Behavior of acute myocardial infarctions in an intensive care unit of a medium-size city over a one-year span

JUAN DAVID LOBO-HERNÁNDEZ, GILBERTO GARCÍA-ZULUAGA, OLGA ALICIA NIETO-CÁRDENAS
• ARMENIA (COLOMBIA)

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Abstract

Objectives: to identify the clinical and paraclinical behavior of myocardial infarctions in an intensive care unit of a medium-size city during 2017.

Methods: a descriptive, cross-sectional study which included 99 medical records with a diagnosis of myocardial infarction on ICU discharge. The variables were described and analysis of variance and Chi^2 tests were performed, using a p-value less than 0.05 for statistically significant differences.

Results: the prevalence of myocardial infarction in the ICU was 11.8%. The average age was 66.8 years. Chest pain was present in 82.8% with an average duration of 335 minutes. The pain most often radiated to the left arm (13.1%). Non-ST segment elevation myocardial infarction was the most frequent (50.5%), and the electrocardiogram located the infarctions on the inferior surface in 28.2%. The average ultrasensitive troponin I was 28.2 ng/mL. A total of 54.5% had complications. Mortality was 14.1%. Hospital stay was 6.5 and critical care stay was three days. There was a statistically significant relationship between chest pain and ST segment elevation ($p<0.001$) and between troponin I plus hospital stay and ST segment elevation ($p=0.007$ and $p=0.003$, respectively).

Conclusion: the study showed that 11.8% of patients admitted to ICU are admitted for myocardial infarction, and there is a statistically significant relationship between chest pain and an elevated ST segment and between increased troponin I plus a longer hospital stay and ST segment elevation. (Acta Med Colomb 2020; 45. DOI: https://doi.org/10.36104/amc.2020.1498).

Key words: *myocardial infarction, critical care, electrocardiography, troponin.*

Dr. Juan David Lobo-Hernández: Médico Interno. Grupo de Investigación Salud Pública, Programa de Medicina; Dr. Gilberto García-Zuluaga: Médico. Especialista en Cuidado Crítico; Dra. Olga Alicia Nieto Cárdenas: MD, MPH, PhD. Grupo de Investigación Salud Pública, Programa de Medicina. Facultad de Ciencias de la Salud, Universidad del Quindío. Armenia (Colombia).
Correspondencia: Dra. Olga Alicia Nieto-Cárdenas. Armenia (Colombia).
E-mail: olgalicianieto@gmail.com
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Introduction

The fourth clinical definition of acute myocardial infarction (AMI) according to the European Society of Cardiology Consensus (ESC 2018) is based on the presence of acute myocardial damage detected by cardiac biomarker elevation with evidence of myocardial ischemia (1).

Myocardial infarction is among the 10 main causes of death worldwide (2). This concurs with the Colombian data revealed by the Health Situation Analysis, 2016 (ASIS, in Spanish), in which cardiovascular diseases were the first cause of death and ischemic heart disease represented 49.3% of all of these fatalities (3). It also constitutes a high cost for the Colombian healthcare system, amounting to $13,883,087,744 in 2014, or 7.2% of the healthcare budget for that year (4).

In the department of Quindío, the health situation analysis noted that ischemic heart disease was the fifth cause of death in the 15-44 year age group and led the list for the 45-64 year and 65 or older age groups (5). The prevalence of acute myocardial infarction in the city of Armenia, according to a study carried out in a healthcare institution´s cardiovascular risk program, was 2.49% (6).

The diagnostic assessment of people suspected of having this disease is performed using three key resources:

1. Clinical presentation: chest and/or epigastric pain lasting for 20 minutes, appearing at rest or during exercise; may radiate to areas of the jaw, upper left arm and back (7).
2. Electrocardiographic signs: on a 12-lead electrocardiogram (ECG), an elevated or depressed ST segment (assessed at the J point), hyperacute T waves, and Q waves are electrocardiographic indications of acute myocardial infarction (7).
3. Serum biomarkers of myocardial necrosis: Currently, a diagnosis is made using ultrasensitive troponin I, although other markers have been used, such as creatine kinase myocardial band (CK-MB) and myoglobin (1, 7).

