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Incidence and impact on prognosis of heart failure in Middle Eastern patients undergoing percutaneous coronary interventions

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ABSTRACT

Background: Heart failure (HF) is a serious complication of percutaneous coronary intervention (PCI) that adversely impacts survival and quality of life. **Aims and Objectives:** We sought to study the incidence of HF in Middle Eastern patients undergoing PCI and its impact on prognosis. **Materials and Methods:** The first Jordanian PCI Registry was a prospective multicenter study of PCI patients who were followed for one year. Patients who developed heart failure during hospitalization had their clinical and coronary angiographic profiles and adverse outcomes compared with those in patients who did not develop HF. **Results:** Of 2425 patients who had PCI, 194 (8.0%) developed HF during the hospital stay. Compared with patients who did not develop HF, those who developed HF were more likely to have diabetes mellitus, prior history of myocardial infarction (MI), elevated levels of cardiac biomarkers, ST-segment elevation MI and multivessel or left anterior descending coronary artery disease (all p values <0.05). Cardiac mortality was significantly higher among patients who developed HF compared with those who did not (5.2% vs. 0.4%; $p<0.0001$) and at one year (11.2% vs. 1.2%; $p<0.001$). Multivariate analysis showed that HF during hospital stay was an independent predictor of one-year cardiac mortality (Odds ratio 6.1, 95% CI 3.3-11.1, $p<0.001$). At one year, readmission rates for HF and ACS were higher among HF patients. **Conclusions:** Certain clinical and angiographic features were associated with higher incidence of HF among Middle Eastern patients who undergo PCI. HF was associated with higher risk of death and other adverse cardiac events during hospital stay and one year of follow up.

Key words: Heart failure, Percutaneous coronary intervention, Outcome, Prognosis

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INTRODUCTION

Heart failure (HF) is a serious complication of acute coronary syndrome (ACS) and percutaneous coronary intervention (PCI) and has a substantial impact on patient survival and quality of life.[1-3] HF due to left ventricular (LV) systolic dysfunction in patients admitted for ACS or those who undergo PCI is not only a determinant of high incidence rate of in-hospital complications and worse procedural outcome, but also of long-term outcome.[4-6] HF has not been studied in patients following PCI for ACS or stable coronary disease in the Middle East where cardiovascular disease is the leading cause of death and heart failure, and where an increasing number of relatively young patients are admitted with ACS and undergo PCI.[7-9]

Studies that assessed the prevalence of heart failure in Middle Eastern ACS populations, did not address HF

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in an exclusive PCI population, and did not evaluate the impact of HF during hospital stay on the incidence of adverse cardiovascular events, including cardiac mortality and readmission for HF and ACS after hospital discharge to one year of follow up.[10-13] The recently completed first Jordanian PCI Registry (JoPCR1) assessed the in-hospital and one-year outcomes in patients who underwent PCI for ACS and stable coronary disease.[14-15] We used data from this registry to evaluate the incidence, clinical and coronary angiographic features, predictive factors, in-hospital and one-year prognosis in patients who developed HF during the hospital stay compared with those who did not.

MATERIALS AND METHODS

JoPCR1 is a prospective, observational, multicenter registry of consecutive patients who underwent PCI at 12 tertiary care centers in Jordan between January 2013 and February 2014. A case report form was used to record data prospectively at hospital admission and discharge. At one, 6 and 12 months after the index hospitalization, data were collected during out-patient clinic visits or by phone calls to patients, household relatives or primary care physicians. The study was approved by the Institutional Review Board of each participating hospital. Baseline data included clinical, laboratory, electrocardiographic (ECG), echocardiographic, and coronary angiographic features. LV ejection fraction (LVEF) was determined by 2-D transthoracic echocardiography in accordance with current guidelines,[16] or by contrast left ventriculography during cardiac catheterization. Details of the PCI procedure and its outcome were prospectively recorded.

