Approaches to Telemedicine

José Aurelio Medina-Garrido
Cadiz University, Spain

María José Crisóstomo-Acevedo
Jerez Hospital, Spain

INTRODUCTION

Information technologies have become essential for most businesses, including those in the healthcare industry (Chau & Hu, 2004; Rodger & Pendharkar, 2000). Information technologies can improve both the delivery of the healthcare service and certain aspects of healthcare centers' administration.

There has been a proliferation of *information systems applied to the health sector*, such as hospital information systems, medical decision-support systems, systems for interpreting medical tests and images, expert systems based on the handling of medical knowledge, or telemedicine (Rao, 2001).

Etymologically, the term *telemedicine* means medicine from a distance. This concept can include something as simple as two healthcare professionals debating the case of a patient by telephone, or as complex as conducting the diagnosis of a patient remotely using videoconference.

Telemedicine implies that there is an exchange of information, without personal contact, between two physicians or between a physician and a patient. Thanks to telecommunications technologies, telemedicine enables the provision of healthcare services or the exchange of healthcare information across geographic, temporal, social, and cultural barriers (Chau & Hu, 2004). Telemedicine makes use of a wide range of technologies to overcome distances, such as radio, analog landlines, e-mail, the Internet, ISDN, satellites,telesensors, and so forth, for the transmission of medical information, (data, voice, and video) and provision of medical services from a distance.

With regard to the *transmission of medical information*, this includes the digital handling of patient information (for example, from their *electronic medical records*), or the transfer of images (such as radiographs, high-resolution medical images, computer tomography scans, magnetic resonance imaging pictures, ultrasound images, electrocardiograms or echocardiograms, video images of endoscopic cameras, etc.) or sounds (for example, from electronic stethoscopes) (Rao, 2001).

With regard to the provision of remote medical services, specialist physicians can see their patients in consultation, conduct medical examinations, arrive at a diagnosis and prescribe treatment, all without needing to be in actual physical contact with them.

The essence of *telemedicine* is to move the medical knowledge and experience rather than move the patient physically. For this, telemedicine involves rather more than just taking medical services to where they did not exist before. It has also become a practice of transmitting and handling knowledge. It enables medical practitioners to exchange their knowledge (Robinson, Savage & Campbell, 2003) so that others can apply it in specific situations.

We should not confuse telemedicine with e-health (or tele-health). Telemedicine only refers to the provision of medical services. *E-health*, on the other hand, refers to both medical services and any other type of service, as long as it has something to do with health and employs information technology. In this respect, e-health would also include healthcare educational activities, research in the health sciences, the handling of electronic files in the healthcare system, and any other use of information technologies in the healthcare system.

The rest of this article is organized as follows. The second section discusses the antecedents of telemedicine, and proposes two taxonomies, one in function of the temporal synchronization of the individuals using it, and the other in function of the medical specialty for which it is employed. The third section tries to identify the obstacles in the way of an adequate acceptance and development of telemedicine. Before the conclusions section, section four suggests some future trends, including what technologies are most in use at present and which ones are promising for the future.

BACKGROUND

The concept of *telemedicine* does not actually require the use of information technologies. Indeed, it was common in the past to exchange medical opinions and prescribe treatments using mail, the radio, or even visual signals. People living in remote areas of Australia at the beginning of the 20th century used radio to communicate with the Royal Flying Doctor Service of Australia. At this time, physicians

on dry land also used the radio to communicate with ships suffering from medical emergencies (Wootton, 2001). Some African villages used smoke signals to warn outsiders not to approach the village during an epidemic. Similarly, ships used flags to warn that they were in quarantine (Darkins & Cary, 2000).

