 (Leventhal 2013). This is an increase of 7.4% per year from $21.9 billion in 2012. Reasons include an increasing demand for clinical information technology, administrative solutions and services.

Factors contributing to the growth of health care information technology are: a growing demand to integrate health care systems; a high rate of return on investment; U.S. government financial support and initiatives (e-Health, health connect, pay-for-performance (P4P) program, e-Health Ontario and Alberta Netcare); a growth in the aging population; a growing demand for computerized physician order entry (CPOE) adoption in order to reduce medication errors; and a rise in incidences of chronic disorders. Disincentives include the high cost of health care IT solutions, such as their maintenance and service costs; interoperability issues; shortage of trained

health care IT professionals; poor standard health care protocols such as HIPAA; insufficient evidence (for some health care practitioners) as to the advantages of certain technologies; and growing incidences of data breaches of patient information, according to the report (WHO 2010 and Zanaboni and Wootton 2012).

3.5 Store-and-Forward and Real-Time Telemedicine

The major two types of telemedicine are store-and-forward or asynchronous and real-time or synchronous telemedicine. Synchronicity refers to timing and technology. Store-and-forward telemedicine utilizes still images in consultation and delivery of patient care. Real-time telemedicine involves video-conferencing. The patient, the physician and sometimes other clinicians, such as a primary care physician or nurse interact together. Their schedules need to work. The physician and patient are separated by space, not time. Equipment is usually more sophisticated and costly than that of store-and-forward consults (Whited 2006). Network design/configuration,Virtual Private Networks, the open Internet, and social networks also need to be considered.

Several studies have been conducted to compare store-and-forward to real-time teledermatology. Kvedar, Edwards, Menn, Mofid et al. (1997) wrote that it is difficult to arrange the schedule of physicians, other health care providers and patients for real-time, and that store-and-forward is usually less expensive. Loane, Bloomer SE, Corbett R, Eedy et al. (2000) conducted a cost-benefit study of store-and-forward and real-time teledermatology and concluded that, although store-and-forward was less expensive than real-time teledermatology, it was less clinically efficient. In real-time teledermatology, the teledermatologist can direct the general practitioner in taking photographs, obtain a fuller medical history and ask questions of the patient. They also concluded that store-and-forward, being more economical, can be used as a triage tool.

However, in store-and-forward teledermatology, the smaller amount of physician-patient interaction limits the dermatologist's ability to obtain clinically useful information to diagnose and manage the patient thoroughly. In addition, more patients, 59% were discharged after real-time consultations versus store-and-forward consultations (31%). Loane wrote that this may be because the physicians using real-time teledermatology were able to more definitively conclude that the patients did not need an office visits consultation. With store-and-forward teledermatology, the image quality was poor or the information on the referral form was inadequate to make a diagnosis and create a plan. There was no gold standard to compare the diagnoses. After the store-and-forward consultation, the dermatologist recommended that 69% of patients required at least one hospital appointment compared with 45% of those patients evaluated by real-time teledermatology. The net societal cost of the initial real-time consultation was 132.10 pounds per patient while the net societal cost of the initial store-and-forward consultation was 26.90 pounds per patient. The real-time consultation took longer. In addition, they found that real-time teledermatology provided more educational opportunities than store and-forward teledermatology.

In 2005, Baba, Seçkin, and Kapdağli conducted a study to compare store-and-forward to real-time teledermatology. The gold standard was the office visits made by one of the two teledermatologists by histopathology, potassium hydroxide testing, Wood's lamp examination, or patch tests. There was no significant difference in interobserver agreement between the two types of consultation. However, combining store-and-forward and real-time, or hybrid technology, was more accurate than using store-and-forward alone. In addition, this combined method increased accuracy from 66% to 87% when poor images were used without versus with the combined model. The accuracy for cases with inadequate clinical information was 77% for office visits and

69% for store-and-forward. The level was 89% for both with adequate clinical information. However, patient satisfaction was higher with real-time teledermatology, and only 18% of patients felt that store-and-forward alone would be adequate for diagnosis.

Massone (2006) wrote that real-time teleconsultations are more time-consuming, especially to set up the participants' schedules, and more expensive than store-and-forward teleconsultations. Kanthraj (2008) wrote that real-time will be most used to diagnose skin cancer in the future. He wrote that real-time teledermatology is not suitable for the diagnosis of inflammatory dermatoses; there is an intrinsic difficulty in this diagnosis, and clinical data must be available. Massone, Soyer, Lozzi, Di Stefani, Leinweber et al. (2007) conducted a study with real-time consultations used in cases of skin cancer. They investigated the feasibility of teleconsultation for pigmented skin lesions using a new generation of cellular phones. Eighteen patients from Pigmented Skin Lesions Clinic of the Department of Dermatology, Medical University of Graz, Graz (Austria) were evaluated by two teledermatologists. This was the first study performing mobile teledermoscopy using cellular phones with an in-built camera. The diagnostic agreement between the physicians was high. Massone concluded that mobile phones can become an easy applicable tool and a new approach for self-monitoring for skin cancer.

After conducting a literature review to assess the past accuracy and reliability of teleophthalmology for diagnosing diabetic retinopathy and macular edema, Whited (2006) wrote that interobserver reliability when using store-and-forward ranged between 41% and 95%. Intraobserver reliability was similar, ranging between 31% to 95%.

While creating a telemedicine taxonomy, Tulu, Chatterjee and Maheshwari (2007) found that store-and-forward technology is preferred for ophthalmology, radiology and pathology, while real-time technology is preferred generally in other areas of telemedicine. In 2009, Heffner, Lyon,

Brousseau, Holland, and Yen studied a teledermatology system for children and wrote that most studies have shown slightly higher interrator agreement rates in real-time versus store-and-forward. They reported an intrarater agreement rate of 82% while they wrote that the past intrarater reported rates were 31% to 88%. Diagnostic accuracy was not affected by the age of the child, the skin tone, previous treatment of the rash, not the duration of symptoms before presentation. Other studies do not show such a high correlation between office visits and teledermatology diagnoses.

Moreno-Ramirez, Ferrandiz, Nieto-Garcia, Carrasco, and Moreno-Alvarez (2007) reviewed results from skin cancer patient teleconsultation in a public hospital in southern Spain with a multicenter, longitudinal, 4-phase, descriptive and evaluation study of almost a year. They concluded that store-and-forward teledermatology in their study was an effective, accurate, reliable, and valid approach for the routine management of patient referrals in skin cancer and pigmented lesion clinics. Patients avoided unnecessary second visits to the physician.

3.6 Health Professional Confidence

High (2000) compared store-and-forward to office visits and said that physicians were less confident using teledermatology than having patients come into the office. Furthermore, the higher the confidence, the more accurate the diagnosis. He wrote that there is less confidence that many dermatologists have using telemedicine than office visits: physicians in office visits were confident 96% of the time, while those using teledermatology were confident only 63% of the time.

Oakley, Reeves, Bennett, and Holmes et al. (2006) reported that specialist confidence was 96% in office visits versus 63% in teledermatology consultations. Physicians using teledermatology were more likely to send patients off for biopsy. This was also found by Cox

(2006). Teledermatologists were also mostly likely to select excision or review for lesions. As may be expected diagnosis was more accurate the more experience a physician had and the better the technology and images (High 2000). Diagnosis was more accurate when images accompanied text. This is to be expected. Teledermatology was useful for triage as a triage tool.

Oakley, Reeves, Bennett, and Holmes et al. (2006) reported 71% accuracy when teledermatologists were given images of benign and malignant skin lesions and text. Having images and newer computer equipment yielded higher accuracy. When the images and text were provided, 53% of teledermatology diagnoses matched the face-to-face diagnosis. When images alone were provided, 57% of diagnoses matched. When text alone was provided, 41% of diagnoses matched. The low diagnostic concordance may have been due to the inexperience of many teledermatologists and the poor quality of images. The teledermatologists were less confident in their diagnoses than face-to-face specialists, especially when they did not have images. The authors concluded that teledermatology may result in an increase in follow-up appointments and surgical procedures.

Waldura, Neff, Dehlendorf and Goldschmidt (2013) measured the confidence of primary care physicians after they could communicate remotely with HIV specialists to take care of their HIV positive patients. The authors found that primary care physician confidence increased after using HIV Warmline and experienced less of a need to refer patients to specialists.

3.7 Physician-Patient Relationship

Several researchers have written about the effects of technology on the patient. Gadow (1985) wrote that the threat of technology is the tendency to dehumanize persons, manifest through a reduction to objects. Pellegrino (1985) wrote that the patient-physician relationship is

composed of three elements: the patient who is ill and needs help, the physician who will take responsibility for assisting with the needs, and the act of medicine.

Certain factors can affect patient comfort and trust. Norton, Lindborg, Delaplain (1993) wrote that, in video consultations, the physician's area should be free of clutter and should resemble their office. They explained that the physician should appear personable. Extra people or clutter should not be in the video. These factors influence the patient's feeling of comfort with the physician and feeling cared-for by the physician.

Lowitt, Kessler, Kauffman, Hooper, et al. (1998) wrote: "We are enthusiastic about the opportunities that telemedicine may provide; however, we urge those who implement telemedicine systems to be respectful of the magnitude of change inherent in altering the traditional relationship between the physician and patient." This theme may come up in content analysis in this study. The researchers conducted a project in the Baltimore Veterans Affairs Medical Center in Baltimore, Maryland comparing live two-way interactive video examinations with in office dermatology care. The patients were equally satisfied with in office and real-time health care while physicians preferred in-person examinations. The physician diagnostic agreement was high between the real-time teledermatology and in-office visits.

Gibbs (2000) investigated how technology affected the intimacy of the physician-patient relationship. He noted that this relationship often consists of the physician acting in a paternalistic way and that time to ask and answer questions on both sides, as well as the sometimes need for touch in a dermatological examination, are compromised with teledermatology, especially store-and-forward teledermatology. He notes that technology can further a process of anonymity that began in society in the Industrial Age and can really be felt in the early part of the 21st Century: People live in small family units, shop in large impersonal malls, and have flimsy relationships,

often only through social media. With managed care, physicians spend less time with their patients. He notes that health technology is useful, but may exacerbate this anonymity. With technology signaling a further move toward evidence-based care, he wrote that patient-based care will suffer more than it has. This, he wrote, is evidenced by more published papers on molecules, and fewer on health service research and epidemiology.

Technology can be used "as a blunt instrument to achieve economic expediency." Individual attention is important and is not often addressed by technology. Some patients are attuned to social circumstances that affect their disease. Care may entail checking in to a facility for days. Conversation and intuition may lead a physician to discover information about the patient. Gibbs believes that technology can decrease the art and intuition involved and often necessary in medicine in favor of a reductionist focus of research. He cited Sams (1998) that the physician is more than a scientist and clinician, he or she is a "caretaker of the patient's person—a professional advisor, guiding the patient through some of life's most difficult journeys. Only the clergy share this responsibility." He wrote why this is especially important in dermatology. There is a stigma of skin diseases. Many patients feel better about themselves when a dermatologist is not afraid to touch their diseased skin. Although dermatologists often save lives, like in the cases of cancer, often the diseases with which they deal are treatable but not curable. This means they must be honest with their patients and there must be continuity of care.

He went on to write that the inability to alter lighting, perform a total skin examination or poor image quality affect examinations. This may be more relevant to store-and-forward teledermatology. He believes that technology can have dehumanizing effects and stifle creative and imaginative thought. Content analysis of results may show if the topic of depersonalization of physician-patient communication is a topic in telemedicine.

Silverman (2003) wrote that technological impact on the physician-patient relationship, and issues of ethics, standardization, medical malpractice, licensure, disciplinary concerns and privacy are important in telemedicine implementation. Regarding the physician-patient relationship, he wrote that most studies have shown both physicians and patients to be satisfied with telemedicine. Besides contact, other problems may involve the development of an adequate medical history, discussion of the benefits and risks of, and alternatives to, available treatments to ensure appropriate informed consent by the patient, and follow-up with the patient.

Turner, Horner, Vankirk, and Myrick et al. (2012) conducted a study in which veterans chose to be evaluated via telemedicine. Fifteen veterans were seen for neuropsychological evaluation and eight chose telemedicine. No significant technical or clinical difficulties were noted, and telemedicine patients were satisfied with telemedicine. They concluded that neuropsychological evaluation via telemedicine is feasible and appears comparable to in-person evaluation.

Khosla (2012) wrote about patient-physician intimacy and telemedicine: Although technology will replace many physician tasks in the future, humans are better at intimacy. He wrote that a medical degree is not needed, and nurses and other health professionals can provide the human communication that patients need. Dorsey, Venkataraman, Grana, and Bull et al. (2013), in a randomized clinical trial evaluating video conferencing for 20 participants with

Parkinson's disease, showed that real-time videoconferencing for Parkinson's patients at home resulted in the same quality of care as in-person care that had been randomly assigned. Some patients were dissatisfied with telemedicine, feeling that the connection with the physician was not intimate enough.

If telemedicine overrides problems in health care such as no access to health care or high cost, and leads to people getting care they would not have otherwise had, its benefits outweigh its cons. Health care practitioners that use telemedicine can be trained to have intimacy with and show care for the patient. In addition, communication office visits can also be impersonal, with some physicians having to see a growing number of patients because of health insurance reasons, and spending less quality time patients.

3.8 Physician Satisfaction

Bratton (2001) monitored 20 patients and 12 residents in family medicine who participated in the eight-week study. At the end of the study, the patients and doctors completed a satisfaction Most patients were satisfied with the system. Eleven physician responses were obtained and showed that they were more uncertain about the benefits of telemedicine: only 45% felt that telemedicine could adequately assess patients, but 82% felt that telemedicine would be an important part of primary-care services.

Collins (2004) conducted a study to find physicians' satisfaction with a particular teledermatology program. The physicians saw patients both in regular office visits and in store-and-forward consultations. Improvements with telemedicine were: a shorter outpatient waiting list, improved access to specialist opinion. For urgent patients, simplification of software system, faster connections, and a less complicated procedure process were observed. Limitations include that physicians that took part in the study may be more accepting of telemedicine, and the ones who responded to the survey may favor telemedicine more than those who did not respond. Before the trial, most thought that teledermatology would result in quicker diagnosis and treatment, decreased referral rates and improved medical education and training. After the trial, however, most physicians were dissatisfied with teledermatology: Only 21% of the GPs felt their

initial expectations were met; 47% of GPs said they were dissatisfied; and only 23% said they would consider using teledermatology again.

3.9 Patient Satisfaction

Patient satisfaction in studies usually has been found to be high (McGowan 2008; Silverman 2003; May 2000; Whitten 2000). Kvedar, Edwards, Menn, Mofid et al. in 1997 wrote that more studies are needed on patient satisfaction with teledermatology. Many teledermatology studies, such as the study of Oakley, Astwood, Loane, and Duffill et al. in 1997, showed an overall satisfaction by patients with teledermatology. Lowitt, Kessler, Kauffman, Hooper et al. (1998), in a real-time teledermatology study involving 139 patients, reported a high rate of patient satisfaction. Harrison, Clayton and Wallace (1998) reported that patients were very satisfied with store-and-forward teledermatology in their study: 78% preferred teledermatology to office visits because of the savings in time and the more efficient service. A total of 85% of patients were satisfied with the store-and-forward service, 96% would attend the service again.

Nesbitt and Siefkin (2000) reviewed 1,000 telemedicine videoconferencing consultations in 19 different specialty areas. The patients voluntarily chose to use telemedicine over office visits. The patient and physician satisfaction rate was high. The authors wrote that more studies are needed to show why some payers, patients, and providers resist telemedicine. Whitten and Mair (2000) conducted a systematic review of patient satisfaction. They concluded that most of telemedicine patient satisfaction research lacks a consistent methodological approach. As a result, it is difficult to conclude whether patients and providers are satisfied with telemedicine. They claimed that patient satisfaction research should focus on specific questions of interest rather than generic satisfaction research so that results yield more useful information rather than generalize across all types of telemedicine programs.

Weinstock, Nguyen and Risica (2002) found that most patients were satisfied with a store-and-forward program they developed. About 42% of patients said it was excellent, while 37% rated it as fair/poor, and 18% as average. They had difficulty rating satisfaction with the dermatologic evaluation because they received feedback from the program, not the physician. They were primarily concerned with waiting time and follow-up. They were concerned with lack of direct contact with a dermatologist more than they were concerned about privacy. Most (75%) would recommend it to others. A total of 58% of patients would not have been willing to travel to Boston for care. Most patients trusted the accuracy, but would have liked more of a relationship with the physician, which they said would have granted them more peace of mind. They liked the quickness of evaluation. Most waited months to schedule a teledermatology appointment at the clinic, and weeks to receive evaluation. If the schedule of the teledermatology clinic changed, it would take longer to reschedule. Patients complained of inconsistencies in receiving follow-up evaluations when needed. They often want written evaluations from physicians, rather than a relayed message from the teledermatology clinic. The providers were more satisfied than the patients: 63% of them rated the clinic as excellent or good, 21% of them thought it was average, 16% fair, and none thought it was poor. A total of 74% of them rated the host site evaluations as excellent and 60% said the treatment did an excellent or good job of treating the patients. Those who would recommend it to colleagues were 74%. Providers said the patient backlog was too great, follow-up of teledermatology clinic providers was inconsistent, and would have wanted more follow-up interview questions to be directed to them, rather than primary care physicians.

Usually, patient satisfaction is high with telemedicine (Heinzelmann, Williams, Lugn and Kvedar 2005), although people prefer office visits. Most studies have been in diagnosis and patient satisfaction and fewer have focused on telemedicine's effects on clinical management or

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patient-oriented clinical outcomes. They wrote: "Among clinic/hospital-based applications, the fields of dermatology, cardiology (i.e., echocardiography), and intensive care and emergency care/trauma have relatively stronger evidence for their benefit when compared with other areas." He cited dermatology as one of the areas where patient satisfaction has been well-documented. He wrote there may be no optimal evaluation design for a study, but methodological rigor should be balanced with the practicalities of clinical workflow, resource availability, and legal/ethical requirements. They (2005) wrote: "Among specialties with both diagnostic and clinical management functions, dermatology appears to have the most evidence of diagnostic accuracy, but like pathology, further research examining live, interactive applications would be beneficial, as would studies comparing live, interactive applications with store-and-forward applications."

Demiris, Speedie and Finkelsein (2000) created a 20-item questionnaire to assess 32 patients' impressions of the risks and benefits of home telecare. They concluded that patients had an overall positive attitude towards home telecare and agreed it could improve their health. They were concerned with trusting the technology.

Demiris (2003) conducted a literature review to assess patient acceptance of and satisfaction with teledermatology. They evaluated 14 studies and concluded that different evaluation tools are needed for store-and-forward and real-time consultations. In real-time cases, patient perception of communication and relationship to the provider and the implication for quality of care need to be investigated, while in store-and-forward cases, patients' perceptions of lack of communication. He wrote about the 2002 Weinstock study where patients were concerned with lack of provider-patient contact. He wrote about the 2001 Williams study where patients expressed embarrassment to pose for photographs and image transmission (14%). Seventeen percent of patients did not like not being able to say all they wanted to say.

Demiris proposed that the following need to be addressed when reviewing patient satisfaction with teledermatology:

- Convenience with the mode of care delivery

- Confidence in accuracy of diagnosis

- Confidence in remote physician

- Ability to express concerns and answer questions

- Lack of physical contact

- Comparison to office visits

- Sometimes having to move equipment like cameras

- Thoroughness of examination

- Preference of type of consultation

- Privacy and confidentiality

- Future use

- Other possible benefits

- Other possible risks

Bowns, Collins, Walters, McDonagh (2006) conducted a randomized controlled trial in the United Kingdom involving 208 dermatology patients. They used quantitative and qualitative methods to explore patients' satisfaction. Patients were randomized into two groups who received a specialist dermatological opinion through a traditional outpatient consultation (the control group) or an asynchronous teleconsultation. Both groups of patients first saw their general practitioner. The main evaluation was carried out by the Patient Questionnaire III, which formed the main part the survey, with general items on the instrument rated on a five-point

Likert scale, ranging from "strongly agree" to "strongly disagree." After completing the survey, 61% of the telemedicine group, n=49, and 59% of the control group agreed to interviews. They received 148 replies from 208 distributed questionnaires (71% response rate). Responders included 80 of the 111 telemedicine patients (72%) and 68 of the 97 control patients (70%). Levels of patient satisfaction were high in both groups: Ninety per cent of patients in the control group were satisfied with their overall care, compared with 81% in the telemedicine group. In addition, 87% of patients in the control group were satisfied with overall management, and 84% in the telemedicine group felt the same. Follow-up interviews were conducted with 30 of the participants. Patients were generally positive about their care and management, regardless of group, age or gender. The authors found that important concerns for patients receiving office and telemedicine care were: receiving a diagnosis, treatment and cure, receiving adequate information and explanations, and a short waiting time. Interhuman relationship concerns were the need to be taken seriously and the need for individualized personal care.

Patients who said that they were confident in receiving traditional care had the perception of having received a thorough consultation; an examination by the general practitioner or consultant, a consultation with a general practitioner or dermatologist in the office and having adequate explanations and information with a subsequent improvement in their skin problem, trust in the general practitioner and having the same diagnosis form the general practitioner and dermatologist.

Baba, Seçkin, and Kapdağli (2005) showed that patients were more satisfied with real-time than with store-and-forward teledermatology. A total of 85% of patients said they would accept teledermatology in the future, with 18% saying that the conventional store-and-forward method was sufficient for proper management of their skin problems, whereas 82% thought that

teleconsultation should include videoconferencing. Another 11% of patients said they would prefer office visits and 4% were undecided. In his literature review of teledermatology, Whited (2006) wrote that, in most studies, both physicians and patients are satisfied.

After conducting a literature review on teledermatology, Fabbrocini, De Vita, Pastore, D'Arco, et al. (2011) wrote that patients are usually satisfied with teledermatology, especially when no specialist is available. In a study by George, Hamilton, and Baker (2012) to examine perceptions about telemedicine among urban underserved minority populations, African-Americans (43) expressed more concern over privacy, confidentiality and absence of the specialist than Latin Americans (44) did. African-Americans preferred the presence of a physician while Latin Americans trusted the precision of the computer. Both groups liked the advantages of telemedicine, which included reduced waiting time, immediate feedback, increased access to specialists, and increased access to multiple medical opinions. African

American participants believed that telemedicine would be especially advantageous for children and the elderly. Latin participants pointed to more advantages of telemedicine such as more choice over which physician is treating them and that telemedicine would result in more jobs for nurses. Latin Americans trusted the physician more to keep their information confidential, especially if the patient asks for the confidentiality. African-American participants were more concerned that one's identity could be stolen and that one's pictures would be floating around on the Internet, which they perceived as insecure and for anybody and that the telemedicine physician was not as experienced as the office visit physician. For Latin Americans, the quality and qualifications of the physicians was determined by the success of the treatment whether it was telemedicine or office based. The authors wrote that his difference may reflect lower levels of trust in new health care innovations among African Americans because of past

abuses in the US. medical system. In general, the participants associated the presence of the specialist to their satisfaction, level of assurance that appropriate information was conveyed, and ability to accurately gauge the reactions of the specialist and monitor their activities. They thought that physician presence for sight and touch were important. Limitations of the study included small sample size and that participants only knew about telemedicine what was shown to them in a video before the study and their experience during the study, and did not know about other telemedicine applications.

Poulsen, Millen, Lakshman, Buttner, and Roberts (2014) handed out and evaluated the answers to questionnaires for rheumatology patients. Answers to patient satisfaction questions for face-to-face and telemedicine patients with rheumatology did not differ significantly.

Gibson, Lightbody, McGlaughlin, McAdam et al. (2015) conducted 24 interviews with 29 participants (16 patients; 13 caregivers) who were present at telestroke consultations.

Telemedicine was well accepted by many participants, but its use added a layer of complexity to the teleconsultation. The authors wrote that this can be ameliorated by clear information for patients and caregivers, and staff interpersonal skills and teamworking.

3.10 Summary

Many telemedicine studies, show that telemedicine care is equal to or at times more effective than traditional care. More comprehensive studies, including randomized clinical trial, are needed. Technology is an important topic in telemedicine. Interoperability, standardization and employee training are important. Sometimes, the technology precedes the need, as with the iPhone. Technology is a necessity for telemedicine and often brings costs down for the provider and patient, even if it is initially costly.

Both store-and-forward and real-time telemedicine have been found to be effective. Real-time telemedicine is appropriate when the physician needs to talk to the patient or another health care professional and observe real-time symptoms. Store-and-forward telemedicine may be more appropriate in certain areas of telemedicine, such as teleradiology. When the physician needs to communicate with the patient, such as to ask questions, or with another physician or nurse, or when another health professional needs to palpate or otherwise examine the patient and communicate in real-time with the telemedicine physician, real-time telemedicine is more appropriate than store-and-forward telemedicine. Professional confidence makes a difference in accurate diagnosis. Several studies show that both physicians and patients are satisfied with telemedicine. Problems in the patient-physician relationship include a reduction in the level of relationship intimacy and inability to palpate skin. Some physicians are wary of telemedicine if they cannot be present to monitor patients. This may just be a matter of getting used to new systems and being confident. In general, patient satisfaction with telemedicine has been high. This may vary by patient age and ethnic background. Patients tend to like the convenience of telemedicine. Some do not like the depersonalization of telemedicine or may be afraid their medical information is not secure online.

Chapter 4

Organization Management and Implementation

Organization management and implementation are views based on the pragmatic view of goals of implementing telemedicine systems and subsequent changes in organization, and a historical view once these changes take place. The views can also be historical if the focus is on organizational changes, and empirical when statistics are considered.

Several factors are important when considering the implementation of telemedicine programs. These include privacy and security of information, especially patient information; policies in health care centers and in the form of laws; licensure; health insurance; costs to stakeholders and costs to patients.