HF was diagnosed by the presence of pulmonary rales, chest radiography showing pulmonary venous congestion and LVEF <40%.[17] The diagnosis of cardiogenic shock was based on the presence of pulmonary venous congestion in association with systolic blood pressure <90 mmHg and signs of peripheral vasoconstriction including diaphoresis, cyanosis and oliguria.[18] All PCI procedures were performed according to current standard guidelines. The arterial access site, type and number of stents and the use of intravenous glycoprotein inhibitors were left to the operator's discretion. All patients received dual oral antiplatelet therapy, which consisted of aspirin, and either clopidogrel (300-600 mg) or ticagrelor (180 mg) loading dose, and a loading dose of unfractionated heparin (100 IU/kg body weight) to keep the activated clotting time ≈300 seconds throughout or immediately at the conclusion of the PCI procedure. PCI was indicated for either ACS or stable coronary disease.

ACS was classified as acute ST-segment elevation myocardial infarction (STEMI), defined by the presence of cardiac ischemic chest pain, ST-segment elevation of >2 mm in at least 2 contiguous leads on the 12-lead ECG, and elevated cardiac biomarkers; or non-ST-segment elevation ACS (NSTEACS), which included NSTEMI, defined by the presence of cardiac ischemic chest pain, ST-segment depression, inverted T wave, or normal ECG and elevated cardiac biomarkers, and unstable angina (UA), defined similar to NSTEMI with no elevation of cardiac biomarkers on admission or 8-12 hours later. Stable coronary disease was defined as either chronic stable angina (ischemic cardiac pain on effort that did not change in severity for the past 3 months, and absence of resting ECG ischemic changes or elevated cardiac biomarkers); or silent ischemia, defined by the absence of angina in the presence of signs of myocardial ischemia on ECG, echocardiography, or nuclear myocardial scan.

PCI for STEMI was primary (PCI as the initial reperfusion strategy with no fibrinolysis); rescue (after failure of fibrinolysis); or elective (after successful fibrinolysis). PCI for NSTEACS was urgent (done within 2 hours after admission for ongoing chest pain, hemodynamic instability, life-threatening ventricular arrhythmias or heart failure); early invasive (within 24 hours after admission); or invasive (within 24-72 hours after admission).

Clinical profiles, coronary angiographic features and complications of the PCI procedure were compared in patients who developed HF during hospital stay and those who did not. We also compared the incidence of adverse cardiovascular events including cardiac mortality, stent thrombosis (ST), major bleeding events, coronary revascularization and readmission for HF and ACS in the two groups up to one year of follow up. Cardiac mortality was defined as any death not attributed to a clear non-cardiac cause. ST, definite or probable, was defined according to the Academic Research Consortium definition.[19] Major bleeding events were defined according to the CRUSADE study definition and included intracranial hemorrhage, retroperitoneal bleeding, hematocrit (Hct) drop >12% from baseline, any red blood cell (RBC) transfusion when baseline Hct was >28%, or any RBC transfusion when baseline Hct was <28% with witnessed bleeding.[20]

Statistics

IBM SPSS Statistics 20 (IBM Corp., 2011) was used for data entry and analysis. Data were described using means and percentages. Chi-square test was used to test differences between proportions, and independent t test was used to test differences between the means in the two groups of patients who developed HF and those who did not. A binary logistic regression was used to test the difference in death rate during hospital stay between the two groups.

Candidate variables for these models were selected based on clinical importance, previously developed models, and a review of related literature.

