BARRIERS TO THE ADOPTION OF TELEMEDICINE AS EXPLAINED BY THE DISRUPTIVE INNOVATION FRAMEWORK

by

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ABSTRACT

Despite its development and suitability to many specialties of medicine for the past forty years and the driving demands of an aging population, telemedicine has not made significant progress in deployment or commercialization. Why is this?

Three case studies of health networks were used to identify the barriers to the widespread use of telemedicine in home healthcare and other applications of medicine. These barriers were further described and analyzed using the framework for disruptive technologies presented in Clayton Christensen's The Innovator's Dilemma.

Although many studies assert that the slow adoption rate of telemedicine is explained by questions of efficacy and cost, this analysis proposes that the change in value networks posed by telemedicine technology is the greatest reason for its anemic implementation.

Telemedicine changes the structure of the healthcare sector changing the organizational dynamics and values of the many players. The changes in structure are explored using the case studies and the successes and failures experienced by the health networks when implementing telemedicine across medical specialties.

In order to harness this technology, recommendations are directed at organizations that need to evaluate new technologies differently and change their behavior with respect to competitors. Public policy needs to recognize the need for a greater thrust in long-term investments in telemedicine research, greater awareness of telemedicine in medical education and in taking the lead in developing standards, guidelines and protocols for telemedicine networks. Research also needs to be encouraged in newer clinical areas and existing standards and technologies in mature telemedicine application areas such as teleradiology and telepathology may be used in medical specialties where telemedicine is not yet a mainstream application. Moreover, the technology

needs to become more ‘human-centered’, to reduce technology barriers for both providers and patients amongst whom the elderly may be predominant.

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Chapter 1: Introduction

The need for telemedicine

The healthcare system in the United States over the last four to five decades has had a primary preoccupation with three problems[1]

- Uneven distribution of health manpower and facilities throughout the country due to the geographic spread
- Inadequate access to certain segments of the population, including the aged, under-privileged, isolated and confined
- The rising cost of care including the costs borne by both private and public players

All the above problems have added significantly to the potential for improving health status and the quality of life for several segments of American society. Moreover, these problems are not unique to American society but exist in variations of degree and intensity in other developed and developing nations.

Telemedicine has proposed a multi-faceted response to address these problems simultaneously through innovate information technologies that expand not only the productive but also the distributive efficiency of the health care system.

Telemedicine means, literally, 'medicine at a distance'. There are several different definitions, which include:

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1. ***Telemedicine – Theory and Practice***, Bashshur R, Sanders J, Shannon G, 1997; 5-14

- Telemedicine is *'rapid access to shared and remote medical expertise by means of telecommunications and information technologies, no matter where the patient or relevant information is locate*d'[2]
- Telemedicine is *'the practice of medical care using interactive audio-visual and data communications. This includes medical care delivery, diagnosis, consultation and treatment, as well as education and the transfer of medical dat*a'[3]

Age demographics and home healthcare

Population aging is about to create a profound impact on many societies in the world, including that of the US. More people are surviving to age 65, and living longer after 65, than in the past. Between 1970 and 2000, the share of the U.S. population age 65 or older increased from 9.8 percent to 12.4 percent (U.S. Bureau of the Census 1996, 2001b). The U.S. Bureau of the Census projects that the population under age 65 will grow by about 35 million between 2002 and 2030—as will the 65-and-over population[4].

Proponents of the crisis view of aging predict that the needs of the elderly will result in a massive shift of both public and private resources from such purposes as education and investment in productive capacity to nursing homes and health care[5].

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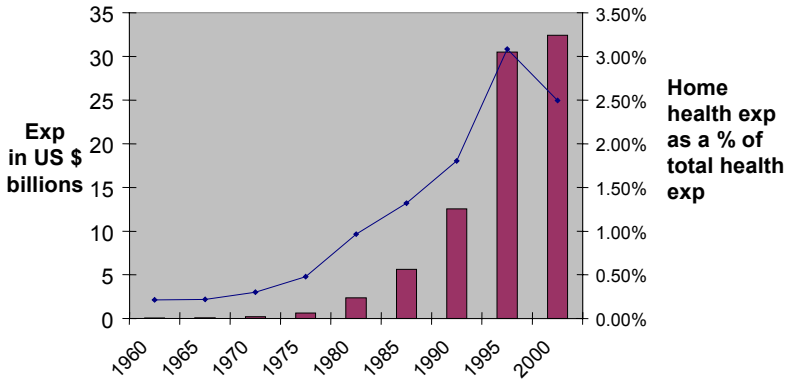
[2] ***Research and technology development on telematics systems in healthcare***: AIM1993, Annual Technical Report on RTD: HealthCare, European Commission: Directorate General XIII, p18
[3] ***Report by the WHO Director General to the 99th Session of the Executive Board***, 6 January 1997
[4] ***Back to which future – The US Aging Crisis revisited***, Korezyk Sophie for the AARP Public Policy Institute, Dec 2002
[5] ***Will Aging Baby Boomers Bust the Federal Budget?***, Jonathan, Lee, Ronald, and Skinner, Journal of Economic Perspectives 13 (Winter 1999): 117-140

At more than $30 billion, the home healthcare industry accounts for less than 3% of current national health expenditures as shown in the Figure 1 (Source: US Census 2001). Looking to 2010, however, the Centers for Medicare and Medicaid Services (CMS) estimates that home health spending will total $87 billion, a 160% increase over the $33.1 billion spent in 1999. The growth rate for the home health industry will continue to exceed that of the healthcare industry as a whole in the coming years as a result of "catch-up" for cuts imposed by the BBA, the increased incidence of disease that will accompany the aging of the U.S. population, and the continued shift of services to less intense settings of care[6].

Figure 1



Home care and telemedicine

Given this demographic trend, recent studies show that home care medical devices were the fastest growing segment of the medical device industry throughout the 1990s[7].

Telemedicine can provide monitoring (telemetry) and home health care services at a distance, using advanced telecommunications and information technology. Aside from videophones,

[6] ***UBS Warburg Research*** Dec 2001
[7] ***Telemedicine – Emergent Trends and Related Policy Issues***, 2001 Report to Congress on Telemedicine (http://telehealth.hrsa.gov/pubs/report2001/trends.htm#aging)

wireless biosensors and feedback loops data can be used to monitor patients who cannot get out of bed. Tele-home health care has been largely successful, and can allow greater access to care, particularly in rural settings where a nurse may have to travel 200 miles one-way to see a patient at home face-to-face[8]. With 'tele-homecare', a rural nurse can "visit" six patients in one day, using interactive video instead of traveling 200-300 miles to visit one patient face-to-face for 20 minutes.

The most significant aspect of tele-home health is the reduced isolation the technology can provide. Often, patients suffering from chronic diseases enter the hospital because they crave emotional support and company that they may lack at home. Video visits from nurses, nutritionists, social workers, and physicians can provide that support far more cost effectively than hospital admissions can. Also, video support groups will evolve in which patients will be able to see and speak with other patients with similar conditions. This will help take the pressure off health care workers in providing emotional support.

Telemedicine thus seeks to reduce some of the inefficiencies of home health care in various ways, including replacing certain nursing visits with video visits, collecting vital-signs data remotely, improving medication compliance, and patient education. The use of telemedicine in home health care settings will provide a means of interacting in a client-centered manner, promoting client autonomy through education and improved communications.

Telemedicine services that are usually provided in the home health market are:

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[8] ***Telemedicine – Emergent Trends and Related Policy Issues***, 2001 Report to Congress on Telemedicine (http://telehealth.hrsa.gov/pubs/report2001/trends.htm#aging)

- Telemedicine videoconferencing consultations
- Store and forward consultations
- Remote Monitoring
- Medical Online Information
- Administrative Services

The low penetration of telemedicine in the home health setting

Despite the seeming strong case for the adoption of telemedicine in the home health sector, its penetration has been considerably low as the figures below indicate.

Home care visits

Year	Number of homecare visits	Number of televisits
1996	185 million	31,200 (est.)
1997	380 million	180,000 (est.)

Source: Home Telecare in the US - A Review of Programs and Technologies, Abt Associates, 1999

The reasons for the low penetration of telemedicine from the perspective of medical practitioners and other key stakeholders are understood to be the following[9]:

1. Payment: At present, with the possible exception of some telemedicine situations, there is no mechanism for reimbursing physicians for the time spent answering queries across the Internet or managing the interaction by means of store and forward messaging. This strongly inhibits any incentives for moving toward Internet-based interaction.

[9] ***Will the internet ever bring physicians and patients together***?, Gartner Group, 7 December 1998

2. Legal and Malpractice Concerns: Currently, there is insufficient legal precedent for what constitutes adequate protection of individual patient information on the Internet, nor are there many solid precedents for the liability that a practitioner risks if the advice he or she provides over the Internet (for example, during an interactive videoconference) leads to an adverse patient outcome. Moreover, tele-consultation networks that cross either state or international lines create additional uncertainties regarding the jurisdiction where a malpractice lawsuit may be litigated and the applicable law.

3. Licensure and Credentialing: Although many telehealth interactions are already crossing state and national boundaries, legal precedents for remote professional licensure are not yet established. Currently, physicians and other healthcare practitioners often must satisfy numerous requirements to obtain a license to practice medicine in each state and have the credentials to practice at each individual healthcare facility. In the US, the Federation of State Medical Boards has proposed that the licensure and certification requirements be standardized to allow practitioners to perform services across state lines without having to undergo a re-examination/refilling of fees and has drafted model legislation to facilitate the practice of telehealth across state lines. However, a number of states have enacted legislation requiring full and unrestricted state licensure of out-of-state healthcare providers[10].

[10] ***Government Regulation of Telehealth – A US Legal Perspective***, Edelstein S, Business Briefing: Next Generation Healthcare 2001

4. Patient Privacy Concerns[11]: In 1996, Congress sought to streamline electronic medical record systems while protecting patients, improving health care efficiency, and reducing fraud and abuse. Passing Congress with bipartisan support, the Health Insurance Portability and Accountability Act (HIPAA, Public Law 104-191) became the legislative vehicle to address those issues. HIPAA is divided into seven standards, collectively referred to as Administrative Simplification. These regulations deal mainly with two issues: 1) reducing the administrative overhead of health care entities; and 2) protecting individually identifiable health information in an increasingly electronic world. Standards for Privacy of Individually Identifiable Health Information is the second final rule to be promulgated by the Department of Health and Human Services (HHS).

   The privacy rule has been applied very broadly to entities that transmit certain information in the course of various health care operations or financial/administrative transactions. Chances are that if an organization contacts patients and is involved in the transmission of their health information, this rule will impact its operations in some way. This rule can be expected to be a heavy financial burden to many health care entities, even though the overall intent is actually to save money by streamlining ways in which health care organizations interact.

5. Time Efficiency and related costs: Physicians are chronically short of available time. Many physicians see use of the Internet to communicate with specific patients as a serious time sink on their already crammed schedules. Until it can be demonstrated that

[11] ***HIPAA's Privacy Rule Summarized: What Does It Mean For Telemedicine?*** Glenn Wachter, Telemedicine Information Exchange February 23, 2001

this approach actually saves time, it will be difficult to persuade doctors to abandon traditional telephone and office-visit practices. A recent study on the costs of telemedicine consultations confirms the fact that telemedicine often tends to save more time for the patients, but is time consuming for doctors. It also costs more than the alternative offline treatment[12].

6. Security: Proposed DHHS security regulations set a high standard for the security of individually identifiable healthcare information, currently beyond the capability of most existing clinical information systems. The basic technology to support secure transactions in the form of public key encryption, digital certificates and certification authorities already exists but has not yet been incorporated into integrated healthcare applications to support physician activities.

7. Aversion to Patient Self-Diagnosis: Most physicians are wary of efforts to promote patient self-diagnosis. This is generally believed to cause much more trouble than any benefits that might result. Physicians often have to devote significant time and energy "unconvincing" a patient about a perceived diagnosis before they can begin to make progress toward identifying the true illness. As a result, the vast majority of physicians have an aversion to patient use of the Internet for healthcare purposes.

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[12] ***Information in Practice, Virtual outreach: economic evaluation of joint teleconsultations for patients referred by their general practitioner for a specialist opinion***, P B Jacklin, J A Roberts, P Wallace, A Haines, R Harrison, J A Barber, S G Thompson, L Lewis, R Currell, S Parker, P Wainwright, for the Virtual Outreach Project Group, British Medical Journal, Vol 327, Jul 2003

8. Nature of the Physician-Patient or nurse-patient Interaction: Many aspects of physician/nurse-patient interaction — including physical examination, tracking of symptoms and clinical findings, and provision of care — involve direct contact between the practitioner and the patient. While some of the need for this can be mitigated by capabilities incorporated into telemedicine technologies, many situations still occur in which in-person one-to-one contact is required and cannot be supplanted by communication over the Internet.

9. Fraud and Abuse – Self-referral Issues: The US has stringent laws governing financial arrangements and patient referrals among healthcare providers. Any financial arrangement involving US practitioners in a telehealth network involving services that are reimbursable under a government healthcare program may raise issues under federal and state anti-fraud and abuse and self-referral laws, particularly in view of the fact that network participants, because of their technological ties, may be tempted to refer patients to each other[13].

10. Insufficient Number of Patients on the Web: Even though the percentage of patients on the Internet continues to grow rapidly, it is still a tiny fraction of the total patient population. Consequently, physicians cannot feasibly view Internet interactions with patients as a mainstream activity. At best, they will reach only a small fraction of their patients in this fashion.

