

Chapter One

Orientation to This Book

- **Introduction: Why This Book?**
- **Method**
- **The Journey**
- **Search for Roots**
- **Continuity and Change**
- **The Context of Telemedicine**
- **The Evolution of Telemedicine**
- **The Telemedicine Solution**
- **The Nomenclature of Telemedicine**
- **The Changing Environment**
- **Concluding Remarks**

INTRODUCTION: WHY THIS BOOK?

Before we began the journey to trace and document the full story of telemedicine, there were many factors to be considered. We had to decide whether there was an important story to tell that others might want to read, whether it had been told already in its entirety, and whether the value of the story would justify the painstaking effort necessary to complete the task once started. The first step in the journey was a review of other accounts of the history of telemedicine in the published literature. In brief, it did not take us long to realize that telemedicine had a long and rich history and a story that has not been told, certainly not in its entirety. It soon became clear to us that it was a story worth telling.

There are varied accounts of the history of telemedicine in the published literature as well as in popular discourse. A careful review of these accounts reveals two common characteristics, despite significant variability between them. First, they tend to be very brief, often cursory or selective, sometimes limited to a couple of paragraphs, and are typically included as a prelude to another topic. Second, they are invariably simple accounts of early attempts to connect providers and patients through telecommunication devices available at the time. Some accounts cite a single episode or an era that prompted the use of telecommunications in healthcare as the beginning of telemedicine. Perhaps the most notable of these episodes is the summons by Alexander Graham Bell to Mr. Watson: “Watson—come here—I want to see you. To my delight he came and declared that he had heard and understood what I said” (Library of Congress 2000). Contrary to myth, Bell had not spilled acid on his leg at that moment and was not calling for assistance. He had simply heard encouraging sounds through the wire and was calling to Watson to tell him so (Lindsay 2000). Some accounts singled out a specific application or an era when organized telemedicine activity was initiated, such as the pioneering programs of the late 1950s and 1960s in the United States and Canada. However, regardless of their focus, none of these accounts tell the full story of telemedicine from its genesis to the present time, including its peaks and valleys, its flows and ebbs. More relevant to the purpose of this book, none of the reports has seriously considered the full story of telemedicine, including its continuity in medical practice in one form or another from ancient times to the present, the enduring necessity of connectivity in the delivery of medical care, the various transformations of telemedicine over the ages, or most importantly the contexts that sustained interest in this modality of practice. These accounts do not pay adequate attention to the rich context that prompted the early experimentation in the use of telecommunication technology in the delivery of healthcare and that continues to guide its development and transformation into the future.

METHOD

We started the task of writing this book with an open mind. Thus, we had to put aside whatever preconceived notions or information we had about the genesis and evolution of telemedicine. We wanted to be guided solely by the documented evidence as we uncovered the information in our search, not by any preexisting ideas or notions. We felt this was necessary to minimize, if not rule out, bias in our reporting. Hence, we spent several months at the beginning of our work on this book reading published materials and going from reference to reference in search of the available information. We used a methodology similar to “snowball sampling,” whereby we scrutinized each piece of literature (akin to a sample selection) for other potential references that fit the inclusion criteria for our review and added all items that were suitable for this review to our reading list. We included both published and unpublished material. In some instances, academic curiosity got the best of us, and we pursued unnecessary

details that distracted our attention from the main focus of the book. In particular, we delved into the detailed history of telecommunications as well as detailed accounts (discussed in chapter 2) and analyses of various national and regional initiatives aimed at addressing the issues of healthcare access, quality, and cost in the United States (discussed in chapter 3). Subsequently, we tried to correct these excesses in the final document by removing what seemed to be extraneous information. Nonetheless, the unintended detour gave us valuable insight and a genuine appreciation of the complexity and difficulty of designing optimal health systems that serve all segments of the population and that assure equity of access to standardized care at affordable prices. Indeed, we gained a better understanding of the broader context for the initiation, development, and persistence of telemedicine and the unique role telemedicine can play in redressing intransigent problems in healthcare delivery as we go forward into an increasingly complex healthcare environment, as discussed in detail in chapter 3. We learned about the rich yet confusing history of inventions in information and communication technology and the difficulty of attributing specific inventions to specific individuals, such as the invention of the telephone, telegraph, radio, and television.

THE JOURNEY

Our journey started with ancient societies and the early attempts to establish rudimentary communication connectivity between settlements when faced with internal or external threats and subsequently to establish “clinical” connectivity between patient and physician/care-giver/priest. Thus, throughout this book, we emphasize the continuing underlying theme of connectivity between those in need of care and those who provide it. Indeed, connectivity, in one form or another, has been a necessary component of medical care delivery throughout history. Telemedicine provided the tools for connectivity when providers and recipients of care could not be in the same place and time.

We trace the history of long-distance communication from its humble origins in semaphore, and much later the telegraph, and radio to advanced digital communication and computer processing systems. In chapter 8 of the book, we discuss recent trends in the transformation of telemedicine from simple “connectivity” tools to “versatility” tools in the mainstream of medical care, such as the use of telemedicine for clinical decision support, prescription ordering, disease management, patient empowerment, and disaster preparedness/response. These newer applications are appropriate in various clinical settings and environments. However, they are not limited to connecting distant participants. Hence, we raise the question whether the term “telemedicine” still applies to these applications under our broader discussion of the nomenclature in this field later in this chapter as well as in chapter 8.

Unlike other abridged accounts of this history, this book makes a special effort to place telemedicine development in its proper context, not simply as a technological innovation but as an effective solution to persistent problems in healthcare delivery including inequitable access to care in the population at large, uneven distribution of quality, and unabated cost inflation. Indeed, the persistence of these problems has provided the strongest rationale for the development and growth of telemedicine, a theme that will be discussed repeatedly in this book.

The inclusiveness of our approach in this book vis-à-vis other attempts to address persistent problems in healthcare delivery provides further justification for pursuing the broader context for the development of telemedicine. Ironically, unlike Panakeia, the Greek goddess of healing, the telemedicine solution may not prove to be the hoped-for panacea for all problems of equity in access, universality in quality and cost containment of medical care. Nonetheless, an appreciation of the context of its development and evolution is critical to understanding the centrality of telemedicine’s role in healthcare past, present, and future.

