

Transtelephonic electrocardiography for managing out-of-hospital chest pain emergencies

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Abstract

Background: Some healthcare facilities lack professionals qualified to interpret electrocardiograms. We aimed to assess the usefulness of transtelephonic electrocardiography in combination with patients' clinical histories in the diagnosis and management of patients with acute chest pain in out-of-hospital healthcare facilities with personnel without expertise in cardiology or electrocardiography.

Methods: Data from 506 consecutive patients (53.9 ± 16.2 years old) referred from 55 healthcare facilities without professionals specialized in cardiology or electrocardiography form the basis of analysis. Patients were classified into 2 groups according to the results of transtelephonic electrocardiography: (A) patients without electrocardiographic abnormalities ($n = 445$) and (B) patients who presented abnormalities suggesting a cardiac origin ($n = 61$) of the chest pain. The presence of risk factors was evaluated by multivariate analysis.

Results: The following risk factors were independent predictors of electrocardiographic abnormalities: male gender ($P = .006$), diabetes mellitus ($P = .0001$), and dyslipidemia ($P = .001$). The multivariate analysis yielded a high degree of specificity (99.6%). Follow-up visits confirmed the noncardiac origin of pain in 432 patients (97%) in group A and the cardiac origin of pain in 59 patients (97%) in group B.

Conclusions: Transtelephonic electrocardiography combined with awareness of the risk factors of patients presenting with chest pain is useful for the diagnostic management of these patients in health care facilities without the means to interpret electrocardiograms.

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Keywords:

Electrocardiology; Chest pain; Diagnosis

Introduction

The correct interpretation of electrocardiograms (ECGs) in patients presenting at the emergency department with chest pain is of the utmost importance. Most emergency facilities are staffed with healthcare professionals with the knowledge and experience to correctly interpret an ECG; and patients with chest pain are evaluated in accordance with guidelines including medical history, physical examination, ECG, and biochemical cardiac marker measurements.^{1,2} However, 1% to 4% of patients with a completely normal ECG result have a final diagnosis of acute myocardial infarction (AMI).

Furthermore, AMI occurs in 4% of patients with nonspecific ECG abnormalities.³ Health emergencies can occur far from hospitals; and staff at many healthcare facilities, like private clinics, rural clinics, company medical departments, penitentiaries, and geriatric centers, are not qualified to interpret ECGs. Furthermore, it is not always possible to follow other recommended guidelines for chest pain (eg, facilities may be unable to perform blood tests). Thus, an acute coronary syndrome (ACS) might go undiagnosed. Several authors have suggested transtelephonic ECG to improve the out-of-hospital diagnosis of patients with chest pain.^{3–8} Furthermore, Adams et al⁸ studied wireless ECG transmission to the cardiologist on call in the United States.

Event recorders that monitor different numbers of ECG leads or a complete 12-lead ECG have proven useful.^{5–16}

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Transtelephonic ECG involves the direct transmission of a prerecorded conventional ECG, which is converted to an audio signal, transmitted by telephone, and then demodulated to a standard ECG recorder on a computer.

We aimed to assess the usefulness of transtelephonic electrocardiography in combination with simple anamnesis in the diagnosis and management of patients with acute chest pain in out-of-hospital healthcare facilities with personnel without expertise in cardiology or electrocardiography.

Material and methods

Protocol

The protocol included 55 out-of-hospital emergency areas equipped with the Cardiotest 4DM event monitor (Cardiplus International, Seville, Spain) (Fig. 1). The device allows a conventional ECG to be recorded and transmitted over any kind of telephone connection. It can store up to 4 minutes of cardiac rhythm recordings. It uses two 1.5-V AA batteries and has a low-battery indicator. It can be connected to a computer via serial or infrared communication ports and runs Windows-compatible software licensed by Microsoft (Redmond, WA). The device is registered and approved by the European Union. Transtelephonic ECGs were sent to a center (Fig. 2) where cardiologists evaluate and report an average of 1000 ECGs daily.