[13] ***Government Regulation of Telehealth – A US Legal Perspective***, Edelstein S, Business Briefing: Next Generation Healthcare 2001

Telemedicine as a disruptive technology

While the current situation may be described in the context of medical systems as they exist, considering telemedicine a disruptive technology may provide an alternative way of assessing the situation and offer hypotheses as to why the promise of telemedicine has yet to be widely realized.

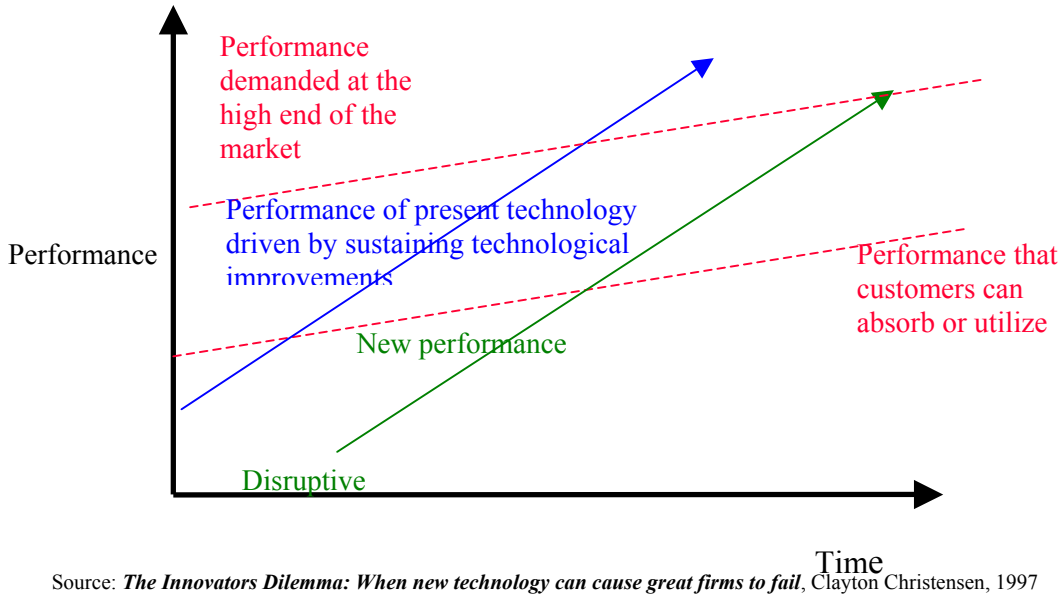
Telemedicine brings about a fundamental change to the way medicine is delivered as well as to the structure of the medical industry. Telemedicine may be classified as a 'disruptive technology' as described by Christensen[14]. Christensen organizes the discussion into a 'failure framework', which shows why companies (and in this case, technologies) can fail. It comprises of three major findings:

1. Sustainable versus disruptive technologies: According to Christensen, most new technology is self-sustaining and improves performance along dimensions that the mainstream customers in major markets have historically valued. By contrast, disruptive technologies typically have worse performance, at least in the near term. But:
    a. They have features that a few fringe and generally new (or fewer) customers value and which represent a key source of competitive value in the future;
    b. Products based on them are typically cheaper, simpler, smaller and frequently more convenient to use -often representing a new product architecture.
    c. They often bring a new and different value proposition

[14] ***The Innovators Dilemma: When new technology can cause great firms to fail***, Clayton Christensen, 1997

Telemedicine fulfils the requirements placed by the definition of disruptive technologies. Its feature of distant care is valuable to a set of people who were earlier on the fringe of regular medical care since they did not have easy access to medical services, such as patients receiving home care. Using telemedicine may be cheaper in the long term (and even per incidence of care) as a study by Kaiser Permanente (1999) indicates. Moreover, the value proposition of telemedicine is unique since it provides care for populations (the aging, rural populations, prison populations[15]) that conventional medical delivery had limited means of providing. Telemedicine permits the increase of the frequency of care, is interactive, involves a great deal of virtual 'touch', and allows the generation of medical data that can be easily shared with caregivers and providers.

2. The trajectory of market need versus technological improvement: The second element of the failure framework is the observation that technologies can progress faster than market demand, as shown in the following figure.



Source: ***The Innovators Dilemma: When new technology can cause great firms to fail***, Clayton Christensen, 1997

[15] ***Teleradiology in rural imaging centers***, Davis MC, Journal of Telemedicine and Telecare 1997, (3), 146-153

The diagram shows that in the effort to provide better products using more advanced technology, suppliers of the technology overshoot the market, giving customers more than they need or are willing to pay for. This also implies that disruptive technologies under-perform today relative to what users in the market demand, but can become fully price competitive in the same market in the future.

Telemedicine has followed a similar trajectory, since its earliest use in Omaha, NE in the 1950s[16] in an interactive televideo psychiatry unit. However, most telemedicine programs had ceased to exist by the 1980s although they were considered a success at inception[17]. The major barriers[18] for the programs were as follows:

a. Most telemedicine technology that was used required expensive satellite uplinks and infrastructure costs (personnel and equipment)[19]
b. Information transmission capability was primitive compared to current standards. This technology had poor quality images transmitted through the systems, making accurate diagnosis difficult. For example, even dedicated telephone lines could transmit only slow-scan analog images, with poor quality audio transmission with co-axial cables. Invariably, the uptake of services was poor[20].
c. Moreover there was also an inability to interface telemedicine into mainstream healthcare provision

[16] ***Two-way television group therapy***, Wittson CL, Affleck DC, Johnson V, Mental Hospitals, 1961; 12:22-23
[17] ***Telemedicine Sourcebook*** 1996-1997 Pg 3
[18] ***Telemedicine Sourcebook*** 1996-1997 Pg 3
[19] ***Telemedicine Sourcebook*** 1996-1997 Pg 4
[20] ***Telemedicine – Theory and Practice***, Bashshur R, Sanders J, Shannon G, 1997; 5-14

Many of these technological barriers have been overcome to a large extent in the 1990s making telemedicine a more viable means of providing healthcare services.

3. Disruptive technologies versus rational investments: The final element of the failure framework is that established companies (such as managed care organizations) will never find it profitable to invest in the disruptive technology for two reasons:
    a. Disruptive products are often simpler and cheaper, generally promising lower margins rather than greater profits. In the case of telemedicine, this may occur because new technology appeared to counter improvements in productivity – in some cases providers spent more time to accomplish the same amount of work making the technology appear to be less profitable[21].
    b. Disruptive technologies are usually commercialized in emerging or insignificant markets. Leading firms' most profitable customers generally don't want, and initially can't use products based on disruptive technologies. By and large, the least profitable customers initially embrace the disruptive technologies. This is seen quite clearly in the early successes of telemedicine in the 1980s in projects whose commonality was their dilemma of needing to provide medical care to people in remote areas that were inaccessible to the usual heath-care services due to either no viable solution or solutions at prohibitive costs[22]. Some examples of such projects:
        i. National Aeronautics and Space Agency (NASA) used telemedicine to monitor the health of astronauts in space as well as for research purposes

[21] ***The Diffusion of Telemedicine***, Grisby J, Rigby M, Telemedicine Journal and eHealth, (8)1, 2002, pg 79-94
[22] ***Telemedicine and Telehealth – Principles, policies and pitfalls***, Darkins AW, Cary MA, 2000; 8-9

ii. Antarctic survey stations are unable to attend to sick persons for several months in the year due to adverse weather, which makes air travel in case of an emergency impossible. These stations rely on telemedicine.

iii. Offshore oil exploration rigs often face situations where they cannot evacuate a sick or injured person due to poor weather conditions. They used telemedicine to access immediate medical support

iv. The US military has had extensive involvement with telemedicine activity throughout the world. The cost and complexity of providing battlefield care to soldiers prompted the use of telemedicine in overseas military engagements.

Note that these solutions are all owned by the government and not by commercial enterprises. The solutions also demonstrate how, by and large, customers providing the least profitability may be the first to embrace a disruptive technology. Hence most companies (and even the government in the case of Medicare/ Medicaid) are likely to continue the status quo of providing services that may only be accessed by the majority of existing customers. As a result, they are not able to realize the benefits of the disruptive technology and will hold back investing in it for as long as possible.

The failure framework will be supplemented with other frameworks for the healthcare organizations that are potential users of telemedicine and will attempt to build a deeper understanding of why this technology is disruptive, leading to its low diffusion.

Chapter 2 will give describe some of the work that has already been done to establish barriers to telemedicine. Chapter 3 will describe the methodology used to gather data to explore the idea of telemedicine as disruptive technology. The findings are described in Chapter 4 and analyzed further in Chapter 5. Chapter 6 provides conclusions and Chapter 7 identifies a series of recommendations.

Chapter 2: Literature review for telemedicine and home health

Introduction

The demand for home health care has sky rocketed in recent years. The aging population as well as the consumer push for an increasingly efficient healthcare delivery system has fuelled this growing demand. Home health agencies struggle to deliver high quality services while staying within the financial limitations that reimbursement changes impose. Telemedicine for the home care population is one way to provide cost effective care in the current environment. However, although telemedicine may be a means to curb rising healthcare costs, its adoption by the medical community has been slow.

The burgeoning home health market

At nearly $40 billion (US Census bureau, 2001), the home healthcare industry accounts for less than 3% of current national health expenditures. The Centers for Medicare and Medicaid Services, however, estimate that home spending will total $87 billion in 2010, a 160% increase over the $33 billion spent in 1999.

Over the last 20 years, home health growth has outstripped the growth in the overall health sector. This is likely to continue largely due to the increased incidence of disease that will accompany the aging US population[23].

Telemedicine and home health care

In recent years, there has been greater involvement of advocacy groups, consumers, and representatives from equipment manufacturing companies to support the advancement of home monitoring and telemedicine. "Telemedicine" describes new delivery systems that enhance interactions between care providers and their patients through use of electronic, Internet or telephone technologies. Regardless of the terminology, the goal is the same -- to reduce the costs of providing care to patients with chronic illnesses while maintaining a high level of quality[24].

The slow adoption of telemedicine

Telemedicine had its beginnings in the United States in the 1960s as a means of providing specialty consultation using closed circuit interactive television. The idea of telemedicine, however, was decades ahead of the limited quality, availability and affordability of the technologies then available.

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[23] ***Home health primer***, UBS Warburg, December 2001
[24] ***A home health briefing report***, Feedback.com, 2001

This last decade has seen a resurgence of telemedicine. Data from the Association of Telemedicine Service Providers (ATSP) Annual Survey of telemedicine reveal a positive growth trend in the number of programs and providers[25]. However, growth in both types of medicine practiced and regions has been highly uneven. In 1999, of 132 programs in the sample, only 15 suggested more than 1000 teleconsultations suggesting uneven regional distribution of services. The number of physicians who reported participating in telemedicine in 1999 was less than 4000 and the annual average number of teleconsultations per site in 1998 was less than 40.

Telemedicine as a disruptive technology

The slow adoption of telemedicine may be explained by considering telemedicine as a disruptive technology. Telemedicine has followed the classic path of disruptive technologies as described by Christensen in his book, The Innovator's Dilemma [1997]. He describes how in most cases, technology is simply the infrastructure that facilitates a new business model. New technology may allow an established company to bring to market a product or service that its most profitable customers (hospitals, home health agencies or patients) cannot use. This new product or service may also appear to be unprofitable relative to the other options on the company's innovation menu. For these reasons, established stakeholders find it difficult to embrace the opportunities of a new technology. In this light, the issue of the slow adoption of telemedicine can be explored once more by considering the stakeholders, economics and regulation in the industry.

[25] ***Diffusion of telemedicine***, Grisgsby J and Rigby M, Telemedicine Journal and eHealth, 8(1), 2002

1. Physician adoption of telemedicine

The poor physician adoption of technology has been studied in several contexts in the past. A study in Hong Kong attempted to understand physicians' decisions while evaluating telemedicine technology by means of exploratory research[26]. The study concluded that physicians anchor their decisions in their perceived usefulness of the technology rather than its ease of use. Other studies have implied that physicians are reluctant to adopt new technologies for a variety of reasons, including issues of reimbursement, liability, training etc[27]. However, viewing telemedicine as a disruptive technology and considering the ensuing change management challenge may explain the adoption behavior by physicians.

2. Institutional change management

Bashshur[28] has addressed the institutional issues with the adoption of new technologies like telemedicine, when he noted that when technological innovations are not accepted or implemented properly, generally the failure may be traced to a poor fit between the nature of innovation and the vested interests, resources and expectations of its major gatekeepers. Organizational behavior models in the face of change such as institutional isomorphism and

[26] ***Examining a model of information technology acceptance by individual professionals: an exploratory study***, Chau PYK and Hu PJ, Journal of Management Information Systems, 18(4), 2002, pp 191-229

[27] ***Online physician patient interaction: serious issues remain***, Strategic planning, SPA-12-4094, Gartner group, Nov 2000

[28] ***Telemedicine and the health care system*** in Bashshur RL, Sanders JH, Shannon GW eds, Telemedicine Theory and Practice, 1997 pp 5-35

collective rationality[29] have been used to reflect the rules and norms that characterize the organizational field rather than reflect responses to market conditions.

3. Cost effectiveness of telehomecare

Many studies indicate a high likelihood that telehomecare will eventually be cost-effective. That cannot be inferred conclusively by current tests since the research and development expenses are often not included.