It is our earnest hope that we have achieved some measure of success in contributing to the full story of telemedicine, the evolution of pertinent information and communication technology, and the broader healthcare context, dating back to ancient societies and continuing through to the present. The modern era of telemedicine, as we know it, dates back to the early 1900s, its concrete manifestations as organized telemedicine programs date back to the 1950s, and its maturation dates back to the last decade or so. The steps leading to its future and its transformation into an integral component of the healthcare process have already started.

SEARCH FOR ROOTS

The search for the genesis of telemedicine technology led us to open doors to rooms of knowledge that we did not originally contemplate opening or looking inside, such as the use of light reflections and smoke signals by ancient societies to relay messages to distant compatriots or neighboring communities about plagues, health events, and wars. Indeed, the rudimentary roots of telemedicine can be traced back to ancient societies where simple forms of distance communication were used as means for coping with external threats, famines, and diseases.

Our inquiry into the genesis of the technology led us to review the long and rich history of information and communication technology, with its twists and turns, and the ultimate introduction of Claude Shannon's landmark theory of information, which laid the foundation for the modern electronic capture, processing, transmission, storage, and retrieval of information.

The search for telemedicine's roots revealed the enduring need for connectivity in medical care in ancient times and the failure of repeated initiatives and national programs to address problems of inequity of access to healthcare in the population, discrepancies in quality of care between areas and regions, and unabated cost inflation in modern times. The failure to resolve problems of inequity in access and quality as well as cost inflation has been especially true in the United States and is increasingly the case not only in developed countries but developing countries as well. The case for telemedicine rests on its promise to address some aspects of all of these problems in one form or another. Whereas the importance of these problems is universally acknowledged, for many observers, the efficacy of telemedicine remains a promise. For others, it has already been demonstrated at a reasonable level of confidence. In response to this discrepancy in perspective regarding the true merit of telemedicine, we have tried to highlight the scientific evidence available to date but only in selected commonly used clinical applications, in order to achieve as much closure on the question as possible. Also, since evaluative research will continue to occupy center stage, we have attempted to identify the methodological requirements for this research as we pursue the search for more conclusive evidence regarding the true merit of telemedicine.

The quest has enabled us to trace the earliest documented modern telemedicine application (as we define the term today) to the Netherlands and the successful transmission of heart rhythms via telephone lines in the early 1900s. This was followed by radio consultations from medical centers in Norway, Italy, and France in the 1920s, 1930s, and 1940s for patients aboard ships at sea and on remote islands. The transmission of radiographic images began in the early 1950s in the United States, followed shortly thereafter by similar experimentation in Canada. The first wave of organized telemedicine programs in the United States began in the late 1950s. It lasted nearly two decades and then came to a halt shortly after extramural funding was terminated. This was followed by a hiatus that lasted nearly a decade, until a new wave of telemedicine projects and programs developed at a much larger scale than its forerunner. This last wave was led by state-based and province-based initiatives throughout the United States and Canada.

We verify the European roots of modern telemedicine and the fact that the first practitioner of modern telemedicine was a Dutch physician, Willem Einthoven. Einthoven was awarded the Nobel Prize in 1924, albeit in recognition for several inventions related to telecardiology but

not limited to it. After careful scrutiny of various sources of information, we can attest that the first clinical application in telemedicine was in cardiology, not radiology as some have contended. As mentioned earlier, another popular but apparently false claim for the first telemedicine encounter pertains to the first telephone message exchanged between Alexander Graham Bell and his assistant Mr. Watson.

The search also led us to some unexpected findings that may dispel other claims perpetuated through verbal communication and presentations at professional meetings without adequate verification. Most of these have to do with the genesis of telemedicine systems, which we have just recounted; however, they extend to the design and purpose of the interstate highway system in the United States, which has been likened to the more recent development of the electronic national information highway. (Earlier claims incorrectly attributed the design of the national interstate highway system in the United States to war planning. In fact, there was another parallel highway system dedicated to defense purposes.) On the other hand, the search has also confirmed other notions, as will be shown throughout the book.

Ironically, some of the information about the deep roots of telemedicine that is available in the archives of specialty areas in medicine (such as cardiology and radiology) and telecommunications and electronics is not necessarily available in the literature of telemedicine per se. Hence, we found it necessary to cast a wide net to collect this information. At the same time, we wanted to limit our reporting to events and developments we could document or else knew from firsthand experience. In many instances we found it necessary to limit our discussion to basic highlights even when we were able to obtain more detailed information on the subject. In some cases, the details did not add much to the essence of the story, and may even have detracted from our central focus.

We hope our effort will not be the last one of its nature. Others may choose to pursue, even more diligently than we did, a variety of other leads, including the perusal of a “gray literature” that can provide more detail and tell an even more complete story of telemedicine projects and activities in other places and countries that may have received inadequate attention here or elsewhere. This would be particularly useful in covering specific countries or regions of the world, as well as specific applications or topics and specific technologies where our coverage is limited by necessity or unfamiliarity.

CONTINUITY AND CHANGE

As we probed the ancient roots of telemedicine and traced its evolution to the present time, we discovered continuity and change existing side by side in a dynamic evolutionary process. Continuity stems from the convergence of medical care delivery and distance communication in various forms and manifestations, whereas change reflects the never-ending advances in the character and capability of the technology that enables telemedicine as well as other concurrent advances in medical science and medical practice.

Historically, medical practitioners have always tried to reach their patients through the existing methods which were acceptable at the time. In ancient times, patients were brought to temples for spiritual healing. In more recent times, practitioners visited well-heeled patients in their homes. Even more recently, medical care moved to clinics and medical centers because of scientific and technological advances, specialization, and increased complexity of care. Similarly, what we see in today’s telemedicine applications and the technology in use is the culmination of a long historical process. Thus, in one sense, the present is an extension of the past. On the other hand, the technology of today bears little or no resemblance to that of the past, and medical care today is vastly different from what it was in the distant past.

Distance communication, like all forms of communication, has been necessary for sustaining life and dealing with threats since the dawn of civilization. However, as time went on,

communication technology became more and more sophisticated and more widely available while medicine became more scientifically based, specialized, and institutionally centralized. Concurrently, societies developed stable institutions to assure continuity of the species, to control the ravages of disease and infirmity, to promote human sustenance, to regulate human activity and minimize social friction, and to promote well-being and happiness. Accordingly, the need for connectivity increased in various facets of society and human institutions, as did the capabilities and efficiency of the technical tools for achieving connectivity.