Nevertheless, modern IT has given new meaning to the practice of *telemedicine* (Bladwin, Clarke & Jones, 2002). The majority of projects have shown that technology enables the exchange of medical information both in urban and rural areas (Thames, 2003). The University of Nebraska was one of the pioneers, in 1959, when its scientists transmitted neurological examinations within the campus, and again in 1964, when it ran a telemedicine project with a distant mental hospital. NASA's activities in telemedicine are more familiar. In the 1960s the space agency used a satellite as part of a telemedicine project in the Appalachian and Rocky Mountain regions and Alaska. In the same decade, NASA monitored the pulse and blood pressure of the first astronauts remotely while they were in space (Rao, 2001). In the 1970s, telemedicine evolved further thanks to satellite technology, which, for example, enabled isolated villages in Alaska and Canada to be connected with distant hospitals (Rao, 2001).

A first taxonomy can differentiate between two types of practice in *telemedicine and* in function of the temporal synchronization of the users. In this respect, we can identify synchronous (or real-time) telemedicine and asynchronous telemedicine.

Synchronous telemedicine can range from a simple telephone conversation to a robot-assisted surgical operation. Videoconference is very often combined with devices for monitoring and diagnosing patients remotely.

Asynchronous telemedicine involves previously storing medical information and then transmitting it to the appropriate medical specialist. As we can see, the two parties need not coincide at the same time.

Telemedicine can also be classified in function of the specialties to which it is applied. In this respect, we might mention the following specialties (Tachakra, 2003):

- *Telenursing*. Nurses tend to use telemedicine in two ways. They can process patient data in a database in order to monitor patients undergoing medical treatment and refer them to the appropriate medical services. Another possibility is to monitor patients remotely, for example, in their own homes, using electronic medical devices, and interactive video applications. Nurses prompt the patients to take their medicine, blood pressure, temperature, and so forth.
- *Teleradiology*. This telemedicine specialty involves sending electronic radiology images such as X-rays, computerized axial tomography scans, or magnetic resonance images.
- *Telepathology*. This specialty involves transmitting high-resolution images of microscope slides, photographs of lesions or smears, and so forth.
- *Teledermatology*. This involves transmitting images of the skin using a dermascope.
- *Telecardiology*. Transmitting information relating to electrocardiograms, echocardiograms, angioplasty, and cardiac pacemaker monitoring.
- *Telesurgery*. The surgeon operates on the patient remotely using robotics and audio/video devices.
- *Video teleconferencing*. Videoconference allows physicians to attend to their patients, conduct diagnoses, and offer treatments remotely.

OBSTACLES TO THE ADOPTION AND USE OF *TELEMEDICINE*

There is no doubt that telemedicine offers considerable advantages to the population in general, and to certain patients in particular (the chronically ill, elderly, population of rural areas, etc.). Physicians can also gain by accessing digital information that can help them in their diagnoses and treatments, as well as allowing them to exchange opinions with expert colleagues. Nevertheless, the use of telemedicine is advancing only slowly, and healthcare professionals have shown some reluctance to embrace it (Audet, Doty, Peugh, Shamasdin, Zapert, & Schoenbaum, 2004; Parente, 2000; Sands, 2004; Wilson, 2005). This section analyzes the main factors that may explain this slow development and practitioners' resistance to accept these technologies.

The most important obstacles to the development of telemedicine are as follows (Adams, 2001; Kirsch, 2002; Lumpkin, 2000; Miller & Derse, 2002; Parente, 2000; Rao, 2001): the difficulty in making money from it; lack of technological infrastructure; lack of standardization; unequal access to the Internet; insufficient legislation; reprisals from traditional healthcare organizations; and cultural barriers.

It has been argued that telemedicine will offer important business opportunities (Parente, 2000). But the healthcare sector is having difficulties making money from it (Kirsch, 2002), due to: government intervention in financing and regulating the healthcare system; physicians' reluctance to pay for information services; the lack of incentives for healthcare professionals to improve their productivity and the quality of their work; and the fact that patients are often captives of public health systems with traditional procedures.

Another problem is the lack of the necessary technological infrastructure. The healthcare sector has been characteristically slower to adopt new information technologies than other service-sector industries (Parente, 2000). In general, the different healthcare centers are rarely interconnected digitally (Rao, 2001).