These variables were female gender, age>60 year of age, diabetes mellitus, hypertension, body mass index >30 kg/m^2, past history of MI, past history of HF, STEMI, elevated levels of cardiac biomarkers, left anterior descending (LAD) coronary or multivessel coronary artery involvement. The significant variables that were kept in the regression model were age, diabetes mellitus, history of HF, STEMI, and HF during hospital stay. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Of the 2425 patients who underwent PCI, the procedure was indicated for ACS in 1870 (77.1%) and for stable coronary disease in 555 (22.9%). Past diagnosis of HF was reported by 15 patients (0.62%) and HF during hospital stay was diagnosed in 194 patients (8.0%). This diagnosis was made on admission in 44 patients (22.7%), during the first hospital day in 77 (39.7%), and between the second day and hospital discharge in 73 (37.6%). The length of stay was < 3 days in the majority (N=133, 72.3%) of patients who developed HF. Among the different subgroups of ACS, those with STEMI developed HF during hospital stay more than those with NSTEMI or UA (12.0%, 7.8%, and 5.1%; respectively; p<0.001).

Table 1 depicts the clinical and coronary angiographic features in patients diagnosed to have HF compared with those who did not HF. LVEF was <40% in the majority (93%) of the patients who developed HF. Of all studied clinical features, patients who developed HF were more likely to have diabetes mellitus and previous history of HF. There were no significant differences between the two groups in the prevalence rates of other major risk factors including gender, hypertension, overweight or smoking. Patients who developed HF were more likely to have ST-segment elevation on ECG and elevated blood levels of cardiac biomarkers compared with patients who did not develop HF.ACS was the indication for PCI in nearly similar proportions of patients who developed HF and those who did not (79.4% and 76.8%, respectively, p=0.49), but STEMI was diagnosed in a significantly higher proportion of the HF patients (Table 2). Patients with HF were more likely to have involvement of the LAD coronary artery or multivessel CAD compared with patients who did not have HF. Among the patients with STEMI, anterior wall involvement was more common among those who developed HF compared with those who did not (69/87; 79.3% vs. 412/639, 64.5%, p=0.01).

There was no difference between the proportions of patients who had multivessel PCI in the two groups. Most of the stents used in this contemporary PCI registry were second generation drug-eluting stents (89.4%). Bare metal stents and bioabsorbable scaffolds were used in 9.6% and 1.0%; respectively. Types of stents were not different in patients with HF and those without HF.

Patients with HF suffered higher rates of serious in-hospital complications and needed more invasive procedures

Table 1: Baseline features in patients who developed heart failure during admission compared with those who did not

Features	Patients with HF n (%) (N=194)	Patients with no HF n (%) (N=2231)	p-value
Age in years, mean±SD	59.4±11.5	58.3±10.8	0.23
Women	42 (21.6)	458 (20.5)	0.79
Hypertension	123 (63.4)	1387 (62.2)	0.80
Hypercholesterolemia	96 (49.5)	1088 (48.8)	0.91
Diabetes mellitus	119 (61.3)	1180 (53.0)	0.03
Cigarette smoking	80 (41.2)	975 (43.7)	0.55
Previous MI	20 (10.3)	242 (10.8)	0.92
Previous PCI	53 (27.3)	546 (24.5)	0.44
Previous CABG	9 (4.6)	76 (3.4)	0.50
Past history of heart failure	5 (2.6)	10 (0.4)	<0.001
BMI kg/m^2, mean±SD	27.7±4.5	28.0±4.5	0.37
Chronic renal failure	7 (3.6)	62 (2.8)	0.68
Estimated creatinine clearance ≤60 ml/minute	34 (17.5)	287 (12.9)	0.09
ST-segment elevation	89 (45.9)	655 (29.4)	<0.001
ST-segment depression	42 (21.6)	395 (17.7)	0.21
Elevated serum cardiac biomarkers	106 (54.6)	864 (38.7)	<0.001
LVEF<40%	180 (92.8)	122 (5.5)	<0.001

BMI: Body mass index; BP: Blood pressure; CrCl: Creatinine clearance; HDL-C: High-density lipoprotein cholesterol; HF: Heart failure; LDL-C: Low-density lipoprotein cholesterol; LVEF: Left ventricular ejection fraction; PAD: Peripheral arterial disease; PCI: Percutaneous coronary intervention

including endotracheal intubation, ventilatory support and intra-aortic balloon counterpulsation than patients who did not develop HF.

