

# Tele-Medicine for Cardiovascular Emergencies: Ready for the Prime Time?

Natale Daniele Brunetti<sup>1\*</sup>, Daniele Amoruso<sup>2</sup>, Luisa De Gennaro<sup>1</sup>, Giulia Dellegrottaglie<sup>3</sup>, Giuseppe Di Giuseppe<sup>3</sup>, Gianfranco Antonelli<sup>4</sup> and Matteo Di Biase<sup>5</sup>

<sup>1</sup>Post-graduate in Cardiology, PhD, Cardiology Department, University of Foggia, Italy

<sup>2</sup>Post-graduate in Radiology, U.O. Cardiologia, Azienda Ospedaliera Policlinico, Bari, Italy

<sup>3</sup>Cardio on Line Europe S.R.L., Bari, Italy

<sup>4</sup>Post-graduate in Cardiology, Cardiology Department, Azienda Ospedaliera Policlinico, Bari, Italy

<sup>5</sup>Post-graduate in Cardiology, Cardiology Department, University of Foggia, Italy

## Abstract

According to the Wikipedia definition, "Tele-Medicine [(TM)] is the use of telecommunication and information technologies in order to provide clinical health care at a distance. It helps eliminate distance barriers and can improve access to medical services that would often not be consistently available in distant rural communities. It is also used to save lives in critical care and emergency situations". TM may therefore be extremely useful in reducing time of treatment, especially when time is paramount, such as in cardiovascular emergencies.

Pre-hospital Electrocardiograms (ECGs) may be useful in improving timeliness of treatments in acute cardiovascular disease, and TM may play a primary role in allowing any patient with a suspected cardiovascular emergency to be examined with pre-hospital ECG by a cardiologist, wherever the patient is, either in rural or urban areas. In the field of TM applied to cardiovascular emergencies managed by an Emergency Medical Service (EMS) in a large region-wide area, the focus is on Apulia, a region in South-Eastern Italy (19,358 km<sup>2</sup>, population 4,091,259). The region is currently served by a TM *hub* from where cardiologists report back, 24/7, on pre-hospital ECGs transmitted by telephone (mobile or other). Evidence is provided showing the clinical utility of pre-hospital TM ECG in improving the quality of medical assistance in cardiovascular emergencies.

The Apulia TM network provides an interesting demonstration of TM potential in health-care management, combining high-quality medical assistance with optimal spending of public resources.

**Keywords:** Tele-Medicine; Cardiology; Emergency medical service

According to the Wikipedia definition, "tele-medicine (TM) is the use of telecommunication and information technologies in order to provide clinical health care at a distance. It helps eliminate distance barriers and can improve access to medical services that would often not be consistently available in distant rural communities. It is also used to save lives in critical care and emergency situations" [1]. So TM may prove extremely useful in overcoming the problem of distance in emergency situations and then reducing delay to treatment when time is paramount, and time is paramount especially in cardiovascular emergencies.

There is evidence that, when treating patients with Acute Myocardial Infarction (AMI), the time from the onset of symptoms to reperfusion is crucial for salvaging myocardium; in other words, "time is muscle". Shorter time-to-reperfusion is associated with smaller infarct size and micro-vascular damage and larger salvaged myocardium [2]. Fast reperfusion may also reduce both in-hospital rates of adverse events after AMI [3], and during the following 12 months [4]. A shorter symptom-to-balloon time is associated with an improved coronary flow, an increased likelihood of subsequent left ventricular systolic ejection fraction > 40 %, and greater 3-year survival [5]. The higher the risk profile, the larger the reduction in mortality benefits from fast reperfusion [6].

However, of 4278 patients transferred for primary angioplasty (PCI) in the United States, only 4-10% of patients were treated within 90 minutes, the benchmark recommended by national quality guidelines [7,8].

Several strategies are currently suggested for achieving better adherence to international guidelines on management of AMI and

timely myocardial reperfusion. In the Vienna registry, an example of a good hospital network with prompt PCI or fibrinolysis availability, a marked increase in the proportion of patients receiving PCI, and a reduction in the proportion receiving no reperfusion therapy, was achieved [9].

Pre-hospital electrocardiograms (ECG) may be useful in decreasing delay to treatment in patients with AMI [10-14]. International guidelines, consensus and scientific statements [15] recommend that emergency medical services (EMS) acquire and use pre-hospital ECGs, and many communities are thus implementing pre-hospital ECG programs.

TM may play a starring role in allowing all patients with suspected cardiovascular emergencies to be examined with pre-hospital ECG by a cardiologist, wherever those patients are, either in rural or urban areas.

