

Technology Implementation for TELEMEDICINE PROGRAMS

Lessons learned in Hong Kong highlight important issues and common pitfalls in telemedicine technology implementation.

As health care organizations and professionals become increasingly interested in employing technology-enabled alternatives to support, enhance, or expand their patient care and services [6, 11], telemedicine programs are experiencing rapid growth worldwide. Broadly, telemedicine involves the use of advanced telecommunications technologies to exchange medical information—allowing for the provision of health care services across geographic, temporal, social, and cultural barriers [2, 10].

The ultimate success of telemedicine as a viable alternative for service delivery and collaboration requires that adopting organizations adequately address issues pertinent to technology and management [9]. One key issue is technology implementation, a fundamental managerial challenge for health care organizations. In this article, we describe the results of a study that uses a framework [3, 7] to examine the technology implementation of a Hong Kong-based telemedicine program. We highlight important analysis results and discuss their implications for organizational management of telemedicine technology implementation.

The development of telemedicine in Hong Kong has proliferated significantly in recent years [1, 8]. All existing programs are urban-based, with limited geographic

dispersion between service providers and recipients. A prominent focus of Hong Kong telemedicine programs has been the achievement of vertical integration of patient care and management services, particularly the collaboration between secondary and tertiary care providers¹ with regard to consultation or patient assessment and management. This service focus can be partially attributed to participating organizations' membership in the Hospital Authority (HA) system, which provides more than 90% of secondary and tertiary health care in Hong Kong.

The Hong Kong Telemedicine Association (HKTA) represents an important

¹In this study, primary care refers to general/family care, whereas secondary and tertiary care refers to services that require particular medical specialties (for example, general surgery and radiology) and subspecialties (neurosurgery and neuroradiology), respectively.

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milestone in the Hong Kong health care community's commitment to educating, promoting, and ultimately utilizing telemedicine in patient care and management, and other services. In particular, neurosurgeons have shown great enthusiasm for telemedicine by assuming leading roles in HKTA as well as actively organizing or participating in telemedicine workshops and seminars. As a group, these surgeons have proactively experimented with telemedicine technology, and have favorable attitudes toward incorporating the technology in their practices. Their active involvement and positive attitudes have contributed to the launching and implementation of several highly visible neurosurgical teleconsultation programs.

Using the case study methodology [12], we examine the technology implementation of a representative neurosurgical teleconsultation program. Supported by image transmission and display systems, neurosurgeons at an acute tertiary hospital can provide remote consultation and patient assessment and management services to attending physicians at a regional general hospital. Typically, a telemedicine service encounter commences with electronic transmission of selected patient images from the associated general hospital. The attending physician at the general hospital then telephones an on-duty neurosurgeon at the tertiary hospital, briefing him or her on the case and providing relevant patient clinical information. Upon completing an image reading, the surgeon discusses his or her assessment and recommendation with the attending physician via telephone. Service requests from the various clinical departments at the general hospital are generally addressed by on-duty surgeons, who may request additional patient images or consult with other neurosurgeons within or outside the department. All patient images are transmitted from the radiology department in the

linked general hospital. Should urgent care be needed, the responding surgeon quickly coordinates a patient transfer to the tertiary hospital (or another neurosurgical care center), or schedules an immediate surgical procedure by securing an operating theater and assembling a staff before the patient arrives. Such agile coordination and responsiveness have frequently meant the difference between life and death for patients.

Utilization has grown at a steady pace since the program was launched and, at the time of this study, averaged two to three services daily. All neurosurgeons in the department use the system to respond to service requests from the connected general hospital. Approximately half of the requests pertain to internal medicine, 30% pertain to general surgery, and 15% involve intensive care units and accidents and emergencies. Charges for services provided by the neurosurgery department are indirectly credited within the HA internal accounting system rather than being settled through direct payments. Overall, the administrators and clinicians at both connection ends consider the program effective and take pride in its success.

Analysis of Technology Implementation

Kwon and Zmud [7] and Cooper and Zmud [3] have examined key technology implementation issues in an organizational setting and proposed a fairly comprehensive framework. We use this six-stage framework as a template to analyze the technology implementation of the investigated program.

