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Attitudes regarding Emergency Medical Services use in patients with Acute Coronary Syndrome: the EPIHeart cohort

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Abbreviations

ACS - Acute Coronary Syndrome
BLS - Basic Life Support
BMI - Body Mass Index
CHD - Coronary Heart Disease
CI - Confidence Interval
CODU - Centro de Orientação de Doentes Urgentes
CVD - Cardiovascular Disease
ECG - Electrocardiogram
EMS - Emergency Medical Services
ESRI - Environmental Systems Research Institute
IMES - Integrated Medical Emergency System
INEM - Instituto Nacional de Emergência Médica
IQR – Interquartile Range
MI - Myocardial Infarction
NER - Northeast Region
NHS - National Health System
NSTEACS - Non-ST segment elevation acute coronary syndrome
NSTEMI - Non-ST segment elevation myocardial infarction
OR - Odds Ratio
PCI - Percutaneous Coronary Disease
PHEM - Prehospital Emergency Medicine
STEMI - ST segment elevation myocardial infarction
TF – Tissue Factor
t-PA - type plasminogen activator
USA - United States of America
VMER - Viatura Médica de Emergência e Reanimação
WHO - World Health Organization

Resumo

Introdução: O reconhecimento rápido dos sintomas e a ativação atempada dos serviços de emergência pré-hospitalar são cruciais para a redução da morbilidade e mortalidade nos doentes com Síndrome Coronário Agudo (SCA). A ativação dos veículos de emergência diminui o tempo entre o início dos sintomas e o tratamento e aumenta a taxa de sobrevivência nestes doentes. No entanto, em todo mundo, verifica-se uma diminuta ativação destes veículos por parte dos doentes com SCA. Em Portugal, um estudo baseado na iniciativa *Stent for Life* encontrou que apenas um terço dos doentes com SCA ativava os veículos de emergência.

Objetivos: Este estudo tem como objetivos caracterizar geograficamente a disponibilidade destes veículos de emergência e descrever a prevalência do seu uso por doentes com SCA assim como os seus fatores preditores.

Métodos: Este estudo foi feito com base na coorte EPIHeart. Para esta coorte foram recrutados doentes admitidos com diagnóstico de SCA no Hospital de São João, no Porto, e no Hospital São Pedro, em Vila Real, entre agosto de 2013 e dezembro de 2014.

Resultados: Do total dos doentes, 40,4% dos doentes foram transportados por veículos de emergência para o hospital. Ter entre 5 e 9 anos de escolaridade (OR 0,61; IC 95% 0,39 – 0,97), estar empregado (OR 0,66; IC 95% 0,44 – 0,99) e viver no nordeste do país (OR 0,58; IC 95% 0,41 – 0,81) são fatores associados à não utilização dos veículos de emergência. Pelo contrário, ter uma dor mais intensa (OR 1,61; IC 95% 1,17 – 2,22), identificar corretamente os sintomas como cardíacos (OR 1,43; IC 95% 1,04 – 1,98), ter doença cardiovascular prévia (OR 1,47; IC 95% 1,03 – 2,10), ter diagnóstico de STEMI (OR 1,44; IC 95% 1,04 – 2,00) e ter uma classe de Killip III-IV (OR 3,56; IC 95% 1,80 – 7,17) são fatores associados à utilização dos veículos de emergência. Não foi encontrada associação com a idade, sexo, distância ao veículo de emergência mais próximo ou com o facto de o início dos sintomas ser ao fim-de-semana ou à noite.

Conclusão: Estes resultados poderão contribuir para o desenvolvimento e implementação de programa educacionais que visem alertar a população para a existência de sintomas típicos e atípicos no SCA e para os benefícios inerentes à ativação dos veículos de emergência, pensando sempre no envolvimento dos profissionais de saúde neste processo de capacitação.

Palavras-chave: Emergência Pré-hospitalar; Síndrome Coronário Agudo; Educação para a Saúde

Abstract

Introduction: Prompt recognition of symptoms and timely engagement of prehospital emergency medicine is crucial to reduce morbidity and mortality related with acute coronary syndrome (ACS). The activation of Emergency Medical Services (EMS) decreases delay to treatment and increases survival rates. The underuse of EMS among patients with ACS has been reported in several studies across the world. In Portugal, a study based on the Stent for Life initiative found that only one-third of the patients activated EMS.

Aims: To characterize the geographical availability of EMS in two different regions in the north of Portugal and to describe the prevalence of EMS use and its predictors in patients with ACS.

Methods: The present study includes patients with ACS from EPIHeart cohort study. Patients admitted to Hospital de São João in Porto and Hospital de São Pedro in Vila Real (north-east region) of Portugal between August 2013 and December 2014 with confirmed diagnosis of ACS were invited to participate.

Results: EMS transportation to a healthcare providing institution was used by 40.4% of patients. We found that having between 5 to 9 years of education (OR 0.61, 95% CI 0.39 - 0.97), being employed (OR 0.66, 95% CI 0.44 - 0.99) and living in NER (OR 0.58, 95% CI 0.41 - 0.81) were independently associated with less frequent use of EMS. The increased use of EMS was independently associated with higher pain intensity (OR 1.61, 95% IC 1.17 - 2.22), correct recognition of the symptoms as cardiac (OR 1.43, 95% IC 1.04 - 1.98), CVD history (OR 1.47, 95% IC 1.03 - 2.10), STEMI diagnosis (OR 1.44, 95% IC 1.04 - 2.00) and higher Killip classes (OR 3.56, 95% IC 1.80 - 7.17). We did not find an association between age, sex, distance to the nearest EMS or symptom onset at weekend or night and an increased EMS use.

Conclusion: These results should contribute to the development and implementation of a successful education programme to increase population awareness and knowledge about typical and atypical ACS symptoms and the benefits of activating the emergency services, involving health professionals in this empowerment process.

Keywords: Emergency Medicine System; Acute Coronary Syndrome; Health Education

Introduction

1. Acute Coronary Syndrome

1.1. Definition and Epidemiology

Cardiovascular diseases (CVDs) are a group of diseases caused by problems in the heart or blood vessels and include coronary heart disease (CHD), cerebrovascular disease, hypertension and other conditions. Acute coronary syndrome (ACS) is a symptomatic CHD, usually presented as acute myocardial infarction (MI) although it can also be presented as unstable angina[1,2].

According to the World Health Organization (WHO), CVDs are the main cause of death across the globe. Estimates from 2016 revealed that every year 17.9 million people in the world died from CVDs, 4 million of which in Europe[3]. It represents 31% of all deaths in the world and 45% of all deaths in Europe[3]. The vast majority of these deaths (84.9%) were due to MI and stroke[4]. In Portugal, in 2015, CVDs were responsible for 29.7% of all deaths[5]. Pereira et al. observed a significant decrease in CVD mortality rate from 1980 to 2010, a trend also observed in other developed countries such as Japan and North America[6]. This decrease is probably due to the strategic measures that have been implemented regarding diagnosis and treatment of acute myocardial infarction and stroke, the two major cause of death from CVD[5]. In contrast with mortality rates, the prevalence of this disease has been increasing, since there was a significant improvement in the care provided to these patients[6].