In the field of TM applied to cardiovascular emergencies and EMS in large region-wide areas, the focus is on Apulia, a region in

**\*Corresponding author:** Natale Daniele Brunetti, MD, post-graduate in Cardiology, PhD, Cardiology Department, University of Foggia, Viale Pinto 1, 71100 Foggia, Italy, Tel: +393389112358; Fax: +390881745424; E-mail: [nd.brunetti@unifg.it](mailto:nd.brunetti@unifg.it)

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South-Eastern Italy (19,358 km<sup>2</sup>, population 4,091,259). The region is currently served by a TM *hub* from where cardiologists, available 24/7, report back on ECGs recorded on a small pocket device, the CardioVox P12™ (Aerotel, Holon, Israel), and transmitted by telephone (mobile or other). The device may record a complete 12-lead ECG in a couple of minutes; after telephone coupling, the ECG is sent to the TM *hub*, which is located in Puglia's capital city, Bari. Here, a cardiologist may read the ECG on a computer screen and report back on the findings; when necessary, a brief consultation may also occur between the on-site sender – a physician, paramedics or others – and the cardiologist. Remote senders may receive back the ECG report on their smart-phone or iPad, or on a PC via an internet or telephone connection. The ECGs may be easily stored and printed as required. The TM service has been in operation since 2004 and is available for the “118” regional public EMS, the local “911”, and hundreds of private customers (patients, pharmacies, general practitioners, specialists in occupational medicine, nursing homes).

In June 2012 the 500,000<sup>th</sup> ECG will be analysed by the service, which is a particularly interesting example of synergy between public health authorities and private enterprise. The regional 118 service is run by the regional government while the tele-cardiology service is provided by Cardio-on-line Europe s.r.l., a private company.

The tele-cardiology service in Apulia combines two principal models of TM delivery for cardiology emergencies: the Boston model, with few TM providers, small areas and paramedic-based ECG analysis, and the Los Angeles model, with a larger area but a large number of TM providers and a computer-algorithm-based ECG report [16]. The Apulia model provides not only qualified, remote, on-site assistance from a cardiologist, as is required by Italian law for ECG analysis, but also cost reduction: a single TM *hub* may potentially support even more than one region with several million inhabitants.

Several studies have shown that TM support can improve the quality of medical assistance and reduce cardiovascular mortality. Transmission of a pre-hospital 12-lead ECG directly to the attending cardiologist's mobile telephone decreased door-to-PCI time by >1 hour when patients were transported directly to PCI centres, bypassing local hospitals.

At a local level, in Apulia, over 233,657 pre-hospital ECGs in subjects with suspected acute heart disease screened using pre-hospital ECG through TM support, 45% were abnormal; of these ECGs, 18% showed signs suggestive of Acute Coronary Syndrome (ACS), 20% were indicative of arrhythmia, and minor problems emerged in 62% of cases [17]. In cases of suspected ACS, ECG findings were normal in 77% of patients; 74% of subjects with suspected ACS were screened within 30' from the onset of symptoms.

In another study, ECG showed signs of ST-elevation in only 3.84% of patients with acute chest pain, while only 78.94% of patients with STEMI reported acute chest pain. The diagnosis was therefore based mainly on ECG findings with TM pre-hospital ECGs despite the presence of atypical clinical presentation [18]. About two thirds of patients with STEMI were resident in small towns without coronary care units, and thus particularly benefitted from an immediate pre-hospital diagnosis.

TM pre-hospital ECG screening could significantly help in avoiding errors and delay in STEMI diagnosis in elderly patients [19]. Among STEMI patients older than 70 years, atypical presentation was detected in 32% of patients (vs. 11%). Number needed to diagnose a STEMI with atypical clinical presentation was 3 among subjects older than 70 years.

TM support may also improve the sensitivity of diagnosis of atrial fibrillation with atypical presentation in elderly patients [20], up to 4-to-7 fold.

So tele-cardiology is now well established in Apulia. Several studies of primary and secondary prevention, also with the support of pharmacies, are currently under way. In the CAPITAL (Cardiovascular Prevention with Telecardiology in Apulia) study, 10 thousand subjects are currently involved in a project aimed at estimating cardiovascular risk and charting cardiovascular risk in a Mediterranean context [21].

Screening studies for early ECG diagnosis of cardiovascular disease among primary and high school students and professional athletes are currently in the advanced planning phase. Further initiatives will probably be useful in the future in reducing waiting lists for ECG examinations in public regional hospitals.

The Apulia TM network thus provides an interesting demonstration of TM potential in health care management, combining high-quality medical assistance with optimal spending of public resources. Tele-cardiology is ready for the prime time in cardiovascular emergencies.

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