

## ► Telemedicine in the future

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### Summary

Telemedicine can provide a compelling alternative to conventional acute, chronic and preventive care, and can improve clinical outcomes. In the industrialized world, it is likely that telemedicine will continue to move health-care delivery from the hospital or clinic into the home. In the developing world or in regions with limited infrastructure, telemedicine will mainly be used in applications that link providers based at health centres, referral hospitals and tertiary centres. The future of telemedicine will depend on: (1) human factors, (2) economics and (3) technology. Behaviours related to technology affect change at the individual, organizational and societal level. Personnel shortages and decreasing third-party reimbursement are significant drivers of technology-enabled health care in the industrialized world, particularly in the areas of home care and self-care. We can safely assume that developments in mobile communications, sensor devices and nanotechnology will alter the way that health care is delivered in the future. The growth and integration of information and communication technologies into health-care delivery holds great potential for patients, providers and payers in health systems of the future. Perhaps the most difficult question to answer, however, is 'When will telemedicine become part of the standard of care?'

### Introduction

Telemedicine has survived the high expectations associated with the 'technology bubble' of the 1990s and its eventual collapse. It continues to thrive. However, forecasting the future of telemedicine is largely speculative, and varying opinions about the future of telemedicine and e-health have been expressed.<sup>1-4</sup>

### Why telemedicine in the future?

Although life expectancy is increasing throughout the world, there is significant morbidity and mortality from chronic diseases such as heart disease, cancer and diabetes,<sup>5</sup> and the ageing of the population will make things worse in future. There is also evidence that high-

quality and cost-effective health interventions are not being used effectively on a regional, national or global scale.<sup>6</sup> This results in over-use, under-use and misuse of resources, long waiting times to access medical specialists, significant practice variability and poor adherence to established standards of care.

Enormous potential exists to improve health services throughout the world by using information and communication technologies (ICTs) to expand access to primary, secondary and tertiary care, raise quality, increase efficiency and decrease costs.<sup>7-9</sup> The burden of chronic disease, for example, can be significantly lessened through telemonitoring to decrease emergency room visits, hospital admissions, hospital stays and costs.<sup>10,11</sup> Telemedicine-based disease management has also been shown to improve outcomes such as blood pressure, glucose control,<sup>12,13</sup> medication compliance, functional status and quality of life.<sup>14,15</sup>

By providing greater access to medical expertise, telemedicine can reduce the geographical variability of diagnosis and clinical management. Teleconsultation has been shown to change diagnoses and management recommendations, and also to reduce the long waiting times associated with access to high-demand specialty

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care.<sup>16</sup> This is particularly valuable in the developing world, where specialist care is often inaccessible.<sup>17</sup>

There are many examples of why telemedicine provides a compelling alternative to conventional acute, chronic and preventive care, and how it can improve clinical outcomes.

## Who will be the future users of telemedicine?

The future users of telemedicine will be patients and providers. The spectrum of patients, however, will probably broaden to include not only ill patients, but also those recently diagnosed, those at risk for disease, the 'worried well' and health-conscious consumers. Providers will include the traditional physician and nurse, but will also include less skilled health professionals as they enter the workforce and health care takes on a broader team approach. This will also include carers, who may be family members or other non-professionals.

## Where will it be used?

One advantage of telemedicine is that it depends less on location and time than traditional care. In the industrialized world, it is likely that telemedicine will continue to move health-care delivery from the hospital or clinic into the home. In some instances, health care will continue to the individual patient level. For example, heart failure patients may have their vital signs and other indicators monitored during their routine daily activities. Any readings outside a pre-determined range can be forwarded to a provider who can intervene as required.

In contrast, telemedicine in the developing world or in regions with limited infrastructure will mainly be used in applications that link providers based at health centres, referral hospitals and tertiary centres.

## How will the future of telemedicine be determined?

The future of telemedicine will depend on: (1) human factors, (2) economic factors and (3) technology.

### Human factors

Behaviours related to technology are influenced by our culture, knowledge, attitudes, beliefs, practices and

routines. These, in turn, affect change at the individual, organizational and societal levels.

### Patients

Patient behaviour and perceptions will guide telemedicine in the years ahead as patients come to appreciate and expect high-quality, technology-enabled health care. Several trends indicate that this is already happening:

- the increasing use of the Internet for health-related purposes;<sup>18</sup>
- growing demand for faster local access to medical services;
- growing dissatisfaction with the current health system;
- greater patient participation in health-care decision-making;
- high levels of patient satisfaction with telemedicine;<sup>3,19</sup>
- increasing use of the Internet and mobile phone technologies globally.

