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Pre-hospital prediction of death or cardiovascular complications during hospitalisation and death within one year in suspected acute coronary syndrome patients

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ABSTRACT

Objectives: To identify pre-hospital predictors of a) death or the development of cardiovascular complications during hospitalisation (primary objective) and b) all-cause death during one year of follow-up (secondary objective), in chest pain patients with suspected acute coronary syndrome (ACS).
Methods: A prospective study that comprised patients in western Sweden, who were transported to hospital by the emergency medical service (EMS) due to chest pain and suspected ACS. Multiple logistic regression was used to identify independent predictors of adverse outcomes.
Results: Among all 1600 eligible patients, 21% died or had a cardiovascular complication during hospitalisation and 10% died during one year of follow-up. Nine factors were identified pre-hospitalisation as independent predictors of death or cardiovascular complications during hospitalisation. They were increasing age, a history of congestive heart failure, nausea and/or vomiting, rapid breathing rate, low oxygen saturation, high heart rate, together with ST-segment elevation, ST-segment depression and right bundle branch block on the pre-hospital electrocardiogram (ECG). For the secondary objective of death during one year of follow-up, the following five factors were identified as independent predictors: increasing age, a history of congestive heart failure, dyspnea, low oxygen saturation and left bundle branch block on the pre-hospital ECG.
Conclusions: In the pre-hospital setting of chest pain and suspected ACS, we identified nine predictors of the primary adverse outcome. They were factors representing previous history, symptoms and ECG findings. This information may contribute to the development of a decision support system for the EMS, which then needs to be clinically tested.

1. Introduction

Among non-trauma patients who call for emergency medical service (EMS), a large proportion have chest pain [1,2]. This is a symptom that may represent a variety of underlying diseases, such as acute myocardial infarction (AMI), angina pectoris, pleuropneumonia, gastroesophageal reflux disorders or musculoskeletal pain [3,4]. Ischemic heart disease is an example of a feared diagnosis behind this symptom. It requires an urgent response by the EMS [5].

After having investigated a chest pain patient, the EMS team needs to make a decision in order to determine the degree of seriousness and urgency. Clinical findings before any medical intervention in the pre-hospital phase include factors that could help the EMS team to predict the outcomes [6]. Immediate action, an appropriate decision by the EMS crew and relevant treatment in the pre-hospital phase may relate to both the short-term and long-term outcomes in subsets of patients with chest pain [7].

The aim of this study was to identify pre-hospital predictors of, firstly, death or the development of cardiovascular complications during hospitalisation and, secondly, death from all causes during one year of follow-up, in chest pain patients with suspected acute coronary syndrome (ACS).

2. Materials and methods

This is a prospective cohort study, which involved data from an interventional trial performed by the EMS in western Sweden. The study was registered in the www.clinicaltrials.gov Protocol Registration System with registration number 151: 2008/4564 [8].

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2.1. Endpoints

In order to describe the full clinical picture of these patients, death or cardiovascular complications during hospitalisation were analysed as the primary endpoint and death from all causes during one year of follow-up as the secondary endpoint. The cardiovascular complications were defined as complications requiring treatment according to the responsible physician and included: congestive heart failure (CHF), hypotension, supraventricular tachyarrhythmias, ventricular tachyarrythmias and atrioventricular block. Date of death or confirmation of survival was obtained from the Swedish National Population Registry.

2.2. EMS structure, training and logistics

The EMS in this study consists of 15 ambulance stations staffed by some 500 nurses, 60 vehicles and one EMS boat and it serves 1.6 million inhabitants in an area of 79,000 km^2 in western Sweden. The staff of each ambulance includes a nurse, who has been educated in pre-hospital emergency cardiac care and has been delegated to give various medications in the pre-hospital setting. In Sweden, health care, including the use of the EMS, is available to every citizen without requiring any insurance. For ambulance transport, the patient has to pay a fee of approximately USD 30.

The majority of EMS nurses participating in the study were trained in recognising ST-segment elevation on an electrocardiogram (ECG). However, in all participating EMS organisations, it was routine procedure to send the ECG to the receiving hospital for interpretation and possible direct admission to the coronary care unit or catheterisation laboratory (if available). In this study, the ECGs were sent to hospital for interpretation in 85% of all the patients.

2.3. Hospitals and catchment area

There are 11 hospitals in the catchment area, of which five had facilities for percutaneous coronary intervention (PCI). However, only one had facilities for emergency PCI at all hours of the week. As a result, in-hospital treatment in terms of early mechanical revascularisation varied, depending on where in the region the patient lived [9]. In overall terms, in Sweden, about half of all hospitalised patients with AMI receive treatment with PCI.

