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Telemedicine: a process enabler for enhanced healthcare delivery systems

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Abstract

Purpose – The purpose of this paper is to provide a conceptual framework along with underlying propositions for the design and deployment of telemedicine projects which provide healthcare organizations with strategic benefits.

Design/methodology/approach – Field research conducted at four healthcare organizations along with academic literature in the areas of telemedicine and process management form the basis for the conceptual framework and propositions provided in this paper.

Findings – Telemedicine can be used as a process enabler for enhanced healthcare-delivery systems. However, there are several challenges which must be considered prior to its implementation. The framework and propositions provided in the paper can be used to facilitate successful telemedicine project deployments.

Research limitations/implications – The framework and propositions are derived from a small sample and must be validated through more rigorous empirical research studies.

Practical implications – The concepts presented in the paper can be used by healthcare planners to increase the likelihood of telemedicine deployment success within their organizations.

Originality/value – This paper begins to fill a void in the literature concerning how telemedicine can be used as a process enabler for improving healthcare-delivery systems.

Keywords Communication technologies, Health care, Medical treatment, Teleconferencing, Service delivery

Paper type Research paper

Introduction

Dramatic changes in the economic, regulatory, political, technical, cultural, and social environments in which healthcare organizations operate suggest that healthcare providers may need to re-examine their healthcare-delivery approaches for future success and survival. Khong and Dhanjoo (2006) note that healthcare planners must seek ways to improve their healthcare-delivery systems without compromising healthcare services to patients. Telemedicine has the potential to simultaneously improve healthcare quality and efficiency by providing patients with virtual access to an organization's healthcare processes (LeRouge *et al.*, 2005). However, despite these benefits, there are several challenges to the successful deployment of telemedicine that must be addressed by healthcare organizations exploring the potential adoption of this technology (Chinn, 2002). Thus, an approach is needed to facilitate the successful deployment of telemedicine within healthcare organizations.

Telemedicine

Telemedicine, although a relatively new term in the medical field, is now familiar to most health care professionals and many patients. Telemedicine has been called

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"an enabling technology – an expansion of what we have used since the telephone was invented. The telephone allowed transmission of audio information – telemedicine uses many media for information transfer" (Larkin, 1997). Brecht and Barrett (1998) stated that "telemedicine is the use of telecommunications technology to send data, graphics, audio, and video images between participants who are physically separated (i.e. at a distance from one another) for the purpose of clinical care." Purcell (1998) defined telemedicine as "consultative, diagnostic, or other medical services delivered via telecommunications technologies to rural or underserved public, not-for-profit hospitals, and primary health care facilities in collaboration with an academic health center and associated teaching hospitals or tertiary center." Another definition offered by a committee appointed by the Institute of Medicine to develop a framework for evaluating telemedicine is "the use of electronic information and communications technologies to provide and support health care when distance separates the participants" (Field, 1996). Telehealth, another commonly used term, is sometimes used to refer to a broad application of telecommunications in three areas: medicine, information, and education (Brauer, 1992).

The first officially recognized use of telemedicine was in 1959, when the University of Nebraska transmitted demonstrations of neurological patients and case information to students across campus. Another notable early project was the Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) program, a joint effort of Lockheed, the National Aeronautics and Space Administration (NASA), and the US Public Health Service. This project involved a mobile van linked to two hospitals where physicians provided consultations to Indian reservations in the 1950s and 1960s. This service was operational for 20 years, but ended primarily due to a lack of funds.

During the 1970s, brief efforts were made to continue the development of telemedicine; however, after several attempts, it was decided that the benefits did not exceed the costs (Park, 1974). There was essentially no development of telemedicine projects in the 1980s because of high costs (Bratton and Cody, 2000). Since those days, new capabilities have become available and costs have decreased, making telemedicine much more attractive.

Telemedicine applications

Current telemedicine consists of several important applications. Teleradiology, one application, involves sending X-rays, computerized tomography (CT) scans, and magnetic resonance images (MRIs) in digital form from one location to another. This is presently the largest use of telemedicine by far (Tweed, 1998). Teleradiology results in lower costs, quicker response time, and greater access for rural hospitals and hospitals that do not have specialists. Rural hospitals and patients also benefit from telemedicine because it reduces the costs of travel for patients and family as well as the frustration of traveling long distances for short office visits (Dymond and Rankin, 1992).

