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Electrocardiographic indicators of acute coronary syndrome are more common in patients with ambulance transport compared to those who self-transport to the emergency department journal of electrocardiology

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Abstract

Introduction: The American Heart Association recommends individuals with symptoms suggestive of acute coronary syndrome (ACS) activate the Emergency Medical Services' (EMS) 911 system for ambulance transport to the emergency department (ED), which enables treatment to begin prior to hospital arrival. Despite this recommendation, the majority of patients with symptoms suspicious of ACS continue to self-transport to the ED. The IMMEDIATE AIM study was a prospective study that enrolled individuals who presented to the ED with ischemic symptoms.

Objectives: The purpose of this secondary analysis was to determine differences in patients presenting the ED for possible ACS who arrive by ambulance versus self-transport on: 1) time-to-initial hospital electrocardiogram (ECG), 2) presence of ischemic ECG changes, and 3) patient characteristics.

Methods: Initial 12-lead ECGs acquired upon patient arrival to the ED were evaluated for ST-elevation, ST-depression, and T-wave inversion.

ECG signs of ischemia were analyzed both individually and collapsed into an independent dichotomous variable (ED ECG ischemia yes/no) for statistical analysis. Patient characteristics tested included: gender, age, race, ethnicity, English speaking, living alone, mode of transport, and presenting symptoms (chest pain, jaw pain, shortness of breath, nausea/vomiting, syncope, and clinical history).

Results: In 1299 patients (mean age 63.9, 46.7% male), 384 (29.6%) patients arrived by ambulance to the ED. The mean time-to-initial ECG was 47 minutes for ambulance patients versus 53 minutes for self-transport patients ($p < 0.001$). Mode of transport was found to be an independent predictor for time-to-initial ECG controlling for age, gender, and race ($p = 0.004$). There were significantly higher rates of ECG changes of ischemia for patients who arrived by ambulance versus self-transport ($p = 0.02$), and patient characteristics differed by mode of transport to the ED.

Discussion: Our findings indicate that less than 30% of individuals with symptoms of ACS activate the EMS '911' system for ambulance transport to the ED. Individuals more likely to activate 911 have timelier ECG but higher rates of ischemic changes, specifically ST-depression and T-wave inversion. Individuals least likely to activate 911 are women, younger individuals, Latino ethnicity, live with a significant other, and those experiencing chest or jaw pain.

Keywords: Electrocardiography; Emergency department; Emergency medical system; Acute coronary syndrome; Disparities

Introduction

Over 8 million individuals with chest pain and/or an anginal equivalent present to emergency departments (EDs) each year, with over 780,000 experiencing an acute coronary syndrome (ACS) [1]. Cardiovascular complaints are the second most common cause for adults to visit the ED and account for 10% of all ED visits. The American College of Cardiology/American Heart Association (ACC/AHA) recommends all persons experiencing ischemic symptoms activate 911 immediately for ambulance transport to the ED [1]. This mode of transport enables patient care to start as soon as emergency medical service (EMS) providers reach the scene of a potential acute coronary event, allowing for the

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early initiation of triage, risk stratification, and treatment [2]. Mode of transportation to the hospital is an important consideration for treatment delays because rapid triage and detection of myocardial ischemia/infarction are essential to reducing total ischemic burden and salving vulnerable myocardium [3]. Studies consistently demonstrate that delays in time-to-reperfusion are correlated with increased morbidity and mortality [4,5]. Efforts to reduce door-to-reperfusion times have been applied to ACS benchmarks; however it is increasingly clear that the prehospital period significantly influences patient outcomes [6]. Consequently, there has been a recent focus on time spent before hospital arrival with an emphasis on patients most vulnerable to treatment delay [6].

ACC/AHA guidelines recommend patients with symptoms suggestive of ACS receive an initial 12-lead electrocardiogram (ECG) with interpretation within 10 minutes of being evaluated by a health care provider (Class I, Level of Evidence C) [7]. The standard 12-lead ECG remains the gold standard for diagnosis of ACS and is the most widely used screening test for evaluating patients with chest pain and/or anginal equivalent symptoms. Guidelines have been extended to the prehospital setting and include acquisition of a prehospital electrocardiogram (PH ECG) for any patient activating 911 with chest pain, shortness of breath, diaphoresis, and/or other anginal equivalent symptoms [8]. Electrocardiographic signs of ischemia (ST-elevation, ST-depression, or T-wave inversion) may drive early treatment decisions such as activation of the cardiac catheterization laboratory by EMS providers or ED clinicians [2,4,8,9]. The importance of this is emphasized in cardiovascular systems of care that integrate tele-electrocardiography notification systems [8].