Since telemedicine represents the confluence of medical care delivery with information and communication technology (ICT), we had to examine relevant aspects of both fields in some detail vis-à-vis telemedicine. We did this not simply out of intellectual curiosity but in a serious attempt to provide a systematic and complete account of the story of telemedicine and the enduring character of connectivity and change in this field.

Today, telemedicine is again at the frontier of the forward march in medical care. Its purpose is not only to increase access to healthcare but also to promote the efficiency, effectiveness, and quality of mainstream clinical care and to enable the integration of complex health systems. It is also at the frontier of the pursuit of a healthy lifestyle, patient empowerment, as well as preparedness and response to natural and man-made threats.

From a public health standpoint, telemedicine also has the potential for reducing the threats from epidemics of emerging and reemerging contagious and infectious diseases through rapid detection, surveillance, and reporting, followed by corrective action.

Major advances in medical science and technology as well as public health practices have led to extending life expectancy, overcoming disease, limiting disability and impairment, ameliorating pain and suffering, and enhancing quality of life. The demographic and associated epidemiologic transitions have dramatically accentuated the need for medical care and public health practice. However, in most countries, the increased need for care has not been matched with a commensurate increase in resources, and the imbalance is growing. Now attention is simultaneously focused on issues of patient safety, quality, and efficiency as well as cost containment, perhaps more than ever before. The tools of telemedicine promise effective and efficient solutions for the remote monitoring of chronically ill and homebound patients, as well as for remote diagnosis and treatment of those who cannot avail themselves of clinical expertise by virtue of where they live. These tools also provide benefits for clinicians facing an ever-expanding body of knowledge and skill in their areas of specialization. As well, they are useful for administrators and managers of complex health systems who must operate in a progressively more complex and restrictive regulatory environment that calls for greater efficiency, enhanced productivity, and increased assurance of patient safety and autonomy.

THE CONTEXT OF TELEMEDICINE

Our perspective in this book is one of evolution, continuity, and change in the history of telemedicine. However, we pay special attention to the broader context for the development of telemedicine, which also explains its endurance despite cycles of advancement and retrenchment, of peaks and valleys in its long history. Indeed, the history of telemedicine would not be complete or fully appreciated without a reasonable understanding of the healthcare context for its development and its persistence through numerous decades.

Like other major innovations in medicine and medical technology, telemedicine did not develop in a vacuum. Hence, we dedicate an entire chapter to a discussion of this developmental context and the limited success of major initiatives aimed at improving access to care, enhancing quality, and containing cost inflation. However, we chose to limit the scope of this discussion to the United States (and to a lesser extent the United Kingdom) mostly because of the sheer availability of information and the prominence of early telemedicine programs in the

United States. We were concerned about keeping the scope of this discussion within reasonable and manageable bounds. Interest in the United Kingdom in this context stems from its early contributions to the development of regionalization in healthcare, which was an important precursor to telemedicine.

We examine the literature on the history of various initiatives and programs in the United States aimed at promoting more equitable access to medical resources, more efficient geographic distribution of resources, and means for achieving cost containment. In some ways, the goals of these initiatives may never be fully realized, because the problems of inequitable access and cost inflation are likely to remain at some level regardless of how much effort we expend to address them. In other words, there will always be segments in the population that are underserved by virtue of geography, ability to pay, or other factors. Quality of care may never become geographically or sociodemographically uniform throughout any country, across regions, or even within local communities because of inherent variations between institutions, providers, and patients. Indeed, no matter how we try to contain price and use of service, the cost of care is likely to continue its upward climb because of advances in medical science and technology as well as the aging of the population and increased health sophistication on the part of the public at large. In that sense, like the pursuit of justice, equity, and fairness, the quest for improved access and quality and cost containment will always exist. Ironically, the more progress we accomplish incrementally in moving toward these goals the more difficult it becomes to move up to the next level.

The full benefits of information technology are also unattainable, though in a different sense. We are far from realizing all the benefits to be derived from the computing, storage, retrieval, and display capacity of information technology currently available. The average user of the average desktop computer leaves enormous capabilities untapped. This situation is perhaps more evident in healthcare than it is in other sectors. This technology has developed a life of its own, and continues to expand at a phenomenal rate, while our ability to exploit its full capabilities lags far behind. Indeed, we have just begun to explore the potential of ICT to enhance efficiency of operations in health institutions, support clinical decision making and medication prescribing, streamline the various facets of the clinical care process, integrate complex health systems, and extend the reach of medical expertise to those in need. We have yet to develop the appropriate instrumentalities to facilitate the transition of healthcare to the information age. In the United States we are severely constrained by historical inertia and the force of habit, as well as the realities of our current political and economic system. In other places with differing political, cultural, social, and economic systems, other constraints may limit the full exploitation of the potential inherent in the application of communications technology to the delivery of healthcare.

THE EVOLUTION OF TELEMEDICINE

Telemedicine today is vastly different from its humble origin in the Netherlands in the early 1900s, as indeed are medicine and medical care in general. Its major hallmark is moving telemedicine to the mainstream.

The early pioneers and program organizers in telemedicine were guided mostly by intuitive logic regarding the merit of this modality of care. It seemed obvious to them that telemedicine would extend the reach of medical expertise to remotely located patients, and that the ready availability of information for providers at both ends of the consultation would reduce waste and duplication in medical care. It was also clear to them that telecommunications would give remotely located clinicians and patients ready access to specialists in medical centers with limited effort. They believed they were opening the door for a promising modality of care delivery that was bound to improve the quality and effectiveness of care,

especially as the technology continued its upward trend in quality and affordability. At the same time, these pioneers (such as Cecil Wittson, Kenneth Bird, and Dean Seibert) realized that the adoption of telemedicine by the mainstream ultimately would depend upon the nature of the empirical evidence to derive from sound scientific research. Many of them focused heavily on research. The sophistication of the methodologies they employed rivals those of today.

The early research in Nebraska, Massachusetts, and Vermont–New Hampshire demonstrated the feasibility of telemedicine in several clinical and diagnostic applications, as well as its acceptance among users, both providers and patients. The early apprehension about the loss of tactile information and the potential for degrading the doctor–patient relationship was dispelled. However, it was not possible to ascertain with any reliability the cost/benefit trade-offs in this field, a topic that will be discussed repeatedly in subsequent chapters.