### Providers

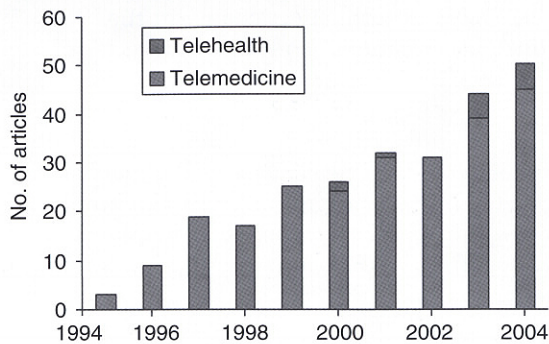
The supply of health-care providers, their perceptions and their behaviour will also be important. Significant trends include:

- anticipated shortages in physician and nursing workforces;<sup>20,21</sup>
- less skilled health professionals and lay carers are playing a larger role, increasing the need for communication among the various providers;
- provider adoption of e-health technologies into clinical practice is occurring, but with some resistance.<sup>22,23</sup>

Telemedicine services can add value by redistributing medical expertise, integrating the contributions of multidisciplinary providers and creating new educational opportunities.

### Organizations

Health-care provider organizations have begun to shift their emphasis from episodic care to continuous care, as chronic disease management and prevention become part of their mission. They are also using less skilled and less costly providers as a part of a multidisciplinary approach to health-care delivery. In addition, the basis on which health-care organizations are competing is beginning to evolve from one based



**Figure 1** The number of studies identified as clinical trials through MEDLINE using the search terms 'telemedicine' and 'telehealth'

on cost shifting to one based on performance and quality.<sup>24,25</sup> Although there has been some resistance, these types of initiatives are likely to gain momentum.

In general, support for technology-enabled health care appears to be occurring within health-care provider, payer, employer and patient advocacy organizations. This support is reflected in policies and practices that encourage future use of ICTs. Such organizations include the American Association of Retired Persons (AARP), the Institute of Medicine (IOM), the National Health Service (NHS), the World Health Organization (WHO)<sup>26</sup> and the World Bank.

Finally, organizational adoption of new health interventions is usually accelerated by scientific evidence of their benefit. There has been an increase in the number of telemedicine clinical trials conducted over the past decade, although further work is required.<sup>27</sup> Figure 1 illustrates the number of studies identified as clinical trials through MEDLINE using the search terms 'telemedicine' and 'telehealth'.

### Society

Within industrialized countries, a societal transformation appears to be occurring in the delivery of health care. Health-care providers, for example, are moving from the role of medical 'authority' to that of health-care 'facilitator', guiding patients and consumers through a growing body of medical information. This is one aspect of the move from industrial-age to information-age health-care delivery, and a more patient-centred model of care.<sup>28</sup>

In addition to changes in the roles of patient and provider, social norms are encouraging technology-enabled health care. The Internet and the mobile

phone are becoming accepted for everyday transactions such as shopping, banking, voice communication, instant messaging, email and information-seeking. The Internet is already being used to communicate and schedule appointments,<sup>29</sup> and the transition to clinical telemedicine applications seems inevitable.

Although laws regarding medical licensure, mal-practice and patient privacy have tended to inhibit the use of telemedicine in the past, supportive regulation is now appearing at the national and state levels. In the USA, for example, the federal government recently appointed a health-care IT coordinator to oversee the integration of communication technologies, including telemedicine.<sup>30</sup>

In contrast, health-care delivery in the developing world remains under-funded, at odds with traditional indigenous practices, physician-centred, and accessible primarily at urban centres and remote health facilities with limited resources. Although Internet and mobile phone use is increasing throughout the developing world, only a fraction of the population use them routinely. The potential impact of international telemedicine is significant.<sup>31,32</sup>

### Economic factors

Most health systems in the world are supported through public funding, but many depend heavily on the contribution of the private sector as well. In the USA, health-care costs continue to rise and millions of people remain uninsured. Personnel shortages and decreasing third-party reimbursement are now significant drivers of technology-enabled health care in the industrialized world, particularly in the areas of home care and self-care. This will only intensify as populations age.

