Sana'a University Journal of Medical and Health Sciences https://journals.su.edu.ye/index.php/jchm
Vol. 17 | No. 2 | Page 32 – 39 | 2023 | ISSN: 2958-7476
Doi: 10.59628/jchm.v17i2.607

Acute heart failure complicating acute coronary syndromes in patients admitted to Coronary Care Unit - Cardiac Center, Al-Thawra Hospital - Sanaa, Yemen

Nora Alsagheer*, Taha AL-Maimoony, Hanaa AbuHadi, Ahmed AL-Motarreb, Ahmed AlAnsi
[1]Department of Cardiology, Faculty of Medicine and Health Sciences, Sana'a University, Sana'a, Yemen.
***Corresponding author:** *nalsageer@gmail.com*

ARTICLE INFO
Article history:
Received: Sept 6, 2023
Accepted: Nov 4, 2023
Published: Dec 2023

KEYWORDS
1. ACS-Yemen
2. Heart failure
3. MI
4. Yemen

ABSTRACT

Background: Heart Failure with all its types and presentation is the end result of acute coronary syndrome. Coronary artery disease and its acute manifestations of ST-segment elevation myocardial infarction (STEMI), non-STEMI, and unstable angina are remarked as acute coronary syndromes (ACS). Yemeni patients usually present themselves to hospital late due to a lack of society awareness of the symptoms of ischemic heart disease, absence of medical insurance, poverty, lack of medical aid and intensive care units (ICU), absence of ambulance services, and long distance to the facilitated hospital with equipped ICUs. Late presentation prevents giving thrombolytic therapy or performing invasive interventions within the right time. These factors in addition to other factors may contribute to the large number of heart failure post ACS. We designed this study to study the heart failure complicating acute coronary syndrome.

Results: Out of 637 patients with ACS, 294 (39%) were in heart failure complicating ACS, with a median age of 51 years. Males represent 66% (194 patients) and females 34% (100 patients). Smoking represents 36%, khat chewing 88%, hypertension 53%, dyslipidemia 31%, past history of MI 29%, and diabetes mellitus 40%. Ischemic-type chest pain represents 49% and Dyspnea as primary symptom occurred in 29% with heart failure (HF). Late presentation of more than 12 hours represents 53% (111 patients) among patients with HF complicating STEMI or LBBB MI. These patients did not receive thrombolytic therapy or primary PCI. Patients who received thrombolytic therapy represent 45% (95 patients) of patients with HF-complicating ACS. No patients received primary PCI.

Conclusions: Heart failure complicating ACS is common among our patients and associated with high in-hospital death and is mainly among young patients and related to late presentation, management with non-fibrine specific thrombolytic agents (streptokinase), and lack of STEMI catheterization team for 24 hours, seven days a week.

CONTENTS

1. Introduction
2. Patients and Methods
3. Statistical Analysis:
4. Result
5. Discussion
6. References Conclusion
7. References

1. Introduction:

Coronary artery disease (CAD) including ST-segment elevation myocardial infarction (STEMI), non-STEMI (NSTEMI), and unstable angina (UA) are referred to as acute coronary syndromes (ACS)[1]. Acute coronary Syndrome is

the most common cause of all types of heart failure (HF)[2]. During acute myocardial infarction, symptomatic pulmonary congestion is the most common cause of death in short and long-term follow-ups[3,4]. The systolic dysfunction of the left ventricle after ischemic insult can be due to extensive myocyte necrosis, but it also can result from transient myocardial stunning or long-standing hibernation according to the time when coronary reperfusion is achieved[5]. Ischemia can induce heart failure through many mechanisms, it can cause impairment in diastolic function and of course impaired myocardial relaxation, so the left ventricular filling pressures increase and lead to acute heart failure (AHF)[6]. Also, ischemia by its acute mechanical complication can cause acute mitral regurgitation that mostly increases the risk of occurrence of acute pulmonary congestion[7,8]. Regardless of which processes dominate in individual patients, it is clear that the intersection of AHF and myocardial infarction remains deadly even in the current era of acute reperfusion[8]. Acute heart failure is one of the most common complications of ACS, and if this happens it is associated particularly with a poor prognosis[9.] The incidence of AHF complicating ACS varies from a very low incidence to a very high incidence in multiple observational data-based registry[9-11]. This variable incidence is according to types of ACS. The global registry of acute coronary events[12] demonstrates that the incidence of AHF was nearly equal in STEMI and NSTEMI (15.6% and 15.7%, respectively), and it was less between patients with unstable angina (8.2%). The HF incidence in patients admitted with AMI in earlier studies was reaching up to 50%[13]. Also during the era of revascularization[14,15] HF is a common complication of AMI[16.]