1.2. Pathophysiology and Risk Factors

Atherosclerosis is responsible for more than one-third of ACS and is a complex pathological process that develops in the walls of blood vessels. In the presence of risk factors, the endothelium becomes dysfunctional and is no longer capable of its antiatherogenic function[7]. Thus, circulating cholesterol can easily penetrate in vessel walls and its accumulation plays an important role in atherosclerosis. Macrophages are responsible for removing cholesterol from vessel walls and when they do, they become foam cells. However, when they are not capable, cholesterol is released to the vessel wall inducing inflammatory substances such as tissue factor (TF) that increase the probability of rupture[7]. Unstable plaques are prone to rupture which may cause vessel occlusion due to thrombosis, triggering an acute ischemic event - an ACS[8]. The presence of atherosclerotic plaques alone is probably not enough for the occurrence of ACS. Circulating TF is responsible for high blood thrombogenicity, either via direct action or via expression on vascular smooth muscle and endothelial cells that are themselves stimulated by C-reactive protein or oxygen free radicals, adopting a prothrombotic phenotype[7]. It is also possible that a plaque rupture does not end in

an occlusive thrombus, therefore not causing an ACS[9]. Therefore, when a thrombus occludes an artery, it is crucial to act fast in order to reduce the amount of cardiac muscle that dies over that time.

Risk factors for ACS are usually divided into modifiable and non-modifiable factors according to the potential of being changed by interventions. Examples of non-modifiable factors are age, sex and family history. Genetic factors can also contribute to the risk of CHD. Genetic influence is most likely due to the combination of small effects from several alleles than due to a single large allele effect[10]. It is well known that the incidence of ACS increases with age and is higher in men, although at a later age it is similar in both sexes[1,11]. The risk of ACS is increased in first-degree relatives, especially in younger ages: a cardiac event before the age of 65 in a female relative or 55 in a male relative increases the risk significantly[12]. Type II diabetes, obesity, an unhealthy diet, sedentary lifestyle, cigarette smoking and hypertension are some of the modifiable factors. Some of these are part of the metabolic syndrome that is known to increase patients' risk of developing heart disease[13]. According to a large international study, these factors combined with alcohol consumption and low physical activity account for more than 90% of the risk of acute MI[14]. These factors can be addressed by lifestyle modifications and/or treatment.

1.3. Diagnosis and Management

There are three clinical forms of ACS with similar presentation, distinguished according to a 12 lead electrocardiogram (ECG) and a measurement of cardiac enzymes: patients with ST segment elevation myocardial infarction (STEMI), patients with non-ST segment elevation myocardial infarction (NSTEMI) and patients with unstable angina[15,16]. Patients with NSTEMI have an elevation of the cardiac enzymes which is not seen in patients with unstable angina[17]. The term non-ST segment elevation acute coronary syndrome (NSTEACS) is used to describe NSTEMI and unstable angina[16]. Unstable angina represents a myocardial injury that occurs with minimum physical effort or at rest. Before developing unstable angina, the patient may have had some episodes of chest pain that lasted for less than five minutes, which represent a reversible mismatch between myocardial demand and supply caused by exercise or stress[18].

The classical presentation of ACS consists in a tightening retrosternal pain that can radiate to the left or both arms. However, one third of patients do not present the classical signs and symptoms[19,20]. They can present with pain on lower jaw, back or stomach area, diaphoresis, nausea, vomiting, dizziness or dyspnea.

The importance of distinguishing these entities lies on the differences in treatment. Patients who present at a healthcare institution with persistent ST-segment elevation should

be referred to reperfusion therapy to restore the flow in occluded arteries as soon as possible. Percutaneous Coronary Intervention (PCI) is the preferred treatment strategy, usually followed by stent implantation[21]. When patient present within 12 hours after initial symptoms, PCI should be done. After 12 hours the benefits of PCI are controversial. Nonetheless, coronary angiography should be considered if there is evidence of continuing myocardial ischemia[22,23]. After the first medical contact, PCI should be performed within 90 minutes and fibrinolysis should be considered when PCI cannot be done within 120 minutes[23]. Figure 1 presents time targets that should be accomplished to decrease mortality and morbidity of these patients.

Intervals	Time targets
Maximum time from FMC to ECG and diagnosis[a]	≤10 min
Maximum expected delay from STEMI diagnosis to primary PCI (wire crossing) to choose primary PCI strategy over fibrinolysis (if this target time cannot be met, consider fibrinolysis)	≤120 min
Maximum time from STEMI diagnosis to wire crossing in patients presenting at primary PCI hospitals	≤60 min
Maximum time from STEMI diagnosis to wire crossing in transferred patients	≤90 min
Maximum time from STEMI diagnosis to bolus or infusion start of fibrinolysis in patients unable to meet primary PCI target times	≤10 min
Time delay from start of fibrinolysis to evaluation of its efficacy (success or failure)	60–90 min
Time delay from start of fibrinolysis to angiography (if fibrinolysis is successful)	2–24 hours

Figure 1: Time targets in the treatment of ACS patients[23]

For those presenting without ST-segment elevation, reperfusion therapy is not recommended as first-line but anti-ischemic therapy should still be initiated[17]. After that, risk of cardiovascular adverse events should be assessed to predict 6-month mortality[24]. The decision to use a more invasive treatment depends on patients' risk criteria. Any patients with at least one intermediate risk criteria, which represents a predicted 6-month mortality above 3.0%, should perform a coronary angiography within 96 hours of hospital admission[24].

2. Prehospital emergency Medicine

According to the 2017 European Guidelines, the management of ACS starts when the patient has the first contact with a healthcare professional able to initiate treatment[23]. Prompt recognition of symptoms and timely engagement of prehospital emergency medicine (PHEM) is crucial to reduce morbidity and mortality related with MI since it reduces the time to definitive treatment[25]**.** Delay in treatment is inversely associated to myocardial salvage and survival rates[26,27]**.**

Two studies, one in Glasgow and other in Middle East, revealed that the majority of patients with ACS died before the arrival to the hospital[28,29]. According to the American Heart Association, nearly two-thirds of the patients who use self-transport and suffer cardiac arrest die before reaching the hospital[30].