For diagnostic and treatment purposes, AMI is classified according to the electrocardiographic findings as AMI with ST elevation (STEMI) and without ST elevation (NSTEMI); and on coronariography, MINOCA is recognized as acute myocardial infarction with no obstructive coronary atherosclerosis (1).

In STEMI: the presence of symptoms compatible with myocardial ischemia along with electrocardiographic findings compatible with ST elevation in at least two contiguous leads are sufficient criteria for diagnosing infarction, and, while biomarkers are indicated in these cases, they should not delay the beginning of reperfusion therapy (8, 9).

The 2018 ESC consensus (1) recognizes a new classification of infarctions into five types, according to which, in type 1 MI there is an emphasis on the causal relationship between plaque rupture and coronary atherothrombosis; type 2 MI: an imbalance is produced between oxygen supply and demand unrelated to the acute coronary atherothrombosis; type 3 MI: is a useful category for differentiating it from sudden cardiac death; types 4-5 MI: an emphasis on differentiation from myocardial injury related to the procedure.

For treatment, the clinical practice guidelines for acute coronary syndrome treatment proposed by the Colombian Ministry of Health divide the therapeutic interventions into three stages: initial emergency and inpatient treatment, revascularization and secondary prevention (9).

Early detection of myocardial infarction and risk classification are relevant in terms of prognosis, since early therapeutic intervention may decrease the risk of potentially fatal arrhythmias in the acute phase to less than 3%, most of which occur within the first 12 hours of clinical presentation (7).

Specialized care of this clinical picture should be provided in an intermediate or intensive care unit, with the key objective of detecting the complication of potentially fatal cardiac arrhythmias in time (10). The timing of reperfusion in AMI patients to limit its spread, and specialized care in an intensive care unit for appropriate monitoring and management of potentially fatal arrhythmias which present as complications of the disease, are crucial determinants of the patients' prognosis and quality of life (11).

This study describes the clinical behavior and biomarkers of AMI in a general tertiary care ICU, in a medium-sized city, and is the first study of its kind in this population.

Materials and methods

This was a descriptive, cross-sectional study which was approved by the Bioethics Committee of the Universidad del Quindío.

Population: all the admissions records of the intensive care unit of a tertiary care hospital in Quindío Department for 2017 were identified and all those who were diagnosed with a myocardial infarction were selected for this study.

Inclusion and exclusion criteria: patients over the age of 18 admitted to an intensive care unit in Quindío Department between January 1 and December 31, 2017 with a diagnosis of myocardial infarction recorded in the medical chart by the attending physician and whose chart included the variables established for the study: signs and symptoms, electrocardiogram and biomarkers (ultrasensitive troponin I and CPK). Other clinical presentations of infarction were not included, such as perioperative infarction, or those with unclear or late-onset symptoms.

Data analysis: the data was tabulated in an Excel database. It was processed and analyzed using STATGRAPHICS Centurion (version 17.2.04) software. Quantitative variables were described using mean, standard deviation and confidence intervals (95%CI). Qualitative variables were described using frequency by categories.

The variables were compared through an analysis of variance (ANOVA) for quantitative variables and a Chi square test for qualitative variables; a difference was considered to be statistically significant when the p value was < 0.05.

Results

Altogether, 836 admissions records were found for the intensive care unit of a tertiary care hospital in the department in 2017, of which 111 were admitted with a diagnosis of myocardial infarction and 99 had a diagnosis of myocardial infarction at discharge, with an 11.8% prevalence of AMI in the ICU.

Table 1 shows the general characteristics. The average age of study participants was 66.8 years, and myocardial infarction was found to be more common in men, 65.6%. The average weight of the participants was 66.1 kg, the average height was 161.7 cm and the body mass index was 25.3 kg/m^2. On average, the pain lasted 335.9 minutes from onset to arrival in the ICU, that is, 5.6 hours. On admission to the emergency room, the average ultrasensitive troponin I was 28.2 ng/L, CPK was 330.2 IU/L and CK-MB was 48.73 IU/L. The average hospital stay was 6.5 days, time in the ICU was 3.0 days and time in the emergency room was 16 hours.