4.1 Organization Management

Organization management includes coordinating: personnel such as physicians, nurses and technology experts; storing, saving and setting up retrieval systems for medical information; and setting up hierarchies in management and in systems to store-and-retrieve data; methods and avenues of communication with people on- and off-site. The field of organizational communication involves: one-on-one communication among peers, superiors and subordinates; small group communication such as meetings; interdepartmental communication; communication between an organization and its environment such as campaigns; and intra-organizational communication. Incorporating telemedicine means incorporating changes in structure of human resources, hierarchy of employees, technology, office and telemedicine appointment schedules and having employees trained, which may be disruptive or take time.

Classic science theory views communication as transmitting information and images, while the emergence of humanism introduced the study of human dynamics to this process

(Taylor 1947). Thinking evolved to suggest that communication is an independent and dynamic force, not controlled or passive. Communication and collaboration are necessities for organization management. Franken, Allen, Budig, and Allen (1995) wrote that scheduling a real-time appointment was a nightmare because it involved coordinating available times between patients, providers and facilities. Telemedicine involves the transfer of diagnostic, treatment, scan, demographic and appointment information.

Whitten and Allen (1995) conducted a study of the University of Kansas Telemedicine Program to identify organizational and communication elements that may hinder telemedicine program effectiveness. The analysis, which used observation, interviews and surveys, focused on the organizational communication regarding formal structures (leaders) and informal structures (influence), boundaries, definitions, goals, leadership, decision-making, membership and roles. They found significant organizational communication deficits such as: a dearth of perceived central leadership; lack of information on technology itself; poorly designed and cumbersome means for scheduling and utilizing technology; absence of specific goals; and poor communication in introducing technology to medical personnel.

Whitten and Allen (1995) found that many program participants did not know about the overarching structure of the telemedicine program, such as the boundaries of the program, especially because there were few physical boundaries. They knew about the program's purpose to provide access to those in rural areas of the state, but they did not know about specific organizational goals. This was true even though 80% (39/49) of those who answered the survey agreed they'd want to use telemedicine more. A surprising 85% (31/36) of respondents had no idea who was in charge of telemedicine. Just more than 50% of decisions concerned medical treatment and diagnosis, and just under 50% were about organizational issues like scheduling. A

little more than 40% (21/49) of respondents agreed or strongly agreed that all personnel were involved somewhat with decision-making. Only 5% (2/499) of respondents agreed that the primary care physician made most decisions. About 70% (34/49) respondents wanted more feedback about their performance. About 80% (40/49) of respondents agreed that traditional office visits and telemedicine were very much alike except for the palpation part. They found that telemedicine services would benefit most from: the redefinition of roles and responsibilities of certain personnel; increasing the efficiency and decreasing complexity of consultation scheduling; and clarifying and formalizing leadership and decision-making.

Jennett, Jackson, Ho, Healy, et al. (2005) in Canada identified four categories of readiness in an organizational setting: core readiness, engagement, structural readiness, and nonreadiness. The following questions were used in telephone interviews: "1. What factors do key informants believe contribute to a successful service? 2. How do these relate to readiness (the degree to which an organization is ready to participate and succeed in telehealth)? 3. How do various organizations react to the prospect of telehealth? 4. What does this tell us about readiness from the perspective of various organizations?" Core readiness refers to the realization of needs and dissatisfaction with the status quo. Some communities, such as rural ones, have a great need for a different type of health service and that are not satisfied with the status quo. Engagement involves the active participation, involving a range from early adopter innovators to blatant resistors. Innovators were helpful in the diffusion of innovation to others and provided an example through experimentation and demonstration. This often involved the perception of cost benefit analysis. Often, telemedicine allows an organization to save in the longer term by earlier intervention, better education and prevention, lower staff turnover, and better staff retention, but in the short term it may save no money or cost money. Organization members may need to change their

attitude to an emphasis of long-term benefits. Structural readiness, or the establishment of efficient structures as a foundation for successful telehealth projects, such as human, technical, training, policy, and funding, within an organization. The authors wrote that training needs to be constant. Another category was codified strategy physician reimbursement, liability, cross-jurisdiction, and issues of privacy to build the structural readiness of organizations in the adoption of telehealth. Funding for implementing and maintaining a telemedicine program was also important and included funds for staff, a telehealth coordinator, technical support and resources, telecommunications connections, and a management fund. The appropriate technology is also needed. Nonreadiness includes perceived risks and proposed solutions. The authors wrote that organizations need to challenge obstacles of risk assessment by changing their views of success and by promoting education and awareness through innovators and pioneers. Changing success perception included: lengthening timelines to a long-term investment, allowing enough time for results to appear, and placing less emphasis on cost-benefit analyses by recognizing utilization alone as success.

Weinstein, Lopez, Krupinksi, Benar et al. (2008) wrote about the obstacles in organizing different players to implement a telemedicine program. They wrote that, while single service programs, such as teleradiology and telepsychiatry programs, are common, few organizations have developed multi-specialty telemedicine programs. A first problem may be that few organizations have a critical mass of individuals with the skill sets required to organize and manage a telemedicine program, including a management team. A shared vision among the participants may be needed. It may be a hard, time-consuming process to reach a consensus on the initial program goals, priorities, strategies, and implementation plans. Appropriate business models and staff hiring must take place. After implementation, ongoing assessments are needed.

4.2 Implementation

Many physicians have embraced telemedicine, but others are hesitating for several reasons: dislike or apprehension to learn and install technology; costs or perceived costs of implementing systems; learning the systems and teaching staff, billing; and legal and insurance reasons. This study may increase the knowledge base of telemedicine needed for appropriate government, insurance, and legal policies. As early as 1995, Bashshur wrote that experience and familiarity increased client and provider acceptance of telemedicine. (Bashshur 1995[1]). In 1995, Sanders and Bashshur wrote that the following were the key hurdles to telemedicine implementation: 1. interstate licensing and physician credentialing; 2. legal liability and litigation; 3. patient autonomy and privacy; 4. knowledge about telemedicine; and 5. system design and infrastructure. They found that, prior to about 1975, there was a period of quiescence for telemedicine until it started getting subsidized again. For example, the Departments of Health and Human Services, Commerce, Agriculture, and Defense started to become strong supporters. State legislatures, private companies and universities also increased funding to make a difference in accessibility, and cost in health care.

Wakefield, Kienzle, Zollo, Kash, et al. (1997) found that, among the Iowa CEOs of acute care hospitals, cost was the biggest concern for implementation, namely the following: reimbursement, costs of hooking up, initial costs, ongoing costs, and costs of maintaining. Other concerns were patient acceptance, reliance on telemedicine providers, and attitudes of medical staff, employees and board.

Hjelm (in Wootton 1999) wrote that implementation is sometimes slow because of: a sometime lack of evidence of effectiveness of specific telemedicine applications; a perceived

threat to the role of health care workers; a fear that telemedicine will increase the current workload of health care workers; and fear of technological obsolescence and cost.

Miller (2001) wrote that adoption has been slow due to: lack of third-party reimbursement; inadequate telecommunications networks; lack of state policy standards; insufficient privacy and security standards; and lack of gold standards.

Silverman (2003) wrote that the absence of consensus impedes standardization and moving telemedicine into mainstream status. Regarding malpractice, he wrote that few lawsuits had been filed about telemedicine not being up to standard of office visits. What hinders telemedicine is that most states and European nations require licensure of physicians from the state in the which the patient lives. If a physician works from his or her hospital to oversee patients in one hospital in one other state or nation, this may work. But when there are many patients in many states or nations, it can be costly and difficult. Violations that district attorneys claim include specific violations, such as violations of prescribing rules, state telemedicine licensure provisions (when available), fraud, or breach of customs laws. When it comes to international telemedicine practice, each nation has different laws that govern what physicians do, outside of Federal law.

Kim (2004) added to the knowledge base of telemedicine implementation, writing that, in spite of over a decade of experience, decreasing technology costs, and increasing technology capabilities, telemedicine is restricted, rather than widely deployed. He wrote that what are needed now are partnerships and clinically meaningful networks, and a single, universal, secure, electronic medical record. They indicated that new management and organization structures may be necessary. The two greatest barriers may be training and the role of providers as gatekeepers to telemedicine access.

Pak (2005) wrote that the following is needed for implementation: 1. understanding how the organization delivers care; 2. analyzing alternatives when it comes to care and cost; 3. obtaining organizational support; 4. creating an execution plan; and 5. training staff and monitoring the process. Thrall (2005) wrote about teleradiology at Massachusetts General Hospital. Teleradiology reduced the required examinations, telephone calls and faxes needed for patient care. He wrote that teleradiology systems must be capable of extracting valuable information from other information. He identified a catch-22: Organizations need to invest in technical infrastructure and human resources to realize benefits. However, if benefits are not realized, investment will not occur. Although much investment has taken place in telemedicine, more is needed.

Broens, Veld, Vollenbroek-Hutten, et al. (2007) reviewed 45 conference papers for what determines implementation and found the following factors: technology, acceptance, financing, organization, policy and legislation. They quoted Berg (1999) in that more than 75% of telemedicine initiatives fail during the operational phase. For acceptance of telemedicine programs, feelings of ownership, enjoyment, self-efficacy, the ability to communicate and to ideally personalize this information were important.

Two years later, Hanson, Calhoun and Smith (2009) conducted a longitudinal study of pre- and post-telemedicine encounters on the attitudes of health care providers who had used telemedicine previously to those experiencing it for the first time. User physicians were given three choices after being asked their thought on the impact of telemedicine: 1. decline; 2. stay the same; 3. improve. They were placed into the groups: 1. shift toward improve; 2. no change; and 3. shift toward decline. First time users were no more likely to shift their attitudes more than ones who had used the system already. First-time user shifts were more likely to be toward improve

than those who had used telemedicine before the study. It was crucial than the technology performed well. One possibility is that the higher expectations after an initial good use may have been disappointed upon subsequent uses. They concluded that first impressions matter a lot on the continued use of telemedicine. Therefore, more evaluation studies need to be done to 1. engender confidence in new users and 2. ensure that telemedicine systems are efficient.

Schwamm, Audebert, and Amarenco, Chumbler et al. (2009) listed the following as issues in telemedicine implementation:

- defining the types of specialties;
- addressing licensure and liability;
- developing acceptable policies for the privacy and confidentiality of information exchange;
- simplifying the process of requesting and delivering telemedicine consultations while improving the training and education of end users;
- developing financial models for reimbursement; and
- gaining acceptance by patients, providers, and payers.

Légaré, Vincent, Lehoux, and Anderson et al. in 2010 conducted a literature review on telemedicine readiness assessment tools. Stakeholders and factors to be targeted were identified. Six questionnaires on readiness were identified. Only one could be applied to different types of telemedicine but it had limited psychometric evaluation. The two that had good psychometric evaluations were specific to particular telehealth projects and groups of stakeholders. They developed and validated a version of the practitioner and organizational telehealth readiness assessment tool.

Lilly, Cody, Zhao, Landry at al. (2011) reviewed the implementation of a tele-ICU intervention in an academic medical center, the University of Massachusetts Memorial Critical Care Operations Group, and concluded that the telemedicine program was associated with reduced adjusted odds of mortality and reduced hospital length of stay, changes in best practice adherence and lower rates of preventable complications. Only part of these associations were attributed to following best practice guidelines and lower rates of preventable complications, suggesting benefits of tele-ICU beyond daytime physician staffing and traditional approaches. The tele-ICU group experienced significantly higher adherence to deep vein thrombosis prevention best practice and cardiovascular protection best practice. It also had lower rates of catheter-related bloodstream infection and ventilator-associated pneumonia, and these factors were associated with lower tele-ICU and hospital mortality. Tele-ICU intensivist involvement was associated with the use of noninvasive ventilation and the lower use of conventional mechanical ventilation. The authors speculate that collaboration between bedside physicians and tele-ICU physicians is important. Limitations included that the study took place in one academic center and was not a prospective, randomized, and blinded trial. Lower length of stay was not related to shifting patients to the chronic care system. Patients in the tele-ICU group had lower rates of complications, recovered faster and were significantly more likely to be discharged. The teleICU program was associated with patient-centered outcomes, strong executive support and targeting changes that were known to improve outcomes. It included robust participation of critical care disciplines in planning and implementation phases and a process that empowered local leaders to define critical best practices.

Zanni (2011) wrote that telemedicine is still evolving, and major obstacles to implementation include licensure, reimbursement issues, and development of telemedicine care

standards. Many telemedicine implementation issues have remained the same throughout the years. Zanaboni and Wootton (2012) wrote that telemedicine has stalled. They claimed that teleradiology is the only telemedicine application that has reached full adoption. According to Rogers (1983), adoption is the decision to make full use of an innovation as the best course of action for the future. Adoption precedes implementation. If users are not satisfied in the adoption stage, they will not implement the technology. Teleradiology has been shown to provide acceptable diagnostic accuracy in remote reporting and to produce cost savings. Reports have shown that teleradiology yields benefits for physicians and hospital administrators and patients because of avoided travel and rapidity of reporting. In addition, health care payers have set specific reimbursements for teleradiology.

According to the Diffusion of Innovation theory, people adopt new ideas according to: a. the perception of advantages; b. the compatibility with past experiences and existing values; c. the complexity of the innovation; d. how much they can observe the benefits; and e. the trialability of the innovation. One crucial determinant of implementation, Zanaboni and Wootton wrote, is that users see the advantages of telemedicine. Evidence of cost-effectiveness is necessary as well, but not sufficient for widespread adoption. Personal incentives for health professionals are needed. They claimed that data about telemedicine adoption should be collected to test this assumption. Professional and financial incentives for potential telemedicine users should be identified through research. The adoption of telemedicine, according to Zabadoni and Wootton, has a patchy history with "a slow, fragmented uptake.

The authors reviewed the findings by Walker and Whetton (2002) about technology adoption: The rate of adoption of technologies is determined by these characteristics of the technology: 1. relative advantage; 2. compatibility; 3. trialability; 4. observability; and 5.

complexity. Relative advantage, the most important factor, refers to the degree the technology is perceived to be better than other available technologies. Governments or hospitals can make technology available, but unless health care professionals see the advantages, the technology will not be implemented, as opposed to use in a number of cases. In addition, different health care professionals may have different perspectives; those in remote sites tend to view telemedicine as more advantageous than those in hub sites. Considering the training and organizational changes that go along with using telemedicine technologies, health care professionals must see the advantage in telemedicine. Financial incentives may help in telemedicine implementation. They may take the form of direct payments to health professionals such as fee-for-service (e.g. fee-for service) or indirect payments such as income to spend on clinical activities. Professional incentives include congeniality of work, career progression, clinical profile and public recognition.

Mahadevan, Muralidhar, and Shetty (2012) reviewed a telemedicine medical school program of classes in India. Analysis included satisfaction of student, infrastructure difficulties (if any) and overall outcome of the program. The authors wrote that a commitment is needed by all sides, such as patient and physician, generalist and specialist, two collaborating medical centers, etc. for a telemedicine program to work. Venture capitalist Khosla (2012) wrote that innovation will most likely not come from the physician community. Many establishments do not want to see change. He wrote, for instance, that pharmaceutical companies do no push cheaper, genetic drugs. He wrote that entrepreneurs, among other forward thinkers, will lead the way.

4.3 Privacy

Privacy is based on a rationalist view, an important topic of telemedicine and a historical view when it comes to different laws and technology that affect privacy. As early as 1993,

Norton, Lindborg, Delaplain wrote that the physician-patient relationship has changed with video consultation. The same rules of privacy apply and the physician is still responsible to keep patient information confidential, but he or she cannot guarantee it. Technical staff at both ends of transmission may see confidential information, even if they are not interested. Technical staff may view images or videos. A patient can choose to not have any sensitive body areas viewed. However, this may at times be necessary. In addition, the physician cannot control what happens to images and videos when he or she is not present during transmission. Transmission is not always secure. Others, wanting to or not, can gain access. They indicated that others should not intrude or disrupt the consultation. They claimed that patients should provide an informed consent notice and that the patient should be notified if another health professional will view the videos. Laws about this vary from state to state.

In 2004, Melenhorst, Fisk, Mynatt, and Rogers conducted structured interviews to find out older adults' (aged 65 to 75 years of age) reviews on telemonitoring. The results show three domains of potential home telemonitoring intrusion (2004): physical obtrusiveness, invasion of privacy, and security risk. The authors defined the terms in this way: *Physical Obtrusion*: "Obtrusiveness in terms of physical presence of the device related to its function and/or location in the home: visual appearance, size, and weight."

Privacy Invasion: "The possibility to invade one's privacy, defined as an undesirable disclosure of private or personal information, although not necessarily leading to misuse as described under 'security'."

Security Risk: "The possibility of intruding the technological system or intruding the home via the system, and doing harm or misusing the information (e.g., hackers/ burglars/ people with bad intensions)." Although physical intrusiveness would often involve a person such as a visiting

nurse, it may also involve a robot such as the Facebook or other type of technology that would change physical aspects of the home such as blinds placement or temperature. Technology intrusiveness accounted for almost half of the negative judgments. The authors concluded that patients carefully weighed potential intrusiveness against benefits such as a greater independence that some technologies could give. The authors conducted a content analysis of the interviews and found that many opinions of intrusiveness were conditional, based on what loss of privacy or intrusiveness or potential loss of privacy or intrusiveness the patients felt. Intrusion was a factor in about 19% of responses.

Wilkowska and Ziefle (2012) wrote about privacy in e-Health: "Privacy in the context of using e-Health assistance comprised requirements of confidentiality, anonymity, intimacy and, not least, invisibility to outsiders." Wilkowska and Ziefle (2012) used a survey and focus groups to learn about patients' attitudes to medical information used in telemonitoring and technology. They found that privacy and security are important to patients, especially to women and healthy adults compared to men and the elderly. Healthy adults wanted a relatively high degree of confidentiality, anonymity and intimacy. Data protection, non-stigmatizing design and confidentiality of measured results were more important to younger women than to older women.

In fact, older women and men attached the same importance to privacy and security of data. They explained that technology can help care for the "constantly growing number of chronically diseased persons, older people, or persons with frail health" (2012). They wrote that technology must be accepted for it to gain mainstream use, and that an utmost concern of patients is the privacy and security of their medical information. They concluded that perceived data security and privacy issues mediate the acceptance of medical technology, and that perspectives vary among groups.

4.4 Security

Most journal articles on security were based on a rationalist view of an important aspect of telemedicine and a historical view when considering changing laws and technology that affect security. According to the National Telecommunications and Information Administration (NTIA; the Executive Branch agency principally responsible for advising the President on telecommunications and information policy issues), there are security problems unique to telemedicine, such as the threat of hackers accessing personal medical records. The challenge for telemedicine policy makers lies in identifying emerging concerns that are unique to telemedicine such as the lack of privacy and security standards. Privacy and security are intertwined. The NTIA defines security as "all the safeguards in a computer-based information system that protect the system and the information contained within it from unauthorized access and misuse or accidents leading to damage."

Rules of the 1996 Health Insurance Portability and Accountability Act (HIPAA) apply to telemedicine. Telemedicine clinicians have the same duty to safeguard a patient's medical records and treatments. Storage of electronic files, images, and audio/video tapes needs to be done with the same care given to paper documents. Employees must be available to do this. Trained professionals must set up and maintain systems that are safe from hackers. Online communication lends itself to hackers and other potential exposure. Protocols must be followed to ensure that patients are informed about all participants in a telemedicine consultation. Legal, technical and administrative security measures and patient education can be used to ensure patients that third unwanted parties do not have access to their information.

Klein and Manning (1995) wrote that EMRs in telemedicine need to be shared across state lines. It is not clear who will have access to extract relevant network information, who is the

ultimate custodian of the medical record and who is responsible to ensure the patient's privacy. Not enough federal legislation exists to regulate the confidentiality and privacy of data passing between states. According to the NTIA, federal protection of privacy is even more limited than state protection because no explicit right to privacy is guaranteed under the Constitution. Privacy protection is derived from case law. Legal protections for health information generally come from the states. About a dozen states have comprehensive health care information confidentiality statutes. Montana and Washington passed the Uniform Health Care Information Act of the National Conference of Commissioners on Uniform State Laws (NCCUSL) in 1985. Many state statutes give special protection to specific classes of health information, such as HIV infection and AIDS patient information. There is lack of standardization of laws. In addition, the patient may not know of technicians and others who have or will have access to their health data. At times, the health professional may not know that either.

4.5 Policy

This division is based on a historical view, since policy changes according to bills and laws and other changing regulations. It is also a rationalist division based on a logical category of importance in telemedicine. Bashshur (1995[2]) wrote that a healthy policy and regulation are vital for the healthy functioning of telemedicine, and that the actions, and in some instances the inactions, taken by federal and state agencies, and private organizations will have far-reaching effects. Physicians and other health care professionals would be more likely to adopt telemedicine if they are clear when and where they can practice and if insurance covers telemedicine.

Bashshur wrote that policymaking required a green or red light, but scientific research often yield equivocal results that must be tested again. In spite of shortcomings, like the hesitation of many to use telemedicine, telemedicine has passed the point of no return. He points out that

even the stethoscope was initially met with much rejection and that Ignaz Semmelweiss, a Hungarian obstetrician, died bitter, after his suggestion that obstetricians wash their hands before delivering babies and after working on cadavers was never accepted during his lifetime

Bashshur wrote that telemedicine systems should include these steps: a formal triage system to direct clients to services; a code of ethics, including practice guidelines; quality assurance mechanisms like criteria and standards; standardized recruitment, training and certification.

Gellman (1995) wrote that there is not enough regulation regarding situations such as a physician or other health care provider residing in one state, treating in another state, sending telemedicine information for review by another physician in yet another state, and receiving payment from an insurance company in yet another state. In 1995, Steve Downs summed up the state and federal telecommunication regulations and policy issues. He wrote that new regulations that would contribute to the diffusion of telemedicine were needed. Policies involved include those of the U.S. Food and Drug Administration (USDA), to provide approvals for new medical devices, and state and federal regulatory agencies involved in the licensing of medical professionals. Regulations can restrict the orderly development and deployment of telemedicine, and others may promote the development. There was disparity in the rate structure, and often high transmission charges. Often, telemedicine programs did not have compatible technology that allowed them to connect. Standardization of design specifications was needed for the interactive dissemination of information.

His policy recommendations were: 1. to extend national telecommunications legislation to eliminate barriers to the orderly deployment of telemedicine by empowering market incentives for broad and enhanced program and, when necessary, preempting state and local oversight of

telecommunication regulations; to support initiatives to reduce disparities in the rate structure between urban and rural areas when it comes to telemedicine access; to encourage the development of linkages with policy initiatives; to develop clinical practice standards and telecommunications requirements for effective clinical care in telemedicine initiatives; to reduce disparities in the rate structure between urban and rural areas when it comes to telemedicine access; to encourage the development of linkages with policy initiatives; to develop clinical practice standards and telecommunications requirements for effective clinical care in telemedicine; to enhance the ability to optimize the design of telemedicine systems to meet health care needs of providers, patients and communities; to optimize the design of telemedicine systems to meet health care needs; and adding/changing policies and regulations to promote the demonstration, dissemination and evaluation of telemedicine. He wrote that telemedicine may introduce structural changes in the process of care that benefit patients and save money.

Goldberg (1995) wrote that standards for the technical requirements, clinical protocols, data formats, and communications protocols for telemedicine systems are needed. Since then, these have grown but must be more fully developed. He wrote that systems must be open to allow for collaboration. This is still true today.

Klein and Manning (1995) wrote that telemedicine's legal issues fall into these categories: 1. The traditional medico-legal issues not unique to the medium; 2. Conflicts in state law, which telemedicine amplifies because it connects geographically separate facilities; and 3. issues unique to telemedicine. One issue arises if networks need a Certificate of Need or license and states vary according to minimum quality standards needed. The reliability and standardization of data must be regulated. Several states require private insurance companies to cover telemedicine services to the same extent in which they cover face-to-face consultations.

Gellman (1995) wrote that legal and ethical rules for the confidentiality of health records are incomplete, unclear and inadequate. He wrote that the chief deficiency in the regulation of health confidentiality is the absence of a general federal law or uniform state laws. The risk of intrusion can be minimized through encrypting procedures, passwords, and legal restrictions. He wrote that privacy legislation differs among states, does not provide consistent, comprehensive protection for privacy of health care information (where it exists on paper or the Internet), and does not provide real protection against disclosure for patients. He wrote that many different institutions, including non-medical and non-health ones, access health information. Patients cannot expect that their information is kept totally private. They can expect, however, to get full disclosure of how it may be shared, and to sign to allow this.

It is not clear, Gellman wrote, if a physician gets a request from a federal agency for patient information, if he or she is obligated to tell the patient or ask for a subpoena. What can be promised, he wrote, is that health records are maintained, used and disclosed following a formal set of rules that prescribe the duties of record-keepers and the rights of patients. Obviously, health records "require a much more detailed and stringent set of rules than records of routine retail transactions." Federal regulation is needed; it would encompass information shared among practitioners, researchers, auditors, public health authorities, health database organizations or others.

Information to third-party payers such as insurance companies makes the situation tricky, especially when they often ask patients to sign away confidentiality rights before payment is issued. Others involved include: medical and social researchers; public health agencies; rehabilitation and social welfare programs; employers; life insurance companies; schools; law enforcement agencies; courts; professional accrediting; certifying and licensing organization; peer

reviewers; credit card companies and processors; outcomes researchers; auditors; cost containers; and health database organizations. It gets more complicated when telemedicine information flows across country borders. The regulation policies of other countries, entities such as the European Union, etc., must be taken into account. He wrote that the basis of any federal law should be the code of fair information practice.

In April 1996, the Federation of State Medical Boards (FSMB) developed a Model Act to regulate the practice of medicine across state lines. The Model Act requires physicians practicing medicine across state lines to obtain a special license issued by a state medical board. This license does not cover the physical practicing of medicine in that state where the patient is located. A full and unrestricted license is required for that. Some state boards issue a special purpose license, telemedicine license or certificate, or license to practice medicine across state lines, while state boards plus the DC Board of Medicine require that telemedicine physicians are licensed in the state in which the patient is located. In Minnesota, physicians can practice telemedicine if they are registered to practice or to practice across state lines.