The occurrence time of heart failure during AMI attacks is important, as it can help to know the mechanisms and management that help to reduce HF burden. Most of the conducted studies, concentrated on the early phase of HF which developed during admission for management of ACS and limited studies did a follow-up after discharge from the hospital in the first ACS[14]. Cardiogenic shock is one of the known complications after ACS, cardiogenic shock is an extreme of HF[17,18]. The incidence of cardiogenic shock is low in Western countries, and this may be due to good medical care and services and also high social awareness, and limited time between the effective therapy of ACS and its symptoms onset. In developing countries, cardiogenic shock is still a real medical complication, therefore, we include it in our study as it is incidence is higher than anywhere else. This is likely to be the result of a late presentation. Early intervention mainly by re-vascularization decreases the rate of the bad outcomes of death, MI, and refractory ischemia and it was superior to delayed intervention in high-risk patients[19]. This paper aims to provide information about the management, course, and outcome of the AHF complicating ACS in our hospital.

2. Patients and Methods:

Study Design, Subjects and Data Collection:

A cross-sectional prospective study including all consecutive patients diagnosed and hospitalized with ACS and all ACS cases complicated by HF who were hospitalized to CCU in the cardiac center- AL-Thawra Hospital. They were enrolled during the period from February 2019 to January 2020. All patients with ACS were collected and included in the present analysis, with no upper age cap or other restrictions. The management of patients was according to the discretion of the physician who treated those patients. The study protocol was approved by the ethical committee of the Faculty of Medicine, Sana'a University.

Diagnosis of ACS and all other variables were defined according to the American College of Cardiology[20]. The definition of ACS (NSTEMI, STEMI, or LBBB) requires raised myocardial necrosis-biochemical markers which include troponin or CK-MB, in association with either ischaemic symptoms or ECG ischemic changes (pathological Q waves on the ECG, which is indicative of ischemia). For UA, the definition needs a normal range of biochemical cardiac

markers, with new onset or prolonged or accelerating ischaemic symptoms besides ECG changes indicative of ischemia. The HF at the time of hospital presentation for ACS was diagnosed according to the Killip classification[21] (class II: mild to moderate HF and a third heart sound (S3), lung crepitation less than one-half way up in the posterior lung fields or/and jugular venous distension. class III: overt pulmonary oedema, and Killip class VI: patients with cardiogenic shock). All data on baseline characteristics, admission presentations, in-hospital management, complications, and outcomes are prospectively collected. All our patients were examined by Echocardiography and left ventricular contractility was assessed using the EF percentage, EF < 50% was considered as HF. The study endpoint was all-cause in-hospital mortality and according to presentations and EF we categorize patients into cohorts: those who have ACS with HF in admission or during hospitalizations and those who have no HF.

3. Statistical Analysis:

All data was entered into the SPSS program version 21. All variables are summarized as median and percentage and compared using the Wilcoxon rank sum test and percentages were used in the categorical variables and then the variables are compared using χ^2 tests (Chi-square). Step-wise, multivariable logistic regression was used to identify independent predictors of in-hospital HF, and in-hospital mortality was examined using adjusted step-wise multivariable logistic regression models by adjusting for the following baseline covariates: age, gender, heart rate, systolic and diastolic blood pressure on presentation, site of ST-segment deviation on presenting ECG, history of myocardial infarction, peripheral vascular disease, stroke, diabetes mellitus, hypertension, dyslipidaemia, prior revascularization (coronary artery bypass graft surgery or percutaneous coronary intervention), smoking, and serum creatinine. For the association between HF and in-hospital mortality, it is also adjusted for reperfusion therapy with thrombolytics or primary angioplasty, initiation of aspirin, clopidogrel, beta-blocker, and statin therapy within 24 h of admission, and type of acute coronary syndrome. In addition, the logistic regression model was used to estimate the odds ratio between age as a continuous variable to assess the prognostic effect of HF on in-hospitality mortality, and its relationship to age. All associations from the logistic regression models are quantified as OR with 95% confidence intervals.