Initiation. Initial discussions of potential provision of telemedicine services began in 1992. Central to the initiation stage were the department head and an external research group. Having received his medical education and specialized clinical training in the U.K., the department head (also

a senior neurosurgeon) was known as an advocate for and practitioner of technology-enhanced patient care and management in Hong Kong. The management style of this neurosurgeon can be best described as communication-based and consensus-building-oriented, as manifested by his enthusiastic encouragement of the proactive involvement of fellow surgeons in departmental decision making. Calling upon his knowledge of telemedicine, the department head offered assistance to his colleagues in several ways. For example, he located relevant literature, met with peers experienced in telemedicine services and technology vendors, and volunteered his own assessments. A university research group also contributed substantially to the program's initiation. Motivated by potential commercialization, the research group had developed an image-based teleconsultation system. The research group demonstrated the system to the surgeons and offered them hands-on experimentation with the system.

All surgeons in the department actively participated in the program initiation, which typically proceeded in informal, peer-to-peer discussions. Based on their understanding of the related clinical literature and experiences with the systems demonstrated by the research group and other vendors, the surgeons exchanged their assessments of and concerns about telemedicine technology and the services it supported. The assessments converged over time and subsequent discussions amplified details and proceeded with increased formality. The surgeons, particularly the senior ones, were excited about the virtual service delivery and collaboration alternatives, unanimously considering telemedicine a promising solution for their inter-organizational service needs, including the provision of consultation or patient assessment services to attending physicians at several regional general hospitals. Overall, the neurosurgeons in the initiation stage developed favorable attitudes toward telemedicine and achieved a realistic understanding of probable target services and the associated technology requirements.

Adoption. Three different systems were adopted over time. The one developed by the research group was adopted first in 1993. Although considered by many surgeons to be workable, this system was adopted primarily because of its zero acquisition costs to the department. In return for clinical efficacy data, the research group voluntarily made the system available to the department and provided baseline maintenance services free of charge. Connection was through public phone lines, over

which a general hospital was linked to the neurosurgery department and another neurosurgical care center. After 16 months of service, this bulky and not particularly user-friendly system gave way to a commercial proprietary system. Acquired through a research grant secured by the department head, the commercial system supported image transmission and manipulation functionality and was considered by most surgeons to be much easier to use than its predecessor. Central to the adoption decision was the vendor's commitment to integrating its system with the CT scanner at the general hospital. In addition, an ISDN line replaced the public phone lines and therefore significantly reduced image transmission time requirements.

By and large, the surgeons considered this Unix-based system to be user-friendly but frustrating because of its variable reliability and limited storage capacity. In addition, the system's proprietary imaging format also greatly constrained its image export capability. Such limitations eventually led to a decision in favor of the current system. To a certain degree, that decision was opportunistically driven, involving the department's favorable response to a voluntary offer by the technology vendor from whom the connected general hospital purchased a CT scanner in 1998. Operating on an NT platform, the current system is Windows-based and includes image export functionality and a storage capacity far superior to its predecessor. Overall, the surgeons expressed satisfaction with the image resolution offered by the current system, which also supports common image-manipulation functionality. Though ostensibly made by the department head, each adoption decision involved and was supported by all the surgeons.

Adaptation. The department head and the external technology provider were instrumental in the adaptation of each adopted system. On average, system installation, testing, and fine-tuning were completed within two to three months following the adoption decision. The adaptation required considerable participation by the surgeons, who anticipated their using the system and therefore proactively provided assessments of system operations and functionality, together with suggestions for probable or desirable enhancements. The technology staff at the tertiary hospital assumed a minimal and passive role in the adaptation, performing such tasks as assisting the vendor by providing the hospital's network configuration and related information. The adaptation at the general hospital centered on the system's integration with the CT scanner and a digitizer (for conventional X-ray

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images), thus mainly involving technicians in the radiology department.