Among other factors, the technology available in the early days of organized telemedicine was expensive, unwieldy, and unreliable. Some components of that technology had to be designed in-house by the programs themselves or by their subcontractors. Yet funding agencies required these programs to evaluate their performance and to assess their costs and benefits long before they met minimal criteria for valid evaluation. The funding agencies were under pressure to justify the expenditures and show positive results. However, in order for these early evaluations to produce definitive results, they had to meet the following minimal criteria:

- the adoption of a uniform and explicit definition of telemedicine—necessary to operationalize variables for reliable and valid measurement, including both inputs and outputs;
- the assumption of a steady state in terms of operational size and standard operating procedures whereby the costs and benefits would reach a stable, fixed, or at least predictable level, and whereby the technology would be fixed in terms of type of equipment used, transmission modality, and necessary support and maintenance;
- the achievement of an adequate and uniform level on the learning curve among all users, including providers and patients; and
- having sufficient volume of patients to provide statistical power for testing hypotheses.

Unfortunately, early telemedicine programs were able to meet few if any of these criteria. In fact, providers in the early telemedicine programs, including physicians and nurses, varied widely in terms of their knowledge or understanding of the field and of how telemedicine could be integrated into their daily clinical routines. In most programs, training was either limited or nonexistent. More critically, the broader culture in medicine viewed this modality of care with a great deal of skepticism, rather than approaching it from a neutral perspective with an inquisitive stance. It was seen as a challenge or a threat to the prevailing paradigm of the traditional doctor–patient relationship—the laying on of hands.

Ironically, it has been clear all along that neither the pioneering programs of the early 1960s nor the first major set of telemedicine programs that were initiated in the 1970s in the United States would be able to produce definitive evidence regarding the benefits and costs of this modality of care. Yet the information they did produce proved to be of critical importance for provider acceptance, health policy, and public investment in telemedicine (Bashshur 1983). As we discuss in more detail later, there were several reasons why, in those days, it was not feasible to design, build, operate, and then evaluate the performance and effects of these systems, all in a very limited time frame. For now, we would just point out that the technology was too new, was changing too rapidly, and was too unreliable and expensive. Moreover, there was no consensus on a precise definition of the field or a clear demarcation of its boundaries. Indeed, we have yet to identify discrete variables (specific measurable inputs and out-

puts) that could be investigated independently of each other and also independently of the context in which they occur (Bashshur 1995). Telemedicine technology continues to be in a state of substantial flux that alters the calculus of variations and renders many of the specific results regarding cost/benefit ratios either invalid or inappropriate for generalization.

In brief, it was not feasible to assess the true merit of telemedicine on the basis of the evidence produced by the first wave of telemedicine projects in the United States in the 1970s. Nonetheless, at the time health policy makers and mainstream medicine interpreted, or acted upon, the lack of definitive evidence as if it were evidence of lack of merit of the field (Bashshur 1983). Thus, telemedicine activity waned during the latter part of the 1970s. Extramural funding for telemedicine projects dried up and all telemedicine activity was abandoned for more than a decade, until the concept was rediscovered and new funding opportunities became available. Interestingly, the long hiatus of activity in this field did not dampen the enthusiasm that characterized the following era. Interest in telemedicine revived, accompanied with renewed vigor and high expectations, reminiscent of the earlier period. It was as if telemedicine's advocates wanted to dismiss or simply ignore the fact that this modality of care was practiced and abandoned a decade earlier. Like the mythical phoenix, a new era of telemedicine emerged from the ashes of previous unsuccessful attempts to establish it.

The revival of telemedicine in the late 1980s can be explained by the confluence of three factors:

- There were major improvements in technology in terms of capability, quality, reliability, versatility, size, and ease of use.
- Simultaneously, there was a substantial decline in the price of transmission, storage, processing, and retrieval of information, as well as in that of several basic components and peripheral devices.
- Finally, there remained major intransigent problems in healthcare delivery that might be addressed by this modality of care.

The first two factors are self-evident. We will discuss the third factor in the following paragraphs.

THE TELEMEDICINE SOLUTION

The basic issues in healthcare delivery that prompted early experimentation with telemedicine in Europe and North America were the same ones that led to its repeated revivals over the past decades. As discussed before, these issues pertain to access, quality, and cost. Interestingly, these are dynamically interrelated, and a change in one is likely to influence the others, but not always in a unidirectional or linear fashion. One good analysis of the complex nature of the relationship between cost and quality in healthcare in general was presented by Donabedian, Wheeler, and Wyszewianski (1982). In essence, they pointed out that the relationship between quality and cost depends on the definition of quality as well as the nature of the cost being considered. In general terms, it can reasonably be argued that an improvement in quality typically requires an additional cost. However, an increase in cost does not always lead to improved quality, and there are instances in which quality may be improved without an increase in cost. There can be excesses in use of service with deleterious effects. Moreover, there are different types of costs and different aspects of quality that further confound this relationship. The same principles apply to the relationship between access and cost, as well as that between access and quality. Here again, access to care is dynamically related to cost, and this relationship also depends on the nature of the cost being considered. For example, telemedicine may provide ready access to primary and specialty care for people living in medically underserved remote

communities. Telemedicine can be a boon for patients, especially where there is substantial pent-up demand for care or unmet need in the community. By removing or reducing distance and time barriers, telemedicine proportionately diminishes the opportunity cost for patients. However, when some of the barriers to care are reduced or eliminated, an increase in use of service is likely to ensue. Increased use of service is bound to increase the total cost of care even if the cost per unit (per visit) actually declines. A large portion of the total cost of care is normally borne by the insurer in an insurance-based system. Thus, telemedicine's advantage in enhancing access to care may have inconsistent cost effects, depending on the type of cost and the perspective from which it is considered. Additionally, telemedicine's effects are likely to change over time by virtue of the ready availability of the service closer to where patients live. Nevertheless, if the increase in the total cost of care comes about as a result of satisfying pent-up demand (or unmet need), the situation is likely to change once the demand deficit is met or the demand is regulated through pricing or some other mechanism. Hence, it can be readily seen that telemedicine's effects on access and cost are quite complex, and one-dimensional explanations can be overly simplistic, if not misleading.