In Portugal, PHEM activation is managed by the *Centro de Orientação de Doentes Urgentes* (CODU), which is part of the *Instituto Nacional de Emergência Médica* (INEM) responsible for answering health emergency calls in Portugal from the European emergency number - 112. In 2017, 1.4 million emergency calls were made[31]. All the emergency calls related to health emergencies are transferred to CODU. This entity is responsible to select and to send emergency vehicles toward patients, to support the emergency teams on the ground and to alert the health institution which will receive the patient. INEM is the entity in Portugal responsible for managing an integrated medical emergency system (IMES) to guarantee that every patient gets the help they need in the appropriate time frame. An efficient articulation between all members of IMES (fire departments, police, hospitals and primary care centers, Red Cross delegations and INEM) is one of the most important roles of INEM.

CODU has several vehicles available to respond to help requests and is responsible for coordinating their activation - ambulances, *Viatura Médica de Emergência e Reanimação* (VMER), emergency motorcycles and helicopters. These are selected according to the clinical situation and their proximity to the patient, usually but not always from the same municipality. The EMS that are coordinated by CODU are located all over Portugal and some of them are located in fire departments or in Red Cross delegations. The former is manned by two firemen with the Rescue Ambulance Crew certification. There are two types of INEM ambulances: those with two Emergency Ambulance Technicians on board able to perform basic life support (BLS) and to use an automated external defibrillator; and the immediate life support ambulances with a nurse and a technician on board who can administer drugs and perform invasive therapeutic acts under medical supervision. These vehicles are located in health units. Additionally, INEM has VMER which take a physician and a nurse to perform advanced

life support. In Portugal there are four CODU centers: Porto, Lisbon, Coimbra and Faro. CODU Porto is responsible for coordinating emergencies in the north of Portugal.

During prehospital care, treatment can be started. INEM vehicles are equipped to perform a 12-leads ECG, to supply oxygen if pulse oximetry is below 90%, to administer medication for pain and to give fibrinolytic therapy as aspirin, tissue type plasminogen activator (t-PA) or heparin[32]. All the INEM vehicles are also equipped with telemetry, which allows health professionals to send the ECG directly to the PCI center[33]. However, fire department ambulances and Red Cross ambulances are only equipped with oxygen, heart rate and blood pressure monitoring and are able to perform BLS. When they arrive to the hospital, patients transported by EMS have priority in the emergency department since the receiving hospital is already warned of the patient's arrival[34].

The underuse of Emergency Medical Services (EMS) among patients with ACS has been reported in several studies across the world. EMS use varies between 40% and 60% in Europe [35,36], between 26% and 60% in the United States of America[27,37,38] and is lower in the Middle East and Asia (4.5% to 21.6%)[29,39,40]. In Australia this is 49.4%[15]. In Portugal, a study based on the Stent for Life initiative found that only one-third of the patients activated EMS[33].

2.1. Coronary Fast-track System

The overcrowdedness of emergency departments, which is a public health problem in many higher-income countries, often complicates the timely access of urgent cases to the necessary care. In order to ensure timely access to healthcare, fast-track systems were created for specific conditions. In Portugal, the fast-track system for patients with coronary disease was created in 2007[41]. This system aimed to achieve an ACS diagnosis in the shorter time frame and to identify patients with STEMI who have indication for PCI. This includes fast and assisted transportation to the hospital[21].

According to the INEM, in 2018, 731 patients with MI were referred to Portuguese healthcare institutions through the Coronary Fast-track[42]. In 71.7% of cases two hours or less have elapsed between the identification of signs and symptoms and the referral of patients to this fast-track system[42]. In the United States of America (USA), the median time between symptom onset and arrival at a hospital varies between 1.5 to 6.0 hours[43].

3. Access to healthcare

Access to healthcare represents the ease with which a patient can use the appropriate healthcare services according to their specific needs. Healthcare access not only depends on providers' characteristics (cost, location, availability) but also depends on the users' characteristics (knowledge about the disease, perception of need of healthcare, cultural beliefs)[36,44]. As Frenk (1992) stated "*Accessibility is the degree of adjustment between the characteristics of healthcare resources and those of the population within the process of seeking and obtaining care*"[45].

In Portugal, the provision of healthcare is characterized by the coexistence of a National Health Service (NHS), public and private subsystems for certain occupational categories and private voluntary health insurance. In mainland Portugal, there are 212 hospitals, from which 91 are private hospitals. In 2012, 342 Family Health Units and 186 Community Care Units were running[46]. The NHS is the main healthcare provider and is characterized for being universal, public and tends to be free of charge. Some groups of patients are exempt from the payment of charges, namely pregnant women, patients with chronic diseases, firemen, children and others. All other patients have a payment fee in the primary care centers and in the emergency department. The use of EMS in Portugal is free of charge.

Other factors may influence the access healthcare, such as its geographic location[47]. This is more blatant when comparing rural areas with urban areas because the EMS and hospitals with PCI are very different in number in those areas. Nowadays, health institutions, equipment and professionals concentrate along the more coastal cities of Portugal, with the interior regions of the country at impaired access to healthcare[48]. Interestingly, Mathews et al. (2011) studied the differences between rural and urban areas in USA in patients with ACS and found no differences in the use of EMS[27].

In addition to factors associated with healthcare facilities, factors related to patients may also influence access to healthcare. Regarding age and sex, studies are not consistent since some studies reported them as influencing EMS use[15,27,29,35,36] and others have not shown this association[15,34,35,39,49]. No other sociodemographic determinants, namely as private health insurance, marital and employment status or income seemed to predict EMS use[34,36,39]. Regarding clinical factors, the presence of previous cardiovascular history proved to be a relevant factor to the increase of EMS use[15,27,34,35] as was the patients' perception of the symptoms as pertaining to a condition in the heart[35,36]. One factor that is consistently shown to be closely associated with EMS use is the presence of accompanying symptoms such as dizziness, vomiting, nausea or dyspnea[15,29,34–36,39,49]. Interestingly, accompanying symptoms motivated the use of EMS more often than pain itself, which has been shown to have no

influence in some studies[34,36]. The presence of hypertension, dyslipidemia and diabetes were not an influencing factor to the higher use of EMS[15,29,34,35,39,49]. However, being a smoker proved to be important[29,39]. Patients diagnosed with a STEMI were more likely to have called an EMS[34–36,39,49]. A study identified the time of day as an influencing factor to EMS use[39] and three studies showed that distance to the hospital contributes to EMS use[27,29,35].

4. Health Education in patients with ACS

According to the WHO, health education is "*any combination of learning experiences designed to help individuals and communities improve their health, by increasing their knowledge or influencing their attitudes*"[50]. These experiences mostly represent health education interventions that are designed to promote health in people. So health education aims to enable individuals to obtain and understand health information and use it to perceive how diseases develop, how to prevent them and how to improve quality of life when living with disease.