Acceptance. Data on technology acceptance, by which we mean an individual neurosurgeon's intended and actual use of the system [4], was primarily obtained from interviews with individual neurosurgeons and was subsequently verified with the department head and colleagues. Overall, the surgeons' acceptance of each adopted system was high and almost instantaneous, partially because of their involvement in the adoption decision and active participation in the adaptation stage. The surgeons recognized the target telemedicine services' value in patient care/management and therefore exhibited strong intentions to use the system. Involving neurosurgeons in the early implementation stages of initiation, adoption, and adaptation was advantageous and crucial. As a result, none of the surgeons viewed the adopted systems as foreign or questioned their compatibility or utility with respect to their practices.

System utility and ease of use also contributed to the observed acceptance. As a group, the surgeons recognized the current system's value in supporting their services to physicians at the general hospital and found its operation easy and manageable. To them, the transmitted images were of adequate resolution and could be manipulated using a common set of functionalities. The implicitly mandatory use of the system was also relevant; in other words, surgeons had to use the system in order to respond to service requests from the general hospital. The current system is housed in a communal working room conveniently and exclusively accessible to the surgeons. From the designated room, the on-duty neurosurgeon can also access other information systems in the department or the hospital.

As the surgeons grew accustomed to the system, they began to suggest ways to improve it. For

example, many surgeons explicitly singled out the immediate need for an image database to store patient images upon service completion. In addition, the growing utilization created a need for mobile access, allowing an on-duty or consulted surgeon to access the telemedicine system from his or her current location.

Routinization. Regular use of the system, although intermittent, became part of the surgeons' routine clinical activities. Overall, surgeons were familiar with the current system's operations and did not find its use difficult. However, utilization of the current or any previous system was largely confined to clinical purposes, such as patient care and management. The service volume grew over time but remained marginally significant, as compared with the total services rendered by the department. Compensation for the services provided was indirect and was settled within the HA's internal accounting system. As a group, the surgeons were not satisfied with the current compensation model and favored a more direct payment scheme.

From the perspective of quality assurance (QA) or outcome assessment (OA), the telemedicine services were subtly different from those delivered in the conventional setting. All of the telemedicine services rendered were reviewed annually, in collaboration with neurosurgeons from other tertiary centers. Periodically, the surgeons contacted the attending physicians at the general hospital for patient status or progress updates. However, such inquiries were mostly ad hoc and not documented systematically. Most surgeons in the department agreed that the current QA and OA mechanisms needed improvement in structure and regularity, both of which understandably have important ramifications for service quality, clinical training, and continuing education. Technologically, sys-

temwide assimilation was also limited. The current system was not integrated with other relevant information systems, such as the hospital information system and the department's multimedia patient tracking system.

Infusion. Despite limited routinization, increased organizational effectiveness was observed in several areas. Using the telemedicine technology, the department became increasingly responsive to patient care and management needs, thus enabling the onsite physician to provide adequate and timely diagnostic or therapeutic services. Technology use became the norm in the department, where the culture encouraged and valued surgeons' use of telemedicine for service delivery and collaboration. Using the technology, the neurosurgeons were able to extensively examine patients at the general hospital before admitting them to their or another tertiary center for care. As a result, the department improved its utilization efficiency and effectiveness by allocating highly specialized but limited personnel resources and care facilities to those in greatest need. The technology also contributed to reduced commuting of the surgeons, who otherwise had to travel to the general hospital frequently for consultation or patient assessment. Although not quantitatively measured, the system's contributions to organizational effectiveness and efficiency were highly visible and pervasive. As a senior surgeon commented: "Use of the system has significantly improved our service quality, efficiency, and effectiveness, and on multiple occasions, has indeed saved patients' lives."

Lessons Learned

We found the role of a motivated and determined clinical administrator was critical to telemedicine technology implementation, especially when such technology directly interfaces with member physicians. Clinical administrators have considerable influence in technology implementation—managerially and clinically. As one neurosurgeon put it, "he (the department head) made this happen...brought telemedicine to our attention, got us to see and use some technologies, secured the necessary resources, and made sure that everyone was using the technology clinically." In the early implementation stages, the influence of a clinical administrator may be particularly prominent. For example, this individual may be responsible for cultivating favorable attitudes, encouraging discussion and assessment of target services and technology requirements, facilitating technology experimentation and evaluation, and fostering

technology acceptance and utilization.