Viewed from a provider perspective, the use of telemedicine can have different benefits depending on whether the provider is a referring clinician located in a remote location or a specialist consultant located in a sophisticated medical center. If used properly, telemedicine tools can enable referring providers to keep up with the latest developments in diagnosis and treatment of specific diseases by communicating with specialist colleagues in medical centers as well as seeking information from expert sources on the World Wide Web. Consequently, the referring providers' "reliance on [telemedicine] should diminish in proportion to their increased clinical sophistication and newly acquired confidence to treat more conditions themselves." This phenomenon has been referred to as an ironic "failure of success" (Bashshur 1997) in the sense that the more clinicians use telemedicine (assuming a resulting corresponding increase in their knowledge and skill) the less likely they will be to need it in the long run. Here again, the long-term trend may not be linear. The availability of telemedicine may enable rural physicians to expand the scope of their practice and see more patients with a variety of health problems. Ultimately, equilibrium will be reached at the remote sites where the demand for specialist consultations becomes predictable. However, this state cannot be predicted with any degree of accuracy, since there is no precedent for it. An additional complication, for example, is the inequitable access to telemedicine stations among rural patients and their providers. To date and for the foreseeable future, remote telemedicine sites will not be geographically or institutionally ubiquitous. Hence, some of the patients and providers living in those areas will be unable to take full advantage of the technology. The question of differing physical and electronic access to available telemedicine consulting stations in remote communities has not been fully resolved.

Obviously, the potential merit of telemedicine generally or any specific application using this technology varies according to the perspective from which it is judged (Bashshur 1980). In particular, three perspectives are relevant here: those of the providers, the clients or patients, and society at large. Thus, the evaluation of telemedicine entails the assessment of effects within a multidimensional matrix. At minimum such a matrix would consist of two dimensions wherein the merits (or potential effects) are listed on one axis and the various perspectives on the other, as illustrated in Figure 1-1. However, it may be appreciated that this is only a general depiction of an approach for the assessment of the merits of telemedicine rather than a specific methodology. If this approach is followed, each of the two dimensions can be expanded further. Other perspectives would include those of payers, client families or caregivers, and policy makers. As well, the benefits can be expanded by an elaboration or refinement of access, cost, and quality. Moreover, the matrix may be applied for the assessment of specific telemedicine specialty and subspecialty applications (such as teleradiology, telepathology, or teler dermatology) as well as specific interventions (such as spirometry, or remote monitoring),

Perspectives			
Benefits	Providers	Clients	Society
Accessibility			
Quality			
Cost			

Figure 1–1. A Proposed Matrix for Assessing Telemedicine

thereby adding more dimensions. Indeed, because of the variability between telemedicine applications, it may be appropriate to use this matrix for each and every specific telemedicine application rather than for telemedicine as a whole. Also, telemedicine applications may be classified on the basis of the nature of the technology and modality in use, such as synchronous or real time versus asynchronous or store-and-forward, as well as practice setting (rural, urban, correctional institutions, etc.).

When considered in this context, the assessment of telemedicine's benefits in general or any specific application thereof must consider the particular perspective from which it is assessed. For instance, as discussed earlier, the cost implications for patients would include out-of-pocket expenditures and other opportunity costs such as reduced need for travel, whereas the cost implications for providers would include return on investment and transaction costs. From a societal point of view, the cost implications would include total cost, financial stability of rural facilities and providers, and "moral hazard."¹

The majority of telemedicine practitioners and program developers emphasized telemedicine's benefits in terms of facilitating access to care for remote and isolated patients and communities. On the other hand, policy makers and insurers have been concerned about telemedicine's potential to unleash pent-up demand for care in areas with limited health resources. Incidentally, this concern has not been substantiated. If anything, the use of telemedicine has been limited even in fully funded programs where reimbursement was not an issue.

To date, only limited attention has been paid to the potential influence of telemedicine on the epidemiology of quality in medical care. This has to do with the incidence, prevalence, and distribution of quality. The importance of this issue may be clarified in the context of broader problems in medical care such as the incidence of errors in patient care and clinical decision making, inefficiencies in the management of large, complex medical institutions, and suboptimal aspects of the medical care process. Still, the epidemiology of quality in this field is not well understood, and has yet to be addressed in a direct and explicit fashion in the telemedicine literature.

All things considered, cost inflation in medical care continues to occupy center stage for a wide variety of stakeholders, including health policy makers at various levels, healthcare managers, insurers and payers, businesses both large and small, providers, and the public at large. Affordability of healthcare has emerged as a leading issue in today's world. Its consequences are the same in poor and rich countries alike. If people cannot afford to pay for the care they need, they may have to sacrifice other needs, or postpone or simply forgo care

¹ Moral hazard in this context is defined by health economists as the tendency to use more medical services when it is relatively nontaxing to do so by virtue of having health insurance. Patients would not bear the full market cost of the service. Thus, patients would lack the incentive to optimize use of service in market terms. In this case, the ready availability of telemedicine in remote areas may lower the full market cost for using service that would require travel and other inconveniences, and hence constitute moral hazard of some sort. Feldstein, among other noted health economists, referred to moral hazard in the context of health insurance.

altogether. While some health problems are self-limiting, others are not. Thus, when needed care is postponed or ignored, health problems often are exacerbated. Treatment becomes more expensive and less effective. The cost of care and affordability are intertwined. Hence, we focus on the promise of telemedicine to address cost inflation and affordability, especially in terms of patient-borne cost savings, and how both can be achieved in an optimal fashion. On the other side of the coin, we will examine the importance of the denial of (or limited reimbursement for) telemedicine services, because this restriction has stymied the diffusion of telemedicine, especially in the United States.

In this instance and in contrast with other countries such as Canada, in the United States the federal government's support for telemedicine, when viewed as a whole, has not been consistent. On the one hand, several federal agencies and some state governments have been actively promoting the expansion of telemedicine through grants and contracts. Substantial financial support for research and demonstration projects has been provided by the Office for the Advancement of Telehealth of the Health Services Administration, the Agency for Health Care Research and Quality, the National Library of Medicine, the Health Opportunity Program of the Department of Commerce, and the Telemedicine and Advanced Technology Center, U.S. Army. There have been a number of congressionally appropriated earmarks for specific telemedicine projects in various states. On the other hand, the major federal insurer, the Center for Medicare and Medicaid Services (CMS), has traditionally been reluctant, if not outright resistant, to allow reimbursement for telemedicine services, for fear of a burgeoning increase in expenditures that could threaten the stability of the trust fund that supports its operations and benefits. Regardless of the validity of this fear, denying or limiting reimbursement for telemedicine service has been very effective in stifling the adoption of telemedicine by the mainstream, whether or not it was intended to produce such a far-reaching effect. Indeed, it is unlikely that any professional service would be viable without adequate compensation. Even religious institutions have to rely on contributions by their parishioners or other forms of support for their financial survival.