Reduced hospital visits in cases of congestive heart failure [Jerant 2001[30]] made telehome-monitoring less costly than hospitalization. Note that this study recommends post hospitalization telemonitoring rather than home care. Telehospices have shown dramatic cost savings [Dolittle 2000[31]] according to some studies, reducing the cost per visit of traditional care of $126 and $141, for the first and second 3 month time periods respectively, to an average telehospice visit cost of $29. Cardiotocography studies [Torok 2000], studies of high risk pregnancy [Morrison 2001[32]], home care of oncology [Subirana 2001[33]] indicate that telehomecare is less expensive than traditional home care. Another study [Tsuji 2001[34]] has indicated that the specific application of telemedicine for the caring of the aged at home instead of hospitals in Japan would

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[29] ***The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields***, Powell W, DiMaggio P eds, The New Institutionalism in Organizational Analysis, U Chicago Press, 1991, 63-82

[30] ***Reducing the cost of frequent hospital admissions for congestive heart failure: a randomized trial of a home telecare intervention***, Jerant AF, Azari R, Nesbitt TS, Med Care 2001 Nov; 39(11): 1234-45

[31] ***A cost measurement study for a home-based telehospice service***, Doolittle, G. C.. Journal of Telemedicine & Telecare. 6 Suppl 1:S193-5, 2000.

[32] ***Telemedicine – cost effective management of high risk pregnancy***, Morrison J, Bergauer NK, Jacques D, Coleman SK, Stanziano GJ., Manag Care 2001 Nov;10(11):42-6, 48-9

[33] ***A cost-minimization analysis of oncology home care versus hospital care***, Subirana Serrate R, Ferrer-Roca O, Gonzalez-Davila E., J Telemed Telecare 2001; 7(4): 226-32

[34] ***An estimation of economic effects of tele-home-care: hospital cost-savings of the elderly***, Tsuji M, Miyahara S, Taoka F, Teshima M, Medinfo 2001; 10(Pt 1): 858-62

result in savings as high as 7.4% of the hospitalization costs of the aged by 2050. Some mention is made of 'smart homes' where intelligent monitoring, sensors etc are placed in the home which manages the individuals' health, safety and other needs [Tang 2000[35]], but it is yet uncertain whether the concept will prove cost effective.

While many studies show the costs of telehomecare to be comparable or lesser than ordinary home care, newer studies place a greater focus on the linkage of costs with clinical outcomes. This has been attempted comprehensively in quasi-experimental studies such as the Kaiser Permanente Tele Home Health Research Project[36], which was amongst the first to demonstrate that telehomecare can maintain the quality of care while producing cost savings. Another study of diabetic patients [Dansky et al 2001[37]] shows that cost effective care can be provided by telehomecare even under current reimbursement constraints. This study illustrates that the potential savings through fewer home visits will offset the higher costs that telehomecare imposes to a home health agency. This study leaves open the question of what the most appropriate means of using telehomecare is – substitution of traditional care by telemedicine or supplementation.

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[35] ***Smar' homes and telecare for independent living***, Tang P, Venables T., J Telemed Telecare 2000; 6(1): 8-14
[36] ***Outcomes of the Kaiser Permanente Tele Home Health Research Project***, Johnston B, Weeler L, Deuser J, Souza K, Arch Fam Med 2000, 40-45
[37] ***Cost analysis of telehomecare,*** Dansky, Palmer, Shea and Bowles, Telemedicine Journal and eHealth, Vol 7 No 3, 2001 225-32

4. Clinical efficacy of telemedicine

Several studies have commented on the clinical efficacy of telemedicine in home healthcare. Positive results have been observed in the case of hypertension [Friedman et al 1996[38] and Catwright et al 1992], home blood sugar monitoring [Marrero 1995[39], Mease 2000[40]]. Compliance for treatment has also been noted in the case of chronic disease [Johnston 2000[41]].

However, it is yet to be conclusively established that telehomecare necessarily improves the clinical efficacy. There is some evidence of comparable diagnosis and management decisions made using store-and-forward telemedicine from the areas of dermatology [Lim 2001[42]], pediatric ophthalmology [Helveston 2001[43]], and neonatology [Robie 1998[44]]. In self-monitoring/testing telemedicine for the areas of pediatrics, obstetrics, and clinician-indirect home telemedicine, there is evidence that access to care can be improved when patients and families have the opportunity to receive telehealth care at home rather than in-person care in a clinic or hospital[45]. Access is particularly enhanced when the telehealth system enables timely

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[38] ***A telecommunications system for monitoring and counseling patients with hypertension. Impact on medication and adherence,*** Friedman RA, Kazis LE, Jette A, Smith MB, Stollerman J, Torgerson J, Carey K., American Journal of Hypertension 1996 Apr, 9, 285-92

[39] ***Using telecommunication technology to manage children with diabetes: The Computer Linked Outpatient Clinic (CLOC) Study***, Marrero DG, Vandagriff JL, Kronz K, Fineberg NS, Golden MP, Gray D, Orr DP, Wright JC, Johnson NB, Diabetes educator 1995 21, 313-19

[40] ***Telemedicine improved diabetic management,*** Mease A, Whitlock WL, Brown A, Moore K, Pavliscak H, Dingbaum A, Lacefield D, Bukre K, Xenakis S, Military medicine 2000, 165, 579-84

[41] ***Outcomes of the Kaiser Permanente Tele-Home Health Research Project***, Johnston B, Wheeler L, Deuser J, Souza KH, Archives of Family Medicine 2000, 9, 40-45

[42] ***Accuracy and reliability of store-and-forward teledermatology: preliminary results from the St George Teledermatology Project***, Lim, Egerton, See, Shumack, Australian J of Dermatol 2001 42(4), 247-51

[43] ***Telemedicine – Strabismus e-consultation***, Helveston, Orge, Naranjo, Hernandez, Journal of AAPOS 2001 Oct, 5(5), 291-6

[44] ***Early experience using telemedicine for neonatal consultations***, Robie DK, Naulty CM, Parry RL, Motta C, Darling B, Micheals M, Poropatich RK, Gomez ER, J Pediatr Surg 1998 Jul;33(7):1172-6

[45] ***Telematic evolution of day-hospital in oncology***, Maceratini, R.; Ricci, F. L., and Rafanelli, M., Medinfo. 9 Pt 1: 302-6, 1998.

communication between patients or families and care providers that allows self-management and necessary adjustments that may prevent hospitalization. There is some evidence that this form of telemedicine improves health outcomes, but the study sample sizes are usually small, and even when they are not, the treatment effects are small [Telemedicine for the Medicare Population, 2001[46]]. There is also some evidence for the efficacy of clinician-interactive telemedicine, but the studies do not clearly define which technologies provide benefit or cost-efficiency. Some promising areas for diagnosis include emergency medicine, psychiatry, and cardiology.

Most of the studies measuring access to care provide evidence that it is improved. Although very few of these studies were randomized controlled trials, they provide some evidence of access improvement over prior conditions. A supplemental report covering the areas of pediatrics, obstetrics, and indirect-clinician home telemedicine echoes the findings of an initial report for the Medicare domain, which is that while the use of telemedicine is small but growing, the evidence for its efficacy is incomplete [Telemedicine for the Medicare Population, 2001[47]]. Nevertheless, experts believe that it will play a pivotal role in the future of home based healthcare and investment in further studies must be made to substantiate this[48].

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[46] ***Telemedicine for the Medicare population: pediatric, obstetric, and clinician-indirect home interventions***, Evid Rep Technol Assess (Summ) 2001 Aug;(24 Suppl):1-32

[47] **Ibid**

[48] ***Executive summary of the symposium of the State of the Art in Telemedicine/ Telecare 2001***, Bashshur RL, Mandil SH, Sanders GW, Telemedicine J and eHealth, 8(1), 95-107.

5. Regulation in telehomecare

Medical reimbursement is the issue that impacts the telehomecare most directly. Due to an upward spiral in healthcare costs over a decade, there is a renewed effort to curtail costs, which is reflected in recent changes in Medicare and Medicaid reimbursement systems. Currently Medicare's part A and part B coverage takes care of nursing and equipment expenses respectively[49] in the case of home health. A new system called the Prospective Payment System (PPS) from fee for payment systems has changed reimbursement so that it may be less costly for a hospital to reduce the patient's stay in the hospital and discharge them as soon as possible. This may indirectly benefit telehomecare if it is proven to be more cost effective than hospitalization. Once again, the extent of cost reduction if telehomecare were adopted has not been proved conclusively.

Telehomecare is also affected by the other issues that telemedicine in general faces. Although many telehealth interactions are already crossing state and national boundaries, legal precedents for remote professional licensure are not yet established. Currently, physicians and other healthcare practitioners often must satisfy numerous requirements to obtain a licence to practice medicine in each state and have the credentials to practice at each individual healthcare facility [Kearney 1997[50]].

The issues of licensure and medical malpractice are significantly intertwined. Licensure laws ensure patients that health care providers are competent while malpractice liability compensates

[49] ***Home health primer***, UBS Warburg, December 13, 2001
[50] ***Telemedicine: Ringing in a New Era of Health Care Delivery***, Julie M. Kearney, 5 Comm. L. Conspectus 289, 290 (Summer 1997) Pg 8

the injured for substandard care. Medical malpractice claims, or the threat of such claims, hinders the development of telemedicine. Physicians, uncertain of facing liability in a distant locale, may choose not to participate in telemedicine programs[51]. Likewise, malpractice insurers do not know how to assess the risk of such activities and therefore may not provide coverage [Pendrak 1996[52]].

Just like the rest of the world that has been touched by the Internet and easier access to information, privacy issues also affect healthcare. The physicians' use of the telecommunications networks to exchange information invariably raises two separate privacy questions. First, how absolute is the duty of confidentiality and which state's privacy laws apply in a telemedicine proceeding [Guttman-McCabe 1997[53]]. Second, what are the ramifications of sending confidential data over unsecured networks? Physicians must consider these two issues if they want to transfer or store patient data using telecommunications [Donaldson and Lohr 1994[54]]. Other issues that also need to be considered would be medical device regulations, intellectual property, electronic prescriptions etc. [Eldenstein 2001[55]].

6. Who pays for telehomecare?

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[51] ***Telemedicine Report to Congress, Legal Issues--Licensure and Telemedicine***, Jan. 31, 1997 at http://www.nita.doc.gov/reports/telemed/legal.html

[52] ***Telemedicine May Spawn Long-Distance Lawsuits***, Pendrak R. F. & Ericson R. P., Nat'l Underwriter, Nov. 4, 1996

[53] ***Telemedicine's imperilled future? Funding, reimbursement, licensing and privacy hurdles face a developing technology***, Guttman-McCabe CG, Journal of Contemporary Health Law & Policy, 1997

[54] ***Health Data in the Information Age: Use, Disclosure, and Privacy***, Institute of Medicine, (M. S. Donaldson and K. N. Lohr, eds. National Academy Press, 1994).

[55] ***Government Regulation of Telehealth – A US Legal Perspective***, Edelstein S, Business Briefing: Next Generation Healthcare 2001

A US Census Bureau's report for the year 2001[56] indicates that the cost of home healthcare is amongst the fastest growing cost amongst the various health expenditures (total health expenditure grew at 6.4% over the last decade while home health expenditure grew at nearly 10%). Moreover, home healthcare is paid for by private or public funds; about 20% of the expenditure is out of pocket. Other entities that pay for home care are private third party payors or public third party payors[57].

As a result of the changes in medical reimbursement to control costs, three models have emerged for home care payment: community-based long-term care (exemplified by PACE, Program of All-inclusive Care for the Elderly), home-based primary care (exemplified by the Veterans Administration Home-Based Primary Care program), and disease management programs (exemplified by Group Health Cooperative of Puget Sound) [Turk 2000[58]].

The available literature was used as a basis for some hypotheses about the slow growth of telemedicine, which will be discussed in the following chapter.

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[56] ***US Census Bureau 2001 and HCFA***, http://www.hcfa.gov/stats/NHE-OAct/
[57] ***Who pays for home care services?***, National Association of Home Care 1996, http://www.nahc.org/Consumer/wpfhcs.html
[58] ***A new era in home care***, Turk L, Parmley J, Ames A, Schumacher KL, Semin Nurse Manag 2000 Sep;8(3): 143-50

Chapter 3: Scope and Method

Introduction

Telemedicine not only offers an alternative way to provide healthcare, it changes the existing structure of the healthcare industry, decentralizing the power to provide care to the user of telemedicine. The impact of this restructuring is felt by the key stakeholders, the doctors, nurses, patients, managed care organizations, hospitals/ hospices, insurance companies, the government and equipment manufacturers.

Moreover, the value provided by telemedicine may not be tangible when the technology is directed at existing patients. In the words of a leading radiologist[59], "telemedicine was a series of technologies that were looking for a problem to solve". However, when telemedicine is not used as an incremental improvement to current methods of delivering care, but when it becomes a tool to address new consumers, its value becomes undeniable.

In order to assess telemedicine as a disruptive technology, I have selected three case studies to illustrate the current status of telemedicine. The focus of the case studies will be to determine the pattern traced by telemedicine technology for home health, and test whether it follows the path of disruptive innovation using Christensen's framework. The results may also be applicable to telemedicine technology in general.

[59] ***In an interview with the author in October 2001***

All three cases deal with organizations that are considered successful[60] users of telemedicine and also deploy telemedicine for the use of home healthcare. These organizations have recorded their experiences while creating successful specialties, which I have gathered from personal interviews and secondary sources. While many of the interviews have generated much data about many aspects of the organizations, I have not been able to gather much detail on failures in one of the organizations. Since no organization enjoys being seen as not being innovative or an early adopter of technology, which may well be a cultural bias for US-based companies, it is quite hard to have interviewees frankly discuss their setbacks. This is reflected in my descriptions of the case studies where I have been able to provide more detail on the failures at the Kansas University Center for Telemedicine and Telehealth than any other organization primarily since the information was more easily available.

