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A Framework for Investigating Impacts of Telemedicine
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1. Introduction

Telemedicine can be broadly defined as "the use of telecommunications technology to provide medical information and services." Use of telecommunications technology to facilitate health care delivery has evolved over nearly four decades, owing its origins to such pioneer works as telepsychiatry consultations and teleradiology in the late 1950s. Telemedicine, with varying degrees of success, has been applied to a wide array of medical specialty areas including radiology, pathology, psychiatry, cardiology, neurology and neurosurgery.

Recently, telemedicine has been undergoing a resurgence. In the International Telecommunication Union's World Telecommunication Development Report 1995, telemedicine has been identified as an important application area of telecommunications technology. The resurgent telemedicine represents another "health care reform" because its adoption and diffusion may cause fundamental changes to health care. Transmitting medical expertise and relevant information at an electronic speed rather than patients and physicians at a mechanical speed, telemedicine allows delivery of health care services to where and when they are needed, beyond physical barriers and time related constraints. Thus, the Euclidean distance becomes obsolete and as a result, house calls will return to the mainstream medicine. As such, patients will be provided with more timely diagnoses/treatments and improved health care quality, thanks to their immediate and continuous access to medical expertise and care without long commutes.

Past research of telemedicine has concentrated on its technical merits and clinical applications. However, technological advances and clinical applicability alone cannot guarantee the success in telemedicine technology management. Telemedicine still has several challenges to meet before it becomes a viable supplement to and/or an alternative of the conventional face-to-face health care delivery. Many of these challenges are nontechnical in nature and involve organizational, managerial, economic and social-political issues and considerations.

This paper proposes a framework of the causal factors related to the resurgence, adoption and diffusion of telemedicine and its impacts on health care delivery and intra- and inter-organizational structures. Established in the premises of organizational theory and configuration design, marketing, sociology, and economics of information and organizations, the proposed framework serves as a vehicle to investigating telemedicine's impacts and therefore is instrumental to the management of telemedicine technology.

2. Resurgence of Telemedicine

As shown in Figure 1, several needs factors have driven the recent resurgence of telemedicine. The economic need to contain the seemingly uncontrollable growth of health care expenditures is an important
factor. The need for better resource allocation is an additional important driving force. The social-political
desire for decentralized and locally adjusted access to health care regardless of geographic conditions is
also significant. Another significant factor is the rising awareness of and needs for "quality" health care. In
addition, the physicians' needs for more effective service delivery channels to package and transmit their
rich medical knowledge and expertise to patients in a timely manner are also essential.

Technology has served as an enabler in this resurgence, empowering telemedicine to meet the
aforementioned needs. Significant advances and development have been accomplished in both medical and
information technology (IT). The Pictorial Archiving Communication Systems and advanced medical
imaging systems such as Computer Tomography and Magnetic Resonance Imaging are examples of
exciting medical technology breakthroughs. Teleconferencing and high-performance communication
networks represent important IT advances. These technological advances along with their continuous
decreases in price/performance ratio have propelled the overt resurgence. In addition, efforts to establish
national and global information infrastructure such as national information superhighways and Internet are
also important.

3. Impacts of Telemedicine

Adoption and diffusion of telemedicine may have significant impacts on health care delivery systems as
well as intra- and inter-organization structures of health care organizations. The following are detailed
discussions of some projected impacts.

3.1 Impacts on Health Care Delivery Systems

The contemporary health care delivery systems are established under the principle of specialization of
medicine. Specialization of medicine inevitably will lead to hierarchy; as a consequence, a sufficient
population base is required to maintain a medical specialty. Because of its electronic communications,
brokerage and integration effects, telemedicine may give rise to several interesting phenomena in the health
care delivery systems. First of all, the hierarchy of health care delivery systems may be enhanced but with a
fundamentally different underpinning. Closely observing the principle of lowest level of efficient care,
telemedicine encourages the separation of highly knowledge-based, diagnosis/consultation-oriented
activities and skill-centered ones such as patient monitoring and treatment administration by promoting
the use of mid-level practitioners who possess sufficient