THE NOMENCLATURE OF TELEMEDICINE

During the last few decades, we have witnessed two contrasting trends in society at large that have a direct bearing on nomenclature in medicine and medical care in general, as well as telemedicine in particular. Thus, the broader social and political environment has had important ramifications on the proliferation of the nomenclature in telemedicine, the definition of its content, and the delineation of boundaries between it and the related concepts now in use.

The first trend is one of *specialization* with the attendant effect of narrowing the focus of study and practice. In medicine, this trend translates into increased reductionism or specialization in scientific research that focuses on very specific topics, as well as clinical practice to assure scientific grounding, proficiency, and expertise. Medical specialties can be limited to body organs, specific diseases, age and gender groups, or therapeutic modalities. Indeed, the trend in medical practice points toward greater specialization and subspecialization as time goes on, reinforced and sanctioned by specialty and subspecialty board eligibility and certification. The legitimacy, significance, and relevance of this trend should not be ignored. It has come about as a result of vast advances in science and technology. It has been reinforced by the necessity to narrow the focus of scientific inquiry and, to a certain extent, technological development. Indeed, advances in medical science and technology are typically limited to specific procedures, interventions, or medications.

Insofar as telemedicine is concerned, the manifestation of this trend can be seen in the addition of the prefix "tele-" to specific medical specialty areas and even to disease states and clinical activities, such as teleradiology, telepathology, teledermatology, and telepsychiatry, as

well as telestroke and telemonitoring. Nonetheless, the specialization trend has not spawned a new specialty in telemedicine practice per se, and this is as it should be. Indeed, telemedicine must be viewed as a *modality* of practice and not another specialty in medicine. For example, teledermatologists are dermatologists who use the tools of telemedicine to diagnose and treat patients with skin disorders. When providing care for remote patients, teledermatologists have to rely on their knowledge and skill in dermatology and not telemedicine. The necessary skill in the use of technology is minimal and will likely diminish as time goes on. Soon this technology will become as commonplace as the ordinary telephone. Whereas the technology behind the telephone is quite complex, the user does not have to understand it to be able to use it effectively. However, it may be appreciated that telephone technology continues to change as various forms of personal communication are introduced and become part of everyday life. Hence, there is also a learning curve associated with the new telephones, such as the iPhone, and what they can do, such as text messaging. The point to be made here is that users need not be encumbered with having to acquire full knowledge of a complex technology when their aim is simply to use it.

To be sure, there are technical skills and methods that are unique to telemedicine, not only in manipulating the equipment but also in handling and processing data and information. But these skills are typically learned on the job, often with minimal formal training, and without certification. However, just as physicians in training must be taught how to use the technology and equipment at their disposal, telephysicians must also be taught how to use the technology effectively and how to interpret the results and information that are made available. There are important ramifications in terms of new or different information available by virtue of the expanded capabilities of the technology, for example, new heart and lung sounds, greater flexibility in the manipulation of X-ray images, data mining, and other diagnostic information.

Interestingly, clinicians of various medical specialties may choose to practice telemedicine side by side with traditional in-person care. No choice of *modality* of care is ever likely to be imposed on medical practitioners, although we may come to the day when clinicians have to treat certain patients in the telemedicine by virtue of working in an environment that offers telemedicine service.

The second trend in the nomenclature also reflects a broader social and political trend in modern society, that of *liberalization* of the taxonomy, which emphasizes inclusiveness, convergence, and equality. Often, the first step in the drive toward a more egalitarian and non-discriminatory society is the adoption of more inclusive and nonjudgmental terminology, avoiding terms and phrases that have possible restrictive or derogatory connotations. However, when the change in nomenclature is not translated into actual behavioral and structural change in the broader social system, this step is typically referred to as “political correctness.” In other words, it is simple tokenism.

To be sure, this second trend has not escaped the healthcare enterprise. It has been applied broadly in the healthcare system as well as in telemedicine. This is illustrated by the changing nomenclature for healthcare institutions and providers. For instance, many large hospitals were renamed “medical centers,” later “health centers,” and more recently “health systems.” This does not imply that the term “hospital” has any derogatory meaning, and there are plenty of hospitals that did not follow the trend. Similarly nowadays, medical doctors share the title of “provider” with a variety of other health workers who were referred to earlier as “auxiliary” or “ancillary” personnel.

An important corollary aspect of this liberalization trend is also a near-universal acceptance of the importance of a healthy lifestyle, including smoking avoidance, moderate alcohol consumption, and healthy diet and exercise, as well as the need for patients to comply with their medical regimen, to look after themselves, and to manage their own health problems as best they can. In addition to all this, there is increased awareness of the importance of protecting the quality of the environment to reduce the risks of exposure to hazardous substances.

The rationale behind the liberalization trend in healthcare goes far beyond simple political correctness. It points to an increased professional and lay awareness of the importance of a variety of factors that influence people's health and well-being in addition to medical intervention. It emphasizes a holistic approach to healthcare. The broader influences on health suggest an appropriate and critical role for all the health professions in promoting and achieving optimal health in the population. In addition to the profession of medicine, these include nursing, dentistry, pharmacy, and public health. The latter field includes epidemiology, the science of the incidence, prevalence, and distribution of health and disease in the population; health management and policy, the study of the organization, administration, financing, and performance of health systems; health behavior and health education, the study of the determinants of health-seeking behavior; and environmental and occupational health, which is concerned with the quality of the living and working environment.