Hypotheses

I have used the case studies to test the following three dominant hypotheses based on Christensen's disruptive technology framework:

1. The studies do not consider that telemedicine is not an incremental improvement in technology but a major discontinuity. If seen in this light, the problems in diffusion may be understood better.
2. There is limited corresponding research for telemedicine in home healthcare
3. The hypotheses offered by the literature for the slow adoption of telemedicine aren't so much incorrect as incomplete since they have not adopted Christensen's disruptive

[60] Based on interviews with Susan Dimmick of the University of Tennessee Telehealth Network and Andrea Hassol of Abt Associates

technology argument to understand how technology is changing the value proposition for consumers, who are today driving the deployment of telemedicine. Previous research also tends to be mainly from the provider's perspective, not from that of the patients or their families in line with today's increasingly consumer driven economy.

Analytic frameworks used for assessment

The barriers that are faced by telemedicine will be assessed using three lenses:

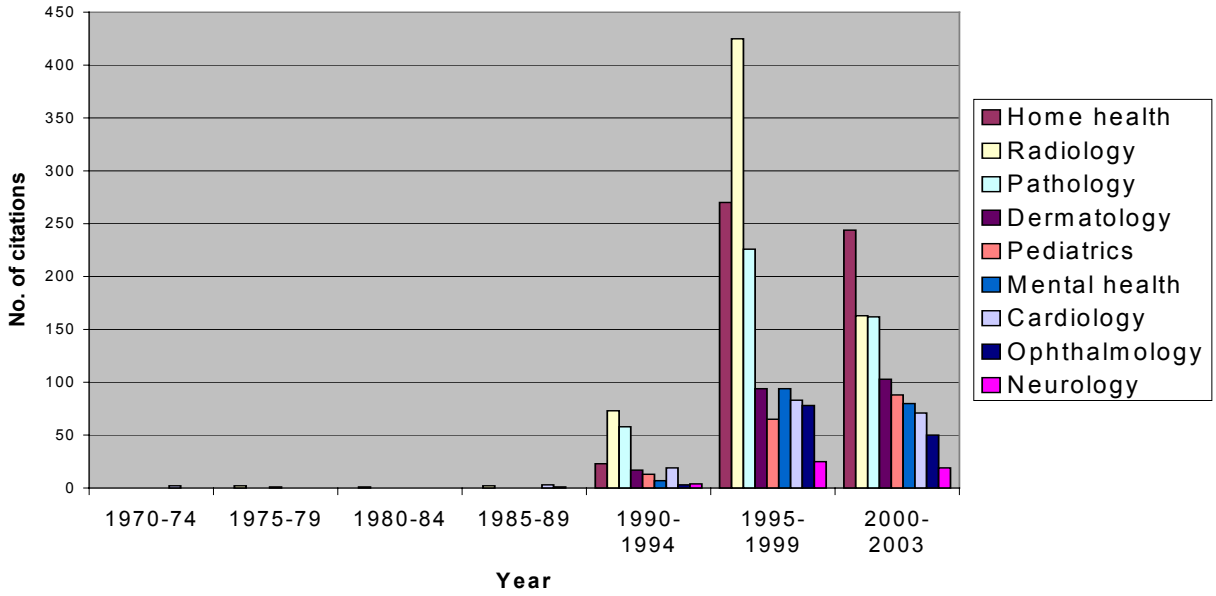
1. The change in the power structure of key stakeholders, due to organizational changes
2. Growth hindered on account of current capabilities
3. The value proposition presented by telemedicine and its applicability to current medical problems (limited to home health)

These barriers will be explained in the context of three case studies.

Rationale for using data from multiple specialties

Many of the case studies discuss the use of telemedicine in areas other than home care. Due to

Figure 1: Specialties that have adopted telemedicine



Source: PubMed

the limitations due to technology, over the years, specialties such as radiology and pathology were early adopters of telemedicine (Figure 1 shows which specialties have had prominence over the last four decades). Since home care has only recently been recognized as a feasible application area for telemedicine, the other specialties are used to trace back the origins of the factors that worked against telemedicine[61].

[61] Figure 1 uses citations from PubMed that refer to each of the specialties, but leaves out citations that discuss telemedicine/ telehealth/ telehomecare in general

Data sources

Information on home healthcare was gathered from a combination of primary and secondary research sources. Publications were reviewed from the following categories:

- Peer reviewed journals
- Industry websites
- Commercial research reports
- Vendor marketing/ technical material

Articles were selected via online searches of PubMed and related search services. Additional articles were selected based upon the relevance in bibliographic citations in the first set of articles reviewed. In addition, reports on telemedicine were also purchased.

Search terms used were a combination of 'telemedicine', 'telehealth', 'telehome' and 'home health'; searches were made from 1970 onwards to trace the growing relevance of the different specialties of telemedicine.

All key stakeholders in the telemedicine industry were interviewed either in person or on the telephone to discuss their experiences with telemedicine and their view of the barriers to telemedicine (see Appendix).

Chapter 4: Three Case Studies

University of Tennessee Health Network

Background

The UT Telehealth Network (UTTN) was begun in 1995. It is the hub site that serves a number of hospitals and community health centers in the East Tennessee Region. UTTN is a multidisciplinary unit contained within the University of Tennessee Medical Center at Knoxville. The UT Graduate School of Medicine is the administrative unit for the UT Telehealth Network.

This case study will discuss one of the projects of the UT Health Network, the Scott County Telehealth Project, funded by the Office for the Advancement of Telehealth (OAT), a division of the Department of Health and Human Services, Health Resources Services Agency. The goal of the network was to deliver 10 different medical, dental, and behavioral health services to a rural community. The network served patients from nine different counties and two states. This program has made Scott County, TN, one of the most "networked" counties in the state for healthcare.

Medical services provided by the network to Scott County

1. Behavioral Health

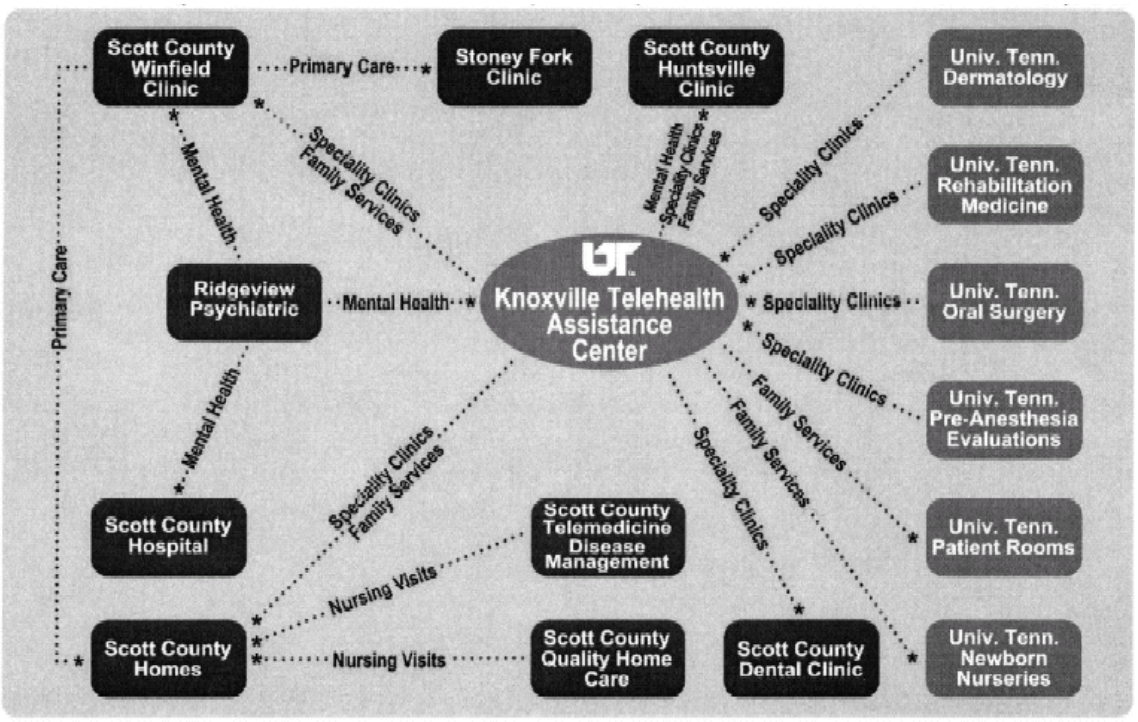
a. Substance abuse

b. Medication management

c. Adult counseling

d. Child/ adolescent counseling

Figure 2: UT Telehealth Network Services for Scott County



Lines indicate a two-way audio/ video communication between patients and providers. Asterisks are located at the ends nearest to patients

Source: Dimmick SL, Burgiss SG, Robbins S, Black D, Jarnagin B, Anders M., "Outcomes of an integrated telehealth network demonstration project". Telemed J E Health. 2003 Spring;9(1):13-23.

2. Dentistry/ oral health
3. Disease management
4. Dermatology
5. Fertility counseling
6. Physiatry
7. Pre anesthesia consultation

8. Follow up surgery consultation
9. Home health care
    a. Diabetes Counseling
    b. Congestive Heart Failure
10. Primary care

Technology used to provide telemedicine[62]

1. The diabetes and CHF programs operated since 1999 and constituted the bulk of the encounters. These encounters included both live video consults and UTTN used its Telehealth Assistance Center (TAC) as the centralized hub for coordinating a range of services from specialty clinics to family services to behavioral health through a combination of full T-1, ISDN at 336 kbps and POTS. UTTN helped implement the delivery of services through a variety of health care agencies in Scott and Anderson counties (Fig. 1).

2. Services provided by teledental health and telebehavioral health used videoconferencing between provider and patient. Compressed video conferencing systems at each location transmitted and received audio and video communications using ISDN lines. For the dental service, an additional oral camera and monitor for the dentist was added to the system to enable observation by the oral surgeon at TAC. Telebehavioral health conferencing was provided by direct dial connections between providers at Ridgeview Psychiatric and patients at Scott County Hospital.

[62] Source: ***Outcomes of an integrated telehealth network demonstration project***, Dimmick SL, Burgiss SG, Robbins S, Black D, Jarnagin B, Anders M., Telemed J E Health. 2003 Spring;9(1):13-23.

3. Other specialty clinics were provided at Scott County Winfield Clinic and Scott County Huntsville Clinic using the same type of technology. The Winfield Clinic was connected to TAC using ISDN 336 kbps service and the Huntsville Clinic was connected to the TAC using full T-1 communications at 1.54 Mbps. TAC provided the interconnection technology permitting videoconferences between systems of different bandwidths (e.g., POTS to ISDN, POTS to T-1, and ISDN to T-1).

4. For medical clinics, nurses used a hand-held patient examination camera (camcorder) to present the patient, and an analog stethoscope using a POTS line provided heart and lung sounds.

5. The disease management services used a combination of videoconferencing, normal telephone conversation, and remote monitoring between patients in Scott County homes and their nurses at the Scott County Telemedicine Center in Huntsville. Videoconferencing was provided in the homes by component systems composed of a 13" video monitor, a patient camera (camcorder), a speakerphone, and an electronic interface box (or a CODEC).
    a. Services for CHF patients were provided by the videoconferencing system and a remote monitoring system that transmitted blood pressure, blood oxygen saturation, and pulse rate.
    b. Some diabetic patients used video systems, and others used the standard home telephone for communication with their nurse. All diabetic patients had a glucometer that transmitted values to a central monitoring station using a home POTS line.

Managing disruptive technological change:

1. **Giving responsibility for disruptive technologies to specialties whose patients need them:**

   The Scott County Telehealth Project was able to demonstrate benefits in many of the specialties that used telemedicine by using telemedicine to improve a very specific aspect of treatment rather than the entire treatment.

   In the case of dental health, telemedicine was used mainly to reduce the trips made by patients to visit oral surgeons prior to and post care. This created a time and distance saving since it cut down on approximately 1 hour and 16 mins of travel (59 miles). In the case of telebehavioral health, a mobile crisis unit was able to make contact with a patient within a very short time of them being admitted to emergency psychiatric care just prior to the arrival of the unit. As a result patients that would have an average wait of 99 mins for medical help now received it in 12 mins. For CHF patients, the technology was aimed at checking on them, manage their moods and to let them learn about significant CHF functions, which was achieved in the program. Diabetic patients with CHF even achieved improved blood sugar control.

2. **Matching the size of the organization/ project to the size of the market**

The Scott County project was on a scale that matched the size of the scattered rural population. The $319,970 grant[63] was used in a focused manner for the three areas that were most problematic for Scott County residents: chronic care, specialty care and dental care.

3. Discovering new and emerging markets

By providing services in Scott County, the program would introduce a traditionally underserved community to more telecommunication technology by subsidizing it through the grant. Further, educating consumers about the use of telemedicine makes it easier for patients that have seen a demonstration of its benefits continue to use it. Moreover, most of the patients in care areas like behavioral health were covered by the State medical insurance, increasing the likelihood of patients like them being willing consumers for telemedicine after the grant expires.

4. Performance provided, market demand and the product life cycle

Telemedicine provided a disruptive performance for the main specialties in Scott County. For example, in the case of behavioral health at the Ridgeview Clinic, if an emergency medical case arose, the county could attempt to improve the medical care provided by the Mobile Crisis by trying to reduce the response time by having more units, local units more easily accessible etc. This may mean a higher cost for the county. However, telemedicine makes it

[63] ***Department of Learning and Telemedicine website***, http://www.usda.gov/rus/telecom/dlt/dltawards_tn.htm

much quicker for the Mobile Crisis Team to reach patients, and by a large factor. It almost reduces the time to an eighth of the time taken before using telemedicine.