After discharge from the hospital, HF patients continued to have higher rates of adverse cardiovascular events (Table 3). Specifically, they had higher incidence of ST and higher rates of readmission for HF and coronary revascularization. Cardiac mortality occurred at a significantly higher rate among patients with HF compared with those who did not have HF, from the time of admission to one year of follow up. Nineteen patients (all had ACS) died during the index hospitalization; 10 (5.2%) were among the HF group and 9 (0.4%) among the patients who did not have HF. Among patients in the three subgroups of ACS; STEMI, NSTEMI and UA, death rates among HF patients were higher than those with no HF (Table 4). No deaths during hospital stay occurred in patients who had stable coronary disease. Table 5 shows the multivariate analysis of the association between HF during hospital stay and death at 1 year after adjusting for important predictors of mortality. Patients who had HF during hospital stay and those who had history of HF in the past had higher odds of mortality at 1 year compared to those who had no HF during hospital stay (p<0.001).

Of 194 patients with HF, 13 developed cardiogenic shock (8 had STEMI, 4 UA and 1 NSTEMI). Eleven patients had LAD and one patient had left main coronary artery involvement. Seven patients with cardiogenic shock died during hospitalization (54%) and at one month death rate was 62%.

Thrombolytic medications were used during hospital stay in a minority of patients who developed or did not develop HF (2.6% and 3.4%; respectively, p=0.70). During hospital stay, all HF patients received dual oral antiplatelet agents (DAPT), 80.9% received beta blockers (BB), 63.4% received renin angiotensin aldosterone blockers (RAASB) and 93.4% received statins. At one year, these medications were used by 90.9%, 83.5%, 69.3%, and 93.4%, respectively, among HF patients. These rates were not different from those of those who did not develop HF.

Table 2: Indications for PCI, coronary angiographic features and PCI procedural details and complications among patients who developed heart failure compared with those who did not

Features N (%)	Patients with HF (N=194)	Patients with no HF (N=2231)	p-value
Indications for PCI			0.487
ACS	154 (79.4)	1716 (76.8)	
STEMI	87 (44.8)	639 (28.6)	
NSTEMI	24 (12.4)	282 (12.6)	
UA	43 (22.2)	795 (35.6)	
Stable coronary disease	40 (20.6)	515 (23.1)	
Coronary artery disease			
Number of vessels			<0.001
One vessel	84 (43.3)	1332 (59.7)	
Two vessels	69 (35.6)	650 (29.1)	
Three vessels or more	41 (21.1)	249 (11.2)	
LAD disease	154 (79.4)	1420 (63.6)	<0.001
LM disease	7 (3.6)	34 (1.5)	0.06
PCI performed for			0.379
One vessel	140 (72.2)	1599 (71.7)	
Two vessels	41 (21.1)	527 (23.6)	
Three vessels or more	13 (6.7)	105 (4.7)	
PCI complications			
Ventricular tachyarrhythmia	8 (4.1)	13 (0.6)	<0.001
Cardiogenic shock	13 (6.7)	0 (0)	<0.001
Intra-aortic balloon pump	4 (2.1)	0 (0)	<0.001
Ventilatory support	11 (5.7)	6 (0.3)	<0.001
Acute renal failure	3 (1.5)	5 (0.2)	0.01
Emergency CABG	0 (0)	3 (0.1)	0.43

ACS: Acute coronary syndrome; BMS: Bare-metal stent; BVS: Bioresorbable scaffold; CABG: Coronary artery bypass graft surgery; DES: Drug-eluting stent; LM: Left main coronary artery; NSTEACS: Non-ST-segment elevation ACS, PCI: Percutaneous coronary intervention; STEMI: ST-segment elevation myocardial infarction