Tele-information is sometimes used to refer to telehealth applications that provide the ability to use telecommunications to transmit administrative and clinical information among multiple locations. This information may consist of patient records, billing information, insurance claims, and appointment schedules. The potential savings in this area are substantial. In some rural locations, where physicians may not be able to afford their own sophisticated computer systems, hospitals have linked the physician's office to the hospital's computer systems. Physicians can access patient

information such as test results from the hospital's system. Hospitals and physicians are also able to share the use of the systems for ancillary services such as payroll, budgeting, and general accounting. These types of shared services arrangements provide cost efficiencies for both the hospitals and physicians (Guiney, 1994).

Tele-education refers to the use of telecommunications in the training of health care professionals. Video-conference networks have been established in various areas to provide regular training sessions for nurses and other health care professionals. These sessions are similar to live sessions in that they cover many of the same topics and are interactive. Educational uses are especially beneficial to medical workers in rural areas where educational opportunities require extensive time and costs for travel to the education site. In some cases, the time required away from work may prohibit attendance at remote sessions.

Telemedicine challenges

The major challenges to the wide deployment of telemedicine have been in the areas of expenses, quality of transmission, and the amount of complex equipment required. During the past few years, transmission-related expenses have been declining because of digital technology. Additionally, the quality of transmission equipment has improved substantially. Digital technology has also resulted in reduced equipment size and costs.

Telemedicine has presented some issues that create legal questions. For example, physicians providing services across state borders may create licensure and liability issues. Challenges have arisen in the regulatory arena because telecommunication is a regulated service. Other challenges that may slow the use of telemedicine include the lack of a workforce trained to use the available technology, the lack of acceptance of the technology by patients, and the lack of restructured health services to accommodate the new environment. Successful deployment of telemedicine will require a new way of thinking about bringing together the patient and the health care professional.

Moore (1996) groups challenges for telemedicine into three categories:

(1) Professional practice, which includes multi-state licensure and liability.

(2) Quality of care.

(3) Financial, which includes the ability to generate positive net income, reimbursement, restrictions of coverage, and payment for procedures by non-physicians.

Reimbursement appears to be the largest challenge to widespread deployment (Haugh, 2003).

Financing the cost of telemedicine can be a challenge for hospitals. Identifying the costs associated with one specific telemedicine service can make it challenging to evaluate telemedicine deployment decisions (Sisk and Sanders, 1998). Crowe (1998) states that the types of costs that should be included in a cost analysis of telemedicine projects include project establishment, equipment, maintenance, communication, and staffing costs. Grigsby (1998) states that most new medical technologies, including telemedicine, are usually inappropriately initially publicized as being cost-effective. Generally, the new technologies result in higher costs in the early stages. Rate of usage is a major factor in the cost-effectiveness of telemedicine projects, because usage is generally low when initially deployed (Strode *et al.*, 1999).

In spite of all the technological and quality-of-care arguments to support the deployment of telemedicine, conclusive proof has not been provided to convince decision makers that telemedicine will generate desired rates of return on investments (Grigsby and Sanders, 1998). Charles (2000) takes the position that providers should consider the return on investment before proceeding with the deployment of telemedicine projects. Although the government has provided funding, it has now begun to recognize the importance of telemedicine in delivering services to underserved rural areas and the importance of financial issues to deployment. The Comprehensive Telehealth Act of 1996 provided for Medicare reimbursement of some telemedicine services by the Health Care Financing Administration. The Act also encouraged research in the area of cost-effectiveness of telemedicine usage. To administer discounts, the Federal Communications Commission (FCC) established the Rural Health Care Corporation (Blackwell, 1998). In further government action, the 1997 Balanced Budget Act required Medicare to reimburse for telemedicine consultations; however, the constraints included reimbursements only for live consultations. Medicare and Medicaid reimbursements were expanded in 2002 (Jones, 2004).

The sustainability of telemedicine projects is an issue of concern. Although governmental or other agencies may provide some funding for initial deployment, the ongoing operating funds are more uncertain. Many past projects have been discontinued when government funding was discontinued. Projects that can provide funds to sustain themselves or not require additional outside funding are more likely to be deployed and continued (Grigsby and Brown, 1998).

