

► Nine years' experience of telecardiology in primary care

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Summary

The ITMS telecardiology network started in April 1995. Over nine years, about 7000 peripheral medical users (mainly general practitioners), who were experienced in using transtelephonic electrocardiography and who were spread throughout Italy, conducted teleconsultations with the Telecardiology Centre. A total of 106,942 patients were evaluated. Teleconsultation was carried out for non-cardiac symptoms or routine control for 30,444 patients (28%) and for symptoms suggestive of heart disease for 76,498 (72%). After teleconsultation, 61,908 patients (58%) were reported to have no heart disease, 27,947 patients (26%) had their drug dose adjusted and remained at home, 11,503 patients (11%) were sent to their cardiologist for further investigations and 5584 patients (5%) were urgently hospitalized. Among the hospitalized patients, the echocardiogram demonstrated an ST-elevation coronary syndrome in 1785 patients (32%), a non-ST-elevation coronary syndrome in 2236 (40%) and a life-threatening arrhythmia in 1354 (24%). Telecardiology improves the decision making of general practitioners, avoids unnecessary hospitalizations, reduces the time before treatment in cardiac emergencies, rationalizes health-care costs and promotes home care.

Introduction

Cardiovascular diseases represent the leading cause of mortality and morbidity in Italy, as in most Western countries¹. On suspicion of an acute cardiac event, it is important to make the correct diagnosis as quickly as possible, so that the appropriate treatment can be instituted. Thus both physicians and the public resort to hospital emergency departments in the case of suspected cardiac events. However, this practice is likely to lead to the referral of many people who have no cardiac disease, and thus to increase both the numbers of unnecessary admissions and health costs²⁻⁷. On the other hand, the misinterpretation of acute cardiac events is potentially fatal⁸.

Telemedicine offers new methods of managing patients with suspected or known cardiac problems; it allows direct access to consultant specialists and thus results in faster diagnosis and better management.

Previous studies have shown that telecardiology can be useful in managing specific cardiac disorders⁹⁻¹¹, supports the decision making of general practitioners (GPs) for patients with heart disease¹²⁻¹⁵ and reduces the number of unnecessary hospitalizations without decreasing the rate of appropriate admissions of patients who have experienced life-threatening cardiac events¹⁶.

The present paper summarizes nine years' experience at the ITMS Telecardiology Centre in primary cardiac care.

The telecardiology network

The ITMS telecardiology network started in April 1995 and its activity has increased year by year. In December 2003, there were about 7000 peripheral medical users (mainly GPs, but also some emergency rescue squads and small community outpatient clinics), who were experienced in the use of transtelephonic electrocardiography (TT ECG) and who were practising in urban, rural or remote areas throughout Italy (Fig 1). Users are equipped with a hand-held 12-lead TT ECG device (Cardiette Microtel, H&C Medical Devices, Italy, or Heart View P12/8, Aerotel, Israel) for recording and

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Fig 1 Locations of the 6857 telecardiology users in Italy: 38% were on the Italian mainland, 29% on Sardinia and 33% on Sicily.

transmitting the electrocardiograms (ECGs) over the ordinary telephone network. In the first few years (1995–7) 9-lead devices were also used (CG 9000, Card Guard, Israel).

The Telecardiology Centre is located in Genoa and is equipped with a local-area network operating at 100 Mbit/s in a client–server configuration (20 clients and 1 server). External telecommunication uses 30 ISDN lines so that 30 ECGs can be received simultaneously. Two cardiologists and four technicians are on duty 24 h per day.

Work-flow

After clinical examination at the patient's home or the GP's surgery, the user records an ECG. The patient's symptoms and the clinical history are briefly discussed with the Telecardiology Centre. The pre-recorded ECG is then transmitted to the Centre (Fig 2). After receiving the cardiologist's recommendations, the peripheral medical user decides the best option to take, by consensus. A full report, including a print-out of the ECG, is subsequently sent to the user.

Reasons for calling

Teleconsultation is carried out for non-cardiac symptoms or routine control, and for symptoms suggestive of a cardiac event. The following symptoms are considered to be suggestive of a cardiac event:

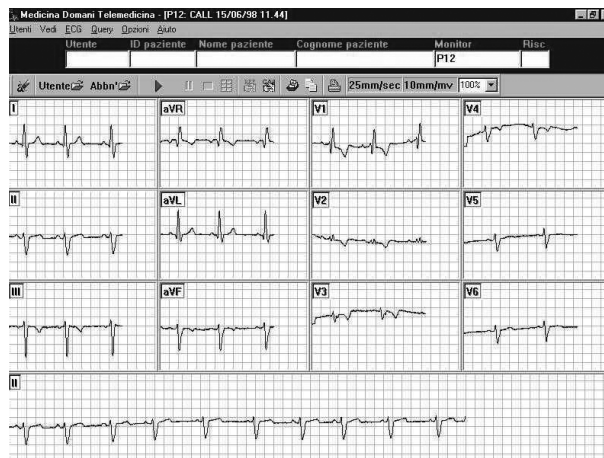


Fig 2 Screenshot from a telecardiology workstation. The ECG of a remote patient is displayed in realtime during a teleconsultation.