Table 3: In hospital, one- and 12-month major cardiovascular events

Events and timing N (%)	Patients with HF (N=194)	Patients without HF (N=2231)	p-value
In-hospital			<0.001
Stent thrombosis	4 (2.1)	5 (0.2)	0.80
Major bleeding events	2 (1.0)	21 (0.9)	<0.001
Cardiac mortality	10 (5.2)	9 (0.4)	
	N=184	**N=2202**	
One month			<0.001
Stent thrombosis	10 (5.3)	23 (1.04)	0.81
Major bleeding events	3 (1.6)	24 (1.1)	<0.001
Cardiac mortality	14 (7.3)	15 (0.7)	<0.001
Coronary revascularization	8 (4.4)	22 (1.0)	
Readmission for			
Acute coronary syndrome	8 (4.4)	33 (1.5)	0.01
Heart failure	6 (3.3)	7 (0.3)	<0.001
	N=176	**N=2171**	
One year			<0.001
Stent thrombosis	13 (7.0)	34 (1.6)	0.96
Major bleeding events	3 (1.6)	27 (1.2)	<0.001
Cardiac mortality	21 (11.2)	26 (1.2)	0.002
Coronary revascularization	13 (7.0)	60 (2.7)	
Readmission for			
Acute coronary syndrome	14 (7.7)	108 (5.0)	0.17
Heart failure	13 (7.0)	16 (0.7)	<0.001

Among patients in the three subgroups of ACS; STEMI, NSTEMI and UA, death rates among HF patients were higher than those with no HF [Table 4]. No deaths during hospital stay occurred in patients who had stable coronary disease

Table 4: Death rates during the index hospitalization among patients with and without heart failure (HF) for each PCI indication

Group of patients	HF patients who died during hospitalization, N (%)	Non-HF patients who died during hospitalization, N (%)	p-value
All patients	10/194 (5.2)	9/2231 (0.4)	<0.001
STEMI	6/87 (6.9)	6/639 (0.9)	0.002
NSTEMI	2/24 (8.3)	1/282 (0.4)	0.008
Unstable angina	2/43 (4.7)	2/795 (0.3)	0.005
Stable coronary disease	0/40 (0)	0/515 (0)	-

HF: Heart failure; NSTEMI: Non-ST-segment elevation myocardial infarction; STEMI: ST-segment elevation myocardial infarction.

Table 5: Multivariate analysis of the association between heart failure during hospital stay and death at 1 year

Variable	Odds ratio	95% confidence interval	p-value
Prior history of heart failure	8.6	(4.7, 15.8)	<0.001
Heart failure on admission	6.1	(3.3, 11.1)	<0.001
Age (>60 vs. ≤60)	2.3	(1.2, 4.1)	0.008
ACS type (STEMI vs. NSTEACS)	2.2	(1.2, 3.9)	0.013
Diabetes mellitus	1. 9	(1.2, 3.6)	0.052

ACS: Acute coronary syndrome; NSTEACS: Non ST-segment elevation acute coronary syndrome; STEMI: ST-segment elevation myocardial infarction.

DISCUSSION

The main findings of this study of Middle Eastern patients undergoing PCI are (1) 8.0% developed HF during hospital stay, (2) patients who developed HF were more likely to have diabetes or prior MI, present with STEMI and have involvement of the LAD or multivessel CAD than those who did not develop HF, and (3) we have shown for the first time in a Middle Eastern study that HF was associated with high incidence rates of in-hospital complications and was an independent predictor of one-year adverse cardiovascular events.

HF complicates ACS as a result of a complex interaction of structural, hemodynamic, and neurohormonal maladaptations related to the abrupt myocyte loss associated with MI leading to contractile dysfunction.[21,22] Patients who do not have extensive myocyte necrosis due to acute MI, post ischemic LV systolic dysfunction leading to HF can result from transient myocardial stunning or hibernation depending on the extent of coronary reperfusion.[23,24] Ischemia or MI leading to systolic or diastolic dysfunction may precipitate pulmonary edema, output failure or cardiogenic shock.[21,22,24] In addition to systolic dysfunction as a major cause of HF in patients with ACS, recent meta-analysis showed that restrictive mitral filling pattern, the most severe form of diastolic dysfunction, was present in approximately 10% of patients with preserved EF who developed HF.[25] However, the true prevalence and relevance of diastolic dysfunction after MI remains to be elucidated.[26] LV systolic dysfunction in patients with stable coronary disease is attributed to myocardial ischemia or hibernation, or prior infarction.[27,28]