The future demand for telemedicine would also be impacted by its marginal cost once the Scott County project was completed. Once again, considering the Mobile Crisis Unit, the cost of using telemedicine for a larger patient population would only be the marginal cost of additional local telemedicine units in the emergency room. However, if the same kind of time saving were to be achieved by additional mobile units, it would imply the investment of one or more mobile units – both the vehicles with equipment and teams. This is likely to be a much higher marginal cost for an increasing patient base. Hence as the demand for the service increases, for a given investment, telemedicine is likely to provide much better performance and could potentially be the preferred method used.

The Kansas University Center for TeleMedicine & TeleHealth (KUCTT)[64]

Background

In 1991, the Kansas University Medical Center (KUMC) launched a telemedicine program to provide video-links between rural communities and urban consultant specialists. Initially, a link was established between the KUMC and the Kansas University Area Health Education Center (located 485 km to the west of Kansas City). Thereafter, over 70[65] telemedicine sites have been established. While the earlier system was used primarily for education, in 1993 clinical consultations were added to provide medical specialty care and consultation for physicians and patients in rural Kansas. It was intended both to reduce the need for patients to travel long distances and to provide quicker responses to urgent cases. In addition, the service had the potential to support rural primary-care providers by encouraging multiple professional links, to reduce their isolation. Ultimately, this was expected to aid the recruitment and retention of rural primary-care practitioners.

Ten years later, the experience has been one of remarkable successes as well as a fair share of unmet potential and missed opportunities.

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[64] ***Telemedicine in Kansas: the successes and the challenges***, Doolittle GC, Journal of Telemedicine and Telecare 2001; 7 (Suppl. 2): S2:43-46

[65] ***University of Kansas Medical Center website***

Medical services provided by the network

1. Consultation for people in rural Kansas in the following specialties
    a. Cardiology
    b. Dermatology
    c. Diet and nutrition
    d. Endocrinology
    e. Neurology
    f. Oncology
    g. Psychology
    h. Rheumatology
2. Continuing education for physicians, nurses, allied health professionals as well as health education programs for patients and their families

The specialties have fared quite differently in their use of telemedicine due to a variety of internal and external factors.

Technology used to provide telemedicine[66]

1. Interactive Tele-Video (ITV) Systems: Video conferencing uses an Interactive Tele-Video System which consists of some version of a video monitor, video camera, speakers,

[66] ***University of Kansas Medical Center website***

microphone, and a CODEC. The CODEC (stands for coder-decoder) that uses hardware and/or software to simultaneously code and decode (compress and decompress) digital video and audio information and sends it to another CODEC where the same process is also being done. There are several brands of ITV systems currently available on the market, most are compatible with one another. The KUCTT has connected with ITV systems all over the world including Europe and Australia.

2. Bandwidth: Greater bandwidth allows for a higher image and motion quality, but at a higher cost (over ISDN lines). Currently, the KUCTT does most of its clinical consults at 384 kbps. For consults more visually intensive (dermatology, rehabilitation therapy, etc.), a higher bandwidth of 768 kbps is used.

3. ISDN vs. IP: ISDN and IP are two ways that data is carried for video conferencing. ISDN (Integrated Services Digital Network) lines are designed to carry voice, data, and video over an existing telephone network infrastructure. There are two types of ISDN lines that the KUCTT uses, BRI (Basic Rate Interface) and PRI (Primary Rate Interface). The difference between the two is the amount of bandwidth each can carry.

   BRI lines carry up to 128 kbps of bandwidth. Sites associated with the TeleKidcare project use one BRI line; other sites at the KUCTT and throughout Kansas use 3 BRI lines to get up to 384 kbps of bandwidth.

PRI lines can carry up to 1.5 MB of bandwidth. A CODEC must be using a PRI line in order to achieve a higher bandwidth than 384 kbps on an ISDN-based network.

IP (Internet Protocol) uses IP addresses rather than dialing an ISDN number

IP and ISDN networks run different video compression protocols, which make them incompatible with each other directly. A third party bridge is needed for an ISDN-based site to connect to an IP-based site.

4. Peripherals: Telemedicine differs from ordinary video conferencing in its use of peripherals. Peripherals enhance what a specialist can examine without having to be at the same location of a patient. With the assistance of a nurse or other medical professionals, the doctor is able to hear breath sounds, see inside the ear, nose, or throat, view echocardiograms, etc. Any medical device that produces a video signal is compatible with the teleconferencing technology used by the KUCTT.

   Some of the peripherals used by the KUCTT include:

   a. Electronic Stethoscope – The electronic stethoscope uses a sending unit at one site and a receiving unit at another site. The sending unit has a standard stethoscope membrane attached and sends the breath sounds over a plain-old-telephone-system (POTS) line to the receiving unit where the doctor can hear the breath sounds through standard headphones. The electronic stethoscope operates independently of the teleconferencing system.
   b. Otoscope – Similar to a clinical otoscope, this otoscope allows the doctor to see inside a patient's ear, nose or throat. Used extensively in the TeleKidcare project.

c. General Examination Camera / Dermascope – A camera with a very short focal length designed for dermatological consults

Managing disruptive technological change:

1. **Giving responsibility for disruptive technologies to specialties whose patients need them:**

The KUCTT programs targeted specialties where there may have been savings for patients in terms of the travel time and also convenience of delivery of medicine at any time of the day. As a result, sustainable sub-programs have been formed in the areas of teleoncology and telehospices where both the patients and nurses benefit tremendously from the time saved. School based pediatrics or 'telekidcare' has also taken off well by providing care for children during school hours when needed.

2. **Matching the size of the organization to the size of the market**

The Kansas University's Center for Telemedicine and Telehealth was built gradually by the Kansas University Medical Center. Initially, it was used primarily for education and progressively ramped up by providing consultations in the various specialties. As the initial specialties were able to demonstrate benefits in terms of reduced travel time or improved preventative care, more were added. Thus, the program has grown through the past 13 years as the market for telemedicine in Kansas matured.

3. **Discovering new and emerging markets**

After many success and some setbacks, the KUCTT has successfully used its expertise in telemedicine to establish many new markets. Its successful teleoncology practice that was well supported by physicians in the University and the community demonstrated that it could take financial risks in a relatively unchartered territory like teleoncology, and still have an established practice. (By 2001, about 670 teleconsultations serving over 170 new patients had occurred). Besides teleoncology, it has discovered and built the markets of telehospices and pediatrics in Kansas State.

4. **Performance provided, market demand and the product life cycle**

Both healthcare providers and the rural community at Hays wished to see the burden of travel on cancer patients reduce, particularly since their treatment itself causes them to suffer and the community wished to make other aspects of their treatment more comfortable. This change (performance change for treatment) became possible only because telemedicine reduced a component of their effort, viz. travel. One successful experiment made the same leap in performance transferable to other areas as well, creating a case for extending telemedicine to home care patients, hospice patients etc.

As the Center was able to demonstrate successful launches of telemedicine programs, more public and private sources were willing to back their future programs, creating a demand for telemedicine services.

If it is assumed that the life cycle of the use of telemedicine in these specialties is in the early phase, as time passes, it is quite likely that the specialties will reach large enough patient volume to be independently profitable.

Kaiser Permanente Health Network in California

Background

The Kaiser Permanente health care program is one of the nation's largest prepaid group-practice HMO and California's second-largest partnership. In Southern California, Kaiser Foundation Health Plan (KFHP) enrolls members and contracts with the Southern California Permanente Medical Group (SCPMG) to provide medical and health care services to Health Plan members. In Northern California, KFHP contracts with The Permanente Medical Group (TPMG) to provide care. As multispecialty group practices, SCPMG and TPMG take direct responsibility for organizing and providing the care their members receive[67].

Home health at Kaiser

Kaiser has a division called Interactive Technologies Initiative, which began operating in late 1995 to identify, develop and evaluate new models of health care delivery using interactive technologies. The proposal to introduce Tele-Home Health was brought to ITI for consideration. Telemedicine/Telehealth technologies are key areas of interest, and have since been deployed in several projects. These utilize different equipment and network solutions depending on the

[67] ***From the Kaiser Permanente Website***

medical specialty being addressed, but share the goal of improving member access and satisfaction while maintaining or improving quality of care.

The home health project was undertaken in a research setting because there was insufficient peer-reviewed literature regarding quality outcomes and cost-benefits provided by tele-home health care. There were simply not enough findings available to make a business decision in support of widespread implementation of telemedicine. With this in mind, Tele-Home Health was designed to include a rigorous evaluation methodology that would measure changes to access, service, quality of care, and cost-benefit.

This pilot project uses a randomized design with one hundred patients in the treatment (intervention) group and one hundred in the control group. Control group patients receive their home health care in the usual manner: most visits are in person by a visiting nurse, with some visits conducted via telephone. A telephone visit is commonly used to follow up on patients who are reporting their health status or any response to medication changes. The treatment group receives some in-person visits and some visits using a remote consultation, home-based video system.

Technology used to provide telemedicine

American TeleCare, Inc. (Eden Prairie, Minnesota) developed the system selected for this research study. It operates over ordinary telephone lines, takes very little time to install, and even frail and elderly patients find it simple to use.

1. Each unit has an electronic stethoscope (American TeleCare) that also operates over an ordinary phone line.
2. Home videophones were provided. Because the video and electronic stethoscope cannot operate over the same phone line, participating patients had a separate phone line installed at their home.
3. Digital blood pressure monitors

Twenty units were deployed for this study, rotated among the one hundred patients as needed.

Managing disruptive technological change:

1. Giving responsibility for disruptive technologies to specialties whose patients need them:

Kaiser Permanente has been actively involved in using new technologies for patients with unique demands. Its Interactive Technologies Group has been set up for the purpose of identifying such technologies and they selected home health patients.

2. Matching the size of the organization to the size of the market

Being a nationwide health provider, Kaiser Permanente is able to transfer its skills in new methods of medicine delivery to its different locations. Hence it can afford to have a large

TeleHome Health program or experiment since it will eventually benefit from it in multiple locations.

Kaiser has probably recognized home health as a major market for telemedicine over the next decade and a large telemedicine program within the organization is quite justified given that Kaiser already has a large customer base in the home health market.

3. Discovering new and emerging markets

Kaiser Permanente has shown its commitment to discovering new markets and new technologies for existing customers by setting up the Interactive Technologies Group. There is increasing pressure on managed care companies to reduce medical costs and entrepreneurial private sector companies like Kaiser do so by innovation in healthcare delivery.

4. Performance provided, market demand and the product life cycle

In the absence of telemedicine, visiting more patients per day for the nursing staff would include an increase in costs for Kaiser due to the increased number of nurses that would be required to maintain the same service level. With telemedicine however, the costs were reduced and the number of patients that the staff could attend to increased with a similar service level. This makes telemedicine a major discontinuity for the delivery of home healthcare.

The market demand for home healthcare has been increasing (see Chapter 1) thus the business case for Kaiser to continue to deploy telemedicine is even stronger.

Chapter 5: Analysis

Introduction

Telemedicine has seen a significant variance in its acceptance across medical specialties and also amongst the different healthcare networks. This chapter uses three frameworks to explain the performance of the various specialties in the three case studies discussed in Chapter 4. It attempts to explain why home healthcare is today the fastest growing area not just for the health sector, but also for the practice of telemedicine.

The schematic below summarizes how the organizations assessed in the case studies manage disruptive technology in the healthcare sector have been successful in harnessing the technology.

	University of Tennessee Telehealth Center	**Kansas University Center for Telemedicine and Telehealth**	**Kaiser Permanente**
Giving responsibility for disruptive technologies to specialties whose patients need them	Targeted specialties whose patients would benefit from time saved and convenience	Targeted specialties where time was saved for patients and nurses	Identified the need for telemedicine in home health as early as 1995
Matching the size of the organization to the size of the market	Project size was matched to the limited performance parameters that were to be improved	Gradual ramp up of telemedicine operations over thirteen years. Initially a small operation directed at education, but as the market matured, the organization increased in size and scope	Large home health population using Kaiser's services justifies a large foray into tele-homehealth
Discovering new and emerging markets	Underserved community introduced to better medical service, telecom for medical service	Replicated a successful practice of teleoncology in other specialties. Created many of the telemedicine specialties in Kansas	Commitment to identifying new markets and technologies demonstrated by the creation of the Interactive Technologies Group
Performance provided, market demand and the product life cycle	Will create future demand for telemedicine by the discontinuous improvement in travel time	Demand created is demonstrated by the public and private sources that want to implement telemedicine by KUCTT doctors at their locations in Kansas	Demonstrated savings in costs AND more patients visited per nurse. Strong case for increasing its tele-home health services.

The barriers for telemedicine in the organizations are further evaluated using existing theories of organizational or cultural changes and Christensen's *value network* theory.

1. Organizational impediments for telemedicine

Organizational models and regional networks constitute the essential building blocks in the development of telemedicine systems. Organizations tend to support innovations that do not require a change in the company or industry's architecture. When architectural change is required for the success of an innovation, innovations are likely to be impeded[68].

Because an organization's structure and how its groups work together may have been established to facilitate its prominent services, the direction of causality may ultimately reverse itself. The organizational structure and the way its groups learn to work together can affect the way it can or cannot incorporate new technologies or procedures in its operations.

Telemedicine systems are usually set up in existing organizations and much of their success depends on how they complement the available organizational structure.

Telemedicine organizational models have been built on one or more of the following variables[69]: geography, target or service population, and/ or specific disease or medical specialty.