2.4. Patients and data collection

From 1 March 2008 to 31 December 2010, all the patients who were transported to hospital by the EMS due to chest pain and suspected ACS were evaluated. The inclusion criteria were pain or discomfort (feeling of weight, dyspnea) in the chest, with an intensity of at least 4 on a colour analogue scale, graded from 0 to 10, where 0 means no pain at all and 10 the worst imaginable pain, on EMS arrival. When the patient did not understand the scale, he/she could be included if the pain or discomfort was described as being of at least medium severity, with a simultaneous clinical suspicion of ACS [10]. Exclusion criteria were age < 18 years, secondary transportation from a clinic (if pain treatment had been commenced), trauma, alcohol influence, drug abuse, dementia, disorientation and communication difficulties.

In eligible patients, a 12-lead standard ECG was recorded just after EMS arrival and was later transmitted to the research centre. Symptoms, such as paleness and/or cold sweat, nausea and/or vomiting, anxiety and dyspnea, were recorded by actively confirming or denying their presence and clinical findings, such as rate of breathing, pulmonary rales, oxygen saturation, heart rate and systolic blood pressure, as well as pain score, were recorded within the first 10 min after EMS arrival, together with the time of pain onset. The final diagnosis, the presence of cardiovascular complications, previous medical history and smoking habits were retrospectively recorded from the database of the healthcare system by specially trained monitoring nurses. In our study, the final diagnosis of AMI was based on the assessment of the responsible hospital physician. It was recommended that an AMI diagnosis was based on a dynamic serial elevation of troponin T, troponin I or CK-MB, plus at least one further criterion (e.g. typical chest pain or ECG signs of acute myocardial ischemia) [11].

ST elevation was regarded as the manifestation of acute myocardial ischemia in the absence of left bundle branch block (LBBB), right bundle branch block (RBBB) and pacemaker rhythm. ST-segment elevation was measured at the J point in two contiguous leads, with the cut-off points for ischemia of ≥1 mm (0.1 mV) in all leads other than leads V_2–÷V_3, where the cut-off points of ≥2 mm (0.2 mV) in men aged ≥ 40 years, ≥2.5 mm (0.25 mV) in men aged <40 years and ≥1.5 mm (0.15 mV) in women apply. In cases of ST depression, the manifestation of acute myocardial ischemia was a down-sloping ST segment with a J-point depression of ≥0.5 mm (0.05 mV) in at least two contiguous leads. "Contiguous leads" refer to anterior leads (V_1–÷V_6), inferior leads (II, III, aVF) or lateral/apical leads (I, aVL) [11]. All ECGs were interpreted by the same physician.

2.5. Statistical analysis

For the patients with multiple admissions, only the first one was included in the present study.

For both the primary and the secondary outcomes, the following analyses were performed: all the factors in Tables 1, 2 and 3 were compared using logistic regression and, except for age itself, all odds ratios and p-values were age-adjusted. To identify independent predictors, a forward stepwise method, using multiple logistic regression, was used, where all factors with a p-value below 0.20 in Tables 1–÷3 were tested for inclusion and $p < 0.01$ was required to stay in the model.

All tests are two-sided and a p-value below 0.01 was regarded as statistically significant. SAS 9.3 for Windows 7 was used for all the analyses.

Approval for this study was given by the Research Ethics Committee at Gothenburg University, Guldhedsgatan 5A, SE-413 20 Gothenburg, Sweden.

3. Results

A total of 1826 admissions were included in the original interventional study. When multiple visits were excluded, 1677 unique patients remained and of these 77 were excluded due to lack of information regarding the primary endpoint. As a result, 1600 patients were included in the present study.

Among these eligible patients, 339 (21%) had an adverse outcome of death (31 patients) or at least one cardiovascular complication during hospitalisation (191 CHF, 68 hypotension, 33 atrioventricular block, 93 supraventricular tachyarrhythmia and 25 ventricular tachyarrhythmia). Ten per cent died during the first year after hospital admission. A final diagnosis of AMI was given to 27% of the patients.

3.1. Age-adjusted comparisons

3.1.1. Baseline characteristics and previous history (Table 1)

Increasing age and a history of CHF were associated with both the primary endpoint of death or a cardiovascular complication during hospitalisation and the secondary endpoint of death during the first year after hospital admission. In addition, the latter was associated with a history of chronic obstructive pulmonary disease, a history of diabetes and current smoking.

3.1.2. Symptoms and signs on EMS arrival (Table 2)

Paleness and/or cold sweat, dyspnea, rapid breathing rate, low oxygen saturation, high heart rate and were associated with both the primary and secondary endpoints. The former was also associated with systolic blood pressure.