Regardless of the source of funding, establishing reimbursement mechanisms for telemedicine remains a challenge. Broad public financing has already resulted in large-scale telemedicine deployment within the health systems of several industrialized countries, including Canada, Australia, New Zealand and the UK, as well as the Veterans Administration (VA) system and statewide networks within the USA. However, demonstrating a return on investment remains critical to the sustainability of telemedicine.

Beyond third-party payers, there has also been growth in the patient-centred consumer health-care market, independent of professional health services. This has led to increased availability of over-the-counter and online diagnostic tests, monitoring devices and medications. Telemedicine services will almost certainly find a niche within this marketplace as well.

**Box 1** Challenges for the future of telemedicine**Human factors***Individuals*

- Address concerns about training, liability, patient security and increased workload among providers

*Organizations*

- Demonstrate the value of telemedicine to the health payer, provider and advocacy organizations
- Align telemedicine with the increasing emphasis on self-care and multidisciplinary care models
- Continue clinical trials at academic institutions to demonstrate that telemedicine is effective and efficient

*Society*

- Promote acceptance of a patient-centred and technology-enabled method of health-care delivery
- Create practice environments that reduce defensive medicine practices, which in turn limit the adoption of new clinical interventions such as telemedicine (e.g. malpractice reform)
- Create a compelling case for lifting licensure restrictions that inhibit telemedicine activities across borders

**Economics**

- Pilot new third-party reimbursement mechanisms to attract greater patient and provider participation, particularly in health systems that are not supported publicly
- Explore global markets for telemedicine that allow the export of medical expertise
- Seek sustainable economic models that support telemedicine in the developing world to address the growing burden of chronic disease

**Technology**

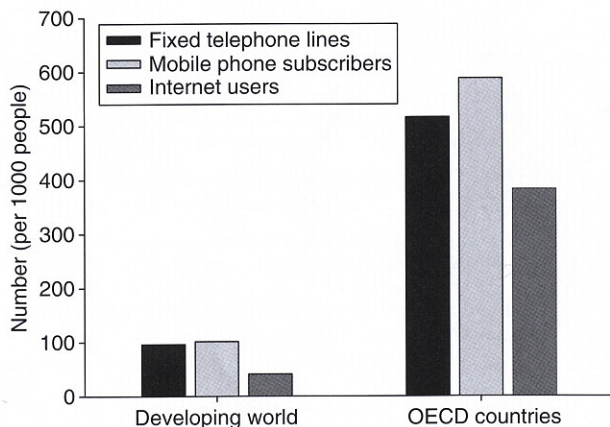
- Improve usability for patients with limited function, but who aim to benefit from telemedicine
- Implement methods that verify and authorize access to health information such as fingerprint and voice recognition
- Create communications devices that are smaller, less expensive and more powerful, which will be available at the point of care
- Create sensors that are more sensitive, less expensive, passive and less obtrusive
- Introduce methods of bridging the 'digital divide' faced by developing countries

Finally, it is unlikely that public health-care funding will be diverted into new delivery mechanisms such as telemedicine in developing countries. In these settings, telemedicine will probably continue to be grant-supported and will therefore continue to face the challenge of economic sustainability. Even low-cost telemedicine will require private sector financing.

**Technology**

We can safely assume that developments in mobile communications, sensor devices and nanotechnology will alter the way that health care is delivered in the future. Mobile phones and other mobile communication devices will become smaller, less expensive, more powerful, easier to use and will be available at the point of care. Sensors will become more sensitive, passive, wearable and, in some instances, nearly invisible to the user.

Communications infrastructure and services are becoming almost ubiquitous, and there has been substantial uptake of broadband technologies in recent years.<sup>33</sup> Unfortunately, however, a significant 'digital divide' persists among developing countries, limiting future telemedicine services.<sup>32</sup> Figure 2 compares the diffusion of communications technologies in the developing world with that of the wealthier countries that form the Organization for Economic Co-operation and Development (OECD). The future challenges to telemedicine are summarized in Box 1.