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[68] ***Architectural Innovation: The Reconfiguration of Existing Systems and the Failure of Established Firms***, Hendersen R, Clark K, Administrative Science Quarterly (35), 1990, 9-30

[69] ***Executive summary of the telemedicine conference in Michigan***, Bashshur R, Mandil S, Shannon G, Telemedicine Journal and eHealth, Vol 8, No 1, 2002

University of Tennessee Health Network

The existing organization had a range of medical specialties readily available and it received a grant from the Office for the Advancement of Telehealth specifically to extend telemedicine services to a rural community. The grant provided incentives for specialists in the UT Health network to extend their services to an outreach community. Being a grant-funded program, it is not an indicator of what may be the foundation of a sustainable telemedicine operation, since programs often discontinue after the telemedicine grants dry up[70].

A subset of the specialties within the UT Health Network is also offered on the UT Telehealth Network. Many of the same specialties were offered to Scott County. The split is as shown in the following figure:

[70] ***Discussion with Susan Dimmick of the UT Telehealth Network***

Specialties offered to Scott County:	***Specialties offered by UT Health and UT Telemedicine***	***Specialties available to UT Health but not via telemedicine:***
Behavioral Health	Behavioral Health	Surgery Divisions
Dentistry/ oral health	Dental Consults	-General Surgery
Dermatology	Dermatology	-Trauma/Critical Care
Physiatry	Physiatry – Rehabilitation Medicine	-Cardiothoracic Surgery
Pre anesthesia consultation	Pre-Anesthesia	-Pediatric Surgery
Primary care	Primary Care	-Plastic & Reconstructive Surgery
Follow up surgery consultation	Surgery Follow-ups	-Surgical Oncology
Home health care - Diabetes counseling - CHF	Home health	-Surgical Rehabilitation
Fertility counseling	Fertility and Reproductive Counseling	-Vascular/Transplant Surgery
Disease management	Diabetes Counseling	-Surgical Research
	Family Practice	-Urology & Urologic Oncology
	Genetics Counseling	-Orthopedics
	Oncology	-Neurosurgery
		-Otolaryngology
		-Ophthalmology
		Internal Medicine
		Medical Genetics
		Oral & Maxillofacial Surgery
		Pathology
		Pediatrics
		Radiology

Source: Adapted from UT Health Network website

The chart above shows that the Scott County Telehealth project is likely to be organizationally simple to set up for the UT Health Network since it offers almost the same specialties as the existing UT Telemedicine. However, UT Telemedicine does not yet have some specialties that have transferred themselves easily to telemedicine (as shown in Figure 1, Chapter 4). These are pathology, radiology, pediatrics and oncology to name a few. This may be a function of the current incentive structure within the organization. For example, reimbursement is available for

pediatrics whereas most insurance systems will only pay the hospitals a lumpsum for congestive heart failure (CHF). Thus the hospital has an incentive to save money in the case of CHF and install telemedicine systems. However, there is no incentive to bring down the cost of treatment for pediatrics (e.g, emergency telemedicine for a newborn in intensive care) since the hospital will receive the full payment from the patient and insurance company. As a result, pediatrics has a limited presence on the UT Telehealth Network.

However, the issue of insurance reimbursement is not necessarily a cause for exclusion of a specialty, it may be the effect of the lack of participation of the doctors in a specialty. If doctors are willing to be included in the telemedicine system and provide telemedicine services, it is a persuasive argument for insurance companies to cover those telemedicine services. But when there is no critical mass of services in a specialty offered via telemedicine, it will continue to stay outside the net of reimbursable services. Thus, providing medical practitioners incentives to use telemedicine is a useful way to increase telemedicine's service coverage. Moreover, the existing organizational structure of a health network which places the power for referral and treatment with local doctors is that much more difficult to change for telemedicine. This is because the key actor in the treatment is the doctor, who will get marginalized with the use of telemedicine. And telemedicine places much of the ability of monitoring and referral upon people other than the doctors themselves – nurses, patients and other doctors on the telemedicine network.

The Kansas University Center for TeleMedicine & TeleHealth (KUCTT)

KUCTT is considered one of the most successful telemedicine programs in the country[71]. While the oncology, pediatrics and hospice practices are used via telemedicine, other specialties, notably cardiology, home care and community psychiatry have been reported by the Center as failures.

The willingness of the care providers and medical practitioners to patiently assist in the creation and smooth functioning of a parallel organization is critical for success. This often requires a great deal of commitment from all the medical practitioners, particularly doctors, who are likely to require or give referrals to other doctors who may have been outside their 'network' prior to telemedicine. This factor, coupled with the economics of the echocardiogram business, caused telemedicine to fail in the case of telecardiology.

In the delivery of conventional medicine, hospitals or medical centers are often set up in a locality to provide services competitively. Telemedicine, on the other hand, works best if the various centers could aggregate their demand, and as a result dismantle their independent organizational structures to a more collaborative combined entity. This tends to be an organizational obstacle, since the organizations are designed in away to be competitive with one another. This was the case in cardiology, where local hospitals compete for the services of providing echocardiograms. It was also the case for community psychiatry, in which the independent community centers were reluctant to work together to invest in telemedicine

[71] Conversation with Susan Dimmick and inferred from results published in a report by Abt Associates "Home Telecare in the US – a Review of the Programs and Technologies", Feb 1999

systems that they could all share. As a result, the equipment purchased using the initial funding from State sources stayed idle, requiring the facility to shut down.

Kaiser Permanente Health Network in California

The Kaiser Permanente (KP) case study mainly focuses on home health, in which the visiting nurses need to make the greatest change in the way they serve patients and the role they play (changing from providing nursing exclusively, to the inclusion of teaching patients). KP was acutely aware of the problems involved, and the case describes the many measures it takes on an ongoing basis to mitigate the organizational risks that telemedicine brings – including the possibility of jeopardizing the jobs of the care givers.

2. Capabilities and radical technologies hindering growth

In assessing the blame for the failure of organizations to adopt new technologies, a distinction is sometimes made between innovations that require radical change and those that use existing and well-practiced technological capabilities, which are referred to as incremental innovations[72]. The magnitude of the technological change relative to the organization's capabilities determines which organizations are able to adopt the technology after it enters the practice of medicine in the particular specialty.

[72] ***The Innovators Dilemma: When new technology can cause great firms to fail***, Clayton Christensen, 1997, pg 30-31

This explanation for the failure of organizations explains some aspects of failure in telemedicine. For e.g. the limited use of IT and telecommunications in most organizations like home health agencies makes practitioners wary to use telemedicine. On the other hand, technologically savvy large hospitals are able to set up experimental telemedicine facilities and use it for their patients. Home healthcare agencies have been forced to consider telemedicine seriously mainly due to the huge shift in outpatient care to home health agencies and the resultant supply shortage of medical practitioners in home healthcare, a gap that telemedicine helps bridge.

3. Value networks and the drivers of failure

Christensen has suggested a third alternative to interpret the drivers of failure by relating success to the changes in technology and the market structure. The 'value network' can be understood as the context, within which a firm or an industry identifies and responds to its customers' needs, solves problems, reacts to competitors and strives for profit. Within a value network, each firm's competitive strategy including its past choices of markets determines its perceptions of the economic value of a new technology. These perceptions influence the rewards that different firms expect through the pursuit of sustaining and disruptive innovations. As firms gain experience within a given network, they are likely to develop capabilities, organizational structures and cultures tailored to their value network's distinctive requirements. The 'firm' in this case is the managed care organization, which recognizes potentially profitable technologies by providing coverage for them whereas the industry is the entire healthcare industry.

These values were well aligned for the three cases discussed earlier, which made them leading providers of telemedicine in the US. The University of Tennessee Telehealth and Kansas University Center for Telemedicine and Telehealth were medical centers that were responsible for dispersed rural populations within their own states. Due to the initiative of some doctors at both centers, telemedicine was recognized as a viable means for treating dispersed populations. The main driver for the use of telemedicine, besides having a well-respected doctor as a champion in hospitals, is that the university saw its role as a center, which could potentially provide care to the large rural populations by using new technologies. On the other hand, Kaiser Permanente (CA) is a private sector company (although not for profit) that provides health services to the largely urban population of California. In Kaiser's case, the focus of telemedicine is on the growing urban dispersed population, the users of home health care. Kaiser being in the private sector appears to put a high value for cost containment and is more consumer-oriented than other public sector organizations. Being a private sector company may also allow it to be relatively more entrepreneurial.

Notably, many of the other largest users of telemedicine in the US are also not for profit – Veteran's Administration, Prison telemedicine (by the University of Iowa) to name a few. This is because telemedicine aligns itself to the existing values of these organizations – to provide care to dispersed individuals despite the accompanying costs. In such as situation telemedicine provides a less expensive alternative to the usual practice of the patient traveling or having a doctor travel a distance to visit the patient. Organizations that have been more conventionally profit oriented would not have found telemedicine profitable (until the sharp increase in the elderly over the last decade). These would include many private health networks, insurance

companies, managed care organizations etc. Until recently, patients that were geographically dispersed were provided relatively limited care (e.g. a home health nurse would visit fortnightly rather than weekly) in line with their medical coverage. With the crises of the shortage of medical practitioners to keep up with the growing elderly population, telemedicine has shown a way to bridge the supply gap. Moreover, it has been studied for a few decades to prove its clinical efficacy for several applications. As a result, many insurance products cover it too and it has made its entry in a smaller way into highly for-profit organizations and health networks as well (e.g. Blue Cross Blue Shield of California's coverage of telemedicine).

Thus, the barriers to telemedicine operate at two levels – at the industry level where structural changes enforced by telemedicine make the key users wary of adoption and at the individual organization level, where traditional value networks accelerate or slow down the progress of a technology.

Chapter 6: Conclusions

The promise of telemedicine lies in its potential to enhance the accessibility to care for remote isolated and confined populations by reducing the need to travel to specialty centers and by reducing appointment waiting time. They can also receive home care more frequently than was possible in the past. Simultaneously, telemedicine technology can arrest the growth in medical costs by substitutions and possible reductions in the intensity of care. However, it has taken many decades for this promise to fructify and even today, the practice of telemedicine is not devoid of barriers.

Telemedicine may be described as a 'disruptive innovation' as it started off as a technology that provided lower quality services to populations outside the coverage of regular health networks. However, telemedicine's ability to bridge the distance between patient and provider made it get increasingly popular in several medical specialties and patient populations. Over the years, the technological infrastructure that telemedicine networks could access rapidly improved, making the use of telemedicine grow significantly in the 1990s.

Being a disruptive innovation, telemedicine demands drastic changes in the healthcare sector organizationally. It fundamentally alters the relation between nurses and patients, doctors and patients and even doctors and nurses, making the former in each case transfer more power and decision-making authority to the latter. The relationships that medical practitioners form with other specialists in their field become less important and forming alliances with other practitioners on the telemedicine network becomes more important for referrals in the

telemedicine network. It also expects competitive entities to collaborate with one another. These changes tend to make most medical practitioners resistant to telemedicine. If they refuse to use telemedicine, there is lesser incentive for insurance companies to provide high coverage for telemedicine, thus weakening the financial incentives for adopting telemedicine.

Many health providers find a capability gap between their technological (particularly IT) skills and those demanded by a telemedicine practice. There has been a slow transition amongst providers such as home health agencies to move from their legacy systems to telemedicine and train the users in the technology.

Finally, health networks adopt technologies based on the values that they are built on. If the network makes investment decisions based on the profitability of the investment (ROI), a technology like telemedicine is not adopted unless a critical mass of consumers demand it. On the other hand, networks such as teaching hospitals serving large rural areas and available research funding see value in investing in telemedicine programs based on the promise of better access and cost savings many years in the future. As a result, the largest applications of telemedicine are observed in public sector health provision like the Veterans Administration, university health networks and prisons.

Chapter 7: Recommendations

1. Increasing the diffusion of telemedicine

Public policy makers need to give the highest priority to funding long term and large -scale telemedicine projects by national and international agencies. Positive results from such undertakings will expedite the diffusion of telemedicine.

The private sector, universities and managed care organizations need to harness the potential of telemedicine in the following way[73]:

a) An autonomous business should be built around harnessing the new technologies. Unlike the case of Kaiser Permanente, many telemedicine programs are set up as a separate entity within the parent organization. In this way there is greater freedom to experiment with the technology and serve customers/ patients that may not be the prime concern of the mainstream business, but may want the disruptive technology since they may be the greatest beneficiaries. Hence patients in many rural areas are more effectively covered by telemedicine in the cases of Kansas University and University of Tennessee than by the main medical center. Thus, sustainable telemedicine programs can be formed when organizations align themselves with the forces of resource dependence rather than ignoring or fighting it and depending on grants to support the telemedicine program.

b) The commercialization of a technology is best left to an organization whose size matches the size of a targeted market. Hence home monitoring is best left to home care agencies

[73] Adapted from ***The Innovators Dilemma: When new technology can cause great firms to fail***, Clayton Christensen, 1997, Chapters 5-8

and supported by large medical centers rather than large medical centers focusing all their resources into making home monitoring successful.

c) New approaches need to be identified to judge the size and future profitability of markets that do not currently exist. Telemedicine has opened the discussion for possibilities that may have been dismissed as science fiction even two decades ago. Today the use of telemedicine to perform robotic surgery is a reality and organizations need to find new ways to evaluate research and investment in such fields. Christensen has developed one such method and called it a 'discovery based' approach. According to him, managers need to develop plans for learning what needs to be known in their field to stay abreast of how future investments should be made.

d) In telemedicine as in many technology intensive sectors, there is a real risk of the technology overtaking consumer requirements, providing high performing gadgets at a high price and leaving a vacuum at lower prices. The selected technology must not be over-designed, or providing and making the consumer/ patient/ MCO pay for much more than they require. It is more useful to carefully observe how healthcare technologies are used by dispersed populations to make sure that the consumers receive appropriately designed products. An example of appropriately designed products catching on with consumers is the simple monitoring equipment for blood glucose or cardiovascular indicators, already popular in home healthcare centers. They are simple to use, elderly consumers are comfortable with the technology[74] and it is priced low enough (about

[74] ***Home healthcare electronics: consumers are ready, willing and able***, Accenture Institute for Strategic Change, September 2002

$100[75]) for them to be recommended by and have widespread use in home healthcare agencies.

