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Applications of Telecardiology

Cardiovascular diseases play a major role in general morbidity and disability, representing one of the major burdens to our healthcare system. Telemedicine can reduce the pressure on medical experts, who are limited in number, and extend their expertise to patients in isolated or remote locations. Telemedicine appears particularly promising in cardiovascular disease, because early, tailored interventions are extremely cost-effective in terms of life-saving and functional recovery.

Telecardiology has advantages for the individual patient in the interaction between primary and secondary care. In addition, general practitioners (GPs) gain educationally and hospital follow-up appointments may be reduced in number, because the GPs can handle more advanced medical problems.

Telecardiology has been widely used in the diagnosis of arrhythmias and for the management of patients with chronic cardiovascular conditions. It is important to note that in many cardiovascular conditions, such as acute coronary syndromes, the opportunity to offer prompt diagnosis and treatment will improve outcomes in terms of mortality and functional recovery.

Technology

In a telemedicine network there are three basic components: the Electronic Personal Record (EPR), digital devices and telecommunications. The main aim of the system is to collect specific and systemised patient data from different medical centres and to organise them in the best possible way in order to make the appropriate medical decisions. The information technology of the telecardiological system uses different solutions. An EPR could be built in an open source/free software; the most popular solution for internet applications is the threelayer client-server application; such a choice ensures that an EPR can be used by various medical centres cooperating with each other and implementing e-health applications. The telemedicine platform handles all the medical information and integrates it with the EPR, which collates all healthcare data in a dynamic way. The characteristics of the platform should be:

- Usability;
- Web based architecture;
- Direct access to information via browser;
- Access to information through cross-links;
- Flexibility;
- Dynamic dealing of medical/health data (easily customisable);
- Interoperability;
- Communication support, as the main standard communications systems, to external server to server and/or platforms of technology providers;
- Health information systems;
- Biological signals acquisition platforms;
- Adherence to standards;
- Semantic standardisation;
- Terminology and coding standardisation, e.g. ICD (ICD-9-CM), LOINC, SNOMED, UHID, AIFA;
- Syntactic standardisation, e.g. HL7,(CDA, Clinical Document Architecture), DICOM; and
- Modularity and extensibility

The type of connection will affect the speed of transmission and the quality of the videoconference. Standard telephone lines (PSTN) or the patient's mobile phone are enough for the transmission of a one-lead electrocardiography (ECG). Digital lines (ISDN) may be required to transmit signals from more complex devices (e.g. multi-lead ECG or video). Digital subscriber lines (e.g. ADSL) for high-speed Internet connections can be used for every type of video, signal and images in cardiology.

Telecardiology Applications

1. Pre-Hospital

Telecardiology can be used to support the treatment of acute coronary syndrome by emergency medical services. Studies have shown the feasibility of obtaining a 12-lead ECG during the pre-hospital period. Diagnostic quality ECGs can be successfully transmitted for approximately 85 percent of patients with chest pain who are eligible for 12-lead ECGs. Pre-hospital 12-lead ECG transfer improves pre-hospital diagnostic accuracy for patients with a final hospital diagnosis of AMI, angina or non-ischaemic chest pain.

The guidelines of the American Heart Association for cardiopulmonary resuscitation and emergency cardiovascular care recommend the use of out-of-hospital 12-lead ECG diagnosis in urban and suburban paramedic systems.

2. In-Hospital

In-hospital telecardiology is used between small hospitals in rural regions and main hospitals. Telemedicine has the potential to improve access to echocardiography diagnoses in the intensive care unit, emergency room and newborn nursery. In some centres, urgent echocardiography is performed during the weekend, evening and overnight to assess ventricular function, ischaemia, pericardial effusion, valvular disease and heart donor status. Several studies have reported close to 100 percent diagnostic agreement when live telemedicine interpretations were compared with videotape interpretations, and the mean time from the echo-images recording to reporting was significantly shorter than the traditional method. Live transmission of neonatal echocardiograms by paediatricians led to an immediate change in management of patients including transport to the main clinic if necessary. More recently, videoconferencing for the transmission of echocardiography data has been also proven useful for the assessment of children with suspected cardiac diseases.