Although the two trends of specialization and liberalization have unique merits, they do go in different directions and are not totally compatible. Thus, the call for a "broad area of specialization" to combine the two, as some have proclaimed, is essentially an oxymoron in any context. More importantly, the choice or emphasis of one trend over the other has significant consequences. Thus, while the emphasis on specialization is necessary for scientific inquiry and technological advances, it is widely recognized that the health of a population reflects more than its ability to receive medical care or personal health services. In other words, health outcomes are not linked solely to medical intervention. Indeed, disregard of any important determinant of health is likely to prove suboptimal when designing or developing programs aimed at achieving optimal levels of health among individuals and populations. On the other hand, the movement away from specialization and specificity may disparage scientific inquiry or else render the research enterprise unmanageable. It would also frustrate technological development. Indeed, it is always prudent to consider all the determinants of health when making decisions regarding the allocation of resources in a manner consistent with optimizing the return on investment of public resources for health programs.

The question of nomenclature in telemedicine has yet to be resolved. We have yet to reach consensus within the telemedicine community on the choice of the appropriate trend (specialization or liberalization) that would guide not only the labels we use but also the type of systems we develop and the core activities under their purview. Specialization would imply an emphasis on specific clinical and other applications, whereas liberalization would imply broadening the scope to include all health-related activities. Currently, the term "telehealth" is used interchangeably with "telemedicine," and almost as frequently, and there is increasing reference to e-health. Hence, a discussion of these two other terms is in order.

Contrary to popular belief within the telemedicine community, the term "telehealth" is not new to this field. In fact, it was introduced in 1978 as the name of a more inclusive concept than telemedicine. It was defined as "systems [that] support the healthcare process by providing the means for more effective and more efficient information exchange" (Bennet, Rappaport, and Skinner 1978).

Bennet and his associates explained their preference for using the term "telehealth" instead of "telemedicine" on the basis of inclusiveness. They suggested that "it implies a broader range of health-related activities, including patient and provider education and administration, as well as patient care." Their research was done under a grant from the Department of Health, Education, and Welfare (now Health and Human Services) to the MITRE Corporation to report on the seven exploratory telemedicine projects it funded during the 1970s (discussed in chapter 5). The National Center for Health Services Research (now Agency for Health Quality and Research) published the final report, entitled "Telehealth Handbook: A Guide to Telecommunications Technology for Rural Health Care."

The original rationale for the more inclusive telehealth concept is still evident today. "Telehealth" is used to encompass what we commonly consider as the all-inclusive domains of

both medicine and public health. Thus, telehealth would incorporate the remote delivery of medical care as well as the application of all other health-related activity under its purview, including both personal and nonpersonal health services. Insofar as the technology is concerned, the modalities of telehealth are no different from those of telemedicine. Essentially it can consist of either synchronous or asynchronous interactions among the participants.

Essentially, telemedicine is to telehealth as medicine is to health. Whereas medicine is defined by medical science and personal health services by the delivery of medical care by clinicians, health is defined by a broad range of health sciences and health outcomes as the result of all interventions including both personal and nonpersonal health services, lifestyle, and the quality of the living environment.

More recently, the concept of e-health has been introduced into the professional literature, spurred by the phenomenal growth of electronic commerce (e-commerce) and the equally phenomenal expansion of information technology, computer processing capabilities, and the use of the Internet in everyday life. The vast resources of the Internet ushered in a host of domain applications, including consumer health, clinical care, administrative and financial transactions, professional education, and biomedical research (National Research Council 2000).

The term “e-health” was “barely in use prior to 1999” (Eysenbach 2001), and there has yet to be a consensus on its definition (Paglilari et al. 2005; Oh et al. 2005; Ahern, Kreslake, and Phalen 2006). Another related term is “medical informatics.” The United Kingdom Health Informatics Society has suggested that the terms “medical informatics” and “health informatics” have been variously defined, but can be best understood as meaning the understanding, skills, and tools that enable the sharing and use of information to deliver healthcare and promote health. The Society acknowledges that “health informatics” is now tending to replace the previously more common term “medical informatics,” reflecting “a widespread concern to define an information agenda for health services which recognizes the role of citizens as agents in their own care, as well as the major information-handling roles of the nonmedical healthcare professions” (United Kingdom Health Informatics Society 2008).

Proponents of the term “health informatics” consider health informatics as a discipline that “now plays an important role in all aspects of healthcare delivery, and public/personal health promotion” (United Kingdom Health Informatics Society 2008). As is evident from the early experiments in the application of electronic communications technology and from the early operational telemedicine programs described below, various elements of telemedicine, e-health, and medical and health informatics have been included in telemedicine programs from the beginning.

THE CHANGING ENVIRONMENT

The formal introduction of telemedicine programs over five decades ago was met with benign neglect and some skepticism in the mainstream medical community in the United States. Not so long ago, back in the heyday of the “experimental” telemedicine programs of the 1970s, the majority within the mainstream medical community paid little attention to telemedicine. There was no evidence of any organized resistance to the concept or experimentation with it. During that era it did not seem that there was a compelling reason to be concerned about it. Some viewed it as a futuristic concept, not attainable in the foreseeable future. Some of the original providers who started experimenting with this technology were concerned that the substitution of technology for in-person care would infringe on the essence of the personal character of the doctor-patient relationship, thereby diminishing the quality of medical care. Medicine would not be complete without touching, they argued. There were skeptics even among those who had direct experience with telemedicine in the early programs. But the

concern among these skeptics was directed mostly at the excessive cost of the technology and technical disruptions rather than the clinical effectiveness of telemedicine once a system is operating properly. They argued that money spent on the technology could be better allocated to help patients in other ways or to improve the efficiency and reach of conventional medical care. These critical views were reinforced by early evidence of telemedicine's inefficiency; telemedicine encounters required more time to complete than in-person encounters and technical failures were not uncommon. Importantly as well, there were virtually no scientific cost-benefit analyses conducted.

All things considered, much of the serious skepticism in the medical community was based on a distrust of the available technology as an effective substitute for personal healthcare and on a strong belief in the necessity of person-to-person contact in clinical practice. In addition, as mentioned before, the technology of the time was expensive and relatively unreliable. Little attention was paid to what would be in store in future developments of technology and its pricing, and how these developments might address some of the concerns being expressed at the time.