2. *Medical Education*[76]

Advanced information technology has the potential to enhance, facilitate, expand, and improve distance medical education in all areas and at all stages. Hence, it can provide unique opportunities for the improvement of medical education at the regional, national, and international scales. Several challenges lay ahead, including skills and preferences of instructors and students, curriculum design, technological configurations, cultural context, social and regulatory constraints. These challenges can be met only in conjunction with development and support for ongoing, systematic, comprehensive scientific evaluation programs to demonstrate the efficiency and effectiveness of the information technology in medical education.

3. *Organizational models and regional networks*[77]

The ultimate success of regional telemedicine networks depends on making progress toward a nested hierarchy of regional programs that lead to national and ultimately international

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[75] Nurse Mary Anders, University of Tennessee Health Network

[76] Adapted from the recommendations of the ***International Symposium of the State of the Art in Telemedicine/ Telehealth*** at the University of Michigan at Ann Arbor, Aug 2001 and from ***Telemedicine and Medical/Health Education,*** Mangrulkar R; Athey B; Brebner E; Moidu K; Pablo Pulido; Woolliscroft J, Telemedicine Journal and eHealth, (8) 1, 49-61

[77] Adapted from the recommendations of the ***International Symposium of the State of the Art in Telemedicine/ Telehealth*** at the University of Michigan at Ann Arbor, Aug 2001 and from ***Organizational Models of Telemedicine and Regional Telemedicine Networks,*** Shannon G; Nesbitt T; Bakalar R; Kratochwill E; Kvedar J; Vargas L, , Telemedicine Journal and eHealth, (8)1, 13-35

regionalized telemedicine networks. In order to make this progress, the following are recommended:

a) National and international organizations should develop guidelines, regulations, licensing procedures as well as security and privacy protection for patients and providers, especially in emerging networks.
b) Regional national and international networks should develop mechanisms for ensuring cooperation and coordination among extant and future telemedicine programs
c) Support must be provided for long-term development of large scale "test beds" to ascertain the true attributes of successful/unsuccessful 'regionalization' models
d) Standards, protocols, and guidelines that are mutually acceptable to all members of proposed regional telemedicine networks must be developed.

4. Technology[78]

Any action agenda pertaining to telemedicine technology is based on the premise of closer cooperation between the information technology and health/medical care sectors. This cooperation is critical to the development of telemedicine systems to deliver health and medical care more fully, effectively, and efficiently, regardless of the type or scale of application being considered.

a) Efforts should be directed toward developing fully interoperable telemedicine stations that interact with and make use of one another's devices. Essential to this development is

[78] Adapted from the recommendations of the ***International Symposium of the State of the Art in Telemedicine/ Telehealth*** at the University of Michigan at Ann Arbor, Aug 2001 and from ***Telemedicine Technology,*** Ackerman M; Craft R; Ferrante F; Kratz M; Mandil S; Sapci H, Telemedicine Journal and eHealth, (8)1, 71-79

merger of policies and regulations and the development and promulgation of industry standards.

b) The development of "middleware" is essential to link the work of software and network engineers.

c) Research into the human (patient/ provider)–machine interface must be a high priority. There is a need for better displays that are more natural and for better and less invasive sensors.

d) Development of "intelligent" medical robots may be critical to the future of some telemedicine sectors. Research should be directed toward the development of these robots, which could decrease medical errors and enhance the quality of care.

e) Security systems must be built into every telemedicine network.

f) Technology transfer, exchange and cooperative development must be a high priority.

g) The ultimate goal is to guarantee end-to-end connectivity. It is essential that technology transfer between "resource rich" and "resource poor" become a high priority.

5. *Clincal Applications of Telemedicine*[79]

Across the spectrum of clinical applications, there are many under-exploited applications that hold considerable promise for improving access and quality, as well as containing costs. Teleradiology and telepathology are already well-established, mature applications that have demonstrated their value and are being widely accepted into the mainstream of medical care. It is

[79] Adapted from the recommendations of the ***International Symposium of the State of the Art in Telemedicine/ Telehealth*** at the University of Michigan at Ann Arbor, Aug 2001 and from ***Clinical Applications in Telemedicine/Telehealth,*** Krupinski E; Nypaver M; Poropatich R; Ellis D; Safwat R; Sapci H, Telemedicine Journal and eHealth, (8)1, 13-35

in the other clinical specialty areas that research and action agendas must be engaged in order to provide the necessary scientific evidence for a reasoned, merit-based deployment of telemedicine. The following must be initiated in clinical areas that have not yet benefited from telemedicine:

i. Technology:

   a. Appropriate extant technologies should be adapted/adopted in clinical applications, and they should be continually monitored and updated as new products and services become available.

   b. Standards and protocols, such as those for teleradiology and telepathology, must be developed by appropriate professional societies and implemented by each clinical specialty.

   c. A repository of technology research literature should be established in order to ensure the efficient development of specific technologies and synergistic research development.

ii. Human factors

   a. Research must assess the human-technology interface for each clinical application in an effort to reduce technology-based barriers for providers and patients.

   b. Research must be conducted in each clinical specialty to determine the extent to which telemedicine technology is appropriate, suitable, and productive in improving patient outcomes.

iii. Research agendas

a. Determination of research priorities in clinical applications including clinical effectiveness and safety.

b. Support for large-scale, multi-institutional, comprehensive and long-term research utilizing randomized clinical trials, large data sets and/samples.

iv. Funding: Cost sharing, when necessary, among funding agencies for large-scale research among a consortium of research institutions.

v. Development of guidelines regarding:

a. Patient safety

b. Provider proficiency, certification

c. Clinical protocols

d. Continuous monitoring for quality assurance

e. Integration of clinical applications into medical school curricula.

vi. Establishment of clinical telemedicine boards within professional societies for the purpose of overseeing research development, promulgation of research findings, development of appropriate protocols, guidelines, and curricula for medical schools and continuing medical education.

vii. Development, testing, and implementation of successful organizational (infrastructure) models appropriate to support teleclinical activities within and between provider institutions, and within regional telemedicine networks.

Appendix I

Phone/ personal discussions were held with

- Industry experts
    - Susan Dimmick, Co-ordinator of Evaluation and Research, University of Tennessee Telehealth Network
    - Andrea Hassol, Abt Associates
- Doctors
    - Dr Joseph Kvedar, MD, Director and Founder of Partners Telemedicine, Asst Prof, Dept of Dermatology, Massachusetts General Hospital
    - Dr James Thrall, MD, Head of Radiology, Massachusetts General Hospital
- Home telecare program administrators
    - Mary Anders, RN, Telehealth Nurse Coordinator, University of Tennessee Telehealth Network
- Equipment vendors
    - Dan Bradshaw, Managing Director, American Medical Alert Corporation

Appendix II

As the bandwidth in the US increases (Figure 3), specialties that require high bandwidth (Figure 2) are likely to have greater adoption of telemedicine. This partially explains the growth of telemedicine in different specialties in radiology, dermatology and pathology as Figure 1, Chapter 4 showed.

Bandwidth Requirements for Different Telemedicine Applications

Type of telemedicine	Bandwidth needed	Examples
High resolution, no motion	Store-and-forward	Radiology, dermatology, pathology
Medium resolution, low motion	128 kbps	Stethoscope, visual exams, psychiatric
Medium resolution, high motion	384 kbps	Cardiology, neurology, and emergency room consultations
High resolution, high motion	768 kbps	Cineoangiography, and echocardiograms
Very high resolution, high motion	Up to 2.5 Mbps	Gait analysis

Note: kbps=kilobits per second; Mbps=megabits per second
Source: East Carolina University, February 1999; e-cology corporation, June 2002

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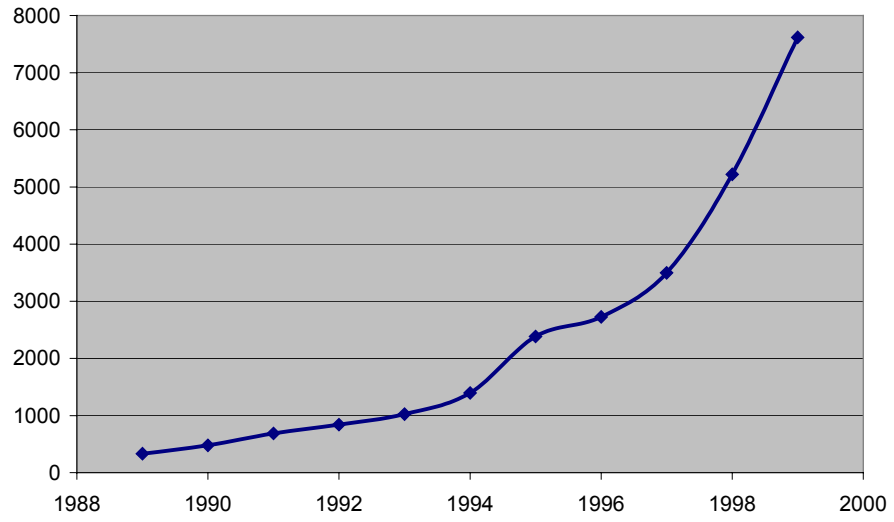
Figure 2

Source: eMarketer.com, 2002

Figure 3: Total bandwidth in the US in Gbps



Source: Federal Communications Commission, 1999

Appendix III

Experiences of specialties that used telemedicine in the organizations studied:

University of Tennessee Health Network

1. Teledental health: The dental health program aimed to demonstrate the use of telehealth to support rural dentists by making consultations available with dental specialists at the UT Graduate School of Medicine dental faculty. Between January 2002 and March 2002, four consults had been completed out of the 20 consults projected. These teledental consults reduced the number of times that patients had to travel to see an oral surgeon in Knoxville. Instead of three out-of-town trips, the rural dentist could perform pre- and post-survey care at the rural clinic and left patients with only one out-of town trip. This represented a time and distance saving of 1 h and 16 min and 59 miles one way.

2. Telebehavioral health at Ridgeview: Ridgeview was a non-profit community mental health center for seriously and persistently mentally ill patients. Persons threatening suicide or harm to others were brought to the emergency department, where attending physicians assessed patients and called Ridgeview's Mobile Crisis Team if warranted. The telebehavioral health program focused on crisis management. The goal was to reduce the travel time and cost of the psychiatric hospital's Mobile Crisis Team to Scott County and to increase access to immediate psychiatric assessment. Traditionally, patients remained in the emergency department for the 1.5 h required for the Mobile Crisis Team to arrive. Since inception, 74

crisis behavioral health visits were completed. Ninety percent of patients had Tenncare (the state version of Medicaid), and 10% were uninsured.

A comparison of crisis activity involving Scott County patients in the 6 months prior to the implementation of telehealth consultations and 6 months into the crisis telehealth demonstration showed that the average response time was reduced from 99 min to an average of 12.7 min.

3. CHF disease management program: In order to determine whether increased access to health care and health education actually made a difference in the lives of those who participated, people with a confirmed history of CHF were recruited, with their physician's permission and informed consent, into the program. Two nurses from Scott County were recruited to provide tele monitoring of participants in the CHF program. The goal was to monitor physical symptoms in an attempt to reduce acute episodes of heart failure and associated lengthy hospitalizations.

   This would allow participants to increase their independence at home. In more specific terms, "tele-video consultations" had the following objectives:

   1. To check on old and new health problems
   2. To learn about significant CHF symptoms, such as fluid retention, weight gain, shortness of breath and medication management
   3. To increase social interaction and mood management to increase quality of life

The program was successful in maintaining the weight and mood of participants. The program also reduced the length of patient hospital stay from the national benchmark of 6.2 days to 4 days, and the CHF hospitalization rate from 1.7/patient/year to 0.6/patient/year.

4. Diabetes disease management program: The goal of the Scott County Diabetes Program was to help diabetic participants manage their care with the help of a home-based telehealth support system. Each participant was given a blood glucose monitor that used POTS to transmit values to the MPHC Huntsville clinic. Participants in the CHF Disease Management Program who also were diabetics were given blood glucometers as well. These participants already were being seen by videophone for CHF management. An additional seven video systems were randomly assigned to diabetic participants who did not have CHF. Dimmick et al.[80] reported progress in achieving better blood sugar control by participants who were diabetic but who also were in the CHF Program.

The Kansas University Center for TeleMedicine & TeleHealth (KUCTT)[81]

1. Tele-oncology: In 1995, a tele-oncology practice was launched to provide care for rural Kansans as a collaborative effort between the KUMC and the Hays Medical Center. A previously established outreach clinic was combined with telemedicine as an adjunct service, creating a state-of-the-art cancer care for rural Kansans. Subsequently, a similar practice was established in Horton, again a combination of outreach (i.e. in-person) clinics and

[80] ***Differences in communication mode in a home telehealth project for diabetics***, Dimmick SL, Burgiss SG, Robbins S. Presented at the American Telemedicine Association, Fort Lauderdale, FL, 2001.
[81] ***Telemedicine in Kansas: the successes and the challenges***, Doolittle GC, Journal of Telemedicine and Telecare 2001; 7 (Suppl. 2): S2:43-46

telemedicine. In addition, cancer patients from four other Kansas communities receive care (both evaluation and management) via telemedicine exclusively.