In patients at risk of an ACS, health education can be important (1) to reduce the prevalence of cardiovascular risk factors, (2) to raise awareness of the symptoms of ACS and (3) the correct measures at symptom onset. Public education campaigns may reduce the incidence and mortality associated with MI because it is expected a reduction in the time between symptom onset and treatment. Late recognition of symptoms and signs is in part responsible for an increase in prehospital care delay[51]. Another factor is the lower use of EMS, as previously shown. Despite that, public campaigns around the world have not been effective in increasing the use of EMS[15,52–57].

Individual and socioeconomic characteristics are known to influence health literacy, which play a crucial role in health promotion and protection against disease. A systematic review found that low literacy levels are associated with a 1.5 to 3-fold increase in adverse health outcomes[58]. Several studies try to determine patient's knowledge about the symptoms of a heart attack. A study made in Pakistan revealed that 81% of the study population could not identify any symptoms and only 6% identified two or more[59]. A British study found these proportions were 9% and 40%, respectively[60]. The REACT trial conducted in the USA showed that, on average, participants were able to identify 3 symptoms related to heart attack and only 3.1% were able to identify six symptoms[61]. These studies found that lower knowledge level is associated with a delay in seeking help.

Some studies found that lack of knowledge is not always the main factor not to call EMS. One of the main reasons patients prefer to use self-transportation is because they think they

will get to the hospital faster. However, when they arrive at the hospital, no one is prepared to receive them, leading to a loss of potentially valuable time until treatment onset[27]. This shows how uninformed certain groups people are about the benefits of ambulance transport[15]. Another reason is that patients fear calling an ambulance unnecessarily or they worry about depending on others[15,36,43].

In Portugal, the Stent for Life initiative launched a public campaign with the slogan ‘‘Não perca tempo. Salve uma vida’’ (‘‘Act now. Save a life’’)[33]. One of the principal aims of this campaign was to increase patients’ awareness of the symptoms of MI and to encourage the EMS activation by calling 112. Although it was not possible to prove that this result was due to the campaign, there was an increase in the number of people calling 112 in the following year (from 33% in 2011 to 38% in 2012). This study also reported that STEMI patients driven to the emergency room by INEM increased from 13% in 2011 to 37% in 2012[33]. Despite the improvement in the number of patients with ACS calling 112, a large proportion of patients still do not use EMS. Therefore, a deeper understanding about patients’ attitudes is necessary for the development of effective interventions to improve the use of EMS transportation.

Aims

This thesis aims to contribute to the understanding of patients' attitudes regarding EMS use among patients diagnosed with acute coronary syndrome in two different regions in the north of Portugal.

The specific aims are:

1. To characterize the geographical availability of EMS in two different regions in the north of Portugal;
2. To describe the prevalence of EMS use compared with self-transports in patients with ACS;
3. To identify factors influencing the use of ambulance transportation in patients with ACS.

Manuscript

Attitudes regarding Emergency Medical Services use in patients with Acute Coronary Syndrome: the EPIHeart cohort

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Introduction

Prompt recognition of symptoms and timely engagement of prehospital emergency medicine is crucial to reduce morbidity and mortality related with acute coronary syndrome (ACS) since it reduces the time to definitive treatment[25]. The activation of Emergency Medical Services (EMS) decreases delay to treatment and is inversely associated with myocardial salvage and survival rates[26,27]. EMS are able to start treatment in the prehospital setting and to warn the receiving hospital about patient's arrival. When patients arrive at the hospital, they do not have to wait in the emergency department and are immediately received by the cardiology team.

The underuse of EMS among patients with ACS has been reported in several studies across the world. EMS use varies between 40% and 60% in Europe[35,36] and between 26% and 60% in the United States of America[27,37,38]. In Portugal, a study based on the Stent for Life initiative found that only one-third of the patients activated EMS[33]. In order to ensure timely access to healthcare, fast-track systems were created for specific conditions. In Portugal, the fast-track system for patients with coronary disease is aimed to achieve an ACS diagnosis in the shorter time frame possible and to identify patients with STEMI who have indication for PCI. According to the INEM, in 2018, 731 patients with MI were referred to Portuguese healthcare institutions through the Coronary Fast-track[42].

Public campaigns around the world have not been effective in increasing the use of EMS[15,52–57]. In Portugal, the Stent for Life initiative launched a public campaign which aimed to increase patients' awareness of the symptoms of MI and to encourage the EMS activation by calling 112. That initiative led to an increase in the number of people calling 112 in the following year (from 33% in 2011 to 38% in 2012). Despite this improvement, a large proportion of patients still do not use EMS. Therefore, a deeper understanding about patients' attitudes is necessary for the development of effective interventions to improve the use of EMS transportation. Accordingly, this work aims to characterize the geographical availability of EMS in two different regions in the north of Portugal and to describe the prevalence of EMS use and its predictors in patients with ACS.

Methods

Study Design and population

The present study includes patients with ACS from EPIHeart cohort study[62]. This cohort was set up to assess inequalities in the management and outcomes of patients with acute coronary syndrome. Patients were recruited at Hospital de São João and Hospital de São Pedro between August 2013 and December 2014. These two hospitals are located in the northern region of Portugal: the former is located in Porto and the latter in Vila Real. Hospital de São João is a first-line service to part of Porto's population, which is mainly urban, whereas Hospital de São Pedro works as a first-line service for local population (mainly rural) and as referral hospital to the population of the north-east region of Portugal (NER) (Bragança and some municipalities of Viseu). The populations of these two regions have different sociodemographic characteristics, which may influence management and outcome of patients with ACS.

Patients admitted to these hospitals during the study period with the diagnosis of ACS were invited to participate. The inclusion criteria were admission due to suspected ACS type I, age ≥18 years, expected to have a length of stay longer than 48 hours and living in the hospitals' area of influence. The exclusion criteria consisted of: no confirmation of ACS diagnosis, discharge or transfer before being invited to the study, inability to answer the questionnaires (clinical instability, no fluent in Portuguese, hearing problems or cognitive impairment) or death. From the 939 patients included in the study, 78 patients were excluded from the present analysis because of missing data in the type of transportation used. Therefore, 861 patients were included.

The study protocol complied with the Declaration of Helsinki and all patients gave a written informed consent.