- (1) atypical chest pain—defined according to the Coronary Artery Surgery Study¹⁷ as an intermittent or persisting transfixing pain, not enhanced by exertion or emotions, located in the left hemithorax, epigastrium, back and arms, without substernal pain;
- (2) typical chest pain—substernal constrictive pain with or without radiation to the shoulders or to the left arm, precipitated by exertion or emotions, and relieved by rest or nitroglycerin;
- (3) palpitations;
- (4) dizziness or syncope;
- (5) dyspnoea at rest.

Diagnostic rules

To avoid the possibility of acute myocardial infarction being missed because the ECG is non-diagnostic, patients with typical chest pain, a normal ECG and a low probability (less than 10%) of acute myocardial infarction, and patients with atypical chest pain, a normal ECG and a moderate to high probability (more than 10%) of acute myocardial infarction are re-examined 1, 3 and 12 h later. Patients with typical chest pain, a normal ECG and a moderate to high probability of acute myocardial infarction are promptly hospitalized. The appropriateness of the diagnosis is checked by the Telecardiology Centre's customer's service, which calls users monthly.

Methods

For each patient, demographic data, symptoms and their time of onset, TT ECG trace and referral, medical diagnosis and action taken were recorded and

automatically stored in the database of the ITMS telecardiology network (MS SQL server). All patient data for the period April 1995 to December 2003 (the first nine years of operation) were extracted from the database using dedicated SQL queries and exported into spreadsheet files (Excel, Microsoft).

Results

Telecardiology activity

A total of 6857 medical users had held teleconsultations with the Telecardiology Centre. Towards the end of the study period there was an average of 2450 users per year. Of all the users, 5472 were GPs, which represents approximately 10% of all GPs practising in Italy. During the nine-year study period, the Telecardiology Centre performed 138,773 teleconsultations with ECG referral. ECG acquisition or transmission had to be repeated in about 12,000 teleconsultations (9%) because the trace first transmitted was of insufficient quality. Poor trace quality was generally due to the patient's anxiety while the TT ECG was recorded, a low-quality (mobile phone) telephone line being used for transmission or incorrect positioning of the electrodes.

A total of 106,942 patients were evaluated by the Telecardiology Centre for heart disease. There were 56,162 females and 50,780 males; their mean age was 62 years (SD 21). The difference between the number of calls and patients was due to repeated teleconsultations for patients with suspect cardiac events but non-diagnostic ECGs or to subsequent tests of patients already evaluated.

Teleconsultation was carried out for non-cardiac symptoms or routine control for 30,444 patients (28%) and for symptoms suggestive of heart disease for 76,498 (72%). The reasons for calling the Telecardiology Centre are summarized in Fig 3 for all 106,942 patients.

After teleconsultation, 61,908 patients (58%) were found to have no heart disease and to require reassurance only; all these patients had a normal ECG pattern and had a low probability of developing an acute coronary syndrome. Nevertheless, 156 patients in this group were subsequently hospitalized for arrhythmia (112) or coronary syndrome (44).

Of the other 45,034 patients, 39,450 (37% of the total) had an abnormal ECG but did not require hospitalization and 5584 patients (5%) were urgently hospitalized. Among the former, 27,947 patients (26% of the total) remained at home and had their drug dosage adjusted, and 11,503 patients (11%) were sent to their cardiologist for further investigations. The

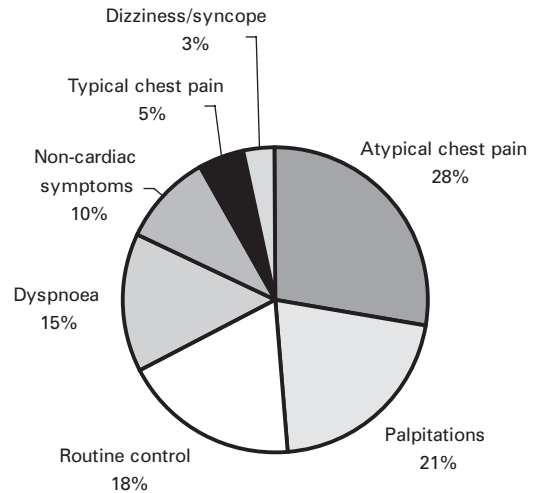


Fig 3 Reasons for calling the Telecardiology Centre for the 106,942 patients.

symptoms and outcomes of patients with an abnormal ECG are listed in Table 1.

Cardiac emergencies

Among the 5584 hospitalized patients, the ECG demonstrated an ST-elevation coronary syndrome in 1785 (32%), a non-ST-elevation coronary syndrome in 2236 (40%) and a life-threatening arrhythmia in 1354 (24%). The other 219 patients (4%) who were hospitalized had presented symptoms suggestive of coronary syndrome either with new onset of left bundle branch block (115) or with a normal ECG but an otherwise high risk of coronary artery disease (104). Table 2 shows the diagnosis made by the Telecardiology Centre for all 5584 patients who were admitted as emergency cases.