4. Results:

Out of the 637 patients enrolled with ACS, 294 were in acute HF either in the form of Killip class II, III, or VI (cardiogenic shock). Table (1) shows the baseline characteristics of patients with acute HF. The median age of patients with ACS and acute HF was 51 years, with 66% male predominance, 65% of them were under 50 years old and only 14% were more than 70 years old (Figure 1). The main risk factors of our acute HF patients were khat chewing (88%), hypertension (53%), DM (40%), smoking (36%), dyslipidemia (31%), and previous MI (29%), previous PCI (16%) and previous CABG (8%). Patients presented with ischemic-type chest pain represent 49%, dyspnea 29%, and 10% of patients were presented with atypical chest pain. The types of ACS were STEMI + LBBB in 71% of the patients, NSTEMI in 25%, and UA in 4%. Out of 210 patients with STEMI and LBBB, 53% (111 patients) present themselves late >12 hours, and only 45% (95 patients) present themselves <12 hours of symptom onset. The remaining 2% (4 patients) did not receive thrombolytic therapy and primary PCI was not performed for any patients in this period. Patients with HF in the ICU showed that 15.6% were complicated by cardiogenic shock, 15% developed recurrent ischemia, 2% developed stroke and 1.7% developed major bleeding. Total in-hospital mortality among patients with HF was 14%. Baseline serum creatinine, fasting levels of low-density lipoprotein cholesterol, and high-density lipoprotein cholesterol were higher in patients

with HF, whereas fasting serum triglycerides were lower in the same group.

Table 1: Basic characteristics

	Total ACS (n = 637)	**ACS with HF** (n = 294)	**ACS without HF** (n = 343)	***P*-value**
Median age (years)	49 (28-74)	51 (28–74)	48 (36–60)	<0.001
Male	73% (465)	66% (194)	79% (271)	<0.001
Risk Factors: Smoking	37% (233)	36% (106)	37% (127)	<0.001
Khat	81% (516)	88% (259)	75% (257)	<0.001
HTN	49% (314)	53% (156)	46% (158)	<0.001
Dyslipidemia	30% (194)	31% (91)	30% (103)	<0.001
MI	23% (147)	29% (72)	22% (75)	<0.001
DM	36% (228)	40% (118)	32% (110)	<0.001
PVD	2% (16)	3% (9)	2% (7)	<0.001
Stroke	9% (58)	13% (38)	6% (20)	<0.001
PCI	16% (102)	16% (47)	16% (55)	0.004
CABG	6% (38)	8% (24)	4% (14)	<0.001
Ischaemic-type chest pain	66% (418)	49% (144)	80% (274)	
Atypical chest pain	63% (418)	10% (29)	10% (34)	
Dyspnoea	10% (63)	29% (85)	3% (10)	
Other	7% (46)	12% (36)	3% (10)	
HF on presentation:		79% (232)		
Killip class II		47% (109)		
Killip class III		30 % (70)		
Killip class IV (Cardiogenic shock)		23% (53)		
HF during admission		21% (62)		
Killip class II		46% (28)		
Killip class III		29% (18)		
Killip class IV		25% (16)		
Anterior/anterolateral	28% (181)	83% (113)	63% (100)	
Inferior/infero-posterior	15% (93)	18% (54)	21% (33)	
Other	4% (28)	7% (22)	16% (25)	
Diagnosis: STEMI	37% (235)	64% (189)	46% (158)	
NSTEMI	16% (103)	25% (73)	30% (102)	
UA	7% (46)	4% (11)	22% (75)	
LBBB MI	4% (23)	7% (21)	2% (9)	
Labs: Highest CPK	1242(172-2312)	1242 (172–2312)	624 (214-1567)	0.03
Highest CPK-MB	202 (26–378)	202 (26–378)	70 (27-151)	0.37
Highest troponin	6.1 (0.3-11.9)	4.9 (0.3–9.5)	2.0 (0.4–11.9)	0.001
Total cholesterol	181 (140-222)	204 (185–222)	196 (140–216)	0.59
Low-density lipoprotein cholesterol	139 (94-185)	140 (95–185)	127 (94–153)	0.02
High-density lipoprotein cholesterol	32 (31-49)	32 (31–49)	29 (31–46)	<0.001
Triglycerides	393 (89-696)	393 (89–696)	207 (98–208)	<0.001
Creatinine	124 (62-185)	124 (62-185)	96 (63-127)	<0.001
Symptoms onset >12 hrs		53% (111)	24% (40)	
Symptoms onset <12 hrs Thrombolytic therapy received %		45% (95)	76% (127)	
Missed		2% (4)	0	
Outcome: Death	8% (49)	14% (41)	2.3% (8)	<0.001
Recurrent ischaemia	12% (77)	15% (44)	9.6% (33)	<0.001
Cardiogenic shock	10% (64)	15.6% (46)	5.1% (18)	<0.001
Stroke	1% (6)	2% (6)	0	<0.001
Major bleeding	1% (6)	1.7% (5)	0.3% (1)	<0.001