Table 2 shows the clinical characteristics of infarction in this population. Chest pain was present in 82.8% of the participants and epigastric pain in 14.1%. Pain most commonly radiated to the left arm (13.1%), followed by the back in 5.5%, jaw in 4.0%, upper limbs in 4.0% and was absent in 42.4%. Concomitant symptoms included dyspnea in 48.4% and diaphoresis in 21.2% of the participants. The most common electrocardiographic location was the inferior wall in 28.2%, followed by the anteroseptal wall 7%, anterior wall 5% and extensive anterior wall 2%. The T wave was altered in 27.2% of the participants, and the most frequent alteration was inverted T wave in 23.23%. Complications were found in 54.5% of the participants, with the most frequent being cardiac arrhythmias (atrial fibrillation and AV block) in 16.1%, followed by mitral regurgitation in 14.1%, heart failure in 11.1% and cardiogenic shock in 4%. The mortality of myocardial infarctions in the intensive care unit in this study was 14.1%.

An analysis of variance was performed to compare the

quantitative and qualitative variables, and a statistically significant relationship was found between troponin I and ST complex elevation (p value=0.003) and between troponin I and hospital stay (p value=0.007).

Categorical variables were compared and a statistically significant relationship (Chi^2) was found between elevated ST complex and chest pain (p value<0.001) and between complications and outcome in the intensive care unit (p value<0.001).

Table 3 shows treatment; antiplatelet therapy was administered as dual ASA and clopidogrel therapy in 94.9% of the participants and as single therapy with clopidogrel in 4%. Revascularization was performed by percutaneous coronary intervention plus stent in 37.3%, and fibrinolysis with tecnecteplase was employed in 21.2%. Anticoagulation therapy employed enoxaparin in 54.5%, and other low molecular weight heparins in 44.4%.

Discussion

The AMI situation in a tertiary care ICU in a middle-sized city is presented, in which a statistically significant relationship was found between chest pain and ST segment elevation and between troponin I and hospital stay and ST segment elevation. While these results coincide with others in Colombia and other countries, they supply a reference point within the context of the current consensus which challenges us to go beyond in its epidemiological, clinical and biomarker definition (1), which will be a reference for subsequent studies.

An 11.84% prevalence of acute myocardial infarction in patients hospitalized in the intensive care unit of a tertiary care hospital was found. That is, of the 836 patients who presented to the intensive care unit, 99 were diagnosed with a myocardial infarction, which indicates the need for a coronary intensive care unit. There are no prior studies on the prevalence of myocardial infarction in an intensive care unit in the department, currently available for comparison. A prevalence of 2.49% was found in a primary care cardiovascular risk program in Armenia, Quindío (6).

The average age of the participants in this study was 66.8 years. In comparison, a multicenter study by Mueller et al. (12) titled *High Sensitivity Cardiac Troponin T assay for Rapid Rule-out of Acute Myocardial Infarction* (TRAPID-AMI), with 1,282 participants, found that the average age of participants with a clinical presentation compatible with myocardial infarction was 62 years, and the average age of participants with a final diagnosis of myocardial infarction was 69. In another study by Shah A. et al. in the United Kingdom, with 1,171 participants diagnosed with type I myocardial infarction, the average age was 68 years. It could be said that the average age is similar to that found in other studies.

Myocardial infarction was found to be more frequent in men (65.66%), similar to the findings of González et al. (14) who reported that 75.1% of the participants were men, and Mazno and Castro (15) in Mexico, who reported 83.3% males.

Chest pain was reported by 82.83% of the subjects in this study, similar to a study carried out by Sprockel et al. (16) in Bogotá, Colombia, in people diagnosed with acute coronary syndrome who were seen at Hospital San José, where 81.2% of the participants had chest pain. This differs from a review of the literature performed by Lu L. et al., which reports that close to 64% of patients with myocardial infarction do not have chest pain; that is, they experience silent myocardial infarction (17). Another review of the literature by Valensi et al. suggests that the percentage of people who had silent myocardial infarctions was greater in studies with younger populations than in studies with older populations (18).