**What future applications of telemedicine will emerge?**

**Figure 2** The diffusion of communications technologies in the developing world compared with that of the wealthier countries that form the OECD

In general, it is likely that health-care delivery in the industrialized world will continue to move further into the patient's home and to travel with patients wherever they go. The future of monitoring will move from the management of chronic disease to include those recently diagnosed, those predisposed to illness, the 'worried well' and the health conscious. In the not too distant future, this information will also be incorporated into the patient's electronic medical record. This will also complement multidisciplinary team approaches to care by allowing patients, their carers and providers with varying levels of skill to contribute collectively to the care process.<sup>34</sup>

Advances in mobile and sensor technology will continue to evolve and 'smart' environments will allow passive and invisible monitoring and screening. The mobile phone, for example, will no longer be thought of as simply a device for voice communication, but rather as an access vehicle to multimedia technology,

with multiple functions including health-related services. The following scenarios illustrate what telemedicine may look like in the decade ahead.

### Patient-provider communication and follow-up care

We are already seeing the gradual adoption of electronic communication between patients and their providers for appointment scheduling, transmission of laboratory results and brief messages.<sup>29</sup> This can be expected to gain momentum as providers become more comfortable with this form of communication. For example, Partners Telemedicine in Boston have a Dermatology e-Visits programme, which allows routine follow-up care for acne patients using the patient's home computer and digital camera. This programme overcomes the long waiting times and travel commonly associated with this type of specialty care.

### Disease monitoring and screening

Patient-centred applications that allow greater patient participation from home and facilitate self-care practices are likely to coincide with the increasing availability of easy-to-use, point-of-care diagnostic tests. Diabetic patients in the future, for example, will probably perform not only glucose testing at home, but also risk assessment through haemoglobin A<sub>1c</sub> measurement and urine microalbumin screening – each of which may become part of accepted self-care practices. Electronic medical records will include the resulting data, which will be widely accessible to all members of the health team who are monitoring and providing care.

### Specialist consultations and second opinions

Today, telemedicine is used routinely in specialties such as radiology, pathology, dermatology and psychiatry. We can expect it to become the norm in other areas as well. Cancer patients, for instance, may routinely seek Internet-based second opinions as a way of ensuring that they are doing everything possible to battle their disease. Special populations who face unique obstacles to receiving care, such as prisoners or soldiers, can also expect to receive a greater proportion of their consultative (and monitoring) care via telemedicine in the future.

### Intensive and emergency care

The use of telemedicine and telemonitoring in the emergency and critical care of patients is proving not only to be feasible but also effective.<sup>35,36</sup> Patients at the end of life account for substantial health-care spending, and remote patients in need of emergency or intensive care face increased risks associated with transport. Telemedicine will play a larger role in these areas as the clinical and cost benefits become more evident to patients, providers and payers.

### Web-based health records including multimedia

When issues of patient privacy are solved, electronic medical records (EMRs) will not only have text and numbers but also other medically relevant data, including still images and videorecordings such as echocardiograms, endoscopies and patient interviews. This will allow specialists, local providers and students located at multiple sites to review archived studies,

**Table 1** Considerations for the future of telemedicine

Question	Issue	Mechanism
Why	Added value	Enable effectiveness, quality, cost-savings and accessibility
Who	Patients/consumers Providers Payers	Healthy, worried well, at-risk, and ill Physicians, nurses, carers and others Public and private
Where	Industrialized world Developing world	Patient/consumer's home and body Traditional health centres and referral hospitals
How	Human factors  Economics  Technology	Increased adoption among providers and patients/consumers Supportive policies, laws and social norms Third-party reimbursement (public and private) Entrance into consumer health-care market Small, increasingly passive, affordable, wearable Ubiquitous Internet and wireless connectivity
What	Clinical Non-clinical	Screening, diagnostic, monitoring, consulting applications Education and administration applications

visualize the course of a patient's disease and obtain a richer educational experience.

## Quality assurance and education

Quality assurance and education are intimately linked. Consider a tuberculosis (TB) screening programme in the developing world that allows experienced radiologists to review chest radiographs of suspected TB patients located at distant referral hospitals. This could redistribute expertise, not only for clinical care. It could also be used to assess the performance of local doctors in their ability to read radiographs, and provide them with a unique training opportunity.

## Conclusion

The growth and integration of ICTs into health-care delivery holds great potential for patients, providers and payers in health systems of the future. Some answers to the questions about the future of telemedicine are summarized in Table 1. Perhaps the most difficult question to answer, however, is 'When will telemedicine become part of the standard of care?' Only our actions now will determine the answer to this most difficult question. In the words of a pioneer and visionary in the field of computer science, Alan Kay, 'The best way to predict the future is to invent it.'

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