Kim (2004) wrote that one of the major barriers preventing the widespread use of telemedicine is physician liability. He broke it up into the following categories; liability of the performing physician and hospital for any patient injuries sustained at the local site as a result of physician error or technology malfunction; liability of the manufacturer and/or vendor of telemedicine equipment for a malfunction; liability for inappropriate use of technology; liability for other non-physician health care provider error; and liability of the federal government in connection with a demonstration program.

In 2002, the Federation of State Medical Boards (FSMB) adopted the Model Guidelines for the Appropriate Use of the Internet in Medical Practice. On April 26, 2014, the FSMB

adopted a Model Policy for the Appropriate Use of Telemedicine Technologies in the Practice of Medicine, or the "Model Policy," on April 26, 2014. The Model Policy addresses establishing a physician patient relationship, appropriate online medical care, HIPAA compliance and patient privacy, and prescribing drugs. State medical boards are not required to adopt the Model Policy, but they may use it to guide their thinking on telemedicine even without wholesale adoption. Compared to the 2002 guidance, the 2014 Model Policy reflects the technological developments of the past decade and the growing acceptance of telemedicine. For instance, the 2002 Guideline provided that email and other electronic communications can supplement but not replace the interpersonal interactions between physicians and patients. The 2014 Model Policy provides that, in some situations, telemedicine technologies can be used in lieu of in-person care in certain occasions. The 2014 Model Policy encompasses a more complete guidance on issues such as arranging for emergency services, providing for continuity of care, and maintaining a patient's medical record.

The situation is easier for members of the Department of Defense (DOD) and VA (Joel White 2013). The Service Members' Telemedicine and E-Health Portability Act, passed in 2011, expanded the DOD state licensure exemption to allow credentialed health care professionals to work across state borders without a new state license. The definition of an exempt health care professional was expanded to include qualified DOD civilians and contractors regardless of where the health care professional or patient is located. Only one active, unrestricted state license is required to practice in every VA facility in every state. This policy has improved patient outcomes and reduced costs.

Currently, there are several telemedicine policy bills waiting for passage in state legislatures and Congress. More work needs to be done for a clear umbrella policy.

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4.6 Costs

The consideration of costs is a pragmatic one based on goals and usage of making health care more affordable to patients and making telemedicine systems affordable and efficient to health care providers and technicians. It is also based on an empirical or statistical view analyzing costs.

4.6.1 Cost of Telemedicine

Franken, Allen, Budig, and Allen (1995) wrote that time is money in telemedicine, and that less skilled professionals must be employed to handle some technical tasks. Grigsby, Schlenker, Kaehny et al., also in 1995, wrote about the importance of standards in cost. Silva (1996) wrote about the dearth of models of telemedicine. Some models could demonstrate the impact of telemedicine systems on each component of the human infrastructure. He recommended a matrix that identifies goals and needs of various constituents on one axis, and the specific roles and tasks needed for achieving these goals and needs on the other axis to facilitate model building. He wrote that optimal telemedicine systems based on user tasks and capabilities, effective for innovative training programs and training assistance, would all contribute to create telemedicine performance support systems that get health care professionals to the optimal performance zone.

He wrote that controlled studies to develop standards are necessary. He proposes the following to be present at regular meetings that would aid these studies: 1.Create an initial symposium on model development; 2. Identify change agents in medical and non-medical communities; define matrices in terms of users, their needs, and identified technologies; identify opportunities for improvement in levels of series; identify infrastructures at federal and local

levels; and develop a self-administered instrument, preferably Web-based, to assess the capacity to develop and pursue objectives for the development of telemedicine. Incentives for the effective use of innovative training and educational programs and training assistance to help providers that use telemedicine appropriately should be in place. This may aid in that health care attributes such as level of sophistication, available resources, practice patterns and more, differed from place to place.

In general, Silva recommended the following to facilitate the improving of the understanding of and education about telemedicine among professionals and non-professionals: development of models; educational programs, research-based knowledge; and the design of human infrastructure. What is needed is an active change-management system for systems designers to provide relevant social and behavior information and to enable them to design and modify the systems appropriately.

Wakefield, Kienzlefinch, Zollo, Kash, et al. (1997) wrote that financial systems were the greatest barrier to the development of telemedicine systems. The cost of implementing telemedicine technologies and programs, as well as determining patient costs, insurance issues and more, has been one of the most talked-about issues of telemedicine from the beginning.

Bashsur, Shannon and Woodward (2016) wrote that the economic effects of telemonitoring include changes in rates or volumes of hospital admissions and readmissions, length of stay and/or emergency department visits.

4.6.2 Cost-Effectiveness of Telemedicine

Several authors have written about the cost effectiveness of telemedicine (Schwamm, Audebert, and Amarenco, Chumbler et al. 2009) result in decreased health care. Huston and Huston (2000) wrote that early intervention for specialty care via telemedicine has often proved

to be less expensive in the long run. They claimed that the question of whether this telemedicine is the equivalent of traditional care has not been answered satisfactorily for third-party payers.

Gardiner and Hartzell (2012) wrote that avoiding unnecessary emergency room reduces costs and allows clinicians to concentrate their expertise when and where it is needed. Patients save travel costs. Often, telemedicine equipment costs less than traditional equipment.

Jackson and Mclean (2012) wrote that cost measures have largely been neglected in telemedicine, and that these are the key assessment criteria for determining future effectiveness of health care interventions. They identified these cost measures that should be used for future evaluations: operational costs (COSO): start up and routine running costs; health care professional costs (COSH) which may be separate to operational costs; cost benefit, effectiveness, consequences, or utility analysis (COSB); cost minimization analysis (COSM) or value-for-money measure; cost of hospitalization; and quality of care proxy, mortality (QM) or changes in mortality rates due to a health care intervention. Cost effectiveness analysis compares incremental costs and incremental health effects of a program. Cost utility analysis measures health improvements in terms of quality-adjusted life years or other related measures. Cost benefit analysis directly compares costs between services. Cost consequences analysis compares the costs and outcomes of a treatment. These terms are sometimes used interchangeably, which is inappropriate according to the authors.

Slabodkin (2013) wrote that telemonitoring heart failure patients with implantable defibrillators proved cost effective according to the economic evaluation of the Evolution of Management Strategies of Heart Failure Patients with Implantable Defibrillators (EVOLVO) study, a multicenter clinical trial. In the study, 200 patients implanted with a wireless

transmission-enabled implantable defibrillator were randomized to receive either remote monitoring or in office evaluations.

4.6.3 Reimbursement

Reimbursement policies vary by state. Puskin (1995) wrote that reimbursement is hampered by the lack of reimbursement policy, the limited factual information on costs and benefits of telemedicine, and the inadequate understanding of managed care plan requirements for implementing telemedicine. She suggested that the federal government and private sectors should work together for evaluation studies that would inform reimbursement policy.

Huston and Huston (2000) wrote that the medical business has been a simple fee-for-service institution but that is changing to some extent. They claimed that health care costs have skyrocketed because of the high cost of medical equipment, increasing insurance premiums, and increasing malpractice claims. Fear of litigation has led to an increase in the number and duplication of diagnostic tests performed. These costs are passed onto the patient/customer. When someone changes jobs, the previously existing conditions covered on their previous health plan may not be covered on the new one.

Some third-party payers are exercising cost containment in the form of capitation, or a predetermined cap on the amount of money paid regardless of the number of patient visits. This directly influences the type and quality of medical care. Hospitals are sometimes not able to be the independent service they once were. Alliances are now being formed among hospitals and private practices and many are forming health-maintenance organizations (HMOs). There is no guarantee these providers will not be dropped from a group if they order too many tests.

Kim (2004) wrote that the slow reimbursement and lack of cohesive reimbursement is a barrier to the implementation of telemedicine programs. He wrote that insurance companies easily accept only teleradiology consultation services and often insist on office visits for other types of telemedicine.

In a 2012 Wall Street Journal article Anna Wilde Mathews reported that, according to a survey by Mercer, a consulting unit of Marsh & McLennan Cos., 15% of very large employers use some form of telemedicine, and another 39% are considering it. According to the article, Webcams and other technology used for telemedicine, often costing $45, can save emergency room costs. Many physician groups and state regulators argue that telemedicine may work when a patient is communicating with his or her regular physician, but care may suffer when patients are connecting with an out-of-area physician. Employers point out that this will ease the effects of the shortage of private physicians. Some groups, such as California Public Employees' Retirement System, are testing virtual consult services. These services pick physicians, who can enjoy flexible hours and increased revenue.

According to Wicklund (2013), 44 states have some form of coverage or reimbursement for video conferencing under Medicaid and 18 states have mandated that private health benefit plans reimburse for services that can be provided by telehealth. As of April 2014, 46 states have some Medicaid coverage for real-time telemedicine and nine states have some Medicaid coverage for store-and forward telemedicine (Vesely 2014). More coverage includes: 39 states have some coverage for telemental health, 15 for home telehealth, 11 for remote patient monitoring and seven for store-and-forward-based services.

The ATA is looking to be more active in helping states with their telehealth strategies, in the hopes of making the telehealth the norm rather than ancillary care, according to Latoya Thomas, the ATA's project director for state telehealth policy. Among the organization's talking points are that telehealth empowers consumer choice, reduces disparities to access in care, enhances physician availability and improves quality of care.

Anthem Blue Cross of Woodland Hills, California plans to launch the integrated telehealth system Live-Health Online early in 2013 to allow its members to choose their physician and address their non-emergency health needs via the Internet and a live two-way video. A record will be created and, with patient permission, be forwarded to their primary care physician, supporting continuity of care and collaboration.

U.S. Senators Amy Klobuchar (D-MN) and John Thune (R-SD) re-introduced the Fostering Independence Through Technology (FITT) Act to agencies to improve health outcomes, expand the use of telehealth technology under Medicare using telemonitoring to reduce hospital re-admissions in rural and underserved communities across the nation, and reduce Medicare expenditures. Senator Klobuchar said telehealth technology reduces health care costs and ensures access to high-quality and affordable health care. The law would create a pilot program to provide budget neutral incentives for home health agencies to use telemonitoring to better monitor Medicare beneficiaries and reduce Medicare expenditures. The legislation is backed by the National Association for Home Care and Hospice, the National Rural Health Association, Health Everywhere, and the American Hospital Association.

Hospitals are subject to payment penalties when a Medicare beneficiary is re-admitted to a hospital in a certain period with a preventable complication. Companies such as Home Depot,

Booz & Co. and Westinghouse Electric Co. are moving to include remote visits to their health plans.

Medicaid does not recognize a patient's home as an originating site or reimburse for telemonitoring, states can reimburse for remote monitoring or home video visits. These 21 states provide some form of home-based telemedicine: Alabama; Alaska; Arizona; Colorado; Indiana; Kansas; Kentucky; Massachusetts; Minnesota; New Mexico; New York; Pennsylvania; South Carolina; South Dakota; Texas; Utah; Washington; Mississippi; Nebraska; Ohio; and Wisconsin.

Since 2002, the Centers for Medicare and Medicaid reimburse for interactive consultations, but not store-and-forward technology. He wrote that what is needed for the reimbursement of telemedicine services is: the scope of malpractice insurance coverage must include both the involved hospitals and physicians, and payment for the procedures must be precisely defined when performed at a remote hospital versus payment for the services provided by the local hospital and physician.

4.7 Summary

Organization management issues in telemedicine involve personnel's learning and adopting to telemedicine systems and technology; continuous assessments of the system; changes in hierarchy and communication among personnel; changes in management and financial plans; a shared vision among participants; changes in scheduling and billing; changes in communication with patients; and continuous education and training.

Barriers to telemedicine implementation include the resistance of some physicians and medical centers to adopt it due to their perception of lack of evidence of its medical and cost effectiveness; resistance to learn how to operate equipment; cost of equipment in some cases; lack

of uniform or sufficient interstate licensing and physician credentialing and legal liability, litigation and state policy standards; insufficient privacy and security standards; and lack of gold standards. Changes in office and organization must take place to adopt telemedicine programs, and not everyone is open to implementing these changes. Current employees need to be trained in telemedicine equipment that may become obsolete. Telemedicine systems need to be monitored, especially after they are first implemented. Some physicians and medical centers are simply not open to change, which may come from public demand and entrepreneurs.

Privacy is a main issue in telemedicine. Some patients, including some ethnic groups more than others, are afraid that their medical information or, in some cases, real-time examination videos, will fall into the wrong hands. Precautions must take place. This was the case, however, with paper and online data before the advent of telemedicine as well. Security can be enhanced with encrypted and firewalls. Several companies are jumping on the opportunity to keep telemedicine records secure.

Policy for telemedicine referring to physician licensure, insurance coverage and privacy issues vary from state to state. New bills are being introduced in Congress and on the state level. Many providers and patients are urging for greater Medicare, Medicaid and insurance coverage for telemedicine.

Telemedicine programs can be costly to implement. A model can be used to show any cost-effectiveness for implementing the program. If there is cost effectiveness, the telemedicine program will more likely be implemented. In general, telemedicine is cost effective for patients because it saves time in travel costs and time off work. It can also save time for practitioners who may not have to rent space every day or have as much staff as they did without telemedicine. In addition, as more health professionals implement telemedicine and as insurance covereage for

telemedicine increases, there will be a pressure for other health professionals to implement it to keep up with changing patient needs.

Chapter 5
Telemedicine Taxonomy

Telemedicine discourse exhibits taxonomic characteristics, suggesting it is a discourse community and potentially a domain. Telemedicine scholarship has evolved to include such categories as types of medicine, (eg: teleradiology, telepathology, and teledermatology), types of use (eg: telemonitoring), and types of professional health groups (eg: telenursing). Other categories of topics in telemedicine revealed in the literature review include financing and implementing telemedicine programs, technology and technological training, site of telemedicine such as hospitals or clinics, legal and insurance policy, medical education through telemedicine and more.

A taxonomy of telemedicine may help in the confusion of what different telemedicine terms mean as described in Section 1.5. This research contributes to the existing taxonomies or a new taxonomy of telemedicine. Hjørland (1998) wrote that the decisions a designer of controlled vocabularies are informed by the designer's epistemological stance. A domain can be organized in several ways, depending on the particular epistemological stance taken. Hjørland's four basic epistemological approaches or contexts are (Hjørland 1998; Mai 2008):

• Empiricist, based on statistical analysis of resemblance and favoring perception and experiences;

• Rationalist, based on logical division and/or external and unchangeable categories and emphasizing reasoning and a priori theorizing;

- Historicist, based on a notion of development or evolution and emphasizing that perception and thinking are influenced by culture and language; and

- Pragmatic, based on an analysis of goals and usage.

In 1995, Hjørland and Albrechtsen wrote that the positivist and rationalist view of science had a nominalistic understanding of language as labels for knowledge. Language did not contribute to the perception of reality and was limited to communication. Individual perception was key. The view of epistemology is moving toward a more holistic approach which takes into account the importance of language in the perception of reality and introduces historical, cultural and social dimension to the theory of knowledge and science. This is reflected in the definitions of telemedicine and other related terms, although they are not mature. The evolution of technology and goals of health care programs, used mostly to define the terms, as well as the holistic view of different aspects such as delivery methods, type of medicine, type of technology, application and more taken on by the taxonomies reflect more of a historicist and pragmatic hermeneutic view on naming and defining terms.

The three taxonomies discussed: Nepal, Jang-Jaccard, Alem; Tulu, Chatterjee, and Maheshwari; and Bashshur, Shannon, Krupinski aned Grigsby, are based on the authors' knowledge of telemedicine and computer systems. With this study, a comprehensive taxonomy taking into account the taxonomies of both groups and the results of keyword analysis of the Scopus random will be created.

Bashshur, Shannon, Krupinski and Grigsby (2011) wrote that a taxonomy serves to "bring conceptual clarity to this burgeoning set of alternatives to in-person health care delivery." And as an "information management strategy to improve knowledge sharing, facilitate research and policy initiatives, provide some guidance for the orderly development of telemedicine." For the

authors, telemedicine is a domain. Essential distinctions for research and policy can be made rather than (2011) "treating telemedicine as a single entity with protean applications."

According to the authors, (2011) taxonomy "brings order to an extant body of information and provides an effective guide to the development, collection, and classification of new information," enhancing researchers' ability to "conduct summative and formative research leading to a greater understanding of complex subject matter." A taxonomy (2011) "is essential for the conduct of research, policy making, reimbursement decisions, as well as provider acceptance."

They explained that, in telemedicine, an understanding of its basic parameters and content of the field and its boundaries have not been derived; the relationship between the whole and its parts has not been defined; the degree in which success or failure in one component, application or segment applies to the general context of the application has not been determined; and the units of analysis that should be used (such as single visits or episodes of care) have not been identified. A taxonomy would be helpful in shedding clarity. Telemedicine is multidimensional, that may mean different things to different people, according to the context in which it is used and the combinations of clinical and health applications, technological configurations, human/technological interfaces, organizational structures, and human resource mixes.
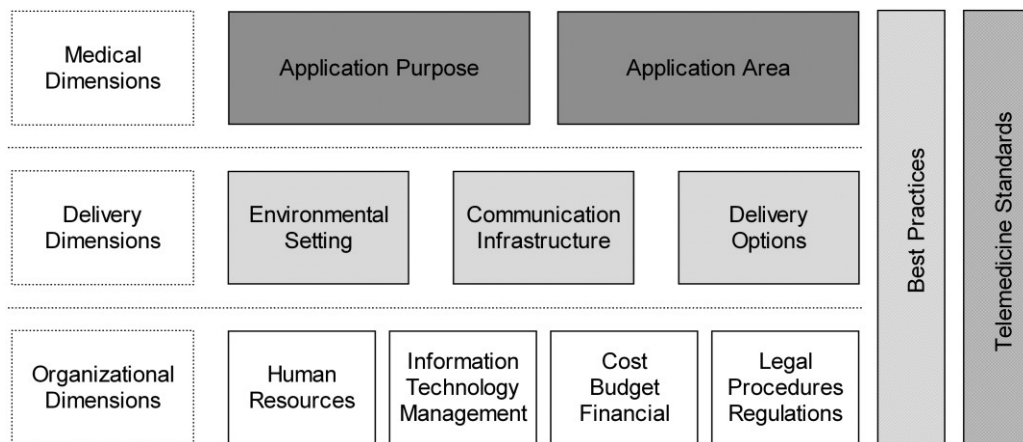
5.1 Tulu, Chatterjee and Maheshwari Taxonomy

In 2007, Tulu, Chatterjee, and Maheshwari conducted a study on the taxonomy of telemedicine by analyzing the Telemedicine Information Exchange (TIE) survey. (The TIE was supported by the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services.) They wanted to provide a framework taxonomy for the classification and comparison of telemedicine, to guide program planners and users for the

implementation of telemedicine using the framework introduced, to identify relationships between different dimensions and to identify existing trends in the use of telemedicine across different application domains. They found that 2,311 telemedicine programs were running in the United States. They wrote that telemedicine has many dimensions that require expertise in different domains and that a holistic understanding of these is needed for effective health care delivery. Taxonomy is the theoretical study of classification, which includes the development of a classification scheme and determination of classification criteria. They expressed this in a matrix to provide a relationship model between discovered and undiscovered phenomena in telemedicine (see Figures 4, 5 and 6). The taxonomy can be used to identify best practices for planning and developing telemedicine programs.

They first categorized telemedicine by the dimensions of medical, delivery, and organizational. Subdimensions of the medical dimension are application purpose (clinical or nonclinical) and application area (radiology, pathology etc.). An example of a clinical application is primary care supervision and an example of a non-clinical application is education. Delivery dimensions include environmental setting, or the physical locations of the two ends of the telemedicine session. Possibilities are home or hospital settings. Communication infrastructure refers to channels for transmission, emission or reception of data or information. Examples are wired or wireless. Three more categories within this are: communication service such as cable or DSL/ADSL; transmission medium such as telephone or satellite; and transmission speed. Delivery options within the delivery dimension include television or Internet. Organizational factors include human resources for telemedicine conduct and information technology management. Budget issues and legal procedures are included.

They used path analysis using stepwise multiple regressions to find out if the delivery option and communication infrastructure dimensions of the telemedicine taxonomy depend on application area and/or application purpose.

Figure 4. Telemedicine Taxonomy

Above diagram excerpted from Tulu, Chatterjee, and Maheshwari, 2007

Figure 5. Tulu, Chatterjee, and Maheshwari: Five Dimensions of Telemedicine Ontology
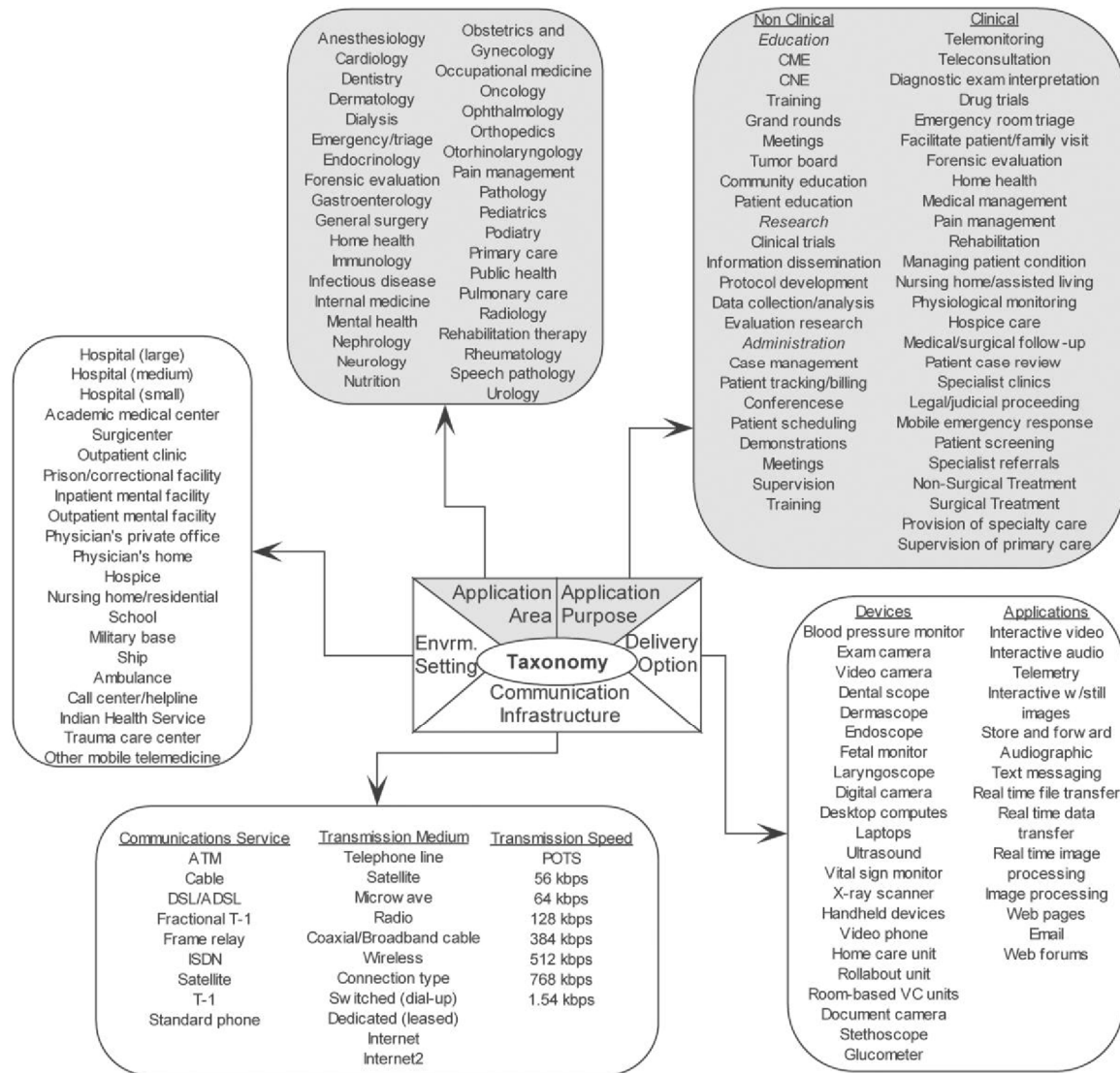
Above diagram excerpted from Tulu, Chatterjee, and Maheshwari 2007

While Figure 4 shows the taxonomy of telemedicine according to Tulu, Chatterjee, and Maheshwari (2007), Figure 5 shows the ontology of medical and delivery dimensions of their taxonomy. A taxonomy is usually a tree graph that shows parent-child or hierarchical relationships of an ontology. An ontology is a formal way of organizing information and includes

putting things into categories which relate to each other. Ontologies are models that can be a simplification of something complex in our environment using a standard set of symbols.

Ontologies show semantic relationships whereas taxonomies show more generic relationships. In Figure 5, the authors provided an ontology derived from the taxonomy, showing what "is" in each taxonomical area. For instance, for environmental setting, this can be several places from different-sized hospitals to outpatient clinics to military bases. The top application area was mental health, followed by cardiology and dermatology. The most common application purpose was diagnostic exam interpretation. Next are managing patient condition and medical management. After that is referral to a specialist. Primary communication services were Integrated Services Digital Network (ISDN) and T-1, and the primary transmission medium was telephone, used 48.8% of the time. The top five environmental settings are listed in Table 6. Hospitals were the most prominent environments.