The present study found a statistically significant relationship between chest pain and ST segment elevation (p value <0.001). In the United Kingdom, in 796 subjects compatible with acute coronary syndrome, Body et al. reported that subjects with ST segment elevation myocardial infarction had a significantly greater probability of experiencing chest pain lasting for more than an hour. Furthermore, they reported that the median duration of pain for subjects with ST segment elevation myocardial infarction was 120 minutes, while the duration of pain in non-ST segment elevation myocardial infarction was 90 minutes (19).

In this study, pain radiated most frequently to the left arm (13.1%), 48.4% had dyspnea and 21.2% had diaphoresis. In a study carried out in Bogotá, the percentages were different: radiation was most often to the left arm, with 27.1% of subjects, 51.8% had dyspnea and 54.1% had diaphoresis (16).

In this study, the electrocardiogram showed that 50.5% had a non-ST segment elevation myocardial infarction, while 47.4% of the subjects had ST segment elevation. These percentages are similar to those in another study titled *French Registry on Acute ST-elevation and non-ST-elevation Myocardial Infarction 2015 (FAST-MI), which was carried out in 204 healthcare facilities in France and found that 51% of the participants had non-ST complex elevation myocardial infarction (20). This shows a greater prevalence of non-ST elevation myocardial infarction.*

The most common location of myocardial infarction on electrocardiography, in the current study, was the inferior wall with 28.2% of all the participants, followed by the anteroseptal (7%) and anterior (5%) walls. In the previously mentioned study carried out in Bogotá, the most common location of myocardial infarction on electrocardiography was the inferior wall in 50.8% of subjects, followed by the anterior wall in 34.4% (16). A comparison of these studies points to the inferior location as the most frequent, followed by the anterior.

The average troponin I level found in this study was 28.24 ng/mL. In a study performed in two hospitals in Bogotá, Colombia, by Rojas et al., the average initial troponin I in subjects diagnosed with myocardial infarction was 0.15 ng/mL (21). Moreover, Manfredonia et al., in Rome (Italy),

Table 1. *General population characteristics (numerical variables) Características generales de la población (variables numéricas).*

Variable and unit of measure	Mean and standard deviation n= 99 patients	95% confidence interval (CI)	Reference value (RV)
Age in years	66.80 ± 11.41	64.53 – 69.08	
Weight in kg	66.10 ± 12.28	63.59 – 68.62	
Height in cm	161.72 ± 6.99	160.24 – 163.20	
BMI kg/m°	25.34 ± 4.41	24.40 -26.28	18.5 – 24.9
cTnI- ng/mL	28.24 ± 70.41	13.41- 43.08	≤ 0.4 ng/mL
CPK - IU/L	330.28 ± 253.17	118.62 – 541.94	Men: 200 IU/L Women: 168 IU/L
CK-MB - IU/L	48.73 ± 33.70	20.56 – 76.91	0 -24
Creatinine in mg/dL	1.05 ± 0.40	0.97 – 1.13	Men: 0.80 - 1.30 Women: 0.60 – 1.00
RBC in 10*6 million/uL	4.23 ± 0.64	4.09 - 4.37	3.80 - 5.20
Hgb in g/dL	12.80 ± 2.25	12.34 – 13.26	Men: 14.0 – 17.5 Women: 12.3 – 15.3
Hct percentage	38.38 ± 6.45	37.06 – 39.69	Men: 42.0 – 52.0 Women: 37.0 – 47.0
WBC 10*3 cells/uL	10.43 ± 4.21	9.56 – 11.30	5.0 – 10.0
CRP mg/dL	4.87 ± 3.88	2,26 – 7.48	≤ 0.3
Blood glucose mg/dL	143.31 ± 78.89	121.34 – 165.27	70 - 110
Percentage of HbA1c	7.62 ± 2.37	6.24 – 8.99	≤ 5.6
Serum potassium mEq/L	3.99 ± 0.55	3.87 – 4.11	3.5 - 5
Serum sodium mEq/L	138.33 ± 4.27	137.42 – 139.23	135 - 145
HDL mg/dL	52.57 ± 28.50	34.46 – 70.68	Men: 35 - 55 Women: 45 - 65
LDL mg/dL	92.56 ± 57.20	54.13 - 131	0 - 100
Cholesterol mg/dL	172.23 ± 51.63	137.55 – 206.92	0 - 200
Triglycerides mg/dL	119.66 ± 69.50	75.50 – 163.82	Men: 30 - 150 Women: 35 - 135
Duration of pain in minutes (from its onset)	335.92 ± 272.16	248.88 – 422.96	
Length of stay in the emergency room, in hours	16.46 ± 19.72	12.53 – 20.39	
Length of stay in the ICU in full days	3.77 ± 3.29	3.12 – 4.43	
Hospital stay in full days	7.63 ± 6.15	6.40 – 8.86	