HF during hospital stay should be distinguished from pre-existing HF reported by patients on admission, which was present in 2.6% of patients who developed HF in this study. Pre-existing HF is related to different pathophysiological mechanisms mainly related to older age and higher incidence of comorbidities and risk factors. Such patients can develop HF during hospital stay due to a new episode of ischemia or infarction, or a clear precipitant or trigger, including an arrhythmia, discontinuation of diuretic therapy, volume overload, infection or severe hypertension.[27,29]

The incidence rate of HF in this registry was less than that reported by other studies and registries that enrolled patients ACS and PCI in this region and other regions. The Global Registry of Acute Coronary Events (GRACE) that enrolled STEMI and NSTEACS patients reported an overall HF incidence of 13%, and a meta-analysis of seven clinical trials that enrolled >46,000 patients with NSTEACS reported a HF rate of 13.5% from hospital admission to discharge[6] Two studies from the Middle East reported HF rates of 13% and 25%; respectively.[10,13] Rate of HF incidence among patients with STEMI in our study (12%) was also lower than rates reported by others. HF rate of 16% was reported by the GRACE investigators,[30] 17% and 24% by a Canadian study in primary PCI and no PCI patients; respectively,[31] 18% by the Which Early ST-elevation Myocardial Infarction Therapy (WEST) trial,[32] 23% by the Valsartan in Acute Myocardial Infarction trial (VALIANT),[33] 29% in meta-analysis of four major thrombolysis trials,[34] and 29% by others.[35]

The variation in the incidence rates of HF in the setting of ACS among registries and studies is mainly due to different populations enrolled, case ascertainment and diagnostic criteria used in each study and the use of invasive diagnostic and revascularization procedures.[23,30,34] This registry enrolled only patients who underwent PCI, thus had an advantage of a procedure proven to preserve myocardium and decrease the incidence of HF.[36-38] Studies from our region vary in the frequency

of utilization of invasive strategy for patients admitted with ACS. High rates of coronary angiography (70%), PCI (60%) and primary PCI (90%) rates were reported by some investigators,[9,39,40] and others reported rates as low as8% to 19%.[11,12]

As we and others have indicated, patients with HF had higher prevalence of multiple comorbidities and cardiac risk factors including diabetes mellitus, prior MI, STEMI, elevated blood levels of cardiac biomarkers and multivessel CAD.[6] Other high-risk baseline characteristics found to be associated with developing HF include prior HF, older age, female gender, race, current smoker status, hypertension, hyperlipidemia, prior angina or stroke, peripheral vascular disease, previous coronary artery bypass graft surgery (CABG), admission diagnosis of STEMI or NSTEMI, ST-segment changes, anterior ST-segment elevation, post-revascularization Q waves on ECG, right bundle branch block, LVEF< 30%, Killip class >2 at presentation, higher presenting heart rate, atrial fibrillation, ventricular tachycardia, and baseline TIMI grade 0 flow.[6,31,32,36,41-45] Close attention to patients with those baseline characteristics in the setting of ACS and PCI, vigilance for early signs of HF and implementing preventive treatment, such as earlier use of the RAASB and BB might potentially lower the rate of HF during hospital stay in such patients.[6]

Rare, but serious, causes of HF in patients who have STEMI include ventricular septal defect, acute mitral valve insufficiency due to ischemia or infarction and rupture of a papillary muscle or chordae. These complications, however, are rare, but lead to cardiogenic shock in the majority of patients and is associated with high early mortality.[45]