but not excessive medical competence to provide basic health care and treatment administration and make
referrals to other medical professionals with higher level of and/or specialized medical expertise only when
necessary. The enhanced health care hierarchy (as shown in Figure 2) is economical in medical resource
allocation and consumption and at the same time is also social-politically desirable because it can provide
access to care in medically under- or un-served areas. However, the enhanced hierarchy is based on
medical competence and specialty and therefore is fundamentally different from the current geographical
proximity bounded and physical population based one which in many cases has resulted in unfortunate
misallocation of medical resources.
Telemedicine may also elevate the integration of health care services, tightening the linkages between different levels of health care to provide improved coordination and continuity of care to patients. However, the strengthened integration is service-oriented and therefore fundamentally differs from the cost containment driven integration (e.g., Health Maintenance Organizations) and operations centered integration (e.g., regional hospital consolidations.) The foundation of the integration is collaborative work among health care providers which usually take place in forms of group diagnosis and consultations. The motivation of the collaboration can be established in the premise of Homan's exchange theory which argues that a health care provider will refer his (or her) patients to other medical professionals only when he (or she) expects positive results from the referral, measured in monetary or other terms.

In addition, telemedicine may change the nature and dimension of the competition in the health care industry. Access is no longer an important dimension; and as a result, health care providers will be competing primarily on service quality and costs. Telemedicine can also create a new competition arena by transforming health care transactions from conventional marketplace to IT-enabled and defined marketspace; thus the geographically based market segmentation will become history. The re-shaped health care delivery systems along with the transformed competition and newly created marketspace may reinforce the adoption and diffusion of telemedicine.

3.2 Impacts on Intra- and Inter-Organizational Structures

Adoption and diffusion of telemedicine may also have impacts on intra- and inter-organizational structures of the health care organizations. One common but effective means to maintaining competitiveness in the escalating health care costs and fierce competition is cost reduction through the use of organization rather than market coordination. That is, individual medical professionals form or join physician groups or hospital-physician alliances. The recent prevalence of Health Maintenance Organizations (HMOs) and Preferred Provider Organizations (PPOs) and their continuing rapid growth provide an evidence to the organizational approach taken by individual practitioners.
With its high asset specificity, relatively high frequency of use, and complexity of and difficulty in measuring transaction performance, telemedicine may directly reinforce the subscription to organization coordination. At the same time, telemedicine can change the environment facing the health care industry by re-shaping health care delivery systems, re-defining the nature and dimension of the competition. Telemedicine also represents innovative technological opportunities available to health care providers. According to the contingency theory, telemedicine can change two classic but essential contingencies facing health care providers (i.e., environment and technology) and as a result has effects on their internal structure of choice. The concept of fit is also supported by Mintzberg's configuration model of organizational design which states that an organization can become effective by establishing a fit with its external contexts. Operating in a context best described as complex but stable with relatively straightforward technical support, a desirable configuration for health care organizations is professional bureaucracy whose structure can be characterized as bureaucratic yet decentralized with standardized knowledge and mutual adjustment as its main coordination mechanisms.

Telemedicine may have effects on the structures of health care organizations in several ways. First of all, telemedicine advocates and produces "virtual" organizations within which members are distributed over various geographic locations and practicing at different times. In addition, telemedicine may give rise to a "meet-in-the-middle" phenomenon by encouraging not only individual practitioners to form or join health care organizations but also a curb on the organization size and possible spin-offs of large-sized organizations into multiple medium-sized ones. The rationale is that when growing beyond a certain threshold, health care organizations will find the costs of ineffective and inefficient coordination as well as undesirable political complexity outweighing the gains from economy of scale and scope. Legal anti-trust considerations may also become issues of concern. Another interesting impact is that telemedicine encourages collaborative work and as a result can solve such problems commonly accompanied with professional bureaucracy as coordination and discretion, making professional bureaucracy a more desirable and appropriate form of organizational design.

Telemedicine promotes inter-organizational connections rather than islands of practice. Inter-organizational connections are in concert with the nature of telemedicine technology, the integrated health care delivery systems, the collaborative nature of health care services, and the strategic needs of health care providers. Networking may be one specific form of inter-organizational connections promoted by telemedicine. The foundation of inter-organizational networking can be established in the premise of Burt's structural theory of action which argues that health care organizations help themselves by helping their network partners, resulting in a win-win situation.

4. Conclusions

This paper has made two contributions to the telemedicine research. First of all, it proposes a framework consisting of a sequence of causal processes for systematic investigations of telemedicine's adoption and diffusion and its impacts on health care delivery and intra- and inter-organizational structures. In addition, based on the proposed framework this paper also generates some valuable insights into the causal factors along with their probable outcomes related to the adoption, diffusion and impacts of telemedicine. The insights can be used to formulate research questions for the subsequent studies.

Reference available upon request from the first author.