Chapter 10
Electrocardiographic Signal Processing Applications in Telemedicine

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ABSTRACT

The chapter focuses on telecardiology, as a significant example of telemedicine applications. Essential elements regarding the benefits and importance of telemedicine are presented first, followed by the introduction of specific telecardiology terminology, theoretical grounds, and existing practical applications. In the final part of the chapter new practical approaches are outlined, mainly related to modern signal processing tools such as wavelet analysis and neural networks.

INTRODUCTION

Following significant advances in microelectronics and communications technologies, novel solutions and improved versions of existing equipments dedicated to medical care, surveillance, and monitoring have been designed and evaluated. As a consequence, during the last decade many healthcare-oriented devices became available not only to medical centers but also to an increasingly number of private users. Justified by an increasing need for more accessible medical information, specialized publicly available databases were created. Those are typically used for research and educational purposes, and facilitate comparative analysis between various proposed technical solutions.

The World Health Organization defines telemedicine as *"the practice of healthcare using interactive audio, visual and data communications. This includes healthcare delivery, diagnosis, consultation and treatment as well as education and transfer of medical data"*. (WHO). According to this definition, disciplines that rely heavily

on imaging techniques are especially suited for telemedicine: radiology, surgery and orthopedics, pathology, dermatology, telecardiology, diabetology, neurology, oncology, otorhinolaryngology, ophthalmology, psychiatry, and many other specialties. The term *tele-health* is often associated with telemedicine. It is used to encompass a broader definition of remote healthcare that does not always involve clinical services. Components of telemedicine and tele-health include video-conferencing, transmission of images, remote monitoring of vital signals, continuing medical education and nursing call centers (ATA).

Products and services related to telemedicine act often as components of complex investment projects made by healthcare institutions in both information technology and clinical care delivery. Even in the reimbursement fee structure, there is usually no distinction made between services provided on site and those provided through telemedicine, and no separate coding is required for billing remote services (ATA).

TELEMEDICINE: HISTORY, ADVANTAGES, OBSTACLES AND APPLICATIONS

History of Telemedicine

The idea of performing medical examinations and evaluations using telecommunication networks is not new. Shortly after the invention of the telephone, attempts were made to transmit heart and lung sounds to a trained expert who could assess the state of the organs. However, poor transmission systems made the attempts a failure. We list below some of the historic landmarks across the evolution of telemedicine:

1906 - ECG Transmission: ECG transmission over telephone lines in 1906 made by the "father of electrocardiography", Einthoven

1920s - Help for ships: During this time, radios were used to link physicians standing at shore stations to assist ships at sea that had medical emergencies

1955 - Telepsychiatry: Nebraska Psychiatric Institute was one of the first facilities in USA to have closed-circuit television in 1955. In 1971 the Nebraska Medical Center was linked with the Omaha Veterans Administration Hospital and VA facilities in two other towns.

1967- Massachusetts General Hospital: This station was established in 1967 to provide occupational health services to airport employees and to deliver emergency care and medical attention to travelers

1970s - Satellite telemedicine via ATS-6 satellites: Paramedics in remote Alaskan and Canadian villages were linked with hospitals in distant towns or cities

An important role in the early development of telemedicine was played by the National Aeronautics and Space Administration (NASA). NASA's efforts in telemedicine began in the early 1960's when humans began flying in space. NASA has been a pioneer in telemedicine research and applications. Since the first days of suborbital flight, telemedicine has been transformed by the increasing complexity of space operations. NASA have started in telemedicine applications field by monitoring physiological parameters of astronauts sent into space (telemetry) and parameters of the cabin and external environments. These first efforts and the development of satellite communication led to the development of telemedicine as well as developing various equipment used in health care today.

Another universally recognized promoter of telemedicine is the U.S. Defense Department that is interested in new remote medicine developments, due of combat missions that are taking place mainly at distance from the national territory.

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