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Table 6 The Top Five Environmental Settings

Environmental setting	Percentage of times telemedicine is discussed in each setting in the U.S., according to Tulu, Chatterjee, and Maheshwari (2007)
Hospitals with 250 or more beds	41.7%
Hospital with 99 or fewer beds	36.5%
Outpatient clinics	33.2%
Hospital with 100 to 249 beds	30.0%
Academic medical center	26.5%

Above diagram excerpted Tulu, Chatterjee, and Maheshwari 2007

Figure 6. Three-Dimensional Model for Evaluation of Telemedicine Services

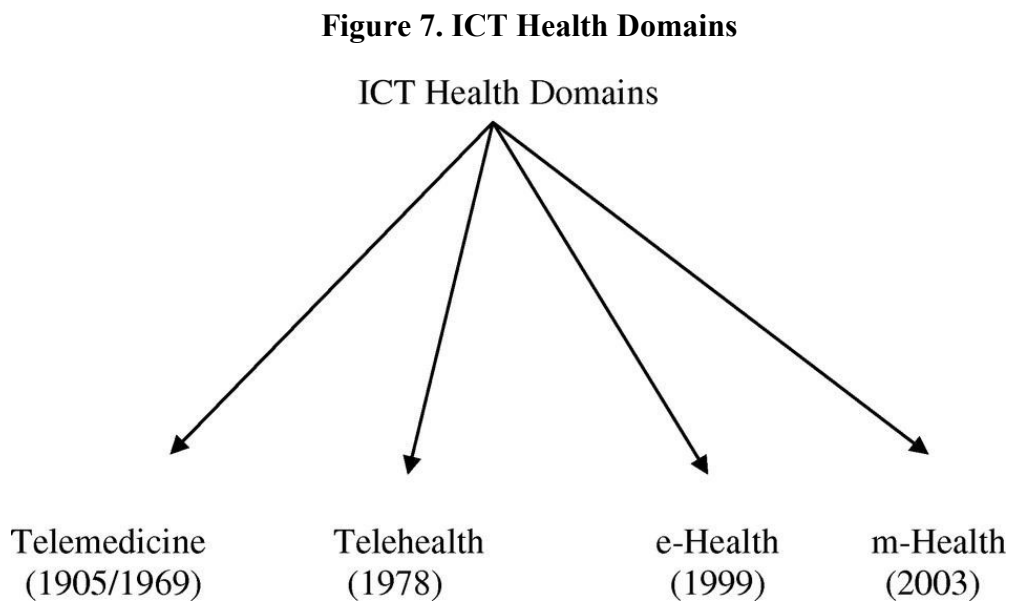Below diagram excerpted from Tulu, Chatterjee, and Maheshwari (2007**)**
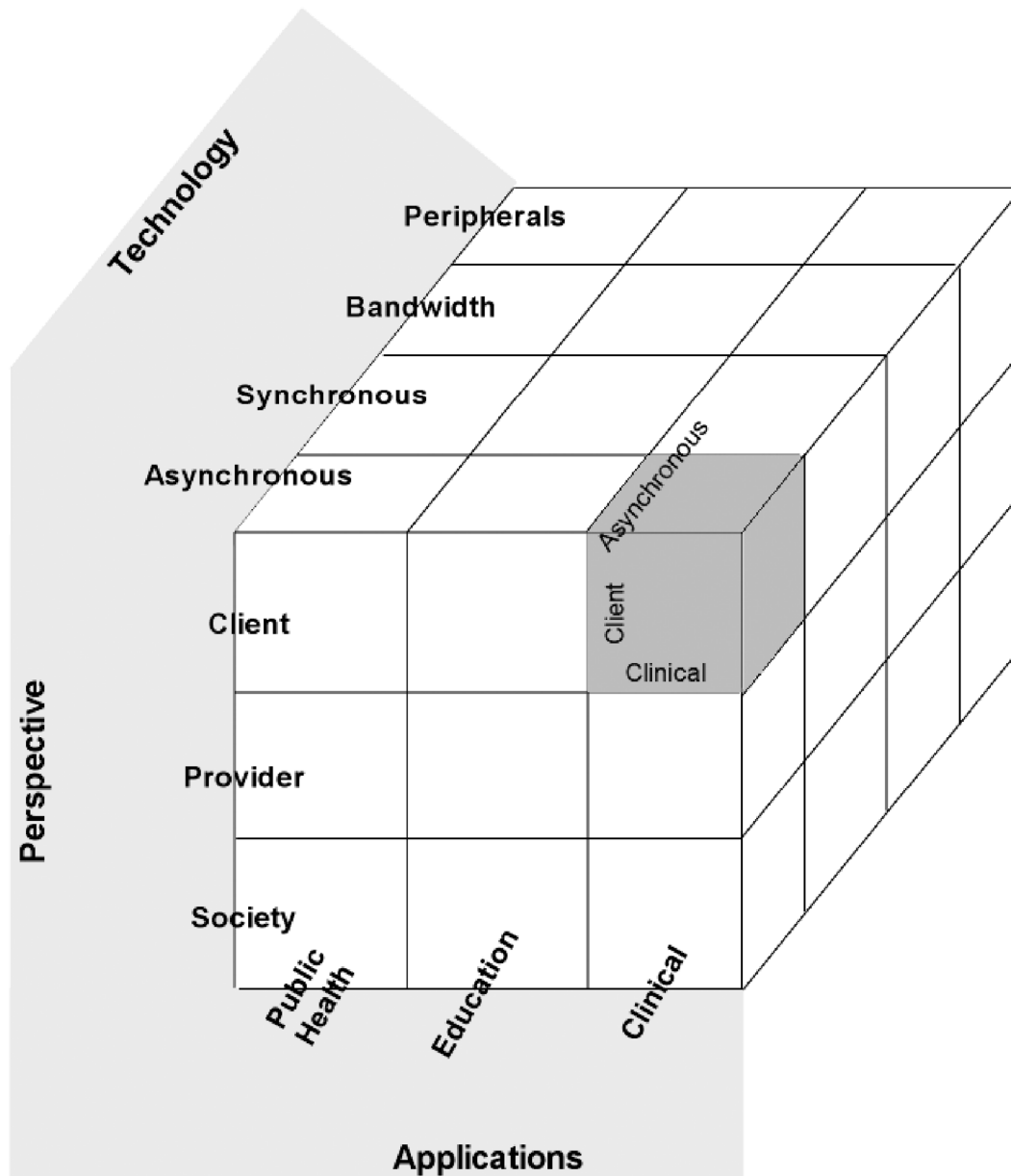
The top application environment, another dimension, was hospitals with more than 250 beds. Interactive video was used in all areas. The authors found that areas such as ophthalmology, radiology, and pathology where high-quality images are needed are marked by a high use of store-and-forward telemedicine. Most programs used high transmission, private ISDN or a T-1 line as their primary communication service, although they are more expensive than the Internet. These lines ensure medical information privacy. The authors indicated that telemedicine delivery relies heavily on communication technologies and supporting devices, and so the evolution of telemedicine is correlated to developments in communication technology and information technology. By choosing a part of each three-dimensional axis and extrapolating to where the lines meet, one can talk about one important aspect of telemedicine. For instance, choosing a client from the perspective axis, synchronous from the technology axis and clinical from the application axis, the topic would be what the client or patient feels about synchronous telemedicine technology used to assess their health.

5.2 Bashshur, Shannon, Grigsby and Krupinski Taxonomy

In 2011, Bashshur, Shannon, Grigsby and Krupinski wrote a pivotal article on the taxonomy of telemedicine. They explained that the taxonomy "can be used to provide definitive information about the true effects of telemedicine in terms of cost, quality, and access" and to bring order to the development, collection, and classification of new information. It may influence legal and reimbursement policies at the state and federal levels. They reflected about the definitions of telemedicine, telehealth, e-Health and, yet did not write why they excluded terms such as telecare or come up with definitive conclusions. Many of the definitions overlap, as can be shown best by diagrams. The precise content and boundaries are not always defined. In the article, the authors used telemedicine to refer to systems, modalities, and applications for the

delivery of health services that use electronic communications and information exchange for in person contact; (2) communication among providers; and (3) patient or provider contact with sources of information, decision making, and support systems such as Web sites.

The authors divided the information and communication technology health domains into telemedicine, telehealth, and e-Health. Figure 7 indicates this breakdown, as well as the years when each domain sector began to gain prominence.

Figure 7. ICT Health Domains

ICT Health Domains

Telemedicine
(1905/1969)

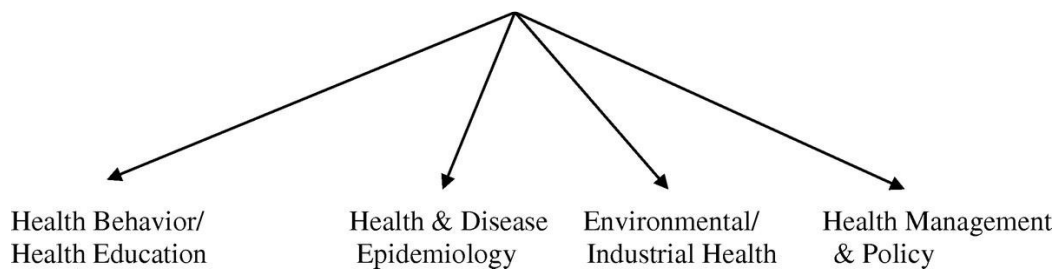Telehealth
(1978)

e-Health
(1999)

m-Health
(2003)

Above diagram excerpted from Bashshur, Shannon, Grigsby and Krupinski, 2011

Bashshur, Shannon, Grigsby and Krupinski (2011) explained that the development of taxonomies depends on guidelines for their cohesiveness of logical types, mutual exclusivity, intraclass reliability, valid generalization, construct validity, and iterative development. Taxonomies also reflect research agenda implementation and decision-making by policymakers, payers, program developers, and providers. This dissertation will contribute to the iterative development of the taxonomic definition of telemedicine. It will help expand upon its proposed hierarchical structure, where each tier in the hierarchy inherits the attributes of the one immediately above it, plus and assumes additional characteristics that distinguish it from its predecessor. Bashshur, Shannon, Grigsby and Krupinski (2011) wrote that the often rapidly changing technology in response to invention, human needs and lower cost makes a definition of terms more challenging. In fact, Bashshur, Shannon, Grigsby and Krupinski (2011) wrote: "It is not clear what constitutes telemedicine vis-a-vis telehealth; whether the two terms can be used interchangeably; and what, if any, are the real differences between them. The introduction of more terms complicates the situation further Bashshur, Shannon, Grigsby and Krupinski (2011). Choices must be made regarding the definition and taxonomy dependence on modality (asynchronous, synchronous, mobile), type of care, patient/provider relationship, use (education, monitoring, diagnosis, treatment), and technology (telegraph, radio, television, videophone, Internet), as well as about where it is used (at sea, in hospitals, in prisons, etc.).

The authors wrote that telehealth includes the spheres of public health and medicine (Figure 8). A separation of the two came about in the early 1900s when physicians wanted to increase their status, credibility and professional control over the field. Public health tended to include education. Public health and medicine overlap. For instance: Physicians are concerned with public health issues such as bacteria spread by airplane travel, smoking and hand sanitizing.

Those in public health are concerned with the decrease in disease statistics, identifying health risks and infection rates. This overlaps with medicine. The authors wrote that the terms e-Health and mhealth are neologisms introduced to reflect technological innovations, and their wider use in health care suggests that they are technetronic.

Figure 8: Schematic of the Telehealth Domain

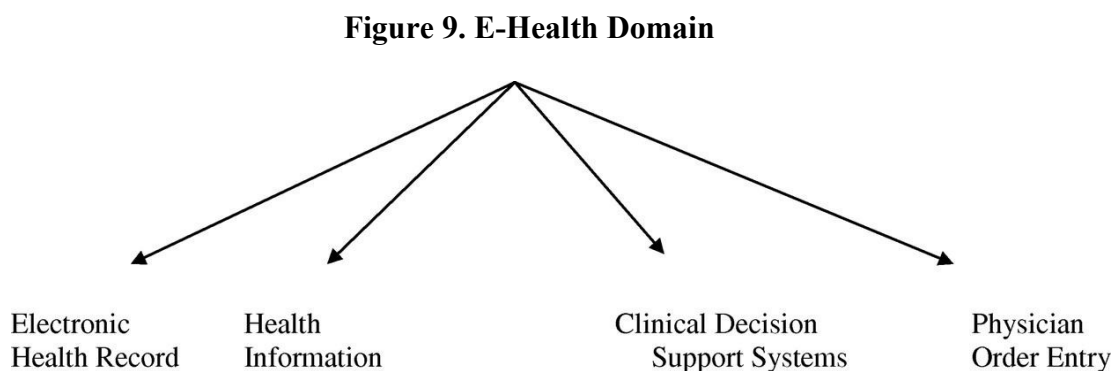| Health Behavior/ Health Education | Health & Disease Epidemiology | Environmental/ Industrial Health | Health Management & Policy |

Above diagram excerpted from Bashshur, Shannon, Grigsby and Krupinski 2011

Bashshur, Shannon, Grigsby and Krupinski (2011) wrote that it has not been decided if medicine is part of public health or vice versa. Bashshur, Shannon, Grigsby and Krupinski (2011) that, in taxonomy, some scholars are "lumpers" and some are "splitters." The former tend to see similarities more than differences while the latter do the opposite. The latter treat telehealth and telemedicine as two distinct domains akin to public health and medicine. Bashshur, Shannon, Grigsby and Krupinski (2011) supposed that telehealth is comprised of the same components as public health: disease epidemiology; health behavior and health education; health services

organization and management and policy, which includes financing environmental and industrial health; and biostatistics. They wrote that not all of these components can be analyzed by electronic devices. They proposed four components of telehealth (Figure 8): health behavior/education; health and disease epidemiology; environmental and industrial health; and health management and policy.

Bashshur, Shannon, Grigsby and Krupinski (2011) wrote that e-Health was introduced in the late 1990s during the beginning of the successful popular use of the World Wide Web by business and commercial interests. They wrote that there is no consensus as to a uniform, unique or nonoverlapping, definition of e-Health. Bashshur, Shannon, Grigsby and Krupinski (2011) wrote that e-Health is used to refer to health applications that rely on electronic processing and the Internet, or as an even more inclusive reference to any computer usage in health care (Figure 9). They chose four areas to include in e-Health, ones that do not overlap with other domains and that are generally agreed-upon: electronic health records, health information, clinical decision support systems, and physician order entry.

Figure 9. E-Health Domain

| Electronic Health Record | Health Information | Clinical Decision Support Systems | Physician Order Entry |

Above diagram excerpted from Bashshur, Shannon, Grigsby and Krupinski 2011

Bashshur, Shannon, Grigsby and Krupinski (2011) wrote that mhealth was introduced in 2005 by Istepanian, Lamiarayan, Pattichis) to reflect the ubiquitous presence of mobile technology. Some suggest that it includes everything the other three domains include if done via mobile technology. The authors wrote that it is not clear if this domain will endure and how to differentiate from the other three domains in the study. They proposed certain components of (see Figure 10): clinical support, health worker support, remote data collection and helpline.

Figure 10. Domain
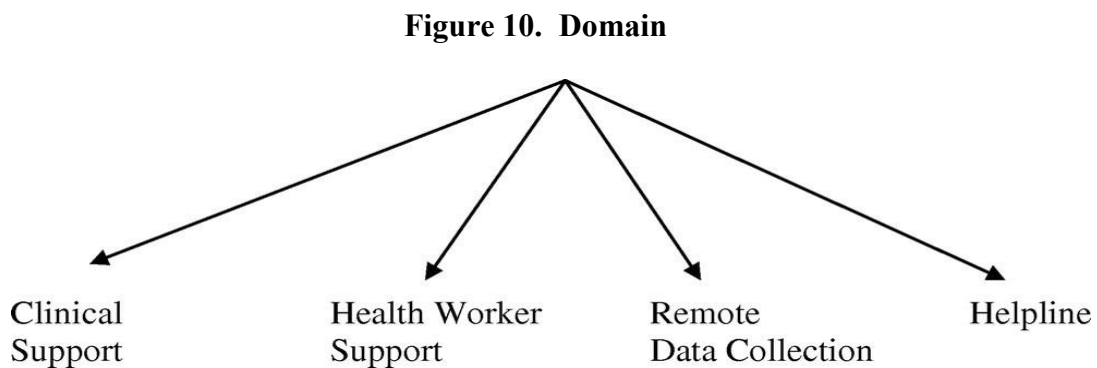
Above diagram excerpted from Bashshur, Shannon, Grigsby and Krupinski 2011

They went on to write about three aspects or dimensions of telemedicine. These are the functions that are performed, the specific applications, and the technological configurations. The second level of the taxonomy is comprised of the specific components and subcomponents of

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each dimension, forming a multidimensional taxonomy. The functionality dimension according to them includes consultation (physician-patient or physician-physician), diagnosis, monitoring and mentoring. With 'monitoring," they refer to telehomecare for the home-bound chronically ill, recently discharged persons requiring continued skilled care, wound-care patients, and patients with chronic conditions such as congestive heart failure. With "mentoring," they refer to physicians mentoring other physicians such as new surgeons.

The application dimension is comprised of disease entities, sites of care (intensive care unit or ICU, emergency room or ER, etc.), and treatment modalities, which could be e-pharmacy or physical therapy. Complications can refer to components of sites of care such as ambulances, and subsectors such as speech pathology and physical therapy in telerehabilitation. The third dimension is technology, and includes synchronicity, network design and conductivity. Synchronicity refers to timing and technology; it can be synchronous or asynchronous. Network design and configuration refers to Virtual Private Networks, the open Internet and private networks. Security arrangements and the ability to protect private information vary within the three modalities. Connectivity can be wired or wireless, and each can vary by bandwidth, which affects quality of service, resolution and speed. The best way to use the three-dimensional taxonomy model is to select a cube and identify the variables of interest according to the three dimensions (Figure 11). Their three-dimensional taxonomy is represented by Figure 12.

Figure 11. The Dimensions of the Telemedicine Taxonomy and their Components
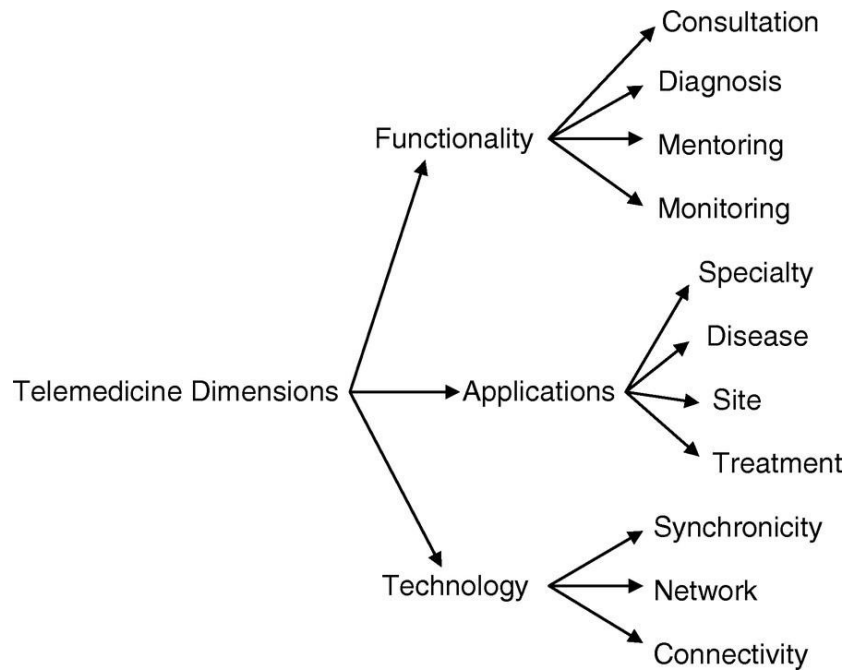
Above diagram excerpted from Bashshur, Shannon, Grigsby and Krupinski 2011

Bashshur, Shannon, Grigsby and Krupinski (2011) put the functions or reasons for telemedicine under "functionality." They include education, consultation, diagnosis and monitoring in the same group. Under "Applications" are categories of patient disease and physician specialty, as well as treatment and place of treatment. Under "Technology" are synchronous or asynchronous, network and connectivity. The taxonomy I propose contains diagnosis, treatment, monitoring and education under health services, since they are indeed services for patients done through telemedicine. Place of the telemedicine program (home, hospital, etc.) is included in the socio-economic section. Figure 12 shows their taxonomy in a

three-dimensional fashion to pinpoint moments in a telemedicine visit. For instance, if a man goes to a hospital for Crohn's disease and gets a second opinion via real-time telemedicine from a physician in another country, the disease, consultation aspect and synchronous telemedicine show his visit is in one "square" of the taxonomy.
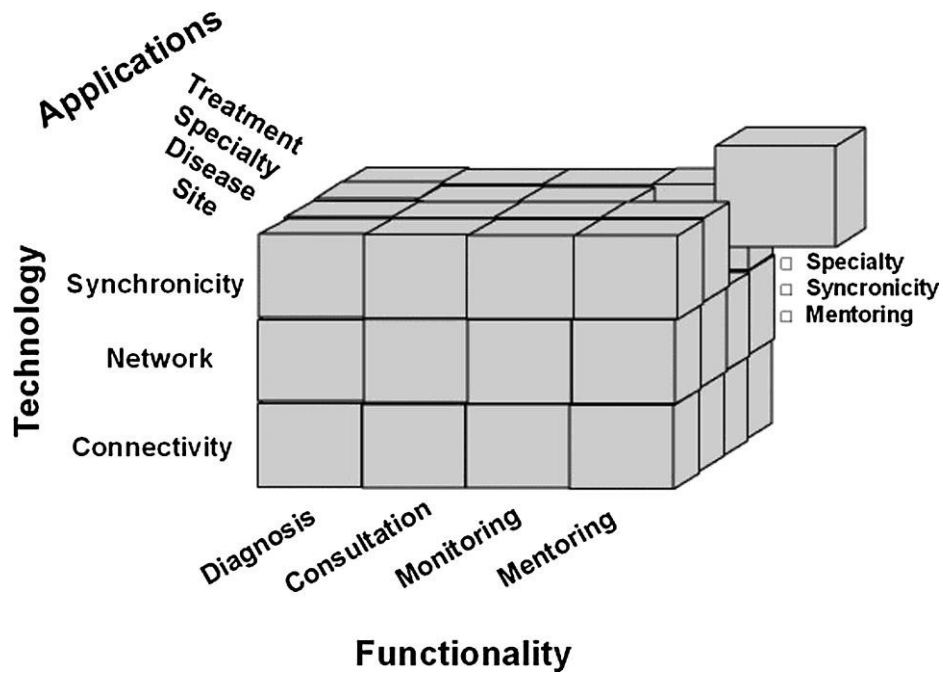
Figure 12: Three-Dimensional Telemedicine Taxonomy Model

Above diagram excerpted from Bashshur, Shannon, Grigsby and Krupinski 2011

Bashshur, Shannon, Grigsby and Krupinski (2011) wrote that the boundaries between telemedicine, telehealth, e-health, are blurry, partly because of the overlap between medicine and

public health. The authors wrote that telemedicine included: The electronic acquisition, processing, storage, retrieval, and exchange of information to promote health, disease prevention, treatment, management of chronic illness, rehabilitation of the disabled, and protection of public health and safety."

5.3 Nepal, Li, Jang-Jaccard and Alem Taxonomy

In 2014, Nepal, Li, Jang-Jaccard and Alem came up with a taxonomy that they claim combines the Bashshur, Shannon, Grigsby and Krupinski and Tulu, Chatterjee, and Maheshwari taxonomies. They divided the taxonomy into the areas health domains, health services, technologies, communication infrastructure and environment settings as represented by Figure 13. Health domains include cancer, mental health, diabetes, cardiovascular diseases and respiratory diseases.

Figure 13 Nepal, Li, Jang-Jaccard and Alem Health Care Taxonomy
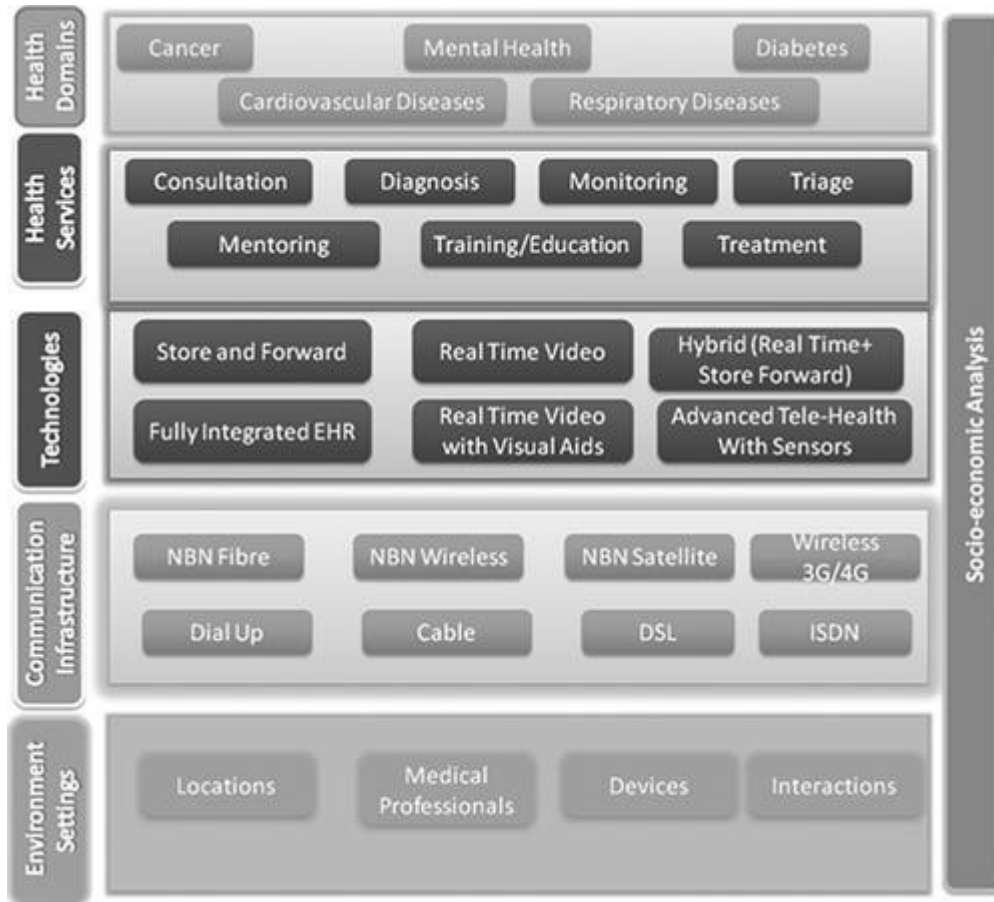
Above diagram excerpted from Nepal, Li, Jang-Jaccard and Alem 2014

For health services, the authors adopted the definition of health service of the Australian Privacy Law and Practice: " a. an activity performed in relation to an individual that is intended or claimed (expressly or otherwise) by the individual or the service provider to (i) assess, predict, maintain or improve the individual's physical, mental or psychological health or status; or (ii) diagnose the individual's illness, injury or disability; or (iii) prevent or treat the individual's illness, injury or disability or suspected illness, injury or disability; or b. a health-related

disability, palliative care or aged care service; or c. a surgical or elated service; or d. the dispensing on prescription of a drug or medicinal preparation by a pharmacist." Clinical health services include triage, diagnostic, treatment, consultation, monitoring, and case review. Non-clinical health services include education, training, supervision and administration, as shown in Figure 14.