Process management

Talwar (1993) defines a process as a "sequence of pre-defined activities executed to achieve a pre-specified type or range of outcomes." The APICS Dictionary (Blackstone, 2008) defines a process as a planned series of actions or operations that advances a material or procedure from one stage of completion to another. An organizational process can be described as s a network of activities that, by the use of resources, repeatedly converts an input to an output for stakeholders (Isaksson, 2006). Organizational processes often span across functional boundaries and lie outside of conventional management systems. Additionally, in most instances there is no one individual who has either the visibility of or the responsibility for the entire process. However, short- and long-term organizational performance is directly influenced by its processes' collective ability to achieve its predefined objectives (Shaw *et al.*, 2007). Therefore, process management systems are needed to ensure that an organization's processes continue to provide output which meet or exceed stakeholder requirements.

An essential element of process management is the continual improvement of current organizational processes along with the development of new processes to accommodate changes in stakeholder requirements. Process models are used to facilitate continuous process improvement (Adamides and Karacapilidis, 2006; Damij, 2007). In addition, approaches are also needed that allow for the formalization of organizational knowledge into frameworks to enable process re-design, support system development, and process innovation activities (Barros, 2007). The purpose of this paper is to provide a conceptual framework along with underlying propositions for the design and deployment of telemedicine projects which enhance healthcare-delivery processes and systems.

Healthcare process management

Under the advice provided by the Institute of Medicine, as well as other sources, healthcare organizations have begun to adopt business practices established outside of their sector for improved process and system management (Reid, 2007). Philosophies and techniques such as total quality management, continuous quality improvement, lean processes, and six sigma have been integrated into the process management approaches used by a growing number of healthcare organizations (Collins and Muthusamy, 2007; Martin, 2007). Business practices such as strategic planning (Zuckerman, 2006), strategic decision making (Parayitam *et al.*, 2007), business process reengineering (Huq and Martin, 2006), process measurement (Anderson *et al.*, 2007; Spath, 2007), and the assessment of new technology (DeMonaco and Koski, 2007) are being used to assist in the management of healthcare processes and systems. Additionally, a growing number of healthcare organizations have placed an increased emphasis on how its established processes can be used to facilitate patient satisfaction (Dreachslin and Lee, 2007; Kollberg and Dahlgaard, 2007).

Telemedicine and process management

The application of telemedicine in the healthcare sector has resulted in the development of new and innovative healthcare-delivery processes and systems such as teleradiology, telepathology, and teleoncology (Weinstein *et al.*, 2007). Thus, telemedicine can be viewed as a process management system that enhances the management, quality, availability, and use of information used in the delivery of healthcare (Atkinson *et al.*, 2001). Telemedicine provides a mechanism for organizations to extend its healthcare-delivery processes to patients in rural locations, and to areas of low patient volumes for particular services (Al-Qirim, 2006). The adoption of telemedicine by healthcare organizations is not only changing healthcare-delivery processes and systems, but also the required skill sets of its personnel. Gioia and Herman (2005) suggest that telemedicine technicians and telemedicine support assistants are among the areas of job growth in the twenty-first century.

The use of telemedicine as a process enabler within healthcare organizations has been shown to increase nursing productivity (Josey and Gustke, 1999; Bodin, 2003), streamline healthcare-delivery processes (Bergmo and Johannessen, 2006), and improve information management (Tan *et al.*, 2002). Telemedicine has facilitated the development of intra- and inter-organizational healthcare-delivery processes which for the optimization of workflows within and between healthcare organizations. This study contains the results of field research conducted at four healthcare organizations used to provide the basis for the development of a conceptual framework and propositions for the design and deployment of telemedicine projects which provide healthcare organizations with strategic benefits.

Case research results

Specific examples provide a setting for further study of the ideas presented thus far. According to Naumes and Naumes (1999), "the opportunity to study an actual situation in a realistic setting is the principal advantage of case research. This allows the researcher to determine not only what happened but why it happened." Sections 2 through 4 of this paper are based on excerpts from research by one of the authors (Smith, 2005). A case research, or qualitative, approach was chosen because there has

been little research in the area of decision making regarding telemedicine; therefore, it is appropriate to delve deeply into this topic, something that qualitative research can facilitate. Using this approach, a small number of participants could be selected, which allowed in-depth exploration with the participants. This approach provided an opportunity to better understand the reasons for decisions made relative to telemedicine (Moussavi, 1989).