In 113 cases (2%), the cardiac emergency was not confirmed and the patient was discharged. A total of 44 patients who presented with a cardiac emergency died before they could reach an emergency department or coronary care unit: 27 with ST-elevation coronary syndrome, 12 with non ST-elevation coronary syndrome, and 5 with significant arrhythmia. The overall mortality in this group was therefore 0.8%. Data on the in-hospital mortality of these patients were not available.

Discussion

Patients with suspected cardiac symptoms usually present to their GPs for clinical evaluation^{11,16}. Unfortunately, the only useful diagnostic tool to assess the presence of a cardiac event is the ECG¹⁸, and so

Table 1 Outcomes of the 45,034 patients presenting with abnormal ECGs

Symptoms	Total no. of patients	No. of patients referred for:		
		Home care	Further investigation	Hospitalization
Routine control	1,331	839	492	—
Non-cardiac symptoms	5,520	3,254	2,095	171
Dizziness/syncope	3,051	1,213	1,107	731
Dyspnoea	9,313	6,101	2,185	1,027
Palpitations	11,522	8,605	2,275	642
Typical chest pain ^a	3,814	772	838	2,204
Atypical chest pain	10,483	7,163	2,511	809
<i>Total</i>	<i>45,034</i>	<i>27,947</i>	<i>11,503</i>	<i>5,584</i>

^aIncludes the 104 patients with typical chest pain, a high risk of coronary disease but a normal ECG.

Table 2 Diagnoses made by the Telecardiology Centre for the 5584 hospitalized patients

Diagnosis	Number of patients	Proportion (%)
<i>Coronary syndromes</i>	<i>4240</i>	<i>76</i>
ST-elevation coronary syndrome	1785	32
Non-ST-elevation coronary syndrome	2236	40
Coronary syndrome with left bundle branch block	115	2
Coronary syndrome with normal ECG	104	2
<i>Significant arrhythmias</i>	<i>1354</i>	<i>24</i>
Atrial flutter	174	3
Atrial fibrillation with high ventricular rate	482	9
Paroxysmal atrial fibrillation	374	7
Supraventricular tachycardia	196	4
Ventricular tachycardia	55	1
Ventricular fibrillation	2	—
High-degree atrio-ventricular block	71	1

symptoms are often interpreted incorrectly^{16,19}. Telecardiology provides a method of online consultation and ECG interpretation between GPs and cardiologists, without the need to move the patient. Compared with usual care, it seems to be a useful way to provide more effective treatment for primary care patients with cardiac symptoms, and to improve the quality, efficiency and cost-effectiveness of health-care^{11,16}.

Considering both the large number of GPs who referred patients to the Telecardiology Centre over the nine-year study period and the multitude of evaluated patients, we can affirm that GPs judge telecardiology to be a very useful tool for primary cardiac care. One of the main findings was the high percentage (58%) of patients for whom heart disease was excluded. In accordance with previous reports, our data underline the role of telecardiology in avoiding unnecessary hospitalizations.

A cardiac emergency was detected in 5% of patients for whom a teleconsultation was performed. Since several patients did not present symptoms or a clinical history suggestive of a cardiac emergency,

telecardiology was of primary importance in improving GPs' identification of cardiac emergencies. Furthermore, since the diagnosis was made out of hospital, many of these patients were sent directly to a coronary care unit. Thus we can reasonably assume that telecardiology reduced the time to treatment in cardiac emergencies.

Patients presenting minor ECG changes or symptoms suggestive of chronic heart disease were treated at home by their GPs (26%) or were sent for further investigation by a cardiologist (11%). Therefore patients with chronic heart disease can benefit from telecardiology that allows for monitoring of heart function in their own homes and avoids the discomfort of hospitalization. Moreover, this method increases GPs' expertise in cardiovascular disease and involves GPs in the management of their own patients. Finally, as it effectively screens patients for cardiological investigations, telecardiology reduces health-care expenditure.

Limitations

The present study has some limitations owing to the heterogeneity of physicians using telecardiology and the large cohort of patients referred to the Telecardiology Centre. About 80% of telecardiology users were GPs while the remaining 20% were physicians operating in emergency rescue squads or in small community outpatient clinics. The interventions of the latter were restricted to suspected emergencies, so they had incomplete knowledge of the patient's outcome. As a consequence, the number of both false positives and false negatives could be underestimated and therefore the diagnostic accuracy of the Telecardiology Centre cannot be precisely assessed.

A cost-effectiveness analysis comparing telecardiology with usual care was not performed because there were no official data about Italian expenditure for patients who underwent a routine cardiac examination (with or without previous heart disease). However, we have previously shown that telecardiology is a

cost-saving tool in the evaluation of patients with a suspect acute cardiac event¹⁶.

Conclusion

The longer survival of patients with coronary heart disease coupled with the ageing of the population will result in a growing number of patients who are at high risk from cardiac events²⁰, and will lead to a higher prevalence of chronic heart conditions. Thus, it is likely that patients will present to their GPs for cardiac evaluation in increasing numbers. The present report on a large cohort of patients suggests that telecardiology improves the decision making of GPs, avoids unnecessary hospitalizations, reduces the time before treatment in cardiac emergencies, rationalizes health-care costs and promotes home care.

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