Setting

In Portugal, healthcare is provided mainly by the National Health Service (NHS), which is composed by 212 public hospitals and, in 2012, by 342 Family Health Units and 186 Community Care Units (PNS). The NHS is characterized as being universal and public and tends to be free of charge. Some groups of patients are exempt from charges, namely pregnant women, patients with some chronic diseases, firemen, children and others. All other patients have a payment fee in the primary care centers and in the emergency department. In Portugal, EMS is managed by the *Centro de Orientação de Doentes Urgentes* (CODU), which is part of the *Instituto Nacional de Emergência Médica* (INEM) responsible for answering health emergency calls in Portugal from the European emergency number - 112. CODU has several types of vehicles available to respond to help requests and is responsible for

coordinating their activation - ambulances, *Viatura Médica de Emergência e Reanimação* (VMER), emergency motorcycles and helicopters. These are selected according to the clinical situation and their proximity to the patient, usually but not always from the same municipality. There are two different types of ambulances: (1) ambulances with two Emergency Ambulance Technicians on board able to perform basic life support (BLS) and to use an automated external defibrillator, usually located in fire departments or Red Cross delegations and (2) the immediate life support ambulances with a nurse and a technician on board who can administer drugs and perform invasive therapeutic acts under medical supervision, which are located in health units. Additionally, INEM has the VMER which take a physician and a nurse to the patient to perform advanced life support.

Data collection

Within 48 hours after admission, patients were interviewed in person by trained interviewers who applied a structured questionnaire to collect data about clinical presentation and healthcare seeking behaviors. Chest pain intensity was measured using a visual analogue scale from 0 to 10. Accompanying symptoms were defined as having syncope, nausea, vomiting, sweating, weakness, palpitations or vision disturbance. ACS perception was evaluated using the question: “Did you suspect that your symptoms were related to a heart problem?” Symptoms appearing on Saturdays, Sundays and holidays were defined as symptom onset during weekends. Symptom onset at night was defined as symptoms starting between 09:00 p.m. and 07:59 a.m. The activity at the symptom onset before the episode was evaluated through several questions, and was then classified dichotomously as sleeping or resting or activities involving effort.

After the first questionnaire, sociodemographic data (age, sex, home address, marital status, health insurance coverage, education, employment status and monthly household income) were collected using another structured questionnaire. Married patients or patients in a civil union were considered partnered, while single, separated, divorced or widowed patients were designated as unpartnered. Health insurance coverage comprised health subsystems and voluntary private health insurance. Patients were asked about their smoking history and height, and their weight was measured in kilograms. Other risk factors, medical history and clinical characteristics were abstracted from patients’ electronic medical records. Diagnosis of ACS was used as clinically defined in discharge notes and classified as STEMI and NSTEACS.

Address geocoding and travel distance

All patients' residence and EMS were georeferenced using ArcGIS Online World Geocoding Service and Google Maps. The shortest road distance (in minutes and kilometres) from the patients' home to the nearest EMS was calculated using a Geographic Information System, more precisely ArcGIS version 10.5 and the Network Analyst extension. This function uses two layers – the incidents (location of the patients) and the target locations (emergency services). Using a street network from 2019, where each edge has a speed class assigned (which varies, for instance, according to terrain slope, road hierarchy and traffic), it is possible to estimate the cost (in terms of travel time and kilometres moved) between the incidents and the target locations. The street network dataset used in the study was provided by the Environmental Systems Research Institute (ESRI).

Statistical Analysis

Participants' characteristics were described through central tendency and dispersion measures for continuous variables, or absolute and relative frequencies for categorical variables.

To investigate the association between the participants' characteristics and ambulance transportation, we used the Student's t-test for continuous variables and the Chi-Square test for categorical variables (or the corresponding nonparametric tests, Mann-Whitney or Fisher's exact test).

A multivariable logistic regression model was constructed with the selection of independent variables based on the literature and on the results of bivariate analysis in the study sample (p-value <0.05). The results were expressed by an Odds Ratio (OR) value and its 95% Confidence Interval (CI). The significance level was set at 0.05. All statistical analysis was performed using STATA V.15.1 for Mac.

Results

Table 1 presents the sociodemographic and clinical characteristics of the study sample. Among the 861 patients included in this study, 73.7% were men and the mean age was 64.0 years. The majority of the patients had four years of education or less (58.6%). Less than one-quarter (23.4%) were partnered and less than one-third (30.0%) were employed. The most common monthly household income was less than 1,000€ and 26.4% of the patients had private health insurance. In regards to clinical status, 98.3% of the patients had at least one risk factor for CHD (smoking history, hypertension, dyslipidemia, diabetes mellitus or overweight/obesity). More than one-half of the patients smoked or had smoked in the past (56.1%), had hypertension (67.4%), dyslipidemia (61.0%), diabetes (32.2%) or Body Mass Index ≥ 25 Kg/m^2 (66.5%). Taking into account the medical history, 33.9% of the patients had previous CVD history and 61.1% had family history of CHD. During the event, 97.3% of patients referred pain, of whom 53.0% attributed to a heart condition. Around 84% of the subjects had other symptoms rather than pain (collapse, nausea, vomiting, sweating, weakness, palpitations or vision disturbance). The majority of the episodes occurred during weekdays (73.3%) and in the daytime (59.3%) and at the symptom onset most were sleeping or resting (69.6%). At presentation, 40.8% of the patients had a STEMI and 6.5% evidenced a Killip class III or IV at presentation.

All Fire Departments, Red Cross delegations and places which have INEM vehicles (small hospitals or primary care centers) were georeferenced and are presented in Figure 2. Figure 2 (A) presents the study area and (B) shows patients' residences locations and EMS distribution in the study area or near its borders. In the study area, there were 218 places with vehicles able to answer an emergency call (187 fire departments, 15 places with INEM vehicles and 16 Red Cross delegations). Most of EMS of study area were located in Porto: 75.4% of the fire departments, 60% of the places with INEM vehicles and 75% of the Red Cross delegations. Twenty-two fire departments, 6 places with INEM vehicles and 11 Red Cross delegations from the neighboring municipalities were also included in the analysis, namely from Braga, Aveiro and Guarda.

The median driving distance between a patient's residence and the nearest EMS was 5.0 minutes, representing the aggregate between Porto and NER, with a median distance of 4.5min (3.0 – 5.9) and 8.4min (2.8 – 13.4), respectively. The difference between regions was statiscally significant ($p<0.001$). There were no significant differences between distances to the nearest EMS between EMS users and non-users (7.1 vs 6.7 minutes, $p=0.39$).