Cardiogenic shock developed in 13 patients in this study (6.7% or HF patients; 0.04% of all patients), a rate much lower than that reported by others and ranges between 3% and 5.4%.[46-48] While most of HF cases complicating NSTEACS are manifested by pulmonary edema, over half of patients with cardiogenic shock have concomitant STEMI. This underlines the importance of early invasive strategy in these patients because mortality rate among patients who developed cardiogenic shock is prohibitively high and exceeds 50%.[24] Recent guidelines advocate an immediate aggressive invasive and coronary revascularization approach by PCI or CABG depending on coronary anatomy.[46,48] Intra-aortic balloon counterpulsation was used in a small percentage (2.1%) of HF patients in this study. The value of this intervention has been challenged when used in patients suffering cardiogenic shock.[46]

HF due to impaired LV systolic function at the time of admission for ACS or during primary PCI for STEMI has been shown to be an independent predictor of reduced early (during hospital stay and at 30 days) and late survival and future MI.[4,44,45,48] HF developing at any time during hospitalization for patients with STEMI, NSTEMI or UA is independently associated with poor outcomes. We demonstrated in this study that death rates among patients with any of the sub-types of ACS were significantly higher among those who developed HF compared with those who did not. We demonstrated that HF was an independent predictor of one year mortality in the studies population.

Mortality rates among HF patients in this study during hospital stay (5.1%) and at one year (11.2%) were lower than those reported by other investigators from this region and other regions. In one study, in-hospital death rate ranged between12% and 18%, depending on the sub-type of ACS.[49,50] Another registry from this region reported a death rate of 7.9% during hospital stay.[12] HF on admission was associated with a marked increase in mortality rates at 30 days, 2 and 7.6 years.[6,46,50] In addition to excess mortality, we also demonstrated, similar to others, increased rates of ST and coronary revascularization among patients with HF.[46]

Recent studies have reported significant decreases in the rates of in-hospital death, cardiogenic shock, recurrent myocardial infarction, and heart failure in in the setting of ACS.[51,52] Rates of HF fell by 9% in patients with STEMI and by 6.9% in those with NSTEMI.[52] Potential explanations of this trend include the increasing use of evidence-based pharmacotherapies, adopting primary PCI as the treatment of choice for STEMI, higher rate of use of PCI for NSTEACS, and advances in PCI instrumentations.[1,3,48,51]

Evidence-based therapies and secondary cardiovascular prevention medications are indicated for patients with STEMI, NSTEACS, HF complicating ACS, and stable coronary disease patients with low LVEF or HF.[32,33,45] These medications, that include DAPT, RAASB, BB, and statins, were prescribed in this study during hospital stay and at one year of follow up at similar rates in patients who developed or did not develop HF.

The study has few limitations similar to those of observational studies, including possible selection bias and not enrolling consecutive patients. Furthermore, the study did not include patients who died before arrival to hospital or before undergoing PCI or those who underwent diagnostic coronary angiography and were referred to CABG. The accuracy, concordance, and inter/intra-observer variability in detecting HF among the patients could not be determined for obvious temporal and practical reasons. Data collection during hospitalization was

complete for the whole cohort, and 1.5% of patients were lost to follow up at one year; a small percentage that would not significantly affect the one year outcome. Patients were enrolled by tertiary care centers, thus the results may not be generalizable to the broader population of patients with ACS treated in all hospitals in the region.

CONCLUSIONS

This study highlights several facts about HF complicating PCI in this Middle Eastern population. HF has an incidence rate less than that reported by similar studies and registries from this region and other regions. HF was associated with significant increased risk of in-hospital and one-year mortality. These results have important implications. Prompt revascularization and optimization of evidence-based therapies following PCI for ACS and stable coronary disease should be emphasized. There are baseline clinical and coronary angiographic characteristics that may identify patients at increased risk of developing heart failure among those admitted with ACS who undergo PCI. Vigilance for HF signs in such a group of patients and early treatment with evidence-based therapies could improve the in-hospital outcome and decrease the risk of future adverse events.

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