Table 2. *Clinical characteristics of myocardial infarction (categorical variables).*

Variable	Categories	Percentage n=99 patients
Sex	Female Male	34.34 65.66
Chest pain	Not recorded no yes	3.03 14.14 82.83
Epigastric pain	Not recorded no yes	11.11 74.75 14.14
Pain radiation	Absent Neck Jaw Left arm Left arm and neck Left arm and jaw Left arm and back Arms Not recorded Back Back and neck	42.42 3.03 4.04 13.13 1.01 2.02 4.04 4.04 20.20 5.05 1.01

Continúa... página siguiente

Continuation... **Table 2.** *Clinical characteristics of myocardial infarction (categorical variables).*

Variable	Categories	Percentage n=99 patients
Dyspnea	Not recorded	19.19
	no	32.32
	yes	48.48
Diaphoresis	Not recorded	23.23
	no	55.56
	yes	21.21
Electrocardiogram	Not recorded	2.02
	yes	97.98
ST elevation	Not recorded	2.02
	no	50.51
	yes	47.47
Location of infarction by EKG	Two or more locations involved	1.01
	Anterior (V3 to V4)	5.05
	Extensive anterior (V1 to V6)	2.02
	Anterolateral (V1-V6, DI and aVL)	1.01
	Anteroseptal (V1 to V4)	7.07
	Inferior (DII, DIII and AVF)	28.28
	Lateral (DI, AVL, V5 and V6)	2.02
	No ST elevation	49.49
	Not recorded	3.03
	Septal (V1 and V2)	1.01
T wave alteration	Not recorded	33.33
	no	39.39
	yes	27.27
Categories of T wave alteration	Two T wave alterations	1.01
	No T wave alteration	39.39
	Not recorded	34.34
	Asymmetric T wave	1.01
	Hyperacute T wave	1.01
	Inverted T wave	23.23
Presence of a Q wave	Not recorded	42.42
	no	51.52
	yes	6.06
Comorbidities	Two comorbidities	22.22
	Three or more comorbidities	19.19
	Anemia	1.01
	Ischemic heart disease	3.03
	Cor pulmonale	1.01
	Diabetes mellitus	1.01
	COPD	1.01
	Heart failure	4.04
	Arterial hypertension	29.29
	Not recorded	1.01
	Obesity	2.02
	No comorbidities	15.15
Smoking	History of smoking	18.18
	Not recorded	63.64
	No history	1.01
	Active smoking	17.17
Complications	Not recorded	3.03
	no	42.42
	yes	54.55
Complications based on diagnosis in the chart	Two complications	1.01
	Three or more complications	2.02
	Arrythmias	16.16
	Pulmonary edema	1.01
	Mitral regurgitation	14.14
	Heart failure	11.11
	Heart failure and arrhythmia	2.02
	Not recorded	4.04
	Cardiogenic shock and arrhythmia	2.02
	Cardiogenic shock	4.04
	No complications	42.42
Health insurance type	Contributory	11.11
	Not insured	6.06
	Special system	1.01
	Subsidized	81.82