To date, over 670 consultations (serving over 170 patients) have taken place, concerning a variety of haematological and oncological disorders. New patient evaluations, second opinion consultations and follow-up visits have been conducted by telemedicine. Other services for supportive care of rural cancer patients have been developed from the teleoncology practice, including pain management clinics, telehospice home-based care, interactive video support groups, and an educational series designed for patients, nurses and 'carers'.

Several key elements have combined to make the teleoncology practice successful. From the beginning there was tremendous support from the university and from the physicians and other health-care providers in the Hays community. Everybody wished to reduce the burden of travel for cancer patients, who often suffer severely as a result of their disease and treatment. From the beginning, rural members of the telemedicine team were active in developing the goals and methods of practice. They quickly became proponents of telemedicine and did not hesitate to refer patients. Part of the university's mission is to serve the health-care needs of all Kansas citizens and telemedicine showed great promise in fulfilling that goal and building the goodwill necessary for financial support.

Once the concept had been developed, KUMC was able to assemble a competent team to implement the plan. The team included a referring physician, an oncology nurse specialist and a technician on the rural side, and a medical consultant, a technician and a project

coordinator at the university. All nurses are chemotherapy certified and have completed additional training in the care of cancer patients. Not only do the primary care practitioners coordinate the initial diagnostic work-up, but they are also responsible for the day-to-day management of cancer patients, which includes any complications of chemotherapy treatments. For its part, the university had a sincere commitment to making the practice work and encouraged the team members to maintain a high level of responsiveness. The critical issue of financial support was taken care of by the Hays Medical Center. The Center was willing to finance the practice itself, with the expectation that local revenues generated from diagnostic work-ups and inpatient admissions would offset the cost of tele-oncology. This willingness to take a financial risk in uncharted territory like tele-oncology is unusual. The KUMC supported the program by continuing to provide an oncologist to fly out each month for the outreach clinics, which permitted a valuable transition from the traditional, face-to-face care to telemedicine, for physicians and patients alike. Also, important support personnel for the practice on the medical center campus are financed through the university.

2. Telehospice[82]: Telehospices have also been extremely successful at KUMC (the use of telemedicine to provide end-of-life care is known as telehospice services). Launched in 1997, they were set up in conjunction with an urban hospice (Kendallwood) serving rural clients. Telemedicine units connected by ordinary telephone lines were used in the home for nursing evaluations, psychospiritual care and social worker services.

After an initial feasibility study, telehospice units were offered to all patients at the start of hospice care. Due to the success of this first program, a larger project in Kansas and

[82] Telehospice is a registered trademark of KUMC

Michigan was launched to investigate issues of acceptance, efficacy and cost. As in the case of tele-oncology, the shared understanding of focused goals, developed in collaboration with key partners, was critical to the success of the project. The small size of the hospice made good communication easy and efficient, and positive working relationships were quickly established. Equally important, the nurses of this hospice had a particularly positive attitude towards using the new technology to provide care. The project therefore worked well in extending care to the target population. Early on, the nurses also noted a significant benefit in managing call responsibilities, especially in determining when on-site visits were necessary. Using the home units, the hospice delivered more visits by video, at lower cost than sending a nurse in person. This happened at the same time that the US Medicare reimbursement for hospice patients in the rural sector decreased. As a result, the financial benefit we had anticipated became even more important.

3. School-based pediatrics: In 1998, the KUMC began to deliver ambulatory pediatric services to children in an urban school who were without care, primarily because of difficulties with access. The partners in the 'Telekidcare[83]' project include the Kansas City Unified School District 500, the KUMC departments of pediatrics and child psychiatry, and the KUMC Center for Telemedicine and Telehealth. Using desktop telemedicine units operating at 128 kbit/s, physicians from the university were connected with nurses from the Kansas City school district. Originally, four schools were involved, although the project subsequently expanded to eight grade schools, three middle schools and one high school. A wide range of ambulatory diagnoses, including ear, nose and throat problems, dermatological disorders and behavioural health issues, has been managed via telemedicine.

[83] Telekidcare is a registered trademark of KUMC

Initial funding for the telemedicine units came from the Kansas City school system and the Kansas University departments of psychiatry and pediatrics. Subsequently, grants from the Department of Commerce Technologies Opportunities Program, the Wyandotte Health Foundation and the Kauffman Foundation enabled an expansion. The Telekidcare project has been successful in serving children with acute ambulatory problems such as otitis media and rashes. Often the family was unable to afford suitable care outside school hours and children would simply do without until the problem resolved on its own or an emergency visit to hospital was necessary. To make the telemedicine project a success, the school nurses had to practice beyond their traditional role of triage and basic care. They received training in the technology of the units and in physical assessment. In the Telekidcare model, the nurses provide evaluation and management under the direction of a pediatrician, and this effectively transformed the nurse's office into a site of care.

The project would have faltered if the pediatricians had been unwilling to accept a practice model in which the nurse often takes the lead. Almost 1000 consultations have now been conducted and parental satisfaction has been over 90%. Evaluations of the experience by both nurses and physicians have been very positive.

4. Telecardiology: A request from the hospital administrator of a primary-care facility in the north-eastern part of Kansas resulted in the setting up of a telecardiology service. Room-based videoconferencing units operating at 384 kbit/s were used to link a staff cardiologist from the KUMC with a primary-care internist and nurse practitioners from the rural facility.

The practice was to be a mixture of weekly telemedicine clinics with monthly outreach clinics. The goal, as in Hays, was to reduce the burden of travel for the patients. Echocardiograms were to be sent to the KUMC by overnight courier or reported over the telemedicine system, depending on the urgency as determined by the referring clinician. Should a patient need cardiac catheterization, and the case was not urgent, a visit would be arranged to the KUMC. Urgent care beyond the capabilities of local providers would result in immediate transfer, as before.

This practice failed; in fact it was never even fully launched. Early on it became apparent there was a strained working relationship between the cardiologist and the on-site presenting nurse. Furthermore, the cardiologist was critical of the echocardiograms that were obtained locally, stating that the quality was substandard and that reading them was far more labor intensive than would have been the case with better studies. More important, the KUMC group learned that another cardiologist had been attending a clinic at the same hospital for several years. There was no true need for the service as perceived by the local primary-care practitioners, who were satisfied with the services of the established cardiologist. (This other cardiologist was sending patients to another institution for echocardiograms.)

In summary, in order for a telemedicine service to be successful, there must be a genuine need perceived by those expected to use the service (as opposed to an administrator hoping to capture revenues lost to another institution). Physicians both at the local center and the telemedicine hub should be involved early on in the development of the practice. Also, the telemedicine team members are interdependent and must have rapport and mutual confidence

in each other's clinical skills in order to work together effectively. Finally, the consultant must be satisfied with the quality of local support services or a suitable alternative will need to be negotiated.

5. Home telecare for cystic fibrosis patients: Cystic fibriosis monitoring was taken up as a home telecare project in an attempt to improve the quality of life of patients (and reduce costs) by avoiding emergency hospital attendance and admission. Low-cost telemedicine units, operating over the ordinary telephone network, were installed in the homes of patients with cystic fibrosis. These allowed televisits to be made by a nurse with expertise in the care of cystic fibrosis patients. Other members of the practice team included a respiratory physician and home-health nurses. Televisits were planned at least twice weekly, to evaluate respiratory status. Working together with a home-health agency, intensive management was planned, including respiratory treatments and intravenous antibiotics when required. The KUMC team hoped to prolong the period of home management and to avoid hospital care. Reimbursement for home visits by nurses came from traditional sources (i.e. third-party insurance, Medicaid). There was no reimbursement for the nurse conducting the televisits. Funding for the pilot project came from the KUMC Hospital.

   This project also failed. First, there were difficulties with using the equipment. Most telemedicine practices have concerned project personnel or a practice team - as a result equipment problems are usually easily rectified. In this situation, the video-phone worked well but the analogue electronic stethoscope did not. Despite multiple telephone calls and repeated visits from the equipment supplier, the telemedicine team was unable to make it

work properly. Expectedly, this was not acceptable to the cystic fibrosis practice team. Eventually the nurse specialist working on the project lost interest and left, followed closely by the respiratory physician. It takes a lot of effort to recruit good-quality team members and most such people have more than enough demands on their time. Once recruited, the practice team should take part in choosing the technology they will be using. Furthermore, equipment should be tested thoroughly before the service begins.

1. Community telepsychiatry: KUMC was consulted by an organization of community mental health centres to help develop a plan for a state-wide telepsychiatry system. The organization hoped to facilitate access to care for rural psychiatric clients by using telemedicine to share clinical staff (i.e. for special expertise or cross-coverage) between mental health facilities. The telemedicine service was to include new patient evaluations, post-hospitalization follow up, and coordination of treatment and second opinions. Funding for the project came from state sources and totaled over $500,000.

6. Currently, the majority of the units is idle and has never been used. The loose organization of the community mental health centres was not adequate to coordinate and implement the service, and KUMC's offer of managing the project were refused. A degree of competition exists between the community mental health centres, so issues of sharing resources and cross-coverage were not easy to resolve. Unfortunately, a funding source had been identified and equipment purchased before these issues were resolved. Involving clinicians in the planning process at the beginning would have ensured a more realistic plan and prevented wastage of resources.

Kaiser Permanente Health Network in California: experiences with home healthcare

Mitigation of common barriers to tele-home health[84]

1. Recognizing that some of the home health staff would regard Tele-Home Health with skepticism, plans were made from the onset to educate staff and take their concerns into account. The group leading the telemedicine initiative was aware that the introduction of this new technology in the Sacramento home health department would be particularly stressful in light of Kaiser Permanente's broader organizational redesign, which is ongoing. To ease the transition, they phased in use of the home health video system rather than introducing it all at once. In Phase One a designated TeleHealth Nurse conducted all the video visits. In Phase Two other staff were trained to do these visits, and were expected to use the system as part of their regular patient care practice.

2. Initially there was significant staff resistance to using the home video system. The major concern was that the home video system would replace nurses, resulting in lost jobs. Also, the nursing staff felt they were being asked to accept a change that might threaten their professional relationship with patients. One strategy that helped to lower staff resistance was a communication plan that apprised people of project developments and nipped in the bud misperceptions surrounding its implementation.

[84] ***Kaiser Permanent Medical Center's Pilot Tele-Home Health Project,*** by Barbara Johnston, R.N., M.S.N., Linda Wheeler, R.N., M.S.N. and Jill Deuser, R.N., M.S.N. Telemedicine Today, August 1997, pp. 16-18.

3. The profession of nursing is for the first time being confronted with job uncertainty. Remington (1995)[85] addressed this fear by stating that telehealth will only put nurses out of the job of driving a car to see a patient. Nurses were shown that they would continue to provide patient care, but in a more efficient manner.

4. The current organizational pressure to increase productivity affected the degree to which home health staff was willing to participate in Tele-Home Health. Until the value of using the technology is personal and experienced by the individual nurse, the team driving the initiative knew that buy-in would likely be limited. Adding telehealth visits to an already hectic day and not counting telehealth into productivity would decrease staff participation. Kaiser developed guidelines for telephonic and video visits, including how to integrate these methods appropriately into a patient care plan.

Staff acceptance developed as providers saw how much their patients liked using the system. Also, providers found that telehealth allows for more flexibility in their daily schedules. For instance, if a nurse has two patients requesting a home visit from 10-11 A.M., only one can be accommodated. The home video system allows a nurse to visit a patient and within 15-20 minutes be with another. The staff has found the system easy to use, but the biggest selling point has been in seeing how reassured patients are to know that they have instant home access to their health care providers.

Tele-Home Health does not replace all in-person visits. The home video system is an additional service. Some visits require hands-on care and these continue to be done in-person. In some

[85] Remington, L. (interview) Telemedicine Today, 3:22-23, 1995

cases, however, patients have even asked their nurses to use the remote system instead of visiting in person because it is very convenient.

Results of the study[86]

Patient satisfaction surveys, with over a seventy-percent survey return rate, indicate patients like using the home video system, find it simple to use and feel it is very reassuring. Staff satisfaction using the system is also very high.

The mean length of time for an in-person visit was 45 mins and 18 mins for a remote video visit. Current productivity standards allowed a nurse to visit 5 to 6 patients per day. A time study indicated that remote video visits allow 15 to 20 video visits per day. Reduction in costs was most attributable to hospitalization costs.

Integrating the results of the study into the mainstream practice

As Kaiser integrates video nursing as standard practice at the Sacramento facility, supervisors considered two different approaches. One approach was to designate certain nurses to handle all video visits. This strategy makes the program easier to manage. However, there were other arguments favoring video nursing as a standard practice for every home care nurse. One of those arguments is continuity of care and the benefits of ensuring that the same nurse visits a patient in-person and via video. (It appears that Kaiser has currently opted for the former – to be verified).

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[86] ***Outcomes of the Kaiser Permanente Tele-Home Health Research Project***, Johnston B, Wheeler L, Deuser J, Sousa KH, Arch Fam Med. 2000 Jan;9(1):40-5

Linda McRae, a resident nurse at Kaiser with 35 years of nursing experience, believes that while the immediacy of video and the time-savings the technology offers are worthy of appreciation, overuse of telemedicine would be a mistake both for patient care and nurse morale[87]. Further, she says "a video visit with [a certain patient] worked fine because [he] thinks and speaks clearly. For someone who is confused and unable to answer questions, it may not be as satisfactory. Also, some patients require hands-on care, for instance, wound care. Or, if you're doing a lot of instruction, like teaching a new diabetic."

Part of the challenge for telemedicine system vendors is to recreate the face-to-face experience through video. The closer vendors come to achieving this objective, the more effective a video visit becomes and the more tolerant nurses become of the technology.

[87] ***Twenty minutes in the life of a Tele-home health nurse***, Telemedicine Today, July 1997