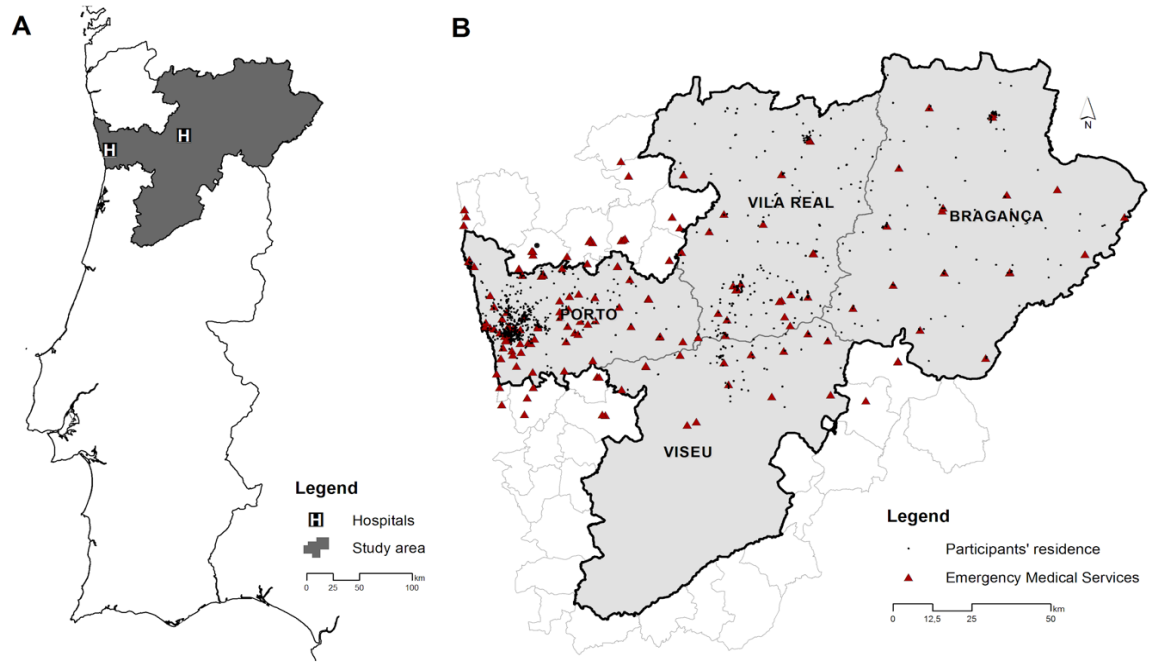

Figure 2: EPIHeart cohort study setting. (A) Study area and location of the hospitals. (B) Location of patients' residence and Emergency Medical Services.

EMS transportation to a healthcare providing institution was used by 40.4% of patients. We did not find a significant association between EMS use and sex (male 39.8% vs. female 42.0%, p=0.56). The mean age was also not significantly different between the EMS users and self-transported patients (mean age 64.8y vs. 63.4y, p=0.12).

Patients from NER were less likely to use EMS transportation compared with patients from Porto (33.5% vs 45.5%, p<0.001) or be employed patients (34.1% vs 43.2% unemployed, retired or disabled, p=0.01). Partnered patients and also were less likely to use EMS (40.4% vs 41.7% unpartnered, p=0.75). Different levels of education meant different transportation choices, with patients with intermediate level of education (5 to 9 years of education) using less often EMS transport (29.7% vs 43.3% for 4y or less vs 42.8% for 9y or more, p=0.008). Patients with private health insurance used EMS less frequently than patients without private health insurance (38.5% vs 41.5%, p=0.44). Regarding clinical status, patients who smoked or had smoked or had hypertension, dyslipidemia or diabetes were more likely to use EMS transportation. Additionally, patients without previous CVD disease or family history of CHD less often used EMS than patients with previous CVD disease or family history of CHD (36.3% vs 49.0%, p<0.001 and 40.4% vs 44.0%, p=0.39, respectively). Patients with pain intensity ≤8 (no pain: 47.8% vs ≤8: 36.4% vs >8: 44.6%) and patients who did not recognize the symptoms as related to the heart (35.5% vs 44.0%, p=0.01) were also less likely to use EMS transportation.

Patients with STEMI were more likely to use EMS transportation than patients with NSTEACS (44.7% vs 37.5%, p=0.03). Similarly, patients presenting with higher Killip classes used more frequently EMS transportation than patients with Killip classes I or II (69.1% vs 38.3%, p<0.001).

Table 1: Baseline characteristics comparing EMS-transported patients and Self-transported patients

	n (%)	EMS transportation	Self-transportation	p
	861	348 (40.4)	513 (59.6)	
Sociodemographic characteristics				
Age (years), mean (SD)	64.0 (13.1)	64.8 (13.6)	63.4 (12.7)	0.12
Sex				0.56
Male	635 (73.7)	253 (39.8)	382 (60.2)	
Female	226 (26.3)	95 (42.0)	131 (58.0)	
Region				<0.001
NER	364 (42.3)	122 (33.5)	242 (66.5)	
Porto	497 (57.7)	226 (45.5)	271 (54.5)	
Marital Status*				0.75
Partnered	653 (76.6)	264 (40.4)	389 (59.6)	
Unpartnered	199 (23.4)	83 (41.7)	116 (58.3)	
Employment Status*				0.01
Unemployed/retired/disabled	595 (70.0)	257 (43.2)	338 (56.8)	
Employed	255 (30.0)	87 (34.1)	168 (65.9)	
Education years*				0.008
≤ 4	499 (58.6)	216 (43.3)	283 (56.7)	
5 - 9	158 (18.6)	47 (29.7)	111 (70.3)	
> 9	194 (22.8)	83 (42.8)	111 (57.2)	
Monthly household income (euros)*				0.06
≤1000	472 (55.5)	209 (44.3)	263 (55.7)	
1001-1500	99 (11.6)	40 (40.4)	59 (59.6)	
>1500	132 (15.5)	42 (31.8)	90 (68.2)	
No response	148 (17.4)	56 (37.8)	92 (62.2)	
Private health insurance coverage*				0.44
Yes	208 (26.4)	80 (38.5)	128 (61.5)	
No	580 (73.6)	241 (41.6)	339 (58.4)	
Distance to the nearest EMS (Red Cross, Fire Department, hospitals) (min), median (IQR)*	5.0 (3.0 – 8.7)	5.1 (2.9 – 8.0)	5.0 (3.0 – 9.1)	0.53
Cardiovascular risk factors				
Smoking history*				0.18
Yes	458 (56.1)	196 (42.8)	262 (57.2)	
No	359 (43.9)	137 (38.2)	222 (61.8)	
Hypertension				0.33
Yes	580 (67.4)	241 (41.6)	339 (58.4)	
No	281 (32.6)	107 (38.1)	174 (61.9)	
Dyslipidemia				0.05
Yes	525 (61.0)	226 (43.0)	299 (57.0)	
No	336 (39.0)	122 (36.3)	214 (63.7)	
Diabetes mellitus				0.13
Yes	277 (32.2)	122 (44.0)	155 (56.0)	