Abbreviation: MI Myocardial infarction, DM Diabetes mellitus, PVD Peripheral vascular disease, PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft surgery, ECG, electrocardiogram; STEMI, ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; UA, unstable angina; LBBB, left bundle branch block, CPK, creatinine phosphokinase. Units for lab investigations are U/L for CPK and CPK-MB, µg/L for troponin I or T (depending on recruiting centre), and mg/dL for other values.

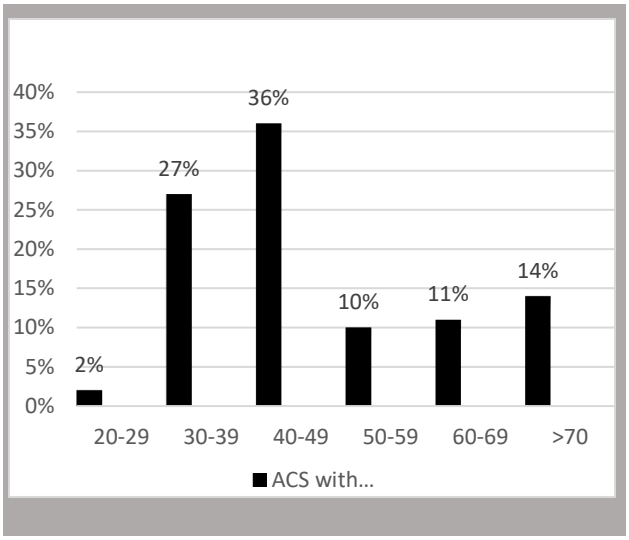

Figure 1: Distribution of ACS with HF according to age

An increased risk of HF in ACS including older age, higher heart rate on presentation, anterior ST-segment deviation on ECG, history of myocardial infarction, diabetes mellitus, hypertension, or peripheral vascular disease, higher creatinine or diastolic blood pressure, and lower systolic blood pressure. Patients with HF were less likely to receive clopidogrel, statin, or beta-blocker in the first 24 h of admission, but more likely to receive diuretics and angiotensin-converting enzyme inhibitors or angiotensin receptor blockers (Table 2). At discharge, Beta-blockers, statins, and clopidogrel were also less often prescribed to patients with HF whereas digoxin and diuretics were more likely to be prescribed. An echocardiogram was performed for all patients with ACS (Table 3). Low systolic function less than 50% was present in 86% of patients with HF, while 14% were in diastolic dysfunction.

Table 2: Medications on admission and at discharge (%)

Medications	On admission	On discharge	P-value
Aspirin	% (94)	%91	<0.001
Clopidogrel	%61	%52	<0.001
Beta-blocker	%51	%55	<0.001
ACE-I/ARB	%69	%80	<0.001
Statin	%89	%78	<0.001
Heparin	%88	0%	<0.001
Spironolactone	%15	%26	<0.001
Nitrates	%52	%61	0.66
Diuretics	%81	%75	<0.001
Digoxin	0%	%4	<0.001

Table 3: Echocardiogram of ACS with HF

EF by M-mode in ECHO	ACS with HF (n = 294)
>50%	14% (41)
40-49%	23 % (68)
30-39%	37% (109)
<30%	26% (76)