Figure 14 Nepal, Li, Jang-Jaccard and Alem Health Services Ontology
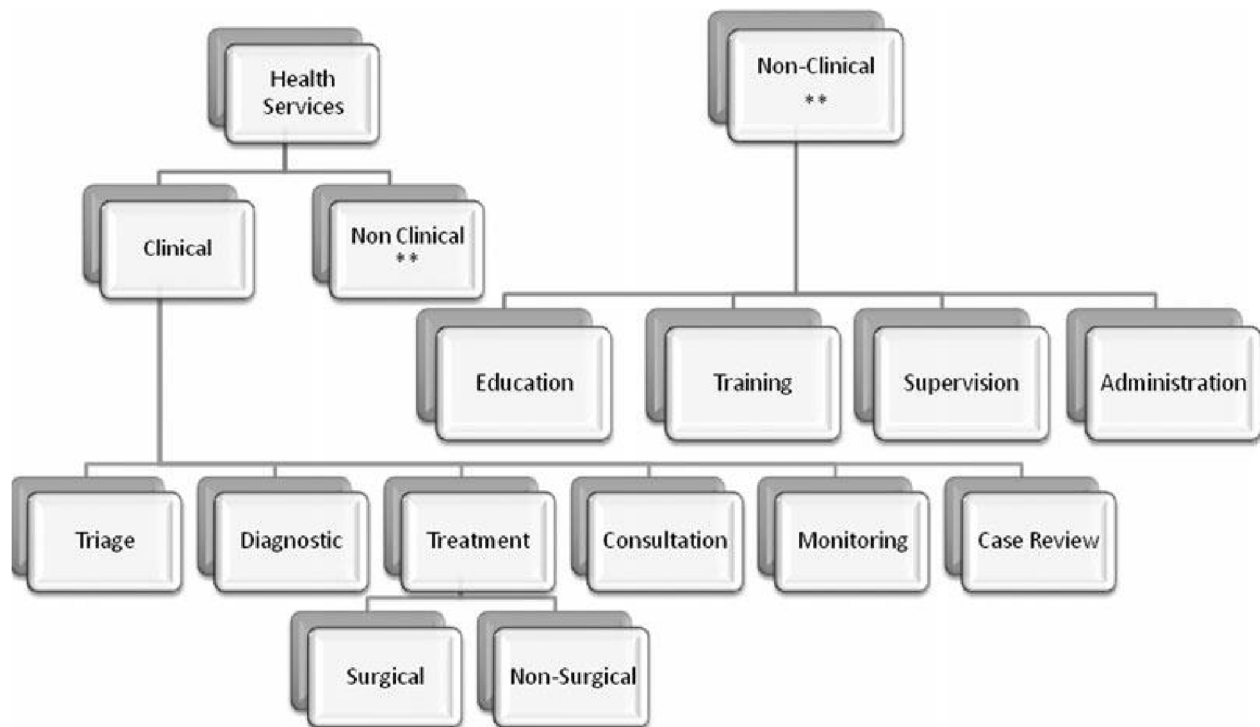
Above diagram excerpted from Nepal, Li, Jang-Jaccard and Alem 2014

Technologies in the Nepal, Li, Jang-Jaccard and Alem taxonomy include store-and-forward, real-time video, hybrid (real-time and store-and-forward), fully integrated HER, real-time video with visual aids, advanced telehealth with sensors. Communication infrastructure included NBN fiber, NBN wireless, NBN satellite, wireless 3G/4G, dial up, cable DSL and ISDN. Environment settings include locations, medical professionals, devices (such as body and environmental sensors and audiovisual devices) and interactions. The socioeconomic evaluation, the authors wrote, cuts across all five components of their taxonomy and includes costs, benefits, barriers and clinical outcomes, as seen in Figure 15.

Figure 15 Nepal, Li, Jang-Jaccard and Alem Socioeconomic Factors in Telemedicine
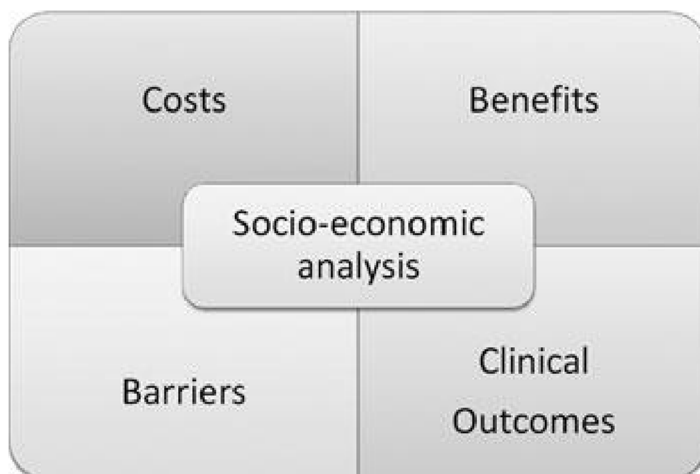
Above diagram excerpted from Nepal, Li, Jang-Jaccard and Alem 2014

5.4 Comparison of Taxonomies

In the following section, the taxonomies will be renamed as follows:

Tulu, Chatterjee and Maheshwari	I
Bashshur, Shannon, Grigsby and Krupinski	II
Nepal, Li, Jang-Jaccard and Alem	III

Both the I and the II taxonomies have an applications component. The clinical section of the I taxonomy relates to the disease section of the applications dimension of the Bashshur, Shannon, Grigsby taxonomy because they cover medical area or disease. The asynchronous/synchronous part of the technology dimension of the I taxonomy are similar to the synchronicity section of the technology dimension of the II taxonomy.

Both taxonomies have a technology dimension. The synchronicity part of the II taxonomy relates to the synchronous and asynchronous part of the I taxonomy and the technologies part of the III taxonomy. The network and connectivity parts of the II taxonomy relates to the bandwidth part of the I, although not precisely and the communications section of the III taxonomy. There is no peripheral section of the II taxonomy. There is no perspective dimension in the II and III taxonomies as there is in the I taxonomy. The perspective dimension covers the human aspect of the provider, client or society.

The mentor part of the functionality dimension of the II taxonomy relates somewhat to the education section of the applications dimension of the I taxonomy and the telementoring under the health services are of taxonomy III because they deal with teaching and learning about

health and telemedicine. The diagnosis and consultation and sections of the functionality dimension of the II taxonomy relates to the clinical and perhaps the public health part of the application dimension of the I taxonomy and to the diagnosis and consultation of the health services of the III taxonomy because these areas deal with the patient-physician relationship, diagnosis and clinical care. The perspectives dimension of client, provider and society in the I taxonomy does not directly correspond to any section of the II or III taxonomy.

The health areas in the III taxonomy, which include diseases, encompass II's applications section. Some of III's health services are included in II's functionality dimension — diagnosis, consultation, monitoring, and mentoring and I's clinical section. All of III's health services are included in the application purpose dimension of I's taxonomy, except for monitoring and triage. Many more categories were included in I's application purpose, as is represented in Figure 5. Specific examples are clinical trials and continuing medical education under non-clinical aspects of the application purpose and patient case review and legal/judicial proceeding under clinical aspects of application purpose and patient case review and legal/judicial proceeding under clinical aspects of application purposes.

The I and II taxonomies were not so specific in communication infrastructure and the III taxonomy is. II's taxonomy did not break this dimension down to such levels as ISDN, DSL, etc., while I's taxonomy did not include such things as dial up, cable or NBN fiber, wireless or satellite per se. In II's taxonomy, communication infrastructure is included as "connectivity" under the technology dimension. Technology in II's taxonomy includes synchronicity, network and connectivity, while in I's taxonomy it includes real-time and store-and-forward technology under their applications part of the delivery options, but does not include hybrid technology, fully integrated EHR, real-time video with visual aids or advanced tele health with sensors as in III's

taxonomy. Environmental settings are not included in II 's taxonomy. They are included under the delivery dimensions of II's taxonomy under environmental settings, which include more categories than III's environmental settings dimension, as represented by Figures 5 and 13.

These taxonomies appear to reflect some of Hjørland's epistemological stances: Empiricism, such as when the creators look at existing data indicated on telemedicine applications, such as the numbers of telemedicine programs that are used for certain purposes, or the amount of technologies used in telemedicine; rationalist, where the taxonomy creators use logical division and/or eternal and unchangeable categories emphasizing reasoning to come up with dimensions and parts of dimensions; historicist, when the taxonomy creators consider the changing telemedicine technology uses over time and technology and how different providers and patients use telemedicine in different places and cultures such as hospitals and other centers; and pragmatic, considering goals and usage of telemedicine such as public health or various clinical uses. At the same time, the divisions are subjective based on the culture, experience, work background, etc., of the creators.

5.5 Proposed Taxonomy

I combined what appeared to be the most important sections and topics in telemedicine after a thorough literature review, and created my own taxonomy.

Each of these areas is representative of specific telemedicine programs and are crucial in their functioning. For instance, there may be a telemedicine program that uses real-time technology to diagnose and monitor heart functioning in a hospital, using video and audio equipment to communicate with nurses and doctors. Patient information has to be private and secure. The cost of the equipment to the hospital, legal policy and reimbursement for health care professionals and the hospital are important, as are access and cost to the patient. From this

example, it is evident that all areas of this taxonomy are taken into account. Some of the nonclinical technology applications of the Tulu, Chatterjee and Maheshwari taxonomy, such as patient billing and scheduling and meetings were not included in this taxonomy because I do not consider these to be within the scope of the telemedicine definition that involves diagnosis and treatment. For instance, the ATA defined telemedicine as the use of medical information exchanged from one site to another via electronic communications to improve a patient's clinical health status. More information as to the definition of telemedicine will emerge from the results of this research.

Figure 16 Proposed Taxonomy

Health Areas	Diseases (diabetes, cancer, etc.)
	Types of telemedicine (teleradiology, telepathology, teledermatology, telesurgery, etc.)
Health Services	Diagnosis, monitoring, treatment, education, triage, rehabilitation, physical therapy, public health
Socio-economic Issues	Legal policy, cost (equipment, training, etc.), reimbursement, barriers to patients (access, cost, literacy)
Communications	Devices (video, audio), NBN fiber, wireless and satellite, ISBN, dial-up, cable, privacy, security
Technology	Asynchronous (store-and-forward), synchronous (real-time), hybrid, Hardware peripherals
Environmental Settings	Hospital, clinic, pharmacy, academic setting, veterans hospital or institution, NASA, military

5.6 Summary

Important aspects of telemedicine that are taken into account with taxonomies include: types of disease and care; areas of telemedicine, such as teleradiology; delivery methods, such as telephone or wired/wireless; technology involved; and human, legal and financial aspects. Uncovering the topics most prevalent in the discourse communities of telemedicine will allow for further validation of existing taxonomies, expansion of these taxonomies to reflect the characteristics of emergent technologies in the field, and provide a more encompassing ontology of the sub-domains of telemedicine.

Nepal, Li, Jang-Jaccard and Alem's taxonomy is comprehensive. The Bashshur, Shannon, Krupinski and Grigsby taxonomy does not include the socioeconomic dimensions of cost, benefits, barriers and clinical outcomes. The Tulu, Chatterjee and Maheshwari taxonomy includes cost, budget, and financial settings under the organizational dimensions; however, this is not expanded in their diagram represented by Figure 5. In the Nepal, Li, Jang-Jaccard and Alem taxonomy, costs include time spent by medical professionals to learn technologies, workforce training, patient traveling and technology costs for medical professionals and patients. Benefits include financial benefits and social benefits and such as peer support, knowledge sharing, public health awareness and interhospital relationships. Barriers include regulatory, financial, cultural, technology and workforce training barriers. An example of cultural barriers is low access to the Internet or telemedicine technology. Outcomes include diagnosis, information flow, treatment and other patient care benefits or detriments of telemedicine.

Tulu, Chatterjee and Maheshwari's Figure 3 is more comprehensive than Bashshur, Shannon, Krupinski and Grigsby's or Nepal, Li, Jang-Jaccard and Alem's work when it comes to breaking down clinical and non-clinical applications, application areas such as medical specialties, environment settings, devices and applications under deliver option and communication infrastructures. Tulu, Chatterjee and Maheshwari's taxonomy also included the organizational dimensions of human resources, information technology management, and legal procedures and regulations. Nepal, Li, Jang-Jaccard and Alem mention in text that barriers in the socioeconomic evaluation include regulations.

Chapter 6
Methodological Background

In this chapter, the history of content analysis and bibliometrics are reviewed. In addition, the Armfield, Edirippulige, Caffery, Bradford study (2014) of telemedicine articles is discussed briefly.

6.1 Bibliometrics and Content Analysis Article

Armfield, Edirippulige, Caffery, Bradford, et al. (2014) used software tools to extract and process 17,932 entries in 2523 outlets in MEDLINE® with the topic of telemedicine. Frequencies of papers by year of author, publication, and outlet were calculated, ranked, charted and tabulated. Frequency of publication by author was also calculated, ranked and tabulated for the time periods 1970–1995 and 2009–2013. Content analysis of abstracts was conducted and tag clouds were created to identify key words and prominent themes. A total of 3152 (18%) articles were published in specialist telemedicine journals in both epochs. The authors found that 46,066 unique authors have contributed to the field, with 21,109 of them publishing in the period 2009–2013.

Content analysis suggested a change of focus from the technical to the clinical from the older to the newer time period. As a health care setting, the home appears to be emergent. The authors concluded that the maturity of the field and its accessibility to clinicians and policy makers remains unclear. The two top outlets overall and for the early period were the *Journal of Telemedicine and Telecare*, and then the *Telemedicine Journal e-Health* (formerly *Telemedicine Journal*). For the new time period, the most common outlets were first *Telemedicine Journal*

eHealth and then the *Journal of Telemedicine and Telecare*. Richard Wootton was found to be the top all-time author.

After content analysis, the authors found that the most popular terms in the older time period were: imaging systems, telemedicine, medical, patients, health and care. For the more recent time period, they were: patients, health, care, study, systems and telemedicine, suggesting a move to more concentration on patient care. (Although patients and care occurred in both time periods, they were more prominent in the more recent one.) Economics terms did not occur with prominence in either time period, suggesting that formal economic analyses in the field are not yet prevalent. Teleradiology and telepathology were considered the oldest applications of telemedicine.

6.2 Brief History of Bibliometrics

I used bibliometric techniques to find the most common topics in scholarly circles of telemedicine. I used facet analysis to search for journal articles in Scopus and related databases if necessary (Hjørland 2013). A random sample of journals was selected, based on statistical analysis of the results of the facet-based searching. Because this study is exploratory, no pilot study was conducted before the dissertation research. In situations where domain boundaries of a field have yet to be established, pilot studies are not considered necessary if the research is purely exploratory (see, for example, White and McCain 1998; Jank 2010; Hoeffner and Smiraglia 2012). This allows for the identification of empirical domain data that can be used in the development of hypotheses for future research. The epistemological stances of the discourse community were determined and were combined with a variety of content analytical techniques. These led to a proposed taxonomy and ontology of telemedicine of the published scholarship in

this field thus far. A brief overview of some bibliometric techniques is provided here in order to help establish context for the dissertation study.

The term "statistical bibliography" was introduced by Edward Wyndham Hulme in 1922 when he delivered two lectures as the Sandars Reader in Bibliography at the University of Cambridge (Pritchard 1969). Alan Pritchard and by Nalimov and Mulchenko in 1969 almost simultaneously introduced the terms bibliometrics and scientometrics. Pritchard (1969) defined bibliometrics as "the application of mathematical and statistical methods to books and other media of communication." Nalimov and Mulchenko (1969) defined scientometrics as "the application of those quantitative methods which are dealing with the analysis of science viewed as an information process". Their definition pertained to science research specifically. Alan Pritchard claimed that, before he used the term bibliometrics in 1969, it was used twice: In 1944 when Gosnell used it in a paper on obsolescence of literature without acknowledging its previous use, and in 1962 by Raisig in a critical essay on citation studies. He used the term to refer to the quantitative analysis of written documents to monitor scientific policies. According to the Centre for Research & Development Monitoring, in 1926,

Alfred J. Lotka published his study on the frequency distribution of scientific productivity and in 1927, Gross and Gross published their citation-based study of 3633 citations in order to aid small college libraries in purchasing chemistry periodicals. Their study is considered the first citation analysis, although it is not similar to present-day bibliometrics. In 1934 Bradford (1934) established a relationship concerning the frequency distribution of papers over journals. In particular, he found that if scientific journals on a given subject are arranged in order of decreasing productivity, they may be divided into core journals more particularly devoted to the subject.

The goal of bibliometrics is to contribute to the analysis and evaluation of science and research. This shows its usefulness in scientific literature evaluation, according to the Centre for Research & Development Monitoring. According to the Centre for Research & Development Monitoring, bibliometrics "can develop and provide tools to be applied to research evaluation, but is not designed to evaluate research results. A shortcoming is that results can be misinterpreted using this quantitative method (De Bellis 2009). For instance, if an author has contributed one work, the author may be deemed an insignificant contributor, yet that work may be a seminal work of the domain. Therefore, qualitative techniques such as content analysis can be used with bibliometrics to assure more well-rounded results.

6.2.1 Bibliometric Techniques

A number of bibliometric techniques were employed in order to examine the discourse community of telemedicine. Citation analysis involves the examination of the frequency, patterns, and graphs of citations in scholarly articles and books to find relations in the research between authors and commonly discussed topics of research. The number of times an article has been cited in published research gives clues about that article's impact on its discipline. Rubin (2010) wrote that citation analysis examines the frequency, patterns, and graphs of citations in journal articles and books. Patterns in leading scholarship, scholarly partnering, important research, core canons, and more can be identified and analyzed. Counting the number of times a work has been cited by other scholars may reveal its importance and impact on a discipline. Finding articles that list an author or work may reveal information about a discipline or topic within it.

Journal citation analysis revealed the most common journals that publish articles on key telemedicine topics. As a result of this research, scholars may find out which journals, including some that may not have been considered prior, can be consulted for relevant telemedicine topics.

6.3 Content Analysis

Content analysis is a qualitative research method conducted for systematically analyzing and making inferences from text (Weber 1985). According to Schutt (2001), content analysis consists of a systematic analysis of the contents of documents or other records. Units are coded to measure the variables involved in the research question. Researchers quantify and analyze the presence, meanings and relationships of words and concepts, and then make inferences about the messages within a text. Content analysis can be performed on journal articles, open-ended interview question transcripts and other texts to find themes and topics. One use of content analysis is to find out the intentions, focus or communication trends of an individual or group (Colorado State University 2013).

In 1931, Alfred R. Lindesmith developed a methodology which became known as a content analysis technique. Glaser made it popular in the 1960s and referred to it as The Constant Comparative Method of Qualitative Analysis. Glaser and Strauss (2012) adapted it to formulate Grounded Theory. Coding reduces the data to a manageable mass and any piece of text can be coded in many different ways. Hierarchical coding exists when there are a number of categories that exist taxonomically. Major groups here are referred to as branches and sub-groups are twigs. Major group can be divided into sub-groups, which can then be divided further, if necessary. This is the approach that was utilized in the axial coding processes of this research.

Although it is common to employ the use of multiple coders during content analysis research – inclusive of inter-coder reliability testing – this is only necessary when codes are being applied independently by individual researchers (Bradley, Curry and Devers 2007; Glaser and

Strauss1967). In instances such as this, inter-coder reliability is not necessary, since automated computer coding is employed (Hoeffner and Smiraglia 2012; Jank 2010; White and McCain 1998).

In their literature review, Currell, Urquhart, Wainwright and Lewis (2000) found that some of the major themes in the studies of telemedicine were: use of teleconsultation; diagnostic accuracy of systems for teleradiology and telepathology; technical development and standards: the medical needs of under-served populations; acceptability of telemedicine to providers and patients; evaluation of frameworks for telemedicine; and how telemedicine services might be funded and regulated. These themes resulted in a taxonomic like structure in which scholarly ontologies could be grouped.

6.4 Summary

Armfield, Edirippulige, Caffery, Bradford, et al. (2014) conducted a bibliometric and content analysis review of telemedicine material in MEDLINE in two time periods. They found the most popular authors, outlets and topics. This study was more comprehensive in that more than one keyword (telemedicine) was used and the years 1996-2008 and also 2014 to the beginning of 2015 were covered.

Bibliometric techniques were used to find the most common topics in scholarly circles in telemedicine. Facet analysis were used to search for journal articles in Scopus. A random sample of journals wes used to uncover the most commonly cited authors. The epistemological stances of the discourse community were determined and were combined with a variety of content analytical

techniques. These led to a proposed taxonomy and ontology of telemedicine, as well as a socio-epistemological map (Hjørland 2007) of the scholarly discourse in telemedicine.

Chapter 7
Methodology

This chapter describes the methodology used in this study to uphold the objective. The problem statement and research questions are described. The methods used to answer each research question are explained.

7.1 Objective of Study

The objective of this study is to discover and gain a better understanding of the discourse community of telemedicine to advance knowledge and research in telemedicine that will benefit providers and patients. Published peer-reviewed research and trade articles of telemedicine were searched for and retrieved using keywords related to telemedicine to reveal the discourse of scholars and research topics and methods. Bibliometric techniques as well as content analytic methods were used. References at the end of journal articles were analyzed, as they reveal the relevance and relationship of past research to the current research.

References reveal information about scholarship that contributes to discourse communities. Examples of this data include author, title of research, journal of publication, year of publication and place of publication. A universe of interconnected knowledge can then be revealed. Bibliometric analysis of the core literature in a discourse community reveals authors who publish the most articles and books in a certain domain, authors who are cited the most, and journals where most research within a domain is published. This reveals important information about the concerns, research and topics of a field in different time periods, as well as what might be important for future research.

7.2 Problem Statement

Several issues and categories of telemedicine have been a priority in scholarly journals. No study thus far has examined scholarly journals to aggregate and analyze the prevalent issues in the discourse community of telemedicine. The purpose of this dissertation is to empirically document the prominent topics and issues in telemedicine by examining the related scholarly discourse. Not enough evaluative research has been conducted in telemedicine (Perednia and Allen 1995; Desai, McKoy, and Kovarik 2010; Zanni 2011). This study will contribute to the field of telemedicine research and care by documenting a comprehensive taxonomy of discussed topics and concerns in telemedicine, and summarizing the ontological constructs of its discourse. Identifying the topics most discussed in telemedicine will help guide future evaluation studies of telemedicine. This research should assist health care professionals who work in the fields of telemedicine to better understand research findings in the field, and understand how to apply this research to improve health care practice and implement telemedicine programs. Health care scholars and practitioners may be able to use this aggregate view of key topics in telemedicine to be informed for future decisions and programs by seeing who some of the main authors and journals dealing with telemedicine are, what some major concerns are and the taxonomy of the different relevant topics of telemedicine.

7.3 Research Questions

In order to ascertain a discourse community or domain of telemedicine scholarship, I utilized research questions similar to those documented by White and McCain (1998), Hjørland (2002), Jank (2010), and Smiraglia and Hoeffner (2012). These approaches to domain analysis are appropriate when studying interdisciplinary fields of study (Sugimoto, 2008).

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In preparation for answering the research questions discussed below, I delineate here the steps that were taken in preparation for doing so. Each research question in the following pages is also operationalized. For an Outline of the methodology steps, see Appendix III.

Step 1. Online literature searching, using the facet analysis techniques documented above, was conducted on the Scopus database (which also includes MEDLINE® data) to establish the population frame. The N = 2000.

Step 2: I then used the standard social science random sample formula to calculate the sample set variable population.   The formula for establishing the necessary random sample size is the standard statistical calculation for the social sciences, where:

n = sample size
z = curve value for confidence interval (1.96)
N = items in the sampling frame (2203)
p = expected proportion (.50, based upon probabilities indicated by the hypotheses)
E = tolerable error (.05)
n = $\dfrac{z^2Np(1-p)}{NE^2 + z^2p(1-p)}$

```
Required Sample Size

n =    (3.8416)(2203)(.5)(.5)        =  2115.76   = 327
     (5.5075) + ((3.8416)(.5)(.5))       6.47
```

Step 3. I then used Excel software to build a random number selection list to identify the records to be selected from the population frame. I used this Web site https://www.extendoffice.com/documents/excel/643-excel-random-number.html#excel to generate a random number selection list from sample of 1 – 1000. This is because I needed more than 327 numbers in case some of the records were duplicates or could not be used because they were from veterinary sources.

I used matrix numbers starting from the left column, working my way to the right, from top to bottom of each column. I exported the correct records to MS-DOS. Items necessary for research were in turn exported to Word pad. Each was entitled "text." Items or fields exported to notepad were author; title; journal title; year; country; author keywords; index keywords. The year, country and keywords were counted manually.

Duplicates were discounted. For example, if the numbers 2, 8, 100, and 120 represented the same article of the Scopus search, i.e. if one article was retrieved more than one time and those numbers of the matrix represented it, the article was counted once. Articles were discounted if they were articles from veterinary journals as well. Once 327 original journal articles of the random sample were found, the matrix was put away.