3. Post-Hospital

I. Teleconsulting Between GPs and Specialists

General practitioners deal with increasing numbers of patients with cardiac disease, who have often been discharged early from the hospital and whom the GP must manage by themselves. In this case, second opinion consultation may be helpful. Telemedicine has mainly been applied in the diagnosis of arrhythmias, or used directly by GPs as an alternative to ambulatory visits for patients with chronic conditions or systemic hypertension. The advantages include early diagnosis and tailored therapeutic interventions, home management of conditions, availability of specialist teleconsultation out of the hospital, and improvement in the appropriateness of hospital admissions and referrals to the emergency department.

II. Home Telenursing for Chronic Cardiac Diseases

Chronic cardiac diseases such as chronic heart failure benefit from a multidisciplinary approach that can reduce hospitalisation and improve the patient's quality of life, while lowering costs for the national health service. Home telenursing is an integrated approach that involves the patient, the family, the GP and specialised cardiac centres. Real-time transmission of objective data (physiological data and biological signals) in association with personal data given by the patient is a new approach to the problem. Telemonitoring allows the follow up of patients for long periods. Indeed, telemonitoring and teleassistance through nurse, specialists and GPs can constitute a disease management programme. There is some evidence that multi-disciplinary management and home-based intervention can reduce readmission rates and length of hospital stay in chronic cardiac patients. However, many studies have involved few patients, often they were not randomised, and also used different types of telemonitoring in combination with the multidisciplinary management of chronic heart failure, making it difficult to determine to what extent beneficial outcomes were due to telemonitoring.

Different results have been reported for mortality, but in no study was this the primary endpoint. Very few studies have assessed the cost-benefits of telemonitoring but implementation of such a programme was found to decrease annual medical costs compared with the previous year in some cases.

III. Diagnosis for Arrhythmias, Monitoring of Pacemakers and Implantations of Cardioverter Defibrillators (ICDs)

Palpitation is a common symptom that sometimes results from a substantial cardiac arrhythmia. Establishing the cause of palpitations may be difficult because historical clues are not always accurate. A 24-hour Holter monitor is usually used, but the yield of this instrument is low in patients whose symptoms occur infrequently. Another instrument used to study palpitations is a transtelephonic event recorder.

Transtelephonic pacemaker monitoring is accurate and reliable and reveals a significant quantity of unpredictable abnormalities, such as failure to sense and capture tachyarrhythmias that necessitate a change of pacemaker mode. As a result of recent trials on prevention of sudden cardiac death, the rate of ICD implementation is increasing, in particular with the advent of biventricular ICDs for patients with heart failure. Remote ICD interrogation allows frequent, convenient, safe and comprehensive monitoring. Device- and patient-related problems were reliably detected and reduced the frequency of outpatient visits. Patients are satisfied with the convenience and easy use of the system.

Other Applications

In paediatric patients with suspected cardiac disease, a telephonic stethoscope can accurately distinguish between functional and organic murmurs and can be used in remote areas where paediatric cardiologists are not present. Moreover, control magnetic resonance (MR) imaging in complex cardiovascular procedures was developed from a remote location and advanced processing of diagnostic images in stereographic display of CT and MR data were performed by an Italian group from Pisa.

Conclusions

Despite the diversity of models and the lack of systematic research, successful telecardiology programmes exist. One barrier to more widespread implementation is that there are many different software, hardware and telecommunications options, but none are designed specifically for cardiology. Thus each component may function well in isolation, but integrating the components is more difficult, e.g. a call centre may receive ECGs from different devices sent via different telecommunication modalities. Reimbursement for telecardiology consultation is also limited and may discourage many physicians from participating.

Telecardiology is one of the fastest-growing fields in telemedicine. There is already a significant quantity of published clinical data, with some randomised multi-centre trials to answer the most important questions in definitive way. The contribution of telecardiology in some fields such as emergency and chronic care undoubtedly improves the quality of healthcare and helps contain rising costs. Telecardiology has yet to reach maturity, but the evidence to date indicates that it has made a good start.

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