5. Discussion:

Acute heart failure complicating acute coronary syndrome is common in Yemen, it represents 39% of the patients and this is higher than in the Gulf states[22] and Canada[23] (Table 4). In both men and women, the most striking feature is the relatively younger age which is nearly one decade younger than that at nearby gulf countries and two decades younger than ACS cohorts from Western countries[24,25]. The higher rate of HF in patients with ACS in Yemen is mainly due to a late presentation, lack of good medical services and care, and khat chewing which decreases the effect of thrombolytic therapy[26]. More than 50% of patients arrived in the emergency department in Killip III and IV. Echocardiographic assessment of left ventricular function by M-mode Echocardiography shows that 23% of patients have EF between 40-49% (moderately reduced EF) and 63% of patients have EF less than 40% (HF with reduced EF)[27,28]. The characteristics of our patients among HF were young age, increased heart rate on admission, a history of myocardial infarction, and ST-segment elevation on the presenting ECG in 64% of the patients mainly an anterior MI.

Table 4: Characteristics of patients with heart failure complicating acute coronary syndromes from different parts of the world

	Yemen (n =	GULF RACE	Canadian Registry7	NRMI2 (n = 176,	GRACE6 (n =	Euro Heart Survey 5
Prevalence	39	25	12	29	19	26
Age (years)	51	62	72	74	73	69
Male (%)	66	68	63	52	61	64
Diabetes	40	50	32	34	29	31
Hypertension	53	62	58	58	60	62
Myocardial	2	34	39	27	29	36
Years of	2012-2013	2006–2007	1999–2003	1994–2000	1999–2001	2000–2001
ACS type	All ACS	All ACS	NSTEMI or	STEMI,	All ACS	All ACS
Definition	Killip II, III	Killip II and	Killip II and	Killip II and III	Killip II and	Killip II and III
Exclusion	Non	Killip IV	Killip IV,	Killip IV, prior	Killip IV,	Killip IV
In-hospital	14	7.9	3.6	24	14	5

Risk factors in our patients show that khat chewing, DM, HTN, smoking, dyslipidemias, as well as previous MI, PCI, and CABG. Diabetes mellitus among our patients is less than those in the Gulf race (40% in Yemen Vs. 50% in the Gulf countries) but higher than that in the Canadian and Grace Registry. This is mostly due to the encouragement of a good lifestyle and very good medical care[29]. Hypertension in Yemen is less than in Arab and European countries because most of the Yemenis are underweight with more or less healthy and simple diets.

Late presentation and lack of quick and effective intervention contribute to the higher rate of HF among our patients due to the unavailability of medical services everywhere and the lack of a STEMI PCI team around the clock which contributes to the increased HF rate. Our results showed that 53% came late and 45% arrived within 12 hours of CAS and received streptokinase which is the only available thrombolytic therapy in our hospital. This seems to be not as effective as it should be because the majority of our patients (86%) developed systolic HF according to the ECHO evaluation. Patients with HF in our study as well as in Gulf countries[22] are less likely to receive evidence-based therapies in the first 24 hours of their ACS admission and at the time of discharge. Among those with HF and reduced LVEF, nearly one in five were not discharged on an angiotensin-converting enzyme inhibitor or angiotensin receptor blocker and more than 40% were not discharged on a beta-blocker. The most common complications in our study were recurrent ischemia, stroke, cardiogenic shock, and major bleeding. In-hospital mortality in our patients among ACS complicated by HF (14%) was higher than in Gulf states and Europe (7.9% and 3.6%, respectively)[22,23]. Further study is needed to investigate the high prevalence of HF in ACS and its high morbidity and mortality in Yemen.

6. Conclusion:

Heart failure complicating ACS is common in Yemen mainly due to late presentation, and lack of facilitated hospital with attending cardiologist and STEMI catheterization team for 24 hours, seven days a week, in addition to management with non-fibrine specific thrombolytic agents (streptokinase)[29].