The participants selected for this study included four hospital systems, one in each of four different states in the United States. A goal of the research study was to gather data from different perspectives within the case study sites; therefore, interviewees included representatives from four disciplines: administrative, clinical, finance, and technology. The reason for including these different disciplines was to assess whether the disciplines have different feelings about the relationship between financial issues and telemedicine. An *a priori* assumption was that financial representatives would be overly sensitive to cost and less sensitive to patient care, that clinical representatives would be more concerned about patient treatment regardless of cost, that technology representatives would be inclined to purchase the latest and most expensive technology products with no concern for cost benefit, and that administrative representatives would more equally balance the financial and patient care issues.

The primary instrument used in this research project was an interview guide designed to assist in administering face-to-face interviews. The seven-page guide was divided into multiple sections: Introduction, Profile, Strategy Process, Technology, and Telemedicine Projects. Also included as part of the interview guide was a Survey Questionnaire utilizing a five-point scale. Because the study focused on financial indicators, a question probed for additional factors that affect decisions in order to identify factors that may be more important than financial factors. Additionally, one question asked whether feelings about using telecommunication-type projects had changed based on recent technological and regulatory developments. When asked about adopting new technology, the interviewees were asked to categorize their system using Rogers' (1995) categories: leader, early adopter, early majority, late majority, and laggard.

Fifteen interviews were conducted with 17 respondents, and lasted approximately 1-1.5 h each. As part of the interview, through use of the Survey Questionnaire, interviewees were asked to rate the five financial factors (initial or capital investment, operating or ongoing costs, profitability or net income, cash flow, and reimbursement) included in the study via a five-point scale on the level of importance in making telemedicine decisions. In addition to rating the financial indicators, respondents were asked to rank the indicators from 1 to 5 as to importance. Ratings of the financial indicators are presented in Table I and rankings are presented in Table II. Average ratings and rankings for each financial indicator are also calculated.

Regarding the quantitative results, financial indicators, in general, were seen as important or very important by all interviewees. Regarding the specific financial indicators, initial capital investment and annual operating costs received the highest average ratings. Initial capital investment and annual operating costs also received the highest rankings.

Telemedicine: a strategic alignment perspective

The case studies revealed that telemedicine projects should be designed and deployed within the context of a healthcare provider's strategy. Strategic alignment between a

	Very unimportant 1	Unimportant 2	Neither unimportant nor important 3	Important 4	Very important 5	Average rating
Financial indicators (in general)				6	11	4.65
Initial capital investment			2	5	10	4.47
Annual operating expenses			1	11	5	4.24
Impact on net income			4	7	6	4.12
Cash flow		1	4	6	6	4.00
Reimbursement			2	9	6	4.24

Table I. Rating of financial indicators: aggregate (n = number of respondents)

Ranking	Initial capital investment	Annual operating expenses	Impact on net income	Cash flow	Reimbursement
1	6	4	5	1	1
2	4	6	3	1	3
3	3	2	3	3	6
4	1	3	4	5	4
5	3	2	2	7	3
Average ranking	2.47	2.59	2.71	3.94	3.29

Table II. Ranking of financial indicators: aggregate (n = number of respondents)

provider's organizational strategy, healthcare-delivery processes, and patients is essential to ensure that:

(1) Strategic objectives are driven by patient needs and expectations.

(2) Healthcare-delivery processes enabled via telemedicine deployment have a strategic impact on the creation of customer value.

(3) Telemedicine is used to enable healthcare-delivery processes which facilitate the achievement of strategic objectives.

Congruency between organizational strategy, healthcare-delivery processes, and patients can be visualized as a "triangle" which links together these three elements. Lockamy and Smith (1997) developed a framework depicting the concept of a strategic alignment triangle for business process reengineering. The framework has been modified to provide a conceptual model for illustrating the concept of strategic alignment for telemedicine deployment, and is provided Figure 1.