Despite ongoing recommendations for patients experiencing chest pain to activate 911 for ambulance transport to the ED, the majority continue to self-transport to the hospital [10,11]. Prior studies about patients with ST-elevation myocardial infarction (STEMI) report those who self-transport have longer treatment times compared to those transported by ambulance [12]. Less is known about the association of mode of transport for other types of ACS conditions (unstable angina and non-ST-elevation myocardial infarction [NSTE-ACS]) that comprise the majority of ACS diagnoses [1]. The purpose of this study was to identify clinical correlates by modes of transport (self-transport versus ambulance transport) to the ED for patients with symptoms suspicious of any ACS condition. We aimed to identify differences by mode of transport in: 1) patient characteristics, including symptom onset to ED arrival times and outcomes, 2) time-to-initial hospital ECG, and 3) ECG changes of ischemia.

Materials and methods

A secondary analysis of data was performed using data from the Ischemia Monitoring and Mapping in the Emergency Department in Appropriate Triage and Evaluation of Acute Ischemic Myocardium (IMMEDIATE AIM) study [RO1HL69753, PI: Drew] [13]. The primary aim of the IMMEDIATE AIM study was to examine sensitivity and specificity of estimated body surface potential mapping (EBSPM) for improved ECG diagnosis of ACS in the ED. Specifically, 12-lead ST-segment monitoring, using a Mason–Likar lead configuration, was compared with an EBSPM, where "optimal" electrode sites were used to create the EBSPM [14]. All patients who presented to the ED from 7 am to 7 pm, Monday through Friday, at the University of California San Francisco Medical Center with suspected myocardial ischemia or infarction were invited to participate. Symptoms suggestive of ACS included chest pain, shortness of breath, diaphoresis, or other anginal equivalents.

A standard 12-lead ECG was performed on arrival to the ED per standard of care, and 24-hour Holter recording was initiated (H-12 recorder, Mortara Instrument, Milwaukee, WI) for the research protocol. Research nurses trained in electrocardiography applied the electrodes and two Holter monitors for continuous ST-segment monitoring and body surface potential recordings for the first 24-hours of patient hospitalization. Patients with ventricular pacemaker rhythm or left bundle branch block were excluded due to difficulty in assessing ST-segment deviation in these patients. Members of the research team performed episodic checks on patients receiving monitoring to ensure intact electrode placement and continuous Holter monitoring. Research nurses abstracted patient data by interview and medical records. Mode of transport was defined as self-transport (i.e. walk-in, private car, public transport, taxi transport) versus ambulance. The Institutional Review Board at the University of California, San Francisco approved the study.

Holter data were downloaded to a computer for off-line analysis using H-Scribe software (Mortara Instrument, Milwakee, WI). While the H-Scribe software performs an automatic analysis, all of the Holter data were manually over-read by an experienced cardiologist (KEF). A second investigator (JZH) performed episodic data checks on approximately 10% of patient data. The initial ECG acquired by Holter monitoring was analyzed for; (a) ST elevation, (b) ST depression, (c) T-wave inversion, or (d) nonspecific ST-T wave abnormalities (slight ST elevation, depression, or T-wave inversion). Next, the initial ECG was classified as (a) ST elevation acute MI/injury, (b) non-ST elevation ischemia/MI, (3) no ischemia/MI, or (4) unclear. Universal criteria for the diagnosis of ACS were applied to determine changes of ischemia/infarction [7]. These revised criteria consider age, sex, and lead differences to enhance sensitivity and specificity of the ECG [7]. Time to ECG was determined by ED arrival time to initial hospital 12-lead ECG acquisition.

Statistical analysis

All data analyses were performed with SPSS software version 23.0 and an alpha of .05 or less was considered to be significant. Descriptive statistics were used to report demographic and clinical information. An independent samples t-test was conducted to compare patients' ages by mode of transport and time-to-ECG; median times from symptom onset to ED arrival and peak troponin levels were compared by Mann–Whitney U tests. Multiple regression analysis was used to evaluate independent predictors of