From March 1, 2003, to March 1, 2007, we prospectively studied all consecutive patients with chest pain seen in these emergency areas in whom transtelephonic ECG was performed either during the pain episode or immediately after (<1 hour after the onset of symptoms). Patients were classified by cardiologists into 2 groups on the basis of ECG results: those without ECG abnormalities (normal ECG result, group A) and those with ECG abnormalities suggestive of ischemia, lesion, necrosis, or pericarditis (abnormal ECG result, group B). In addition, cardiologists at the ECG interpreting center used a predefined data collection form to record patients' clinical data (age, gender, arterial hypertension, diabetes mellitus, dyslipemia, tobacco use, and previous history of ischemic heart disease)

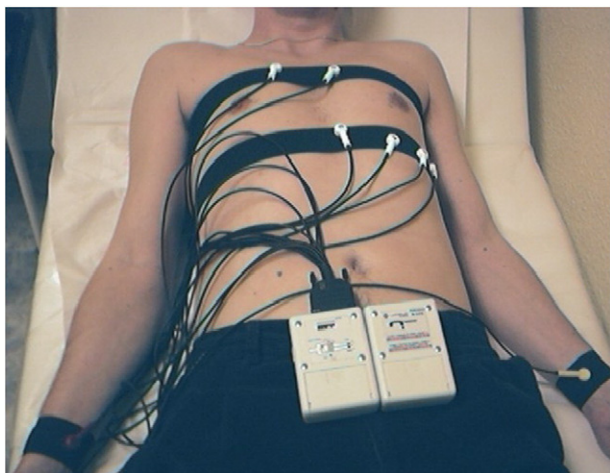


Fig. 1. Cardiotest 4DM event monitor.

collected at the attending emergency facility and entered those clinical data and the ECG interpretation in a database for further analysis.

After evaluating the ECG findings, the ECG evaluating center (Fig. 2) sent a binding report to the emergency (recording) area. Patients classified in group A underwent elective follow-up ECG 7 to 10 days later; recordings were sent to the evaluating center to evaluate possible changes and confirm the diagnosis or recommend further study at a hospital. Patients in group B group were referred immediately to hospital for thorough study and therapy. Fig. 3 summarizes the study protocol. At discharge, we recorded the test results, final diagnosis, and treatment of all patients referred to the hospital (Fig. 3).

Patients with atrial fibrillation, signs of systolic left ventricular overload, or bundle-branch block at transtelephonic ECG and those administered digoxin or amiodarone were excluded from the study.

Definitions

Electrocardiographic alterations were defined in accordance with established guidelines.^{1,2,17} *Ischemia* was defined as a symmetrical negative T wave. A *lesion* was defined as elevation or depression of the ST segment greater than or equal to 0.1 mV in frontal leads or greater than or equal to 0.2 mV in precordial leads. *Necrosis* was defined as a Q wave observed in the ECG. Alterations were considered only when they appeared in at least 2 contiguous ECG leads. A diffuse concave-upward ST-segment elevation occurring in more than 2 regions was considered suggestive of pericarditis.

Statistical analysis

Using a predefined data collection form, cardiologists at the ECG interpreting center recorded the pertinent data and entered them in a database. Qualitative variables were summarized as absolute or relative frequencies. Continuous variables were summarized as means ($\pm$ SD) or medians (interquartile interval) depending on the distribution of the variable according to the Kolmogorov-Smirnov test. To compare groups, we used the χ^2 test or Fisher exact test for qualitative variables and the Student *t* test or Mann-Whitney *U* test for quantitative variables, as appropriate. To reduce possible errors in ECG results, we used a stepwise logistic regression model with the ECG result as the dependent variable and gender, previous diagnosis of arterial hypertension, dyslipemia, tobacco use, previous history of ischemic heart disease, and diabetes mellitus as independent variables. A *P* value < .05 was considered significant. We used SPSS version 14.0 (SPSS, Chicago, IL) for all statistical analyses.

Results

The Cardiotest 4DM event monitor was used to evaluate 578 consecutive patients with chest pain. Of these, 72 patients were excluded from the study for the following reasons: chronic systolic left ventricular overload (*n* = 30), atrial fibrillation treated with digitalis (*n* = 20), bundle-branch block (*n* = 10), and amiodarone administration (*n* = 12). Thus,

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