Research Question 1:

What are some discursive characteristics evident in the professional literature of telemedicine?

To answer this question, I analyzed both terms and themes. I examined articles in the sample set and itemized the occurrences of various words. I looked at author and index keywords in each of the 327 records in the sample set and copied them all onto an Excel file. I alphabetized these words. I then manually placed them in categories in the taxonomy: health areas, health services, technology, communication, environment and socio-economic.

Hypotheses

As a result of the literature review above, I have drawn the following hypotheses. These are being included in Research Question 1 in order to explore certain potentially significant themes within the discourse community of telemedicine.

Hypothesis I. More than 50% of the identified research on telemedicine will include a discussion of cost.

Hypothesis II. More than 50% of the identified research on telemedicine will include a discussion of technology.

Hypothesis III. More than 50% of the identified research on telemedicine will include a discussion of diagnosis.

Hypothesis IV. More than 50% of the identified research on telemedicine will include adiscussion of treatment.

Research Question 2:

What are some of the bibliographic characteristics of the published scholarship in telemedicine?

To answer this question, I examined a number of bibliographic characteristics that relate to telemedicine scholarship, such as publication years, leading journals, and countries of contributive scholarship. Excel worksheet keywords were examined to extract journal titles, years and countries of research for the 327 sample records. Each was placed in a separate Excel sheet.

For countries, if authors of each record were from different countries, all countries were listed and counted. Countries were put in alphabetical order and then counted for statistics.

Research Question 3:

Who are the leading authors in the field of telemedicine, and in what journals do they publish?

Author names were extracted from the 327 random sample records and placed in alphabetical order in an Excel spreadsheet. Author names were counted and statistics were created. Journal titles were extracted from 327 random sample records and placed in alphabetical order in an Excel spreadsheet. Top journal titles were determined and statistical charts were created. Authors and journals were ranked according to the number of times they occur and constructed frequency distributions. Works by these authors revealed key questions and issues in telemedicine.

Research Question 4:

What are the epistemological characteristics of the discourse community of telemedicine?

Titles and abstracts of the 327 random sample records were read, examined and categorized according to Hjorland's epistemological categories of empirical, rationalist, pragmatist or historicist. One article could be in more than one category if the paradigm in which it was studied and written was in fact more than one.

Each time an article fell into one or more categories, the categories were marked on an Excel worksheet list. This list was alphabetized and the occurrences of different categories were counted. A pie chart was created to represent these occurrences.

This revealed what areas and methods of study correspond to telemedicine, what the prominent publishing characteristics of telemedicine problems might be, and where telemedicine research is concentrated.

Research Question 5:

Is there evidence of a taxonomic or ontological structure in the professional discourse of telemedicine?

The most common terms used in keywords, titles and abstracts of articles were mapped and similarities to and differences from this taxonomy were noted. This revealed the potential hierarchical or classification structure of telemedicine scholarship, as well as its ontological characteristics. A total of 1619 author and index keywords were copied from each record and entered into Excel. They were sorted in alphabetical order. Then, duplicates were removed. Keywords were categorized and fit into one of the six categories of the Proposed Taxonomy:

Health Areas, Health Services, Technology, Communications, Environment or Socio-economic. Keywords fit neatly into these areas.

In knowledge organization, text is examined and an ontology and taxonomy are drawn up. In information science, an ontological framework names and defines the types, properties and interrelationships of the entities in a discourse community. An ontology is filled by keywords found in text and depicted within these characteristic frameworks.

Results of this analysis confirmed the taxonomies of Nepal, Li, Jang-Jaccard, and Alem (2014), Bashshur, Shannon, Krupinski, and Grigsby (2011), and Tulu, Chatterjee and Maheshwari (2007), or as well as the proposed taxonomy.

Research Question 6:

Does the discourse community of telemedicine suggest scholarly coherence either as a domain or discourse community?

Patterns of scholarly citation activity can reveal key authors, areas of interest, and topics and concerns in the field of telemedicine. Further, they can also suggest whether a coherent domain or discourse community exists (Hoeffner 2012 and Hoeffner and Smiraglia 2012). The amount of journal articles written by the same author was noted. The number of articles by one, two, etc. authors was noted and indicated that telemedicine is still a discourse community.

7.4 Research Strategy

7.4.1 Facet Analysis

When determining values for the sample selection formula, coming up with an appropriately random selected sample for the study is key. Indian librarian and pioneer in modern information science S.R. Ranganathan developed his faceted classification scheme in the 1930s

(Hjørland 2013). The scheme recognizes that any given subject has many aspects that can describe the subject. Some aspects of telemedicine are medical terms, telemedicine terms and thematic terms. After the literature review, the following descriptive terms were documented:

Table 7 Facet Analysis

Telemedicine Services	Medical Terms	Application Terms
Telemedicine	Teleradiology	Store and forward
Tele-medicine	Telepathology	Store-and-forward
Telehealth	Teleoncology	Real-time
Tele-Health	Teledermatology	Real-time
Telecare	Telesurgery	Videoconferenc*
Tele-care	Telepsychiatry	Video-conferenc*
Teleconsult*	Telerehabilitation	Asynchronous
Ehealth	Teleproctor*	Synchronous
e-Health		Mobile phone
Emedicine		Informatic*
e-medicine		Computer*
Mobile health		Militar*
Telenurs*		Veteran*
Telemonitor*		Internet
		Web
		Hospital*
		Computer
		Technology
		Network
		Cost

Terms associated with telemedicine in the MEDLINE® thesaurus include telehealth; ehealth; mobile health; health; health, mobile; teleradiology; telepathology; telemetry; and remote monitoring. Variations of these key words are accounted for in the facet table provided here.

The Scopus search term was:

telemedicine OR "tele-medicine" OR telehealth OR "tele-health" OR telecare OR "tele-care" OR teleconsult* OR ehealth OR "e-health" OR emedicine OR "e-medicine" OR "mobile health" OR telenurs* OR telemonitor*) AND TITLE-ABS-KEY (teleradiology OR telepathology OR teleoncology OR telesurgery OR telepsychiatry OR teledermatology OR telerehab* OR teleproctor*) AND TITLE-ABS-KEY ("store and forward" OR "store-and-forward" OR "real time" OR "real-time" OR videoconferenc* OR "video-conference*" OR asynchronous OR synchronous OR mobile OR informatic* OR computer *) AND TITLE-ABS-KEY (militar* OR veteran* OR internet OR web OR hospital* OR computer OR technol ogy OR network OR cost

7.4.2 Determining Sample Size for Research

I conducted a pre-test of my faceted analysis in order to determine the viability of my faceted search strings and the probability of working with a viable population frame. This number was plugged into a formula to randomly select documents to be studied:

n = sample size
z = curve value for confidence interval (1.96)
N = items in the sampling frame (2203)
p = expected proportion (.50, based upon probabilities indicated by the hypotheses)
E = tolerable error (.05)
n = $\dfrac{z^2Np(1-p)}{NE^2 + z^2p(1-p)}$
Required Sample Size

n = $\dfrac{(3.8416)(2203)(.5)(.5)}{(5.5075) + ((3.8416)(.5)(.5))}$ = $\dfrac{2115.76}{6.47}$ = 327 |

Hence, 327 records were randomly selected to constitute the sample set for analysis.

7.4.3 Compiling Data

Scopus was chosen as a database because it is the ultimate aggregator of online data, including the contents of MEDLINE®, the online database of the National Library of Medicine. Scopus also offers author profiles covering affiliations, publications with bibliographic data, references, and details on the number of citations each published document has received.

The results of the faceted database searching constitute the population frame. Boolean searching with AND and OR were used to collect the potential articles that served as this population frame – the collection from which the testing sample were drawn. As previously

mentioned, facet analysis was used to establish the terms to be utilized for searching for relevant journal articles. This may retrieve too many samples, false drops or double repeats. For instance, the same article may be retrieved twice because an author's name is spelled differently each time, or there could be duplicate coverage of articles within Scopus, which is an aggregator rather than a publisher itself. The use of controlled vocabulary may reduce the instances of the above, however, that is not important because purposive sampling allows for rejection of individual items when their inclusion does not appropriately represent the topic being studied.

This is common practice in domain analysis (White and McCain 1998, Jank 2010). Given the variety of terminology utilized in the telemedicine field (such as telehealth and e-Health) and the variety of topics revealed in the literature review (such as technology, patient physician relationship, reimbursement, diagnosis, treatment, history, implementation and more), a large sample size is expected to be retrieved. The ultimate sample size was determined utilizing the standard statistical formula mentioned above. This included random sampling calculations for determining the size of the representative sample, and random number generation for identifying the individual items to be selected for analysis using this formula.

I found the authors of each record in the random sample. I entered their names into Excel and then put the list in alphabetical order. I counted how many times each author was mentioned. I used that information for the most prominent author information and Zipf table.

Chapter 8

Data Collection and Results

This chapter reviews the data collection procedure for each research question. Data collection took place in June 2015 using the Scopus database. Limits by time or year were not placed and records were retrieved by June 2015.

8.1 Research Question 1:

What are some discursive characteristics evident in the professional literature of telemedicine?

The 327 records were examined and a list in Excel was created to show main subject areas of each record. The following was discovered.

Hypothesis I. More than 50% of the identified research on telemedicine will include the discussion of cost.

This hypothesis was not supported. A total of 64 out of 327, or 20% of records had cost as at least one main subject. Although cost is an underlying important aspect of every telemedicine program, perhaps this was not a subject to be discussed in scholarly publications as much as other subjects were.

Hypothesis II. More than 50% of the identified research on telemedicine will include discussion of technology.

This hypothesis was supported. A total of 275 or 84% of records had technology as one main subject. A total of 192 or 59% of records featured technology as the only main subject of the source. It seems that, while diagnosing, treating and increasing access for patients may be a primary goal for telemedicine, this cannot be practically done without the underlying technology involved in every telemedicine program, from mobile health to secondary diagnosis.

Hypothesis III. More than 50% of the identified research on telemedicine will include discussion of diagnosis.

This hypothesis is not supported. A total of 113 out of 327, or 35% of records had diagnosis as one main subject.

Hypothesis IV. More than 50% of the identified research on telemedicine will include discussion of treatment.

This hypothesis is not supported. A total of 93 out of 327, or 28% of records had treatment as one main subject.

In the literature review, technology, cost, diagnosis and treatment were found to be discussed to a great extent. Technology was one of the most popular journal article topics, and in the random sample, it was the only one of the three hypothesis topics to be discussed in more than half of the research articles.

8.2 Research Question 2

What are some of the bibliographic characteristics of the published scholarship in telemedicine?

To answer this question, each of the 327 records was examined and years of publication, journal titles and countries of research scholarship were each recorded in separate Excel Workbooks. Table 8 and Figure 17 represent the year of publication of sources, primarily journals, in the sample set. Year limitation was not entered during the Scopus search. Yet only one source retrieved had a date in the 1990s. The year from which most sources were retrieved was 2011. More than 30 sources were obtained from years 2008, 2009, 2011 and 2012. The search went into June 2015, but year data for this year were not plotted because they would be
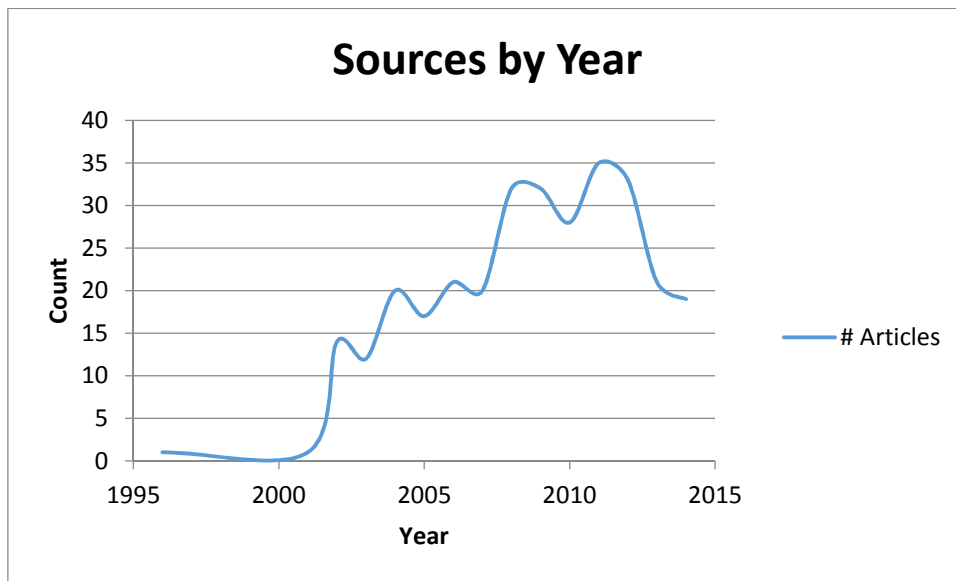
incomplete. As can be seen most clearly from Figure 17, a linear increase of sources per year was not found. There was a steep increase between 2001 and 2002, from 1 to 14 sources. This may have been due to advances in the Internet such as online medical sources, during that time.

There was another increase from 2007 to 2008, from 20 to 32 sources. The number of sources from 2012 to 2014 decreased to that before 2008.

Table 8 Sources by Year

| Year of Publication	Number of Documents by Year of Publication
1996	1
2001	1
2002	14
2003	12
2004	20
2005	17
2006	21
2007	20
2008	32
2009	32
2010	28
2011	35
2012	33
2013	21
2014	19

Figure 17 Sources by Year

The shape of the graph supports telemedicine as a discourse community, and not as a domain. While the number of publications rises by year between 2000 and 2011, there is a substantial drop between 2011 and 2013, another small drop to 2014. Perhaps with initial excitement on the topic of telemedicine, since it expanded greatly in the late 1990s with the Internet, an increase of published scholarly research occurred. This may wane a bit or expand each year, while in a domain there is usually an annual increase in academic literature as the discipline gets established. In a domain there are also a known core group of authors and journals, a high co-occurrence of authors, a library classification, and courses taught at universities under the umbrella of the domain. An example is psychology with divisions of psychology such as cognitive psychology (Tennis 2003).

Table 9 Contributions per Country in 327 Records

Country	Number (n)	(n/327) %
United States	100	30.6
Canada	20	6.1
Spain	18	5.5
Italy	17	5.2
Australia	15	4.6
United Kingdom	14	4.3
Germany	13	4
France	11	3.1
South Africa	9	2.8
Austria	9	2.8
Netherlands	9	2.8
Brazil	8	2.4
Japan	7	2.1
Poland	7	2.1

Table 9 shows that, by a large percentage, records from the United States (33%) predominated in the random sample. Of the top six countries, Spain and Italy (third and fourth) did not have English as the main language. At least 158 of the 327 records, or 48%, were sourced from an English-speaking country, showing the high occurrence of English in the spread of telemedicine information. At the same time, countries where English is not the main language were a good source of telemedicine documents, showing the importance of telemedicine in many areas of the world. The fact that the United States was by far the country source of most telemedicine articles may be because of the tradition of innovation and high amount of research and development dollars in the country.

Figure 18 Country of Research and Number of Records
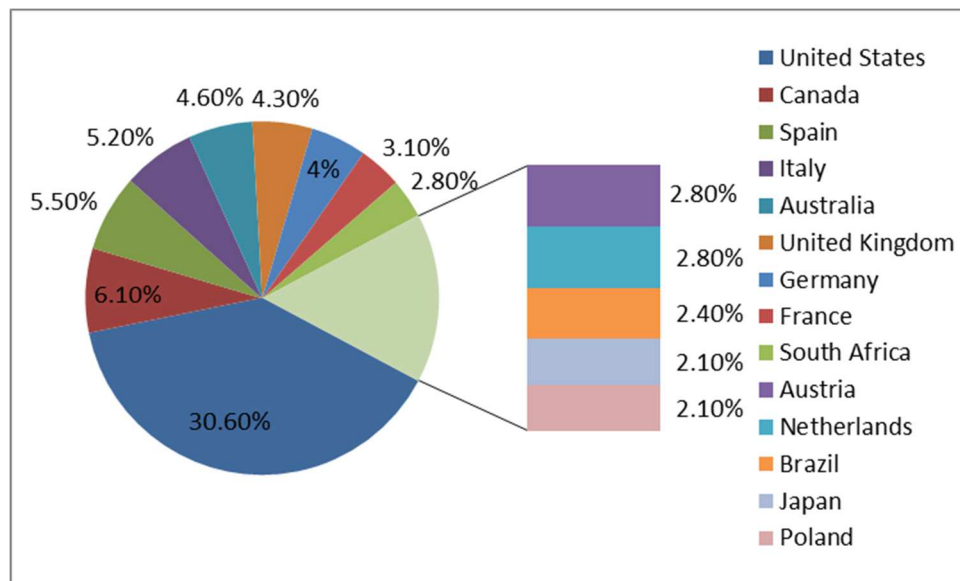
According to Figure 18, of the records retrieved, 30.6% involved research in United States institutions, followed by Canada, at a much lower percentage of 6%. Next were Spain and Italy with about 5%. Almost a third (32%) of countries affiliated with research found in the sources were affiliated only one time each. Every continent except for Antarctica was represented. Countries included: United States, Brazil, Egypt, France, Iran, Israel, Malaysia, New Zealand, and South Africa. The occurrences of the top countries affiliated with research in the records (each mentioned seven times or more), as a percentage of the records, composed 78.4% of the records. The table and figure show that telemedicine is widespread as a discourse community.

8.3 Research Question 3

Who are the leading authors in the field of telemedicine, and in what journals do they publish?

Author data was retrieved and counted from the 327 records. Table 10 records the frequency distribution of authors. Out of the 1051 authors found, 21 were found to be authors of 3 or more records. Some authors were encountered several times in the literature review, such as

Bashshur, Grigsby, Pak, Patel, Shore and Whited, but were encountered 0 (Bashshur, Grigsby) or 1 (Pak, Patel, Shore, Whited) time in the sample set. Some authors found 3 or more times in the search, such as Gilbert or Mat Kiah, were not encountered during the literature review. This may reflect a limitation in this random sample. Another set of numbers generated in Excel for a random sample may have brought up a different set of authors mentioned 3 or more times. A vast majority (899 authors; 85.6%) were found to be authors of one record. The next

largest author set, comprised of people who authored or co-authored two records, was only 11.4% (120 authors). Only one person authored or co-authored 6 or 8 records.

Table 10 Frequency Distribution of Authors

Author	Publication Frequency
Spadaro L	8
Gilbert GR	6
Mat Kiah ML	6
Holcomb M	5
Yen K	5
Braunberger PG	4
Gabriel, MH	4
Krone J	4
Martínez-García S	4
Moreno-Alvarez P	4
Cavallerano, A	3
Chrustowicz A	3
Documet J	3
Dwyer SJ	3
Godeau P	3
GurD	3

Hashizume M	3	
Low RK	3	
Ludvigsen JA	3	
MacCoubrey J	3	
McEntee, MF	3	
Palaian S	3	
Rutkowska-Talipska, J	3	
Samaniego-González E	3	
Savage R	3	
Visintin M	3	
Wirdnam M	3	

Table 11 Zipf Test

Number of Articles	Number of Authors	Zipf Calculation (Lotka's Law)
8	1	$327/(8^2)= 5$ (5.10)
7	0	$327/(7^2) = 7$ (6.67)
6	2	$327/(6^2) = 9$ (9.08)
5	2	$327/(5^2) = 13$ (13.08)
4	5	$327/(4^2) = 20$ (20.43)
3	17	$327/(3^2) = 36$ (36.33)
2	120	$327/(2^2) = 82$ (81.75)
1	899	$327/(1^2) = 327$

As per Table 11, at seven publications, Zipf's law is not supported; there are no authors who authored seven works in the random sample. This is further evidence that telemedicine is a discourse community, as the statistical product in the third column is not reflected in the data collection in the first column.

About 85% of authors in the random sample authored one document. This points to telemedicine being a discourse community, not a domain (Jank 2010, Hjørland 2002, White and McCain 1998). This may signal a discipline that is relatively new and has room to grow to a point where most authors have published two or more scholarly, peer-reviewed documents, gain experience in telemedicine, and work in established groups to develop telemedicine. In discourse communities, many people author a small amount of work each, while in domains, fewer people author a greater amount of work (Jank 2010). The authors in a discourse community usually are not specialized only in one area, such as telemedicine; the area is not yet established enough to be a domain.

8.3.1 Brief Biographical Sketches of Leading Authors

In Appendix II, I provide thumbnail biographical sketches of some of the leading authors as shown in Table 11, who have written 3 or more sources found by Scopus in the research sample the number three was a subjective choice. Most of the authors wrote one or two articles, while many authors also wrote three articles in the sample. I did not want to limit the selection to those who wrote four or more, since that would yield a very small amount of authors and important biographical sketches may have been overlooked.

8.3.2 Contributing Source Titles in Sample Set

An overwhelming number of journal titles were found one or two times in the retrieval results of the sample set. Only four journals were the sources of 13 or more records: Studies in Health Technology and Informatics, Journal of Digital Imaging, Journal of Telemedicine and Telecare, and Telemedicine and e-Health (Telemedicine Journal and e-Health).

Table 12 Bradford Test

Source Title	Number of Articles	%	Type	Discipline
First Tier Journals				
Telemedicine and e-Health (Telemedicine Journal and e-Health)	35	10.7	Journal	Telemedicine
Journal of Telemedicine and Telecare	24	7	Journal	Telemedicine
Second Tier Journals				
Journal of Digital Imaging	16	5	Journal	Imaging
Studies in Health Technology and Informatics	13	4	Journal	Health Informatics

Third Tier Journals				
Journal of Rehabilitation Research and Development	6	1.8	Journal	Rehabilitation
Journal of the American Academy of Dermatology	6	1.8	Journal	Medical-Dermatology
Annual International Conference of the IEEE Engineering in Medicine and Biology	5	1.5	Conference	Medical-Engineering
European Journal of Radiology	5	1.5	Journal	Medical: Radiology
Actas Dermo-Sifiliograficas	4		Journal	Medical: Dermatology
International Journal of Health care Technology and Management	4	1.2	Journal	Technology
JAMA Dermatology	4		Journal	Medical-Dermatology
Methods of Information in Medicine	4		Journal	Medical Information

The journal article discipline was mostly medical (30.6%), followed by technology (4.5%), followed by information (3.4%). The latter suggests there is likely a relationship between the study of telemedicine and the study of information. Two telemedicine specialty journals garnered the most results: Telemedicine and e-Health, formally called Telemedicine Journal and e-Health, (10.7%) and the Journal of Telemedicine and Telecare (7%). Journals varied from general medical journals such as PLoSONE, MedInfo and Hungarian Orvosi Heitilap to specialty journals such as Human Pathology, Clinical and Experimental Dermatology and European Journal of Radiology. More than half (53%) of the conference sources were conducted by the Institute of Electrical and Electronics Engineers. This shows the importance of technology and robotics in telemedicine. Because sources derived from both journal articles and conferences, telemedicine is most likely a discourse community. Journals of different types contain its sources and people are getting together to find out more about it in conferences.

The Bradford distribution of journals, which utilizes groupings of frequency distribution to illustrate primacy or prominence in discourse, White and McCain (1998), is the following: frequency distribution 2 core or first-tier journals (24-35 articles each), 2 second-tier journals (13-16 articles each) and 2 third-tier (5-6 articles) journals. In a discourse community, various disciplines, whether they are domains or not, contribute to scholarly research. In a domain, research is usually sourced by a smaller number of journals, the sources constituting the domain itself (Jank 2010).

Almost 94.5% (309) of the sources retrieved were journal articles, 15% (17) were from conferences and 1 (.3%) was from a database. This also points to telemedicine being a discourse

community, rather than a domain (Jank 2010, Hjørland 2002, White and McCain 1998). Once more research in the area of telemedicine is done and studied, people will likely come together and hold conferences, discussing areas of telemedicine that are most important to them.

8.4 Research Question 4:

What are the epistemological characteristics of the discourse community of telemedicine?

I documented a number of epistemological characteristics evident in the literature. This revealed how telemedicine is most often studied. As shown in Figure 19, most documents by far were journal articles, showing that telemedicine may not be a full domain yet with many conferences occurring.

Figure 19 Count of Document Types

Database 0.1%
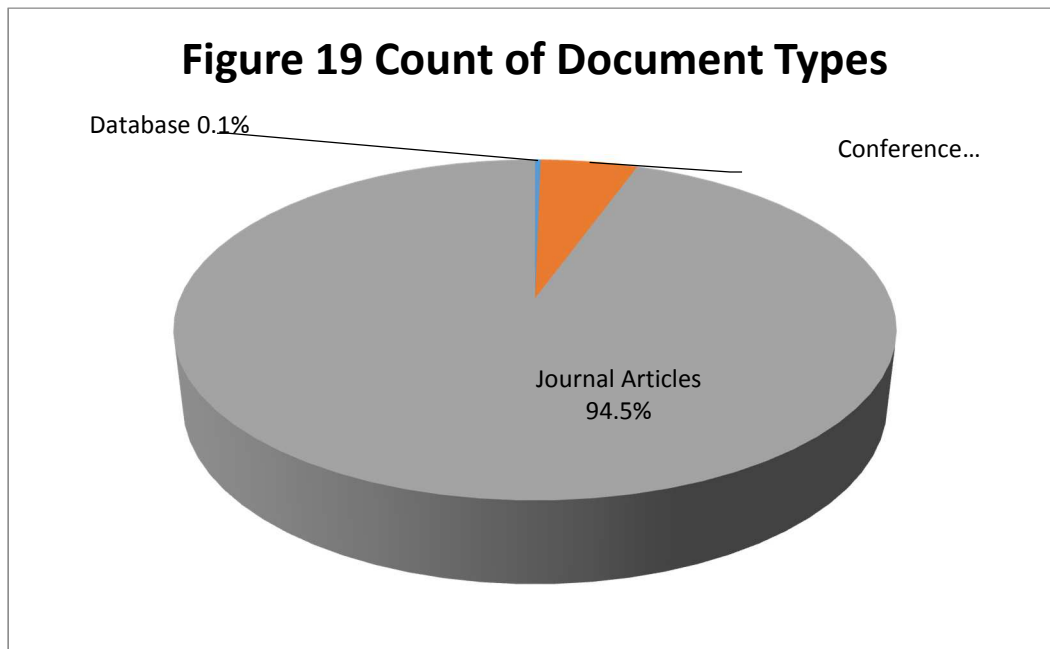
Conference...