Table 3. ***Treatment characteristics*****.**

Variable	Treatment	Percentage
Antiplatelet therapy (APT)	ASA + clopidogrel Clopidogrel Not recorded	94.95 4.04 1.01
APT dose	ASA 100 mg, 1 daily. Clopidogrel 75 mg, 1 daily. ASA 100 mg, 3 tablets now and then 1 daily. Clopidogrel 75 mg, 3 tablets now and then 1 daily. ASA 100 mg, 3 tablets now and then 1 daily. Clopidogrel 75mg, 4 tablets now and then one daily. Clopidogrel 75 mg, 1 daily. Clopidogrel 75 mg, 4 tablets now and then 1 daily. Not recorded	59.60 1.01 30.30 3.03 5.05 1.01
Revascularization	CABG Fibrinolysis - Alteplase Fibrinolysis - Tenecteplase PCI PCI + stent Not performed Not recorded	1.01 2.02 21.21 14.14 37.37 21.21 3.03
Anticoagulant therapy (ACT)	Enoxaparin Other low molecular weight heparins Not indicated	54.55 44.44 1.01
RAAS inhibitor therapy (RIT)	Two medications ARB ACE inhibitors Not indicated Not recorded	1.01 36.36 44.44 13.13 5.05
Lipid-lowering therapy (LLT)	Atorvastatin Not indicated	95.96 4.04
Gastric protection (GP)	H2 blockers Proton pump inhibitors Not indicated Not recorded	67.68 18.18 12.12 2.02
Beta blockers (BB)	Carvedilol Metoprolol Not indicated Not recorded	71.72 12.12 13.13 3.03

found an average maximum troponin I level of 13.4 ng/mL in participants with evidence of significant obstructive coronary disease (22). This suggests that the average troponin I found was high compared to the troponin I levels in other studies.

A statistically significant relationship was found between troponin I levels and ST complex elevation (p value=0.003). At the University of New Mexico, Henrie et al. concluded that subjects with ST segment elevation myocardial infarction had higher troponin I levels (23), which coincides with the findings of the current study.

A statistically significant relationship was found between troponin I levels and hospital stay (p value=0.007). This agrees with Arboine-Aguirre et al., who determined that subjects who had a myocardial infarction with higher troponin I levels had a longer hospital stay (24).

Arterial hypertension was the most frequent comorbidity, affecting 29.2% of the participants. A history of smoking and active smoking added up to 35.3% of the participants, 2% had obesity, and 1% had diabetes mellitus. In a multicenter study by McCord et al. (25), 73.9% of the study population diagnosed with myocardial infarction had the comorbidity of arterial hypertension, followed by a history of myocardial infarction in 34% and diabetes mellitus II in 25.4%, and the percentage of smokers was 66.2%. In Armenia (Quindío) (6), at a primary care level, the percentage of participants with myocardial infarction who had arterial hypertension was 84.3%, and the percentage of smokers was 12.9%. Comparing the studies, arterial hypertension is the most frequent comorbidity in AMI.

Complications were found in 54.5% of the participants and there was a statistically significant relationship between complications and intensive care unit outcome (p value<0.001). In Cuba, Martínez and Ravelo found that, in patients with ST elevation acute myocardial infarction admitted to intensive care, 14.7% had arrhythmias, 7.3% had mechanical complications and 12.8% had heart failure (26). These findings are similar to those of this study.

There was a myocardial infarction mortality of 14.14%, which was greater than that in other studies, such as the Cuban study by Sánchez et al., who found a 12.5% mortality in myocardial infarction patients hospitalized in an intensive care unit (27). In an intensive care unit in Venezuela, Moldes et al. also found a mortality of 12.5% (28). The MASCARA (Manejo del Síndrome Coronario Agudo. Registro Actualizado [Acute Coronary Syndrome Management. Updated Registry]) study carried out in 57 healthcare facilities in Spain, found a mean total inpatient mortality of 5.7% (29).

The average hospital stay was 6.5 days, with a three-day

intensive care unit stay and a 16-hour average stay in the emergency room. A multicenter study by Stolker et al., in the United States, with 35,806 participants diagnosed with myocardial infarction on admission to 348 intensive care units, found that the average hospital stay for participants admitted to low-volume intensive care units was 6.9 days, and the average hospital stay for participants admitted to high-volume intensive care units was five days (30). Hospital stay is related to multiple patient and treatment factors, including early reperfusion (12).

Conclusions

This study found an 11.8% prevalence of myocardial infarction in the intensive care unit, and an average age of 66.8 years. Myocardial infarction was more common in men, with 65.6%. Chest pain was present in 82.8% of the participants, with an average duration of 5.5 hours. The average troponin I was 28.24 ng/mL.

Statistically significant relationships were found between chest pain and ST segment elevation, and between troponin I and hospital stay and ST segment elevation.

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