No	584 (67.8)	226 (38.7)	358 (61.3)	
Body Mass Index (kg/m^2)*				0.33
≤ 25	264 (33.5)	117 (44.3)	147 (55.7)	
25 - 30	357 (45.3)	137 (38.4)	220 (61.6)	
> 30	167 (21.2)	68 (40.7)	99 (59.3)	
Medical history				
Previous CVD history*				<0.001
Yes	290 (33.8)	142 (49.0)	148 (51.0)	
No	567 (66.2)	205 (36.2)	362 (63.8)	
Family history of CHD*				0.39
Yes	343 (61.1)	151 (44.0)	192 (56.0)	
No	218 (38.9)	88 (40.4)	130 (59.6)	
Clinical presentation				
Chest pain*				0.04
No pain	23 (2.7)	11 (47.8)	12 (52.2)	
Pain intensity ≤8	473 (55.2)	172 (36.4)	301 (63.6)	
Pain intensity >8	361 (42.1)	161 (44.6)	200 (55.4)	
Recognition of the symptoms*				0.01
Attribution of symptoms to the heart	443 (53.0)	195 (44.0)	248 (56.0)	
No attribution of symptoms to the heart	392 (47.0)	139 (35.5)	253 (64.5)	
Symptom onset at weekend*				0.18
Yes	219 (26.7)	98 (44.7)	121 (55.3)	
No	602 (73.3)	238 (39.5)	364 (60.5)	
Symptom onset at night*				0.63
Yes	334 (40.7)	140 (41.9)	194 (58.1)	
No	487 (59.3)	196 (40.2)	291 (59.8)	
Accompanying symptoms*[1]				0.74
Yes	524 (84.0)	216 (41.2)	308 (58.8)	
No	100 (16.0)	43 (43.0)	57 (57.0)	
Activities before the episode				0.25
Sleeping or resting	546 (69.6)	228 (71.9)	318 (68.1)	
Involving effort	238 (30.4)	89 (28.1)	149 (31.9)	
ACS characteristics				
Classification				0.03
STEMI	351 (40.8)	157 (44.7)	194 (55.3)	
NSTEACS	510 (59.2)	191 (37.5)	319 (62.5)	
Killip				< 0.001
Class I or II	797 (93.5)	305 (38.3)	492 (61.7)	
Class III or IV	55 (6.5%)	38 (69.1)	17 (30.9)	

* Total may not add to 861 due to missing data.
[1] Syncope, nausea, vomiting, sweating, weakness, palpitations or vision disturbance
ACS, Acute Coronary Syndrome; CHD, Coronary Heart Disease; CVD, Cardiovascular Disease; EMS, Emergency Medical Services; NER, North-east region; NSTEACS, Non-ST Segment Elevation Acute Coronary Syndrome; STEMI, ST-segment Elevation Myocardial Infarction

The results of multivariable logistic regression analysis are presented in Table 2. We found that having between 5 to 9 years of education (OR 0.61, 95% CI 0.39 - 0.97), being employed (OR 0.66, 95% CI 0.44 - 0.99) and living in NER (OR 0.58, 95% CI 0.41 - 0.81) were independently associated with less frequent use of EMS. The increased use of EMS was independently associated with higher pain intensity (OR 1.61, 95% IC 1.17 - 2.22), correct

recognition of the symptoms as cardiac (OR 1.43, 95% IC 1.04 - 1.98), previous CVD history (OR 1.47, 95% IC 1.03 - 2.10), STEMI diagnosis (OR 1.44, 95% IC 1.04 - 2.00) and higher Killip classes (OR 3.56, 95% IC 1.80 - 7.17). We did not find an association between age, sex, distance to the nearest EMS or symptom onset at weekend or night and an increased EMS use.

Table 2: Independent factors associated with EMS transportation in patients with ACS

	Odds Ratio (95% CI)
Age (per year)	1.00 (0.98 - 1.00)
Sex	
Female	1
Male	1.26 (0.87 - 1.84)
Education Years	
≤ 4	1
5 - 9	0.61 (0.39 - 0.97)
> 9	1.04 (0.69 - 1.57)
Employment Status	
Unemployed/retired/disable	1
Employed	0.66 (0.44 - 0.99)
Region	
Porto	1
NER	0.58 (0.41 - 0.81)
Distance to the nearest EMS (min)	1.00 (0.98 - 1.03)
Chest pain	
Pain intensity ≤8	1
No pain	0.88 (0.30 - 2.56)
Pain intensity >8	1.61 (1.17 - 2.22)
Symptom onset at weekend*	
No	1
Yes	1.19 (0.84 - 1.67)
Symptom onset at night*	
No	1
Yes	1.04 (0.76 - 1.42)
Attribution of symptoms to the heart	
No	1
Yes	1.43 (1.04 - 1.98)
Previous CVD history	
No	1
Yes	1.47 (1.03 - 2.10)
Diagnosis	
NSTEACS	1
STEMI	1.44 (1.04 - 2.00)
Killip	
I or II	1
III or IV	3.56 (1.80 - 7.17)

All independent variables were included in the model as categorical, except age and distance to the nearest EMS (continuous)
CVD, Cardiovascular Disease; EMS, Emergency Medical Services; NER, North-east region; NSTEACS, Non-ST Segment Elevation Acute Coronary Syndrome; STEMI, ST-segment Elevation Myocardial Infarction

Discussion

This study showed that only 40.4% of patients diagnosed with ACS were transported to the hospital by EMS, in northern Portugal, in 2013-2014. Patients who did not use EMS were more likely to live in NER, have from 5 to 9 years of formal education, be employed, have intermediate intensity pain (8 or less on a scale from 1 to 10), not attribute symptoms to a heart condition, have no previous history of CVD, be diagnosed with NSTEACS instead of STEMI and have lower Killip class at presentation.

The EMS use in this study showed only a modest improvement when compared with a study conducted in 2012 based on Stent for Life initiative, where only 37% of patients used EMS[33]. Nevertheless, it is not much different from those in other countries in Europe which showed similar or poorer results[35,36]. Reasons for underuse of EMS transportation have been discussed in several studies. Most of them reported that patients thought of self-transportation as faster than EMS[15,35,49,63], some thought there was no need for an ambulance and others that their symptoms would disappear[34–36,49], they did not know the benefits of EMS[34,43], were afraid to call an ambulance unnecessarily[36,43] or thought they would have to pay for it[43,49]. In order to build effective health education actions we should take into account that the intervention must go from patient's beliefs to behavioral changes[64].

Our study showed that age had no significant influence on EMS use, although patients using EMS were older than patients using self-transportation. This is similar to what was reported in other studies[15,27,29,34–36,39], some of them showing only a minor influence of age on EMS use[27,35]. In the specific context of the northern Portuguese population, we expected to find a relationship between age and use of EMS, as older patients have less access to different types of transportation compared with other patients still capable to drive. Regarding education level, patients with higher education level did not use EMS more often when compared with patients with lower education level. However, patients with intermediate levels of education were less likely to call an EMS.