Journal Articles
94.5%

Table 13 and Figure 20 show the results of counting which of the 327 are empiricist, pragmatist, rationalist or historicist, including if more than one term described one source. Most (212 finds from 327 records = 65%) were described as empiricist alone or in combination with

the other three terms. Historicist, alone or with other terms, was found to describe records the

least, .1% or 23 times out of 327 records. Table 14 summarizes the findings.

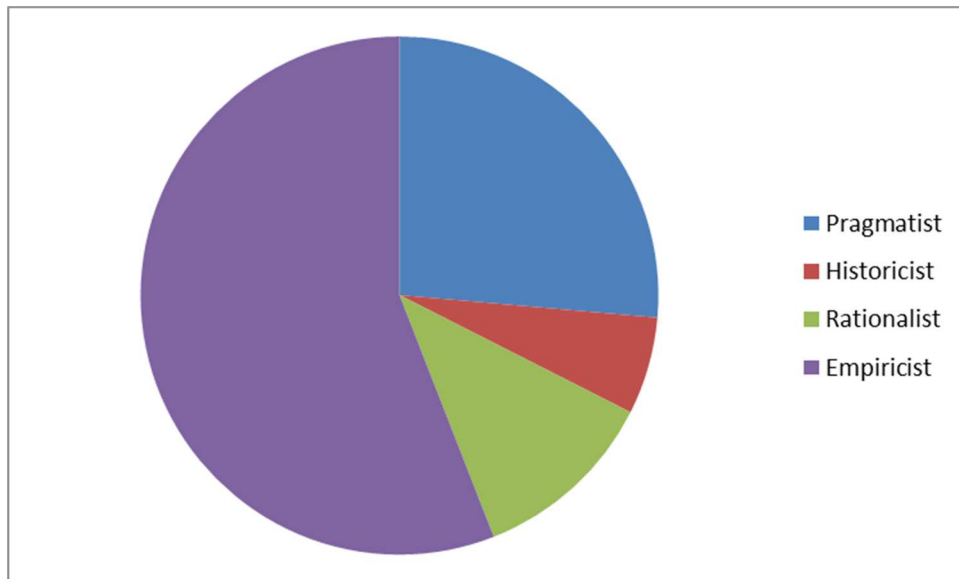**Figure 20 Epistemiological Categories of Documents**

Table 13 Epistemological Category Analysis

Episte-mological Category	Times Found to Describe a Record Alone	Times Found to Describe a Record with Other Categories	Percentage of 327 Records	Percentage of Categories Found (379)
Empiricist	198	20	60%	52%
Pragmatist	90	31	27%	24%
Rationalist	34	16	10%	9%
Historicist	13	10	4%	.03%

Clearly, most sources were empirical in nature, followed by pragmatic. Not many

historicist sources were found, perhaps because telemedicine is a relatively young field and still a

discourse community. Researchers have not likely had time to follow the effects of telemedicine

implementation over a long enough period of time. These are the usual breakdowns (empiricist

followed by pragmatist, then rationalist, then historicist) in epistemological studies in information

science (Hjorland 1995). The empiricist category, where researchers observed telemedicine

programs working, was found most often. This may reflect the discourse community nature of

telemedicine where researchers and stakeholders are still observing ways that are best to implement telemedicine programs and their effects on patients and employees. Pragmatist approaches were the second most popular in the records found. Researchers probably observed telemedicine programs being implemented and working, and went beyond rationalism to see if known principles actually worked in the day-to-day management and workings of telemedicine. The need and use of telemedicine, after all, is practical in that it is used to increase access and quality of health care and affordability to patients. Rationalist approaches may involve using already known medical logic and showing how it applies to telemedicine.

8.5 Research Question 5

Is there evidence of a taxonomic or ontological structure in the professional discourse of telemedicine?

Author and index keywords, a total of 1619, were copied from each record and entered into Excel. They were sorted in alphabetical order. Then, duplicates were removed. Keywords were categorized and fit into one of the six categories of the Proposed Taxonomy: Health Areas, Health Services, Technology, Communications, Environment or Socio-economic. Keywords fit neatly into these areas.

The majority of keywords were in the health area section of the proposed taxonomy. This includes disease types and types of telemedicine. The high occurrence of keywords in this section underscores the importance of telemedicine in various areas of health, and the sophistication of the different types of telemedicine, as well as the many times words like "telemedicine" were found in the records themselves. Technology keywords came out at a close second, with 34% of the keywords. Health services, socioeconomic and environment keywords were each mentioned between 6% and 7%, while communication keywords were mentioned the least, at 2%.

The title and abstracts of the 327 items examined for research in support of this question revealed that a primary subject of most sources was technology. The keywords considered by authors and indexers to be important were mostly health area keywords, showing that the underlying reasons technology is important in the first place is for diagnosing and treating various diseases and that various areas of telemedicine such as teledermatology are often the subject matter of studies.

Table 14 Taxonomy Keywords

Taxonomy Category	Number of Keywords	Percentage of Total Keywords
Health Areas	726	44.8%
Technology	550	34%
Health Services	108	6.7%
Socioeconomic	106	6.5%
Environment	97	6%
Communications	32	2%

Figure 21 Taxonomy Keywords by Percentage of Total Keywords
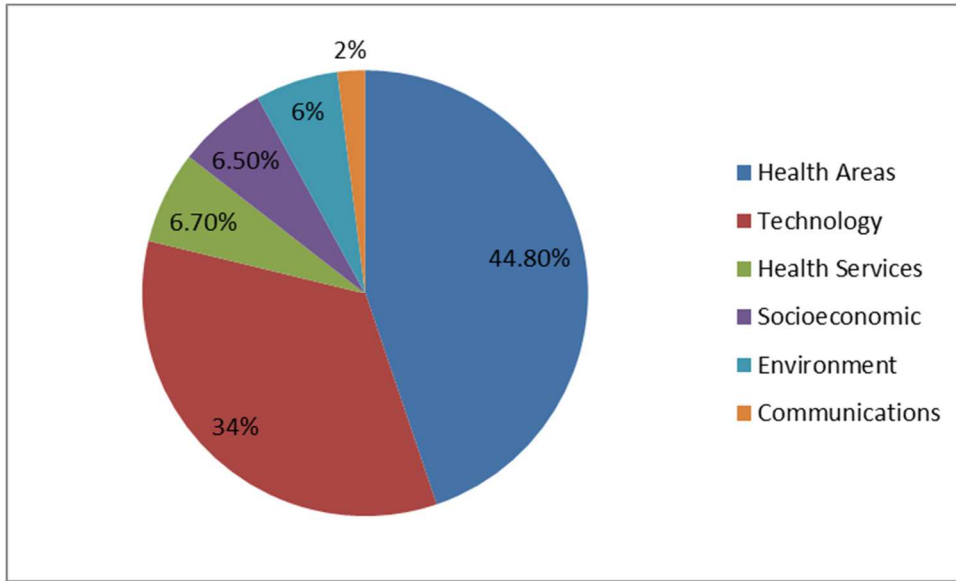
After reviewing the keywords which were broken down into the categories in Table 14, an ontology was created. Many areas of each taxonomy, incorporated by many subareas, were found in the research. In each discipline, a wide variety of keywords are found. This shows that areas and concerns of telemedicine have a wide span. This is fruit for much future research. For instance, in the Health Area discipline, topics range from body parts like brain cortex to diseases like brain disease to quality of life like exercise. In the Socioeconomic Discipline, topics range from Medicaid to patient satisfaction. As seen in Figure 21, the keywords found confirm the comparison of taxonomies (page 180) and proposed taxonomy (page 183).

The first part of an ontology is shown in Table 15. The full table is in Appendix V. This study only includes references to the documented data in the sample set of literature review

materials, and does not claim to be exhaustive of all variations. A variety of subareas and words were found under each taxonomical category. Some of these words, such as information, were found in more than one category. This ontology is not exhaustive for telemedicine worldwide. The ontology is based on keywords found from the random sample in Scopus. If another database were used or another random sample were drawn, the keywords might have been different. In addition, if a similar study is conducted in the future, new keywords and terminology, especially in technology, which is a very innovative field, may be found. This ontology, which was derived from the keywords found from the random sample, validated the Tulu, Chatterjee and Maheshwari taxonomy, the Bashshur, Shannon, Krupinski, and Grigsby taxonomy, the Nepal, Liang-Jaccard and Alem taxonomy and the proposed taxonomy. The taxonomy is not a formal thesaurus of telemedicine. Rather, it is a representation of what areas constitute telemedicine based on the past taxonomies already studied and the keywords found.

Table 15 Proposed Telemedicine Ontology (partial)

Academic/ Scholarly Discipline	Scholarly Research Area (Subareas covering the majority of terminology occurrence)	Prominent/Thematic Terminology Usage (Classes within subareas with majority of word occurrence)
Health Areas	Body Part	Brain cortex, coronary artery, cyst, fetal heart, finger, hemoperitoneum, lung parenchyma, lymph node, nevus, retina, verruca vulgaris, wrist
	Chronic Conditions	Chronic obstructive pulmonary disease, chronic pain, rash, substance abuse
	Demographics	High risk population, urban area, urban health
	Dentistry	Molar, tooth, impacted, tooth disease-adult, tooth-impacted

8.6 Research Question 6 Does the discourse community of telemedicine suggest scholarly coherence either as a domain or discourse community?

Most articles were written by between one and seven authors (285/327 = 87%). A total of 45/327 = 14% of sources were written by one author. Five authors were the most common amount of authors per source (56/321= 17%). With an almost 20% (N= 64) number of retrieved documents from the sample set being written by five collaborating authors, it is safe to say that there is community coherence and therefore telemedicine is a discourse community (Jank 2010).

In addition, 43% of sources had three authors and 34% of sources had six authors, further

signaling coherence.

Table 16 Number of Authors per Source

Number of Authors per Article	Number of Articles	Percentage of Total Number of Articles
1	45	14
2	43	13
3	53	16
4	43	13
5	57	17
6	34	10
7	14	4
8	7	2
9	8	2.4
10	7	2
11	7	2
12	5	1.5
13	1	0
14	1	0

15	0	0
16	0	0
17	1	0
18	0	0
19	1	0

Figure 22 Authors per Source
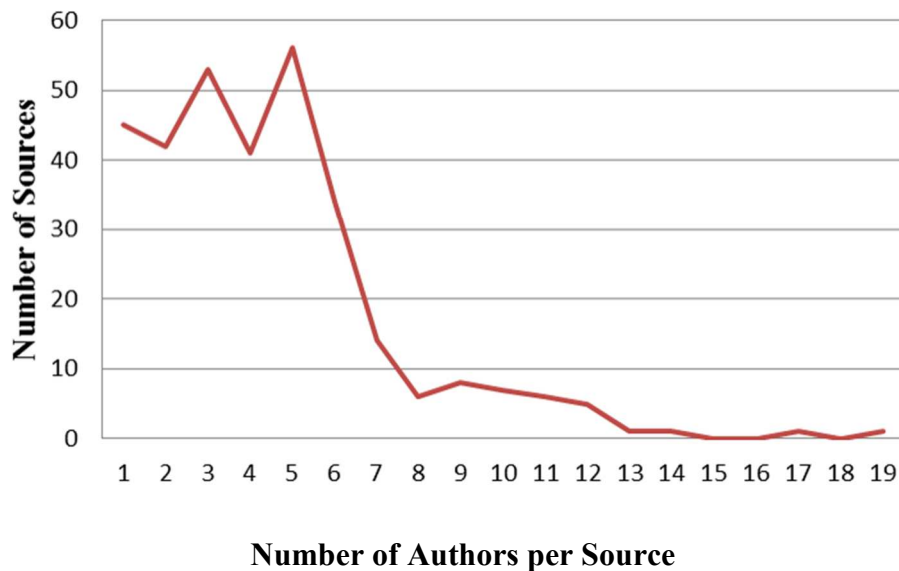
Number of Authors per Source

Table 16 and Figure 22 show that telemedicine is a well-established discourse community most likely headed to being a domain. In a domain, more articles are likely to be written by a large number of authors. The greatest amount of articles (57) in the sample were written by 5 authors. Sixteen articles were written by 10 authors, so telemedicine may be headed toward being a domain. As in discourse communities, many articles were written by one author. Few retrieved documents were written by 8 or more authors, and the amount drops greatly after 12 authors. The

most important part of their being a discourse community is that literature is published in a wide variety and number of journals, and that is shown the Table 16 and Figure 22.

As telemedicine advances toward being a domain, a greater number of authors will collaborate in writing more articles. However, from the growing amount of telemedicine articles per year, despite a recent dip, and from the telemedicine articles from a wide array of journals and countries, although most are from the United States and English-speaking countries, it appears that telemedicine is not emerging. It has in fact emerged and is growing.

CHAPTER 9

Summative Information

This chapter contains a summary of the limitations of this study, implications for future study and conclusions drawn from the findings.

9.1 Limitations of research

There were limitations to the research study presented in this dissertation. Given the exploratory nature of the research, I do not believe that any of them seriously hampered the process. Domain analytic research is not yet completely defined, and discourse analysis still dominates research in the field.

Domain definition

Information science is a discipline that is interdisciplinary at its heart, and, fortunately, scholars in this field have established grounded methodological approaches to handle this task. I prefer to use the term "discourse community," as this appropriately relates to a community of scholars tied to topical areas of scholarship rather than definitive academic domains.

Search source

Although Scopus is an extensive database, some sources may have been missed. These sources may for some reason not have been included in Scopus. For instance, I did not retrieve many books. While books, journals and conference papers are covered by Scopus, social media, chat rooms, blogs, tweets, and popular magazines are not.

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Search years

Scopus records were gathered up to early 2015. Telemedicine has been a rapidly developing field for years. Very recent records were missed. There is a chance that a trend of topic, new authors, a new journal or popular country of publication and research were missed. As found in the research, however, the peaks of publication were 2011, and then 2012.

Faceted searching

Although I am satisfied with my use of three facets to organize and narrow down the search, it is possible that using different facets or two facets would have influenced the types of records retrieved and items discovered.

Random sample

Of course, a different random sample may have generated different results in terms of authors, journals, evidence for a discourse community and more. I deleted duplicate records. As a result, I became more familiar with the sample set and types of records. My random sample was inclusive, however, in that it did not limit by year, language, or type of record, and was built using scientific standards for sampling.

Most records were retrieved from the Scopus database until June of 2015. This means that conclusions cannot address immediately current discourse. However, as seen in the results of this research, 2012 appeared to be the primary year of telemedicine. The decreasing frequencies for the years 2013 and 2014 suggested the beginning of a decline in the prominence of discourse.

Cronin (2012) suggests the scholarly research topics go through a series of peaks and valleys. A new topic will be the subject of much discussion of scholars for a period of time in which it peaks. This is replaced with valleys, when another new topic will be the focus of a discourse community.

9.2 Future Research

A different sample can yield different results and data. In the future, other terms can be used in facets to derive scholarly sources from Scopus. Terms can include new terms in telemedicine, such as twiage, used to refer to an HIPAA-secure mobile and Google Glass telemedicine solution for paramedics and hospitals. Authors that were encountered in the literature review, new researchers and new journals in telemedicine may be revealed. A spike or decrease in annual telemedicine article publications may be seen.

As more health professionals implement telemedicine, there will be a pressure for other health professionals to implement it to stay competitive and to keep up with changing patient needs. This also depends on insurance coverage. Physicians and other health personnel that are using or interested in using telemedicine can use this dissertation as a reference to discover: issues of telemedicine; popular authors; important journal sources; countries where telemedicine is most used and researched; and areas of telemedicine that are most advanced. They can find information that they did not even know existed or would be useful. Future research can include finding newer articles and themes in telemedicine. The Proposed Taxonomy and Working Ontology can further inform health care professionals, stakeholders and computer programmers what challenges there are to meet in telemedicine. This information can help them create, implement and monitor telemedicine programs.

Telemedicine centers in hospitals and other medical centers can be visited and studied to investigate changes in diagnosis and treatment after telemedicine implementation. Staff and patients can be interviewed and content analysis performed to describe nuances, problems and actors in telemedicine implementation, technology, cooperation and more not found or explored deeply in this dissertation. The needs and problems of different types of telemedicine (telepathology, teledermatology, etc.) can also be explored. Pilot studies on hospital and health center cost savings and benefit to patients can be conducted.

More pragmatist studies should be conducted to find the benefits of telemedicine by disease state and according to the age, comorbidity, gender and more of patients. The amount of pragmatist studies may increase as more telemedicine programs, already adapted into hospitals, are reviewed for efficiency and service. More studies are needed with tools that can compare office visits versus telemedicine according to disease and patients. Are they equivalent in terms of benefits, diagnosis, treatment and cure? Benefits of telemedicine such as access to care and getting a second opinion have been shown. But the same number of studies for the comparison of office visits to telemedicine in a specific manner, according to the literature review and epistemological category evaluation, have not been conducted. This may lead to specific ways to improve telemedicine programs.

Trends, including mobile apps after 2007, have been more popular but that is just advancing technology, not a trend. Cost, diagnosis, and treatment were always big. Online therapy has gotten bigger in past 10 years. More attention is being paid to health care laws and reimbursement as affordable health care is becoming an increasing issue in the United States. As more competition and innovation is leading clinicians to adopt telemedicine and entrepreneurs

and investors, including ones that are clinicians, to create telemedicine companies such as video equipment and telemonitoring devices.

Hospital managers may become more aware that telemedicine reduces readmission and so readmission penalties. Clinicians increasingly may see that telemedicine may reduce their costs in terms of the quantity of staff members or days of ranting space. Clinicians may set up low-cost pay systems with patients willing to pay for low-cost telemedicine "visits" without the help of insurance. Some clinicians, however, may not want to take the time to learn technology and teach their staff, or still may believe that in office visits are best for clinician-patient relationships. Or they may fear not getting reimbursed fully and all the time. More random control trials are needed for funding. Staff training is needed with equipment.

Telemedicine is a growing field, with a general uptrend in journal articles published annually, at least as is shown by this random sample and an increasing amount of bills introduced to legislatures on the state and national level. In the future, telemedicine and medicine may be synonymous, as "telephone" or "calling" someone are with cell phones.

Future research may show if the label "telemedicine" or "telehealth" dissolves to be incorporated into medicine. This may make it easier for policy, laws, insurance coverage, and licensing. After all, technology is becoming a heightened part of our lives, sometimes for the better, and sometimes for the worse. If it can increase access and quality of health care and decrease cost, medicine will be an area where the ubiquity of technology is for the better. An increasing amount of virtual reality work may occur in the future. This work will include using virtual reality in mental health centers for children, adults and veterans as a means of palliative care of post-traumatic stress reduction (Maples-Keller JL, Yasinski C, Manjin N and Rothbaum BO 2017; Mitrousia V and Giotakos O 2016).

9.3 Conclusion

Year ago I was a premed student but decided that being a physician is not for me. In my Ph.D. program, I starting reading about physician communities of practice and found out about telemedicine. When the dissertation topic of communities of practice did not work out, I began my literature review on telemedicine in 2008. Overwall, I read good things about it: telemedicine often increases access and quality of health care and lowers costs of health care. It allows for second opinions and for the sharing of medical information, which can lead to new cures for diseases and conditions. Technology in the area of telemedicine, such as in telesurgery, is introduced often. Most physicians and patients are satisfied with telemedicine programs. Since 2008, many hospitals have implemented telemedicine programs. Radiology and teleradiology are now synonymous. In the 2017 annual ATA meeting, one topic of discussion is that telemedicine and medicine may become synonymous. Telemedicine may be one tool to fight against escalating health care costs and the unaffordability of health care, two topics that Congress is tackling.

I was surprised that the random sample did not yield many of the authors I had encountered in my literature review. I was delighted to find a new prolific telemedicine author Spadaro and a new journal. The random sample bore a similarity to my literature review in that it showed the span of areas where telemedicine is used: teleradiology, telepsychiatry, telesurgery etc. The random sample, like the literature review, showed an array of studies, although mostly empirical, such as interviews of stakeholders, diagnostic accuracy studies, cost analyses, and implementation outlines.

I enjoyed conducting my study and writing my dissertation, and I do hope it helps at least some health care providers find out more about telemedicine and perhaps implement it in their practices. And if this helps patients, I would be very pleased.

APPENDIX I

GLOSSARY

Bibliometrics - The application of quantitative measures or statistics to bibliographic data to measure the impact of scholarship, networks of scholars and scholarly communication, links between scholars, and the development of areas of knowledge over time. It is a way to measure the impact of scholarly publications.

Bradford's Law - A pattern described by Samuel C. Bradford in 1934 that estimates the exponentially diminishing returns of extending a search for references in journals, dividing them into core or first-tier journals, second-tier journal and third-tier journals.

Domain – Thought or discourse communities that are parts of society's division of labor (Hjorland and Albrechstsen (1995).

E-health - The cost-effective and secure use of information and communication technologies (ICT) in support of health and health-related fields, including health care services, health surveillance, health literature, and health education, knowledge, and research (WHO 2010)

Lotka's Law – An interpretation of Zipf's test that describes the frequency of publication by authors in any given field and states that the number of authors making contributions in a given period is a fraction of the number making a single contribution.

Meaningful use - Using certified EHR technology to improve the quality, safety, efficiency of health care while reducing health disparities, to engage patients and families in their health care, to improve care coordination, to improve public health, while maintaining privacy and security. (CMS, 2010)

Mhealth- mHealth or mobile health as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices. (WHO, 2011)

Real-time - Telemedicine in which video and audio data are communicated from one site to another within milliseconds or microseconds

Store-and-forward - A technological technique in which information is sent to an intermediate station where it is kept and sent at a later time to another intermediate station or to the final destination

Taxonomy – the classification of things or concepts.

Telemedicine - The use of technology and the Internet to provide health care cooperation, diagnosis and treatment at a distance

Thesaurus - A form of controlled vocabulary, acceptable by formal organizations such as the National Institues of Health or the IEEE, that seeks to dictate semantic manifestations of metadata in the indexing of content pertinent to that organization.

Videoconferencing - Technique that allows two or more locations to communicate by simultaneous two-way video and audio transmissions

Telemedicine - The use of technology and the Internet to provide health care cooperation, diagnosis and treatment at a distance

Telehealth - Patient-physician interaction through email; patient and health care professional education through health Web sites; using mobile phones to monitor, diagnose and treat disease; using telemonitoring or using mobile phones, computers and other technology to monitor patients at home; and using mainly the Internet to diagnose and treat disease (Health Resources and Services Administration 2013).

Zipf's Test – A bibliometric test named after the American linguist George Kingsley Zipf (1902–1950), that analyzes the relative proportion of authors in a set of publications on the same topic.

APPENDIX II

Author Bios

Leila Alem, Ph.D.

Dr. Leila Alem is a primary research scientist at Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia. She has researched about cloud collaboration, telemedicine and game using in virtual environments, including the area of health.

Rashid Bashshur, Ph.D.

Dr. Rashid Bashshur, the Executive Director of eHealth at the University of Michigan Health System and Emeritus Professor of Health Management and Policy at the University of Michigan School of Public Health, he has been a catalyst for the development and evaluation of telemedicine systems in the U.S. since the early 1970s. He was consultant to the Office of Economic Opportunity on the use of telecommunications in rural communities while he was at the National Academy of Sciences. He has served as senior consultant to numerous telemedicine projects, agencies and governments such as the Navy, Bell Laboratories, the Office of Technology Assessment, the Department of Defense, and several countries, and has published extensively on the topic.

Cesare Massone, MD

Cesari Massone is an Assistant Professor at the Department of Dermatology, Medical University of Graz, in Graz, Austria. He graduated in medicine at the University of Genoa in Italy in 1997. He is a board certified dermatologist (2002) and dermatopathologist (2004). His research areas include dermatopathology, dermato-oncology, general dermatology, telemedicine and teledermatology. He has authored or coauthored more than 40 scientific papers in peer-reviewed scientific journals, 5 of which have been awarded. From 2003 to2005 he was the moderator of the DermOnline Community on www.telederm.org, a freely available online consultation platform in dermatology.

Kurt Brauchli, Ph.D.

Kurt Brauchli is an evolutionary biologist that teaches at the Department of Pathology at the University of Basel in Switzerland. Dr. Brauchli has written several articles about telepathology, some with fellow University of Basel professor Oberholzer. The "open" telepathology system iPath (http://telepath.patho.unibas.ch) has been accepted globally by many groups around the world. The main application fields are: consultations between pathologists and medical institutions that do not have a pathologist, such as those in rural areas in Africa; tumor boards; field studies; and distance education.

Samir Chatterjee, Ph.D.

Samir Chatterjee is the Fletcher Jones Chair of Technology Design & Management at CGU's Center for Information Systems & Technology (CISAT) and is considered a leading technology designer and strategist for 21st-century health care. He leads the emerging field of Persuasive

Technology, a stimulating interdisciplinary research field that focuses on how interactive technologies and services can be designed to influence people's attitudes and support positive behavior change.

Charles R. Doarn, MBA

Charles R. Doarn is a Fulbright Specialist with the US Department of State, is a Research Professor of Family and Community Medicine and Director of Telemedicine at the University of Cincinnati, Ohio. In March 2016, Doarn participated in a NATO meeting in Bucharest, Romania for refining the Multinational Telemedicine System in support of disaster response, funded by the NATO Science for Peace and Security Program. He serves as the team lead for the Governance Team, which is responsible for developing the Concept of Operations document. He is a Special Assistant to the NASA Chief Health and Medical Officer at NASA Headquarters and is currently serving as the co-chair of FedTel for the US Government. Mr. Doarn has served as the Executive Director of the award winning International Virtual e-Hospital. He has served as the principal investigator on a number of federally-funded grants and also serves as the Executive Secretary of the Multilateral Medical Policy Board for the International Space Station. He has published more than200 manuscripts, editorials, federal reports and 15 book chapters on telemedicine.