Indeed, when telemedicine was revived in the 1990s, the technology was much improved and the cost was more affordable. Hence, any latent resistance in the medical community subsided to a large extent. However, this time, in the United States, the Health Care Financing Administration (HCFA, now Centers for Medicare and Medicaid Services (CMS)) and most major insurers in the private sector put a serious damper on the diffusion of telemedicine by resisting reimbursement for telemedicine services. HCFA equated telemedicine with the telephone, and telephone consultations had never been approved for reimbursement (Sanders and Bashshur 1995). More fundamentally, HCFA was concerned about the potential of opening the floodgates by providing specialist services to underserved populations living in rural areas. It also expressed concern for the displacement of rural providers even if telemedicine were not intended to have this effect (Smits and Baum 1995). Weissert and Silberman (1996) observed that "HCFA is likely to decline to favor telemedicine unless ordered to do otherwise by Congress." The case was very different in other countries, such as Canada. As we shall see, beginning in the late 1990s the federal government began a systematic approach for a pan-Canadian development of telemedicine as an independent nonprofit entity, specifically charged with accelerating the pace of adoption of modern communications technology to improve the health of its citizens.

To be sure, today's environment is much different from that of the past. The early skepticism has abated, reimbursement is no longer categorically denied, and professional resistance has abated substantially, if not disappeared altogether. Indeed, the proliferation of telemedicine into every clinical specialty in medicine, the worldwide growth of telemedicine programs, and telemedicine's acceptance by organized medicine in various specialty medical societies all offer clear evidence that the old negative views have been put to rest. The current discourse is focused on the need for developing standards to assure quality and patient safety, developing uniform protocols for interoperability of systems and quality assurance mechanisms, and integrating telemedicine into the mainstream.

CONCLUDING REMARKS

We wrote this book in order to document the complete history of telemedicine as best we could. We believe the full story cannot be told without explaining the context for telemedicine's genesis, evolution, and endurance through a century of development and change. And since telemedicine is a technologically based modality of care, the story cannot escape a discussion of the vast evolution of this technology or of the likely transformation of future telemedicine applications and their adoption by mainstream medical care.

“Telemedicine” is an umbrella term that covers a variety of specific clinical applications, technological modalities, and treatment interventions, as well as health information delivered or processed electronically. Sometimes the term is used indiscriminately. A specific application, such as teler dermatology or telepathology, is sometimes referred to as telemedicine, as if each application is a microcosm of the total field. Sometimes “telemedicine” and “telehealth” are used interchangeably despite the obvious difference in their referents. This becomes problematic only when we try to evaluate the merit of the field as a whole or any specific application within it, focusing on performance, costs, and benefits. Indeed, telemedicine does not constitute a single or uniform entity, nor can it be assessed as such. Success or failure in one telemedicine application may not extend to all other telemedicine applications. As well, the results from using one technology may not extend to the use of other technologies. Technologies vary in design, capability, and cost.

Thus, the clinical and economic evaluation of telemedicine as a whole would make sense only when comparing telemedicine as a system of care to that of in-person care in general. Even then it still would be problematic. Since we have yet to identify discrete variables that capture the essence of telemedicine as a modality of care versus in-person care, we are still unable to establish the cause-and-effect relationships that would be necessary for a sound scientific assessment of this field. Nevertheless, telemedicine programs continue to proliferate nationally and internationally.

Telemedicine is the focus of this book. Typically the concept is used indiscriminately to include various clinical, nonclinical, and educational applications. However, for our purposes we limit the purview of the concept and this book to the delivery and receipt of personal health services via electronic information and communication technology (ICT). This approach excludes extended discussion of public health applications, distance education, and electronic health records, except when these are linked to the actual delivery of medical care. The one exception to this approach is the discussion of telemedicine developments in Canada in chapter 7. Following a summary report of telemedicine activity in the provinces, we incorporate another section to the development and “rollout” of interoperable electronic health records. This is acknowledged by the Canadian telemedicine community as fundamental to improving access and quality as well as containing the cost of medical care.

We chose to focus on the domain of personal health services partly out of the need to draw some boundaries around the subject matter in order to make the task more manageable, and partly to cover the topic more comprehensively. Of course, some of these boundaries are arbitrary. The unique attributes of this field include geographic separation between patient and provider or provider and provider, reliance on information and communication technology to facilitate patient care, development of unique systems and organizational structures for the remote delivery of medical care, and the development of communications tools and protocols to facilitate remote interactions.

It may be appreciated that the primary objective of the health system is to produce health, or to optimize the health status of the entire population it serves. We have suggested elsewhere that “the health status of a population is not totally contingent on the quality or quantity of medical services available and that which it receives” (Bashshur 2000). Thus, the health system, considered as a system, must incorporate all activities aimed at preventing disease and infirmity as much as possible, providing treatment and rehabilitation for those who become ill or disabled, and—when necessary and unavoidable—minimizing pain and suffering and ultimately according dignity for the dying. However, the question here has to do with the most effective approach to reach the goal of optimal health, and how telemedicine figures into the process.

Reflecting the vitality of the field, telemedicine applications continue to proliferate along medical specialties (as in teleradiology, telepsychiatry, and so on), along the locus of care (whether in hospital, clinic, or home), along specific clinical interventions (such as retinopathy

and spirometry), and even within disease entities (such as stroke and diabetes). At the same time, the trend toward liberalization that permeated the entire health system has introduced more inclusive terms, such as “telehealth” and “e-health.” However, to date, the liberal trend in the nomenclature has remained largely symbolic. It has not produced comprehensive and all-inclusive programs with adequate attention to all factors influencing health and well-being in the population.

We dedicate a special chapter to the changing role of telemedicine and the shift in emphasis from accessibility issues to the efficiency of the healthcare process. In chapter 8, we discuss the new applications to streamline and enhance the efficiency of the clinical process and to improve quality and patient safety.

After reviewing the history, evolution, context, and transformation of telemedicine and drawing the lessons we can from this history, we turn our attention to the available evidence in selected clinical applications and where to go from here in our research endeavor in the final chapter. In addition to answering basic questions for policy and decision-makers at various levels, such evidence would inform the healthcare process and provide a basis for continuous quality improvement. It would provide reliable information on what works and what does not work, and how we might refine our processes for optimal outcomes. That is why the search for evidence is crucial in telemedicine, as it is in medicine generally and all aspects of medical practice. Research and evaluation occupy a prominent place in this volume, including discussion of methodologies employed, analysis of the evidence produced from research and evaluation efforts, and the conclusions that can be made on the basis of the available evidence. Our efforts conclude with a view toward the future and the full integration of telemedicine tools into mainstream healthcare as well as a discussion of the nature of the available evidence and how we may proceed to collect the more definitive evidence necessary to validate this modality of care.

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