The second lesson learned from our study is that consensus is an inevitable ingredient for effective implementation, and must be closely monitored and managed in anticipation of a subsequent adoption decision—positive or otherwise. Toward this end, informal communication that takes place on a peer-to-peer basis may be instrumental to consensus building. Managerial influences can catalyze and accelerate such communication, but its convergence cannot be driven administratively. Central to communication-driven consensus building are evidence-based evaluations by physicians, particularly those based on firsthand experience. As one neurosurgeon commented, "hands-on experiences are important in my assessment of the technology and the services it supports. Without seeing the technology or playing with it personally, I do not know how realistic my assessment would be."

Third, user acceptance greatly depends on consensus building in the initiation phase and on member physicians' participation in adoption decision making and subsequent adaptation activities. Favorable psychological attachments and cognitive/behavioral familiarity with system operations are both important to technology acceptance, and can be effectively achieved through user involvement and training in early implementation stages. Convenient access is also relevant, as illustrated in the described case. Because of the virtual nature of telemedicine, system access may need to extend beyond geographical constraints or organizational boundaries, allowing, for example, the remote specialist to access the case under examination from his or her current location.

Fourth, connection choice is critical and when not adequately selected, may eventually become a bottleneck to technology utilization. As shown in our case, even though service utilization grew over time, it peaked at the current level of two to three cases daily. Circumstances at the time of program initiation contributed to the choice of a connecting general hospital by the university research group. But the constraints of the general hospital, as measured by patient base and service/facility capacity, adversely affected the utilization of the telemedicine services by the neurosurgery department. As pointed out by a neurosurgeon, a logical solution for increased utilization is to expand the current point-to-point arrangement to a service network over which the department can provide services to attending physicians at multiple general hospitals. Also implied by our analysis is the fallacy of supply-side economics: availability of telemedicine services

cannot solely drive demand, which may be considerably constrained by the connection choice.

Fifth, routinization requires adequate service financing, which is essential to program sustainability. At a minimum, a program must be economically accountable for operations costs incurred in service provision and delivery. In arrangements characterized by dominance of the service provider, operations costs that typically include connection and maintenance charges may be allocated to the service recipient organization. As highlighted in our case, programs based on this or a similar model may be more sustainable than those completely depending on research grants for operations costs. Currently, overall telemedicine development in Hong Kong and elsewhere is still in an early stage, and funding from various government agencies or private organizations is reasonably available. But such resources may diminish as telemedicine matures over time, demanding increased sustainability on the part of individual telemedicine programs.

Also relevant to service financing is technology enhancement and replenishment, both of which are as important as initial acquisition. To reach desired routinization, a program must draw compensation for the services provided on a per-encounter basis, taking into account the consulted care provider's time and effort as well as technology depreciation costs.

Last but not least, integration of telemedicine services with the existing infrastructure is an essential prerequisite to its amalgamation into the adopting organization. From this perspective, existing information systems and quality assurance and outcome assessment mechanisms are relevant. Comprehensive integration with the telemedicine technology in use may have important service-level ramifications, as the remote specialist may need access to information stored in multiple systems when rendering services. At the same time, telemedicine services must be monitored, documented, and reviewed systematically and routinely to ensure their meeting the defined service level, and supporting the continued training and education of the care providers at both connection ends.

Conclusion

Telemedicine represents a promising and exciting technology-enabled solution for long-standing problems in health care, including service accessibility, quality, costs, and resource allocation. The ultimate success of telemedicine as a viable service delivery and collaboration alternative requires that

health care organizations properly address technological and managerial challenges. In this vein, technology implementation is an essential aspect of telemedicine program management. As Huston and Huston conclude in [5]: "Whether or not (telemedicine) technology will drive these changes is not the question. What is important is how the technology can help facilitate the changes and how obstacles can be removed in the deployment of the technology." Clearly, effective management of technology implementation can remove fundamental obstacles to program success. The case presented here highlights important issues and common pitfalls in technology implementation together with lessons learned from experiences in Hong Kong. **C**

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