William K. Durhee, Ph.D.

William K. Dubhe is a Professor in the Department of Mechanical Engineering, College of Science and Engineering at the University of Minnesota. Dr. Durhee's main interest in the area of telemedicine is telerehabilitation. His professional interests include: the design of medical devices, rehabilitation engineering, advanced orthotics, biomechanics and physiology, product

design and design education. He has a mechanical engineering Ph.D. from the Massachusetts Institute of Technology.

Maria Rosaria Giovagnoli, Ph.D.

Maria Rosaria Giovagnoli is a professor at the Sapienza University of Rome. Her research topics are: the molecular assessments in oncology, concentrating on the potential diagnostic and prognostic applications of cytopathology; cell cultures from liquid and neoplastic payments; and biological and personalized therapeutic approach characterization. She is committed to the advancement of mage analysis, quantitative cytopathology, telepathology applied to diagnostics and what teaching tools.

Gunter Haroske, MD, Ph.D.

Gunter Haroske is a pathologist working at the Hospital Dresden-Friedrichstadt Institute of Pathology in Dresden, Germany. His main area of interest regarding telemedicine is telepathology. He is the author or coauthor of at least 167 publications.

Rainier Hofmann-Wellenhof, MD

Rainier Hofmann-Wellenhof is a Professor of Dermatology in the Department of Dermatology, Medical University of Graz, in Graz, Austria. He has been a dermato-oncologist for 10 years and the Director of the Pigmented Skin Lesion Clinic. His interests include pigmented skin lesions, dermoscopy, and skin culturing.

Julian Jan Jaccard, Ph.D.

Dr. Jaccard specializes in security, privacy, and trust in e-commerce, cloud, and mobile network. She devises security architecture and algorithms and defines privacy policy for personal data. Her work often incorporate ideas from other disciplinary areas of computer science for example, machine learning technique and Human-Computer-Interactions.

She has also been a professional java developer and database administrator. She's a certified java developer and oracle DBA.

Elizabeth Krupinski, Ph.D.

Elizabeth Krupinski is an Experimental Psychologist with research interests in medical image perception, observer performance, medical decision making, and human factors as they pertain to radiology and telemedicine. The goal of her research is to improve our understanding of the perceptual and cognitive mechanisms underlying the interpretation of medical images in order to reduce errors, improve training, and optimize the reading environment, thereby improving patient care and outcomes. She has published extensively and internationally in medical image perception, assessment of observer performance, medical decision making, and human factors. She has presented at conferences nationally and internationally. Dr. Krupinski serves on the Editorial Boards several journals in radiology and telemedicine, and on review panels for organizations such as the National Institutes of Health. Dr. Krupinski is also a past President of the American Telemedicine Association, and Past Chair of the Society for Imaging Informatics in Medicine.

Sunita Maheshwari, MD

Sunita Maheshwari is a Yale trained Pediatric Cardiologist who was nominated one of the Top 20 women achievers in medicine in India in 2009. She is the Chief Dreamer at Teleradiology Solutions (India's first and largest teleradiology company that has provided over 4 million diagnostic reports to patients and hospitals globally) and incubated other telemedicine companies. She is co-running a trust fund-the Telrad Foundation that provides teleradiology and telemedicine services to poor areas in Asia that do not have access to high quality medical care.

Maurice Mars, MD

Maurice Mars is a medical practitioner with a background in orthopedics, vascular surgery, sports medicine and physiology. He has been researching and working in telemedicine for more than 20 years and is Founding President of the South African Telemedicine Association, Editor of the Journal of the International Society for Telemedicine and eHealth, Chair of the eHealth sub-committee of the Ministerial Advisory Committee on Health Technology, Chair of the

Education Committee of the International Society for Telemedicine and eHealth, Chair of the International SIG of the American Telemedicine Association, and member of the Telemedicine Working Group of the International Medical Informatics Association.

Michael McCue, Ph.D.

Michael McCue is Professor and Vice-Chair of the Department of Rehabilitation Science and Technology at the University of Pittsburgh and is Director of the Rehabilitation Counseling Program and Co-Director of the University of Pittsburgh's Rehabilitation Engineering Center on Telerehabilitation (NIDRR). Dr. McCue holds a Ph.D. in Rehabilitation from the University of

Pittsburgh. He completed his postdoctoral training in clinical neuropsychology at the University of Pittsburgh and holds a Masters in Education in Rehabilitation Counseling from Kent State University and a Bachelor of Arts in Psychology from John Carroll University. Dr. McCue is the Project Director and Principal Investigator of an Interagency Agreement between the University of Pittsburgh and the Commonwealth of Pennsylvania's Hiram G. Andrews Rehabilitation Center and a member of the Executive Committee of the UPMC Center for Assistive Technology, having served in that capacity since 2001. Dr. McCue is a clinical neuropsychologist who has been providing assessment and neuropsychological rehabilitation services to individuals with brain injury and other cognitive disabilities and his main telemedicine research area is telerehabilitation. Dr. McCue has directed more than 20 national research, demonstration and training programs in telerehabilitation, rehabilitation assessment and intervention. He has published more than 40 articles, chapters and abstracts related to telerehabilitation, neuropsychology and rehabilitation of cognitive disability. He has been elected Fellow of the National Academy of Neuropsychology and Past President of the Pennsylvania Rehabilitation Association.

Surya Nepal, Ph.D.

Surya Nepal is a data security expert and a team leader at Distributed Systems Security at Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia. His research includes developing secure cloud connections and controlled date sharing in a cloud-based collaborative environment.

Wolfgang Salmhofer, MD

Wolfgang Salmhofer is a Professor at the Medical University of Graz, Austria. He has published in several dermatology journals and his interests include telemedicine.

Ando Saptono Ph.D.

Ando Saptono is an Assistant Professor at the University of Pittsburgh. He holds a Ph.D. in Health and Rehabilitation Sciences and an M.S. in Health Information Management, both from the University of Pittsburgh. He has more than five years of experience in software design, development, and usability study. He developed of ACCESS, a system to transcode the Internet for people with visual impairment and blindness; MyHealthBits, a personal health record system; and VISYTER, an integrated system to support telerehabilitation service.

H. Peter Soyer, MD

H. Peter Soyer is a dermatologist and professor with more than 30 years of experience. He was appointed as the inaugural Chair in Dermatology by The University of Queensland (UQ) in 2007 and as Director of the Princess Alexandra Hospital (PAH) Dermatology Department in 2008. His expertise is internationally recognized in the areas of clinical dermatology, dermatooncology, dermatopathology and dermatologic imaging (dermoscopy and reflectance confocal microscopy. He is a key creator of the morphologic classification system. Dr. Soyer is a world leader in dermoscopy of pigmented skin lesions, a non-invasive diagnostic method. Another focus of his has been to expand the concept and applications of teledermatology and teledermoscopy. His publication record includes more than 550 publications to date and more

than 500 citations per year. Dr. Soyer has achieved more than $9 million for the University of Queensland.

Letteria Spadaro, Ph.D.

Letteria Spadaro is a psychologist and Ph.D. student at the University of Messina in Italy. She holds a Masters degree in clinical neuropsychology from the University of Palerma. She is interested in using information and computers to enhance mental health.

Bengisu Tulu, Ph.D.

Bengisu Tulu holds completed a dissertation entitled Assessing Objective and Subjective Quality of Audio/Video for Internet based Telemedicine Applications from the Worcester Polytechnic Institute. Her current project is to develop a virtual classroom for the HeartMath Institue where they can conduct Internet training sessions.

Claude Vincent, Ph.D.

Claude Vincent holds a Ph.D. in public health from the University of Montreal. She is interested in telerehabilitation. An occupational therapist, she is interested in the promotion, prevention and use of technology by people at risk of developing disabilities or those with disabilities who are losing their autonomy. She believes that new information technologies and telecommunication methods for the provision of rehabilitation and support services in the home can greatly help patients. She is also involved in the development of measurement tools to assess this type of technology, participatory research methodologies and social participation of people with disabilities. She works at the Center for Interdisciplinary Research in Rehabilitation and

Social Integration, whose mission it is to contribute to the development and knowledge transfer in rehabilitation and social integration.

Jack M. Winters, Ph.D.

Jack M. Winters is a professor of biomedical engineering at Marquette University. His main telemedicine interest is telerehabilitation. The focus of most of his nearly 100 publications during the 80's and 90's, was biomechanics and neuromuscular control. He was the original Principal

Investigator and co-director of the $4.5 million Rehab Engineering Research Center (RERC) on

Telerehabilitation. In 2002 he edited a book on *Emerging and Accessible Telecommunications, Information and Health care Technologies*, and feels strongly about the need to re-think new ways for providing researchers and consumers with timely access to information and services. He has been an organizer, session chair and speaker for several conferences pertaining to telemedicine.

Peter Yellowlees, MD

Peter Yellowlees completed his medical training in London, and then worked in Australia for twenty years. He was always a prolific writer and became interested in telemedicine early in his career. His research and teaching voyage took him to UC Davis to continue his research in telemedicine and eHealth. He is internationally known for his knowledge and research in telemedicine and long distance health and education delivery. Dr. Yellowlees has given more than100 presentations in 20 countries in the past five years. His current research projects include: electronic record implementation, data mining and disease management protocols, Internet email

and video consultation services, the use of virtual reality for health education on the Internet, and store and forward telepsychiatry.   He has published three books and about 150 scientific articles and book chapters. He has been a consultant to governments and private sector companies throughout the world, and has received about $8 million in research grants. He has recently been voted the vice president of the American Telemedicine Association.

Appendix III

Outline of Steps in the Dissertation

I.   The faceted search terms were used to retrieve Scopus records. The N was about 2,000.

a.   Each record was exported onto MS-DOS.

b.   Items necessary for research were in turn exported to Word pad. Each was entitled "text."
Items or fields exported to notepad were author; title; journal title; year; country; author
keywords; index keywords. The year, country and keywords were counted manually.

II.   A matrix of numbers representing random sample records was printed out. Scopus records
were chosen based on the numbers of the matrix. Duplicates were discounted. For example, if the
numbers 2, 8, 100, and 120 represented the same article of the Scopus search, i.e. if one article
was retrieved more than one time and those numbers of the matrix represented it, the article was
counted once. Articles were discounted if they were article from veterinary journals as well. Once
327 original journal articles were found, the matrix was put away.

III.   Research Question I

a.   Author and index keywords from each of the 327 records were copied onto an Excel
sheet. They were alphabetized.

b.   Keywords were examined to answer the hypotheses questions.

IV.   Research Question II

a.   Excel worksheet keywords were examined to extract journal titles, years and countries of
research for the 327 sample records. Each was placed in a separate Excel sheet.
For years, they were sorted in increasing number order. Counts were conducted manually for
creating charts and figures.

b.   For countries, if authors of each record were from different countries, all countries were listed and counted. Countries were put in alphabetical order and then counted for statistics.

V.   Research Question III

a.   Author names were extracted from the 327 random sample records and placed in alphabetical order in an Excel spreadsheet. Author names were counted and statistics were created.

b.   Journal titles were extracted from 327 random sample records and placed in alphabetical order in an Excel spreadsheet. Top journal titles were determined and statistical charts were created.

VI.   Research Question IV

a.   Titles and abstracts of the 327 random sample records were read, examined and categorized according to Hjorland's epistemological categories of empirical, rationalist, pragmatist or historicist. One article could be in more than one category if the paradigm in which it was studied and written was in fact more than one.

b.   Each time an article fell into one or more categories, the categories were marked on an excel worksheet list. This list was alphabetized and the occurrences of different categories were counted. P pie chart was created to represent these occurrences.

VII.   Research Question V

a.   Author and index keywords, a total of 1619, were copied from each record and entered into Excel. They were sorted in alphabetical order. Then, duplicates were removed. Keywords were categorized and fit into one of the six categories of the Proposed Taxonomy: Health Areas, Health Services, Technology, Communications, Environment or Socio-economic. Keywords fit neatly into these areas.

VIII.   Research Question VI

a.   The amount of journal articles written by the same author was noted. The number of

articles by one, two, etc. authors was noted. A Zipf chart was created (Table 12). Data from Table

11 was noted.

Appendix IV

Record 1

Fang, Y.
Visualizing the structure and the evolving of digital medicine: a scientometrics review
(2015) Scientometrics, 17 p. Article in Press.
http://0-www.scopus.com.liucat.lib.liu.edu/inward/record.url?eid=2-s2.0-84939864715&partnerID=40&md5=71788f55f1e607db29797c2e32f163e5

AFFILIATIONS: Library, Nankai University, No. 94 Weijin Road, Nankai District, Tianjin, China
ABSTRACT: This article aims to analyze and visualize the structure and the emerging trend of digital medicine, a new medical pattern of twenty-first century. Our study objectively explores the document co-citation clusters of 6060 bibliographic records to identify the origin of digital medicine and the hot research specialty of domain. Pivotal point articles, prominent authors, active disciplines and institution have been identified by network analysis theory. CiteSpace was used to visualize the perspective of digital medicine domain. As an interdiscipline which integrated computer science, information engineering with medicine, digital medicine originally and mainly on digital medical imaging technology research for accuracy and speedy clinical diagnosis and therapy. Of 6060 relevant records reviewed, 1719 (28 %) are on radiology, 902 (15 %) are on engineering, 539 (9 %) are on computer science. The largest co-citation cluster is on digital tomosynthesis. The earliest cluster is on medical imaging segmentation and registration. Post-processing imaging technology, detector, phase contrast, reversible watermarking, input, model 3D reconstruct, real-time dynamic imaging, dosimetry have been the hot research topics. The recently cluster is on internet health information. Harvard University of USA is the prominent institution. The coverage of digital medicine research is widely from clinic to laboratory. Recent year, domain research front is thematically on teleradiology, telemedicine and hospital information management system. © 2015 Akadémiai Kiadó, Budapest, Hungary
AUTHOR KEYWORDS: CiteSpace; Cluster analysis; Digital medicine; Document co-citation analysis; Medical imaging; Network analysis
CORRESPONDENCE ADDRESS: Fang, Y.; Library, Nankai University, No. 94 Weijin Road, Nankai District, China
PUBLISHER: Kluwer Academic Publishers
ISSN: 01389130
LANGUAGE OF ORIGINAL DOCUMENT: English
ABBREVIATED SOURCE TITLE: Scientometrics
DOCUMENT TYPE: Article in Press
SOURCE: Scopus

Record 2

Antón, D., Goñi, A., Illarramendi, A.
Exercise recognition for kinect-based telerehabilitation

AFFILIATIONS: Department of Computer Languages and Systems, University of the Basque Country UPV/EHU, Donostia -San Sebastián, Spain
ABSTRACT: Background: An aging population and people's higher survival to diseases and traumas that leave physical consequences are challenging aspects in the context of an efficient health management. This is why telerehabilitation systems are being developed, to allow monitoring and support of physiotherapy sessions at home, which could reduce health care costs while also improving the quality of life of the users. Objectives: Our goal is the development of a Kinect-based algorithm that provides a very accurate real-time monitoring of physical rehabilitation exercises and that also provides a friendly interface oriented both to users and physiotherapists. Methods: The two main constituents of our algorithm are the posture classification method and the exercises recognition method. The exercises consist of series of movements. Each movement is composed of an initial posture, a final posture and the angular trajectories of the limbs involved in the movement. The algorithm was designed and tested with datasets of real movements performed by volunteers. We also explain in the paper how we obtained the optimal values for the trade-off values for posture and trajectory recognition. Results: Two relevant aspects of the algorithm were evaluated in our tests, classification accuracy and real-time data processing. We achieved 91.9% accuracy in posture classification and 93.75% accuracy in trajectory recognition. We also checked whether the algorithm was able to process the data in real-time. We found that our algorithm could process more than 20,000 postures per second and all the required trajectory dataseries in real-time, which in practice guarantees no perceptible delays. Later on, we carried out two clinical trials with real patients that suffered shoulder disorders. We obtained an exercise monitoring accuracy of 95.16%. Conclusions: We present an exercise recognition algorithm that handles the data provided by Kinect efficiently. The algorithm has been validated in a real scenario where we have verified its suitability. Moreover, we have received a positive feedback from both users and the physiotherapists who took part in the tests. © Schattauer 2015.
AUTHOR KEYWORDS: Exercise recognition; Kinect-based motion tracking; Telemedicine; Telerehabilitation
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Record 3

Scopus
EXPORT DATE:05 Oct 2015

Giansanti, D.a , Castrichella, L.b , Giovagnoli, M.R.b c
The design of a health technology assessment system in telepathology
(2008) Telemedicine and e-Health, 14 (6), pp. 570-575. Cited 10 times.
http://0-www.scopus.com.liucat.lib.liu.edu/inward/record.url?eid=2-s2.0-50249113675&partnerID=40&md5=36a85b133407d3f9583285e7c9d5c805

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ABSTRACT: Up to a few years ago, the management of the information on the slides (virtual slides) in telepathology applications was principally based on the design and construction of a few identical and expensive platforms with microscope units and software tools for the display and for electronic control (zooming, moving, and cutting of images). The development of information technology tools allows the diffusion of new visualization strategies and the availability of low cost or free visualization proprietary tools. New competitive systems such as client-server architectures are available in telepathology today. The investigation of the new technologies for telepathology is a basic and core aspect in telemedicine technology assessment. A new interactive environment to investigate the health technology assessment of a telepathology system has been studied. In particular, in consideration of previous experience the methodology focused both on the senior pathologist and younger student pathologist. Two interactive forms were created by a working group: a feedback form and a diagnostic form. The first was designed to investigate the technology characteristics and acceptance of the telepathology systems. The second tool was designed to investigate the diagnostic accuracy on a significant sample of virtual slides by two different groups of pathologists (senior and younger students). The acceptance of the methodology was very high. © Copyright 2008, Mary Ann Liebert, Inc.

AUTHOR KEYWORDS: Technology assessment system; Telepathology; Virtual slides

INDEX KEYWORDS: Client server computer systems; Computer software; Concurrency control; Construction industry; Cutting tools; Electronics industry; Health; Information management; Planning; Power electronics; Software design; Strategic planning; Students; Technological forecasting; Telemedicine; Visualization, Client-server architectures; Design and construction; Diagnostic accuracy; Electronic controls; Health technology assessment; Information technology tools; Interactive Environments; Low costs; New technologies; Software tools; Technology assessment system; Telemedicine technology; Telepathology; Virtual slides; Working group, Technology, article; biomedical technology assessment; computer program; diagnostic accuracy; information technology; pathologist; priority journal; telemedicine; telepathology, Diagnosis, Computer-Assisted; Female; Humans; Image Interpretation, Computer-Assisted; Immunohistochemistry; Information Storage and Retrieval; Male; Pathology, Clinical; Sensitivity and Specificity; Software Design; Technology Assessment, Biomedical; Telepathology; User-Computer Interface

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Appendix V Working Ontology

Academic/Scholarly Discipline	Scholarly Research Area (Subareas covering the majority of terminology occurrence	Prominent/Thematic Terminology Usage (Classes within subareas with majority of word occurrence)
Health Areas	Body Part	Brain cortex, coronary artery, cyst, fetal heart, finger, hemoperitoneum, lung parenchyma, lymph node, nevus, retina, verruca vulgaris, wrist
	Chronic Conditions	Chronic obstructive pulmonary disease, chronic pain, rash, substance abuse
	Demographics	High risk population, urban area, urban health
	Dentistry	Molar, tooth, impacted, tooth disease-adult, tooth-impacted
	Disease	Acne, actinic keratosis, acute poisoning, arthralgia, arthroplasty, arm rehabilitation, aspiration biopsy, blood clot lysis, blunt trauma, body position, brain diseases, brain hemorrhage, breast cancer, dysarthria, dyspnea, ectopic pregnancy, eczema, emergency, emergency care, emergency health service, emergency medical service, emergency ward, endocrinology, endoscopy, exercise, eye examination, eye tracking, female, fetus, gait disorders, GI tract, hand function, hand injury, hand strength, headache, head injury, head and neck cancer, health hazards, heart failure, health risk, hearing implant, heart failure, hemiparesis, herpes complex, herpes simplex,

		histopathology, HIV, hydronephrosis, hyperkeratosis, lung neoplasms, lung parenchyma, lung pathology, lung resection, lymph node, lymphoma, neurologic disease, neurology, neuromonitoring, neuromuscular rehabilitation, pain assessment psoriasis, pain retrolental fibroplasia, rheumatology, skin biopsy, skin cancer, skin disease, skin examination, skin infection, skin inflammation, skin neoplasm, skin pigmentation, skin temperature, skin tumor, urinary tract obstruction, wound care, wound healing
	Quality of Life	Child, exercise, frail elderly, high risk patient, male, mental stress, middle aged, neonatal nursery, stress management, young adult
	Surgery	Aspiration biopsy, computer assisted, dermoscopy, esophagus biopsy, dissection, emergency surgery, endoscopy, laparoscopic surgery, minimally invasive surgery, neurosurgery, plastic surgery, stroke, surgical anatomy, surgical approach, surgical biopsy, surgical equipment, surgical instrument, surgical pathology, surgical procedures, surgical robotic system, surgical robotics, surgical technique, urologic surgery, urologic surgical procedures
	Types of telemedicine	Telediagnostics, teleemersion, telepathology, telepathology – analog-digital conversion, telepathology – biopsy; telepathology-computer communication networks, telepathology-computersystems;

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		telepathology-diagnosis-computer assisted; telepathology-diagnositc services; telepatholgoy-hospital information system; telepathology-image cytometry; telepharmacy-telephone; telephone lines; telephone sets; telephone systems; telephone-survey; telephone-telemetry; telephone-adolescent; telepsychiatry, telepsychogeriatrics; teleradiology; teleradiology-equipmenht; teleradiology-adolescent; teleradiology-adolescent; teleradiology-aged; teleradiology-algorithms; teleradiology-article; teleradiology-biomedical technology; teleradiology-bluetooth; teleradiology – equipment; teleradiology-adolesent; teleradiology-aged; teleradilogy-alogrithms; teleratiology-articles; teleradiology-biomedcial technology; teleradiology-bluetooth; teleradiology-cell phones; teleradiology-communication systems; teleradiology-computer aided analysis.
Health Services	Accessibility	Health care service accessibility
	Diagnosis	Diagnosis, diagnosis accuracy, diagnosis quality, diagnostic test accuracy study, diagnostic value, differential diagnosis, face to face dermatologic consultation, outcome assessment, assessment statements, assessment
	Education	Post-graduate education, education benefits, educational benefits, education

		programming, educational opportunities, patient education as a topic, health education, psychoeducation
	Home Care	Health care delivery, home rehabilitation, home use, home care, home hazard assessment, home modification, home health services, monitoring, monitoring tool
	Patient	Automated survey, patient treatment, patient education, patient care planning, patient compliance, patient attitude, self-care
	Public Health	Public health service, public transportation parameters
	Quality of Care	Care, quality of life, quality study, total quality management, quality assurance, quality factor, quality improvement, total quality management
	Quality of Service (QoS)	QoS class, QoS control, QoS requirements, QoS support
	Treatment	Appointments and schedules, multicenter study, functional rehabilitation, patient treatment, post-treatment, pre-operative planning, practical implementation, practice guideline, professional practice, competence, occupational therapy, physical therapy, strategic planning, treatment barriers, treatment outcome, treatment outcome Europe, treatment planning, treatment planning adults
Socioeconomic	Community	Community based rehabilitation, community care, community integration, community model health, community program
	Cost	Commercial phenomenon, commodization, commoditization of radiology,

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		cost analysis, cost benefits analysis, cost control, cost effectiveness analysis, cost efficient, cost efficient analysis, cost reeducation, cost savings, costs analysis, economic aspect, economic evaluation(s), economic values, low costs, reimbursement, ROI, socioeconomic factors
	Insurance	Health insurance, Medical, anti-kickback law
	Law	Legal aspect, legal procedure, legislation, licensure, malpractice, medicolegal aspect
	Management	Health management, health management practice, organization management, patient centric health care access, work flow
	Satisfaction	Consumer satisfaction, patient satisfaction, physician satisfaction
Environment	Countries, States, Cities	Afghanistan, Albama, Angolia, Australia, Austria, Bangladesh, Belgium, Bolivia, Boston, Botswana, Canada, Denmark, District of Columbia, France, Georgia, Germany, India, Malaysia, Minnesota, Nepal, Netherlands, Norway, Poland, Samoa, South Africa, Thailand, United States
	International	International corporations, international environment
	Places – institutions	Battlefield operations, health care institutions, health center, health center facility, home environment, homes for the aged, hospitals, inversive environment, laboratory, medical center, medical communities, military hospital, overlapping regions
	Vehicles	Unmanned airborne vehicles,

		TAGS-CX
Communication	Imaging	Arnold Cat Nap, DICOM, jpeg, jpeg 2000, PACS
	Information	Health information, information based, information dissemination, information management, information processing, information protocol, information storage and retrieval, information-based communication, medical information
	Internet	Internet IPv6 and IPV4 protocols
	Interoperability	Automatic turning protocol, parallelism, Lyapunov methods
	Privacy	Confidentiality
	Security	Security, security of data
	Time	Time factors, time management, time synchronization, time and motion studies, timed up and go test
	Web	HTML5, Web sites, Web services, Web browser, Web-based central station, Web-based system, WebRTC
Technology	Data	Data display, data format, database management systems, electronic patient record, electronic
	Digital	Digital image management, digital imaging, digital imaging and communications in medicines
	Equipment	Engineering, equipment design
	Instrumentation	Cellular phone, robotic arm, robotics, surgical instrument, ultrasonography

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