List of Abbreviations

ACS: Acute coronary syndrome, AHF: Acute heart failure, CABG: Coronary artery bypass grafting, CAD: Coronary artery disease, CAG: Coronary arteriography, CCU: Coronary care unit, CPK: Creatinine phosphokinase, CVD: Cardiovascular disease, DM: Diabetes mellitus, ECG: Electrocardiogram, HF: Heart failure, ICU: Intensive care unit, LBBB: Left bundle branch block, LV: Left ventricle, LVEF: Left ventricular ejection fraction, LVH: Left ventricular hypertrophy, LVSD: Left

ventricular systolic dysfunction, MI: Myocardial infarction, NSTEMI: Non-ST elevation myocardial infarction, NSTEMI/UA: Non-ST elevation myocardial infarction/ Unstable angina, STEMI: ST Elevation Myocardial Infarction, UA: Unstable angina.

Declarations

Ethics Approval and Consent to Participate

Informed consent was obtained from all subjects before collecting data, and all methods were performed in accordance with the relevant guidelines and regulations. The study protocol was approved by the ethical committee of the Faculty of Medicine, Sana'a University.

Competing and Conflict of Interest

The authors declare that they have no competing interests

Authors' Contributions

All authors have read and approved the manuscript. NA: Data collection, interpretation of data, and writing the manuscript; AA: writing the manuscript as well as revising it; TA, HA, and AK: revised the manuscript.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Acknowledgments

The authors thank all the participants.

7. References:

[1] Lloyd-Jones D, Adams R, Carnethon M, et al. American Heart Association Statistics. Committee and Stroke Statistics Subcommittee Heart disease and stroke statistics - 2009 update. Circulation 2009; 119(3): e182.

[2] Ko DT, Alter DA, Austin PC, You JJ, Lee DS, Qiu F, et al. Life expectancy after an index hospitalization for patients with heart failure: A population-based study. Am Heart J. 2008; 155: 324-331.

[3] Zubaid M, Rashed WA, Al-Khaja N, Almahmeed W, Al-Lawati J, Sulaiman K, et al. Clinical presentation and outcomes of acute coronary syndromes in the Gulf Registry of Acute Coronary Events (Gulf RACE). Saudi Med J 2008; 29: 251-255.

[4] Braunwald E, Kloner RA. The stunned myocardium: Prolonged, post-ischemic ventricular dysfunction. Circulation 1982; 66: 1146-1149.

[5] Velazquez EJ, Pfeffer MA. Acute heart failure complicating acute coronary syndromes: A deadly intersection. Circulation 2004; 109(4): 440-442.

[6] Abbate A, Biondi-Zoccai GGL, Bussani R, et al. Increased myocardial apoptosis in patients with unfavorable left ventricular remodeling and early symptomatic post-infarction heart failure. J Am Coll Cardiol. 2003; 41: 753-760.

[7] Lawesson SS, Alfredsson J, Fredrikson M, et al. A gender perspective on short- and long-term mortality in ST-elevation myocardial infarction—a report from the SWEDEHEART register. Int J Cardiol 2013; 168: 1041-1417.

[8] McManus DD, Chinali M, Saczynski JS, Gore JM, Yarzebski J, Spencer FA, et al. 30-year trends in heart failure in patients hospitalized with acute myocardial infarction. Am J Cardiol. 2011; 107: 353-359.

[9] Follath F, Yilmaz MB, Delgado JF, Parissis JT, Porcher R, Gayat E, et al. Clinical presentation, management and outcomes in the Acute Heart Failure Global Survey of Standard Treatment (ALARM-HF). Intensive Care Med. 2011; 37: 619-626.

[10] Harjola VP, Follath F, Nieminen MS, Brutsaert D, Dickstein K, Drexler H, et al. Characteristics, outcomes, and predictors of mortality at 3 months and 1 year in patients hospitalized for acute heart failure. Eur J Heart Fail 2010; 12: 239-248.

[11] Steg PG, Dabbous OH, Feldman LJ, Cohen-Solal A, Aumont MC, Lopez-Sendon J, et al. Determinants and prognostic impact of heart failure complicating acute coronary syndromes: Observations from the Global Registry of Acute Coronary Events (GRACE). Circulation 2004; 109: 494-499.

[12] Hellermann JP, Jacobsen SJ, Gersh BJ, Rodeheffer RJ, Reeder GS, Roger VL. Heart failure after myocardial infarction: A review. Am J Med. 2002; 113: 324-330.