Healthcare-delivery processes

Process management as applied to healthcare environments changes the emphasis of the organization from functional performance to process performance, based upon multi-functional performance criteria driven by strategic objectives and patient requirements. Process management requires the support of senior leadership to

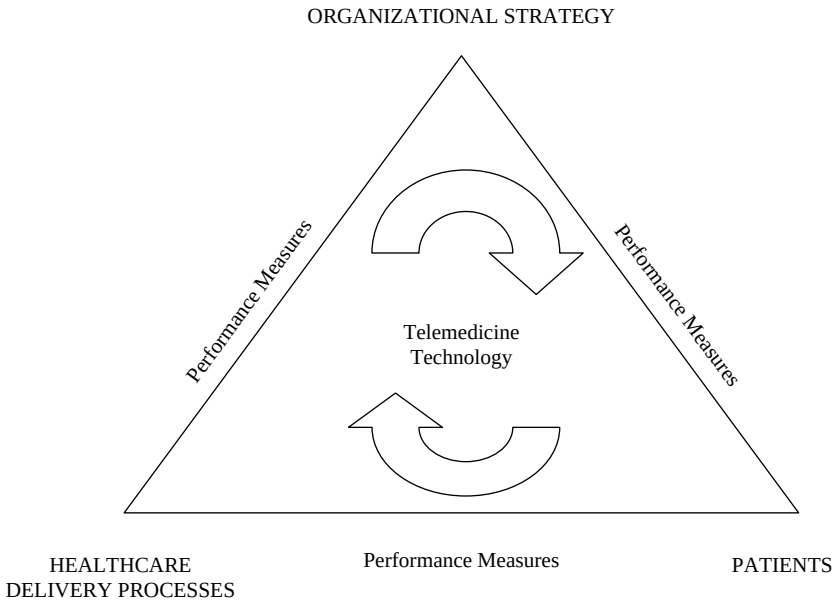

Figure 1.
Strategic alignment framework for telemedicine deployment

promote organizational change and the extensive use of leading-edge information technologies such as telemedicine to facilitate information exchanges and communication.

Patient satisfaction

Telemedicine deployment must first concentrate on processes that improve patient satisfaction and value while enhancing the organization's ability to achieve its strategic objectives. Therefore, effective telemedicine deployment efforts require that healthcare organizations focus on applying this technology to critical healthcare-delivery processes which influence the patient's perception of satisfaction and value within the context of the organization's strategy. Processes which may indirectly provide patient value and only complement core healthcare-delivery processes should be given a lower priority during telemedicine project implementations.

It is important to note that the use of telemedicine must not only address the needs of patients, but also internal users of the technology. These users must be viewed as "internal customers" who are part of an interdependent "value chain" which directly impacts the degree of customer satisfaction and value ultimately received by patients. Therefore, telemedicine projects must address the needs of both patients and internal users to ensure the effective use of this technology.

Performance measurement

Integrated performance measurement systems provide a means for improved coordination across functional boundaries and among organizational processes (Lockamy and Cox, 1995). For healthcare organizations, these systems are comprised of performance criteria, standards, and measures designed to monitor the congruency between a provider's organizational strategy, healthcare-delivery processes, and patients. Traditional performance measurement systems focus primarily on the final results,

usually expressed in financial terms. Thus, these systems fail to measure the ability of organizational processes to consistently provide value to their users. In addition, traditional performance measurement systems fail to measure core organizational processes against established strategic objectives. Healthcare providers seeking to deploy telemedicine within their organizations need to develop integrated performance measurement systems which link together organizational strategy, healthcare-delivery processes, and patients through the creation of the proper criteria, standards, and measures necessary to ensure coordination and alignment along these three dimensions.

Telemedicine technology

As stated earlier, telemedicine can be viewed as a telecommunications technology to facilitate clinical care between participants who are physically separated (Brecht and Barrett, 1998). The strategic use of telemedicine not only enables enhanced patient satisfaction and value, but also multi-functional and inter-organizational communication. Telemedicine technology must, therefore, be deployed in conjunction with core healthcare-delivery processes rather than conventional functional organizations. Formal descriptions of core healthcare-delivery processes are required to determine specific information requirements. Once these processes and corresponding information requirements have been defined, telemedicine can be utilized in a manner which supports effective process management.

Telemedicine projects: principles for success

Based upon the case study results and conceptual framework, the following propositions are provided for the effective deployment of telemedicine projects. The propositions are also supported by prior research studies:

P1. Healthcare-delivery processes selected for telemedicine deployment must have a strategic impact on the firm.