But most of the studies that took patients' education level into account were not able to demonstrate association between higher education and increased use of EMS[36,39,49]. Therefore, interestingly, formal education does not seem to be a predictor of EMS use. The most likely explanation is that the EMS use is more associated with health literacy (the degree to which individuals can obtain and understand health information to make the best health decisions[65]) than education level. In fact, inadequate health literacy is prevalent in Portugal and studies have already demonstrated that low health literacy level was associated with poorer outcomes in patients with ACS[66]. Another factor that was found to be an independent factor to a decreased use of EMS was being employed. This can be explained by the fact that

patients were not alone at the symptom onset and working colleagues could drive them to the hospital.

Although there was a significant difference in the median distance to the nearest EMS (Red Cross, Fire Department or hospitals) between the two regions (4.5min for Porto vs 8.4min for NER), this distance was not associated with EMS use. Most published studies have only assessed the distance to the nearest hospital emergency department, disregarding the nearest EMS capable of answering the emergency call[27,29,35]. Since the median time to the nearest EMS in this study was only 5.0 minutes, it would be important to assess patients' reasons not to use EMS. As stated before, it is possible that patients who live closer to the hospital might think they will arrive faster if they use self-transportation compared to EMS. The problem is that patients seem to neglect the fact that EMS is an extension of hospital care. Therefore, they may not understand that the benefits of using an EMS are not only associated with a potentially faster arrival, but also the possibility of initiating clinical evaluation and immediate referral of the patient to a hospital with PCI or starting reperfusion during transport itself with fibrinolysis[34,36,67]. Additionally, the region itself proved to be an independent factor for EMS use, with patients in the NER region using the EMS less often. A study using data from the EPIHeart cohort showed that patients from NER took significantly longer to get to a PCI-capable hospital than patients living in Porto. This happened because almost half of the NER patients lived 60 min away from PCI-capable hospital and were more frequently referred to a non-PCI-capable hospital first[68]. This is one of the reasons of treatment delay in the prehospital setting[69]. In fact, when the diagnosis is fast, telemedicine services are working and the patient is correctly referred, it is possible for patients from more rural areas to arrive at the hospital with the same elapsed time as patients from urban areas[70]. Our results support a great potential of improvement in the indicators of treatment delay if EMS are activated particularly in this region. Other reasons are influencing the use of EMS, other than distance. One possible reason is the fact of inland regions have more elderly inhabitants, living in isolation and with less health literacy[71].

Some studies found an increased used of EMS during the night and weekends[37,39]. However, the symptom onset at the weekend or at night was not associated with EMS use in our study. EMS are available 24 hours a day, and it is reassuring to confirm that this factor did not condition patients' use.

Previous history of CVD was associated with increased EMS use, which is in agreement with previous studies[15,27,34,35]. Patients with previous history of CVD are expected to be more aware of CVD signs and symptoms and to have been advised by their doctors to call an EMS immediately at symptom onset. In fact, in our study, we found that only 43.0% of the patients attributed their symptoms to a heart condition. However, patients who recognize the problem as a heart condition were more likely to call an EMS. This highlights the importance of investing

in interventions to increase awareness to MI signs and symptoms, mostly in patients with previously diagnosed CVD[35,36].

Patients experiencing a higher intensity pain (>8 on a scale from 1 to 10) were more likely to call an EMS. However, we did not find any association with accompanying symptoms, in contrast with the majority of studies[16,34–36,49], possibly due to the fact that only 16% of patients had at least one of these symptoms. We found an independent association between higher Killip class at presentation and the increased use of EMS, potentially related with patients with higher Killip class being physically unable to walk, let alone drive, and ending up relying more on EMS. Additionally, being diagnosed with a STEMI was also found to increase EMS use, which further corroborates the association mentioned above, since STEMI patients usually have a more severe presentation[29].

Our results suggest that patients with previous history of CVD and patients who attribute their symptoms to the heart were more aware about the need for calling an ambulance. Misinterpretation of ACS symptoms has been cited as one of the reasons for late arrival to the hospital[19,60]. So it is crucial to increase awareness of all citizens for the importance of calling the EMS at the symptom onset, even if the symptoms are not so severe. One of the biggest concerns is in patients who present with atypical symptoms, such as vomiting or nausea, without the typical retrosternal pain. These may represent up to 30% of the cases[19,20]. Patients with typical symptoms tend to come to the hospital faster because these symptoms match their preconception of what a critical heart problem can feel like[19,35]. Therefore, it is not only important to warn them to call EMS as soon as possible, but also that MI can present in ways other than the typical retrosternal pain.

In addition, patients seem not to give the adequate importance to the use of EMS in this clinical situation. A study made in Portugal revealed that only half of the patients experiencing facial drooping (stroke sign) or chest pain would call 112 and 40% of the patients stated they would go directly to an emergency department[72]. Another study in Ireland, which studied patients' pathways from symptom onset to hospital arrival, found that general practitioners advised patients to go to the emergency department using their own vehicle[36]. This shows the importance of educational actions targeting not only patients, but also their families, the community and health professionals[29]. Public campaigns have been conducted in order to increase the awareness of the community to the typical and atypical ACS symptoms and to the importance of the use of EMS. However, these campaigns only seem to be short-term effective. As an example, a mass media campaign developed in Melbourne between 2008 and 2013 showed a variable effect over 5 years, with the largest effect during the first year[73]. The immediate effect in patients with ACS was an increase of 11.3% on the EMS use[73]. A systematic review published in 2004 evaluated interventions to reduce both prehospital and patient delay time in patients with suspected heart attack[52]. Only five of the eleven public

education campaigns evaluated actually led to a decrease in patient delay, despite being similar in terms of population, duration, baseline delay and year in which conducted to those that were ineffective. Other systematic review showed that interventions that successfully reduced prehospital delay in patients with stroke were based on public education by mass media, education of target groups and individual education[74]. Differences in the effectiveness at raising awareness of interventions on heart attack and stroke could be due to an easier identification of stroke signs than typical symptoms of MI (retrosternal pain), which can be caused by multiple entities.

At present, no sustainable education strategies have produced the long-term effects which are thought to be needed to change recognition of symptoms and improve EMS use in patients having an ACS. Our study shows that there are gaps in the population knowledge and research should be done in order to develop an effective multicomponent intervention based both on community education and individual literacy improvement.

Limitations

One important limitation of our study is that we could not assess how many vehicles were available from each EMS provider at a given time. In consequence, we cannot exclude that some patients not using EMS could have been farther from an EMS than the supposedly nearest vehicle.

Patients who died before arriving at the hospital were not included in the study, possibly contributing to an overestimation of the use of EMS.

Conclusion

There is still an underuse of emergency services among patients with ACS in northern Portugal. The severity of the symptoms, the previous history of CVD and the region of patients' residence were independently associated with EMS use. These results should contribute to the development and implementation of a successful education programme to increase population awareness and knowledge about typical and atypical ACS symptoms and the benefits of activating the emergency services, involving health professionals in this empowerment process.

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