[13] Juilliere Y, Cambou JP, Bataille V, Mulak G, Galinier M, Gibelin P, et al. Investigators F-M. Heart failure in acute myocardial infarction: A comparison between patients with or without heart failure criteria from the FAST-MI registry. Rev Esp Cardiol. 2012; 65: 326-333.

[14] Shah RV, Holmes D, Anderson M, Wang TY, Kontos MC, Wiviott SD, et al. Risk of heart failure complication during hospitalization for acute myocardial infarction in a contemporary population: Insights from the National

Cardiovascular Data ACTION Registry. Circ Heart Fail. 2012; 5: 693-702.

[15] Torabi A, Cleland JG, Khan NK, Loh PH, Clark AL, Alamgir F, et al. The timing of development and subsequent clinical course of heart failure after a myocardial infarction. Eur Heart J. 2008; 29: 859-870.

[16] Jhund PS, McMurray JJ. Heart failure after acute myocardial infarction: A lost battle in the war on heart failure? Circulation 2008; 118: 2019-2021.

[17] Sulo G, Igland J, Vollset SE, Nygård O, Øyen N, Tell GS. Cardiovascular disease and diabetes mellitus in Norway during 1994-2009: CVDNOR–a nationwide research project. Nor Epidemiol. 2013; 23: 101-107.

[18] Mehta SR, Granger CB, Boden WE, et al. Early versus delayed invasive intervention in acute coronary syndromes. New England Journal of Medicine 2009; 1298-1314.

[19] Cannon CP, Battler A, Brindis RG, Cox JL, Ellis SG, Every NR, et al. American College of Cardiology key data elements and definitions for measuring the clinical management and outcomes of patients with acute coronary syndromes. J Am Coll Cardiol. 2001; 38: 2114-2130.

[20] Killip T, Kimball JT. Treatment of myocardial infarction in a coronary care unit. A two-year experience with 250 patients. Am J Cardiol. 1967; 20(4): 457-464.

[21] Alsheikh-Ali AA, Al-Mallah MH, Al-Mahmeed W, Albustani N, Al Suwaidi J, Sulaiman K, et al. Gulf RACE Investigators. Heart failure in patients hospitalized with acute coronary syndromes: Observations from the Gulf Registry of Acute Coronary Events (Gulf RACE). Eur J Heart Fail. 2009 11(12): 1135-1142.

[22] Segev A, Strauss BH, Tan M, et al. Prognostic significance of admission heart failure in patients with non-ST-elevation acute coronary syndromes (from the Canadian Acute Coronary Syndrome Registries). Am J Cardiol. 2006; 98: 470-473.

[23] Goldberg RJ, Yarzebski J, Lessard D, Gore JM. A two-decade (1975 to 1995) long experience in the incidence, in-hospital and long-term case-fatality rates of acute myocardial infarction: A community-wide perspective. J Am Coll Cardiol 1999; 33: 1533-1539.

[24] Mubarak M. Thrombolytic therapy response in khat chewing patients presenting with STEMI, M.Sc. Thesis, 2015.

[25] Hasdai D, Behar S, Wallentin L, Danchin N, Gitt AK, Boersma E, et al. A prospective survey of the characteristics, treatments and outcomes of patients with acute coronary syndromes in Europe and the Mediterranean basin; The Euro Heart Survey of Acute Coronary Syndromes (Euro Heart Survey ACS). Eur Heart J. 2002; 23(15): 1190-1201.

[26] Ponikowski P, Voors AA, Anker SD, Bueno H, Cleland JGF, Coats AJS, et al. ESC Scientific Document Group. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the Diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC) Eur Heart J. 2016 14; 37(27): 2129-2200.

[27] Yancy CW, Jessup M, Bozkurt B, Butler J, Casey DE, Drazner MH, et al. American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. 2013 ACCF/AHA guideline for the management of heart failure: A report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. Circulation 2013; 128(16): e240-327.

[28] Velazquez EJ, Pfeffer MA, McMurray J, et al. VALsartan in acute myocardial infarction (VALIANT) trial: Baseline characteristics in context. Eur J Heart Fail. 2003; 5: 537-544.

[29] Swischuk JL, Smouse HB. Differentiating pharmacologic agents used in catheter-directed thrombolysis. Semin Intervent Radiol. 2005; 22(2): 121-129.