It is imperative that improvement initiatives such as telemedicine projects include processes which support the achievement of organizational objectives (Akhavan *et al.*, 2006; Rosemann, 2006; Nurcan *et al.*, 2005). Thus, healthcare providers must assess the degree to which a healthcare-delivery process affects its ability to achieve its stated objectives prior to its inclusion in a telemedicine deployment effort. Healthcare providers who failure to make such an assessment will likely expend valuable organizational resources without achieving meaningful results:

P2. Healthcare-delivery processes selected for telemedicine deployment must have a significant impact on patient satisfaction and value.

Healthcare providers should only be engaged in activities which "add value" to patients and other legitimate stakeholders who rely on their processes and systems (Lutz, 2007). The needs and expectations of both patients and other stakeholders must be well understood and incorporated into telemedicine projects. Telemedicine deployments that ignore stakeholder requirements will likely result in strategy-process-patient misalignments which negatively impact customer satisfaction and value:

P3. Performance measures are needed to evaluate the potential impact of telemedicine projects on patient satisfaction and value.

Performance measures must be established that allow healthcare providers to assess the potential impact of a telemedicine project on customer satisfaction and value prior to its deployment. The measures must represent patient-driven performance criteria, and be compared to performance standards derived from organizational objectives (Lloyd, 2007; Slovensky, 2007). Healthcare-delivery processes which exhibit the highest improvement potential-based on the performance measurement system become the primary candidates for telemedicine deployment:

P4. Healthcare-delivery process measures are needed to assess current performance and reveal future improvement opportunities.

Healthcare providers must routinely evaluate the efficiency and effectiveness of their current healthcare-delivery processes in supporting organizational objectives (Mercer, 2001). Additionally, healthcare providers must routinely evaluate these processes to reveal improvement opportunities. The creation of a performance measurement system containing healthcare-delivery process measures is necessary to monitor the alignment between a provider's organizational strategy, healthcare-delivery processes, and patients. The system can also be used to establish organizational goals for continuous process improvement. Healthcare-delivery process measures must be linked to organizational objectives to maintain proper alignment between core healthcare-delivery processes and strategy:

P5. Telemedicine projects should utilize a project management approach to control cost, performance and timeliness objectives.

Telemedicine projects should begin with a plan containing well-defined objectives. These objectives usually revolve around cost, performance, and timeliness requirements. A project management approach contains the following elements useful in achieving these objectives (Antony, 2006; Chrusciel and Field, 2006; Ulbrich, 2006; Orr and Sankaran, 2007; Wang *et al.*, 2007):

(1) *High performance work teams.* Multi-functional teams are used to plan, organize, direct and control various phrases of the telemedicine project as it moves from conceptualization to implementation.

(2) *Organizational structure.* Project organizations are created to support telemedicine projects. These organizations can range from the creation of a project coordinator to the development of autonomous project management teams.

(3) *Information sharing.* The development of teams and organizational structures facilitate information sharing between individuals involved in the telemedicine deployment effort.

(4) *Tools and techniques.* Project management techniques such as network scheduling diagrams, work breakdown structures, and cost schedule control systems are useful in monitoring and controlling telemedicine deployment activities.

Limitations and future research

Since the framework and propositions provided in this study are derived from a small sample of healthcare organizations, it is necessary to conduct more rigor studies to test their robustness within the healthcare industry. This study provides the basis for

future researchers to further explore the strategic deployment of telemedicine to enhance healthcare-delivery processes and patient satisfaction. Future researchers may also explore the ideas presented in this study regarding the need for performance measures to evaluate the impact of telemedicine on patient satisfaction and healthcare-delivery process performance. Finally, the role of project management techniques in the successful deployment of telemedicine in healthcare organizations as outlined in this study may be explored by future researchers to validate the findings of this study.

Summary

Telemedicine can be used as a process enabler for enhanced healthcare-delivery systems which result in higher levels of patient satisfaction and value. However, there are several challenges which must be carefully considered before adopting this technology. This paper presents a summary of the results of four case studies of telemedicine deployment to improve patient care. The case study results provide insights which are used as a basis for developing a strategic alignment framework for telemedicine deployment, along with guiding principles for the effective deployment of telemedicine projects. The framework and principles revolve around five primary areas:

(1) strategic alignment;

(2) process management;

(3) patient satisfaction;

(4) performance measurement; and

(5) project management.

The model and principles can be used by healthcare planners to increase the likelihood of telemedicine deployment success, and by researchers to further explore issues concerning the effectiveness of telemedicine technology as a process enabler in healthcare organizations.

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