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Clinical features, management, and short- and long-term outcomes of patients with acute decompensated heart failure: phase I results of the HEARTS database

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Aims The HEart function Assessment Registry Trial in Saudi Arabia (HEARTS) is a national multicentre project, studying clinical features, management, short- and long-term outcomes, and mortality predictors in patients admitted with acute decompensated heart failure (ADHF).

Methods and results Our prospective registry enrolled 2610 ADHF patients admitted to 18 hospitals in Saudi Arabia between October 2009 and December 2010, and followed mortality rates until January 2013. The patients included 66% men and 85.5% Saudis, with a median age (interquartile range) of 61.4 (15) years; 64% had acute on chronic heart failure (HF), 64.1% diabetes mellitus, 70.6% hypertension, and 55.7% CAD. Exacerbating factors for hospital admission included acute coronary syndromes (37.8%), infections (20.6%), non-compliance with low-salt diet (25.2%), and non-compliance with HF medications (20%). An LVEF <40% was found in 73%. In-hospital use of evidence-based medications was high. All-cause cumulative mortality rates at 30 days, 6 months, 1 year, 2 years, and 3 years were 8.3, 13.7, 19.5, 23.5, and 24.3%, respectively. Important independent predictors of mortality were history of stroke, acute on chronic HF, systolic blood pressure <90 mmHg upon presentation, estimated glomerular filtration rate <60 mL/min, and haemoglobin <10 g/dL.

Conclusion Patients with ADHF in Saudi Arabia presented at a younger age and had higher rates of CAD risk factors compared with those in developed countries. Most patients had reduced LV systolic function, mostly due to ischaemic aetiology, and had poor long-term prognosis. These findings indicate a need for nationwide primary prevention and HF disease management programmes.

Keywords Acute heart failure • Saudi Arabia • Middle East • HEARTS • Registry

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Introduction

Heart failure (HF) is a major cause of morbidity and mortality worldwide, and has significant negative impacts on quality of life, healthcare costs, and longevity.[1−3] It has been estimated that each year >2 million patients in Europe and the USA require hospitalization due to acute decompensated heart failure (ADHF).[4,5] The total cost of HF in the USA exceeds US$40 billion annually, with >50% of this cost related to hospitalization.[6] Randomized controlled trials studying HF are often biased by the inclusion of selective HF patient populations that are managed in ideal settings. Therefore, registries have been created to record 'real-life' clinical features and management of patients with ADHF.[7−16] However, most of these studies have been performed in North America and Europe, and scarce data are available for Arab populations that have different ethnic and cultural backgrounds.[17−19]

The HEart function Assessment Registry Trial in Saudi Arabia (HEARTS) is the first prospective multicentre survey in the Kingdom of Saudi Arabia and in the Arab population to study patients with ADHF and high-risk chronic HF. HEARTS also involves a quality improvement initiative that aims to identify 'knowledge−care' gaps and potentially improve patient outcomes. In the present study, we examined the HEARTS data, and reported the baseline clinical presentation, management, short- and long-term outcomes, and independent predictors of death in patients with ADHF. We also compared our overall results with the international data available about this patient population.

Methods

Study population

HEARTS is a prospective registry and quality improvement initiative that comprises consecutive inpatients and high-risk outpatients with HF. In this report, we included only patients with ADHF admitted to hospital [coronary/intensive care unit (CCU/ICU) or ward], whether *de novo* (no previous history of HF) or acute on chronic HF, who required treatment with i.v. diuretics, inotropes, or vasodilators. Patients with ADHF were defined as those with rapid onset of symptoms and signs secondary to abnormal cardiac function, and included (i) symptoms (dyspnoea at rest or on exercise, fatigue, tiredness, ankle swelling); (ii) signs (tachycardia, tachypnoea, elevated jugular venous pressure, pulmonary rales, pleural effusion, hepatomegaly, peripheral oedema); and (iii) objective evidence of structural or functional abnormality of the heart at rest (third heart sound, murmurs, cardiomegaly, abnormal echocardiogram, raised natriuretic peptide concentration).[3] We excluded those who were ≤18 years of age, who refused to consent, and ADHF patients who were managed and discharged from the emergency department without hospital admission. The study was approved by the ethics committees at each hospital. Verbal informed consent has been obtained from the patients, and written informed consent was not required.

Study design

The full study design has been described elsewhere.[20] In brief, the study was divided into three phases. First, the pilot phase aimed to identify the logistic challenges and test the feasibility of completing the

Table 1 Clinical characteristics, investigations, and procedures in patients with acute decompensated heart failure

	Overall, *n* = 2610
Demographics	
Age in years, mean (SD)	61.4 (15.0)
Age of Saudis in years, mean (SD)	61.9 (15.3)
Age of non-Saudis in years, mean (SD)	57.8 (12.3)
Age >70 years, *n* (%)	754 (29)
Female, *n* (%)	893 (34.2)
Saudi, *n* (%)	2231 (85.5)
Body mass index in kg/m^2, mean (SD)	29.2 (6.7)
Ambulance use, *n* (%)	135 (5.2)
CCU and/or ICU bed, *n* (%)	1418 (54.3)
Days of CCU and/or ICU stay, median (IQR)	5.0 (6)
Days of hospital stay, median (IQR)	8.0 (9)
Past medical history	
HF, *n* (%)	1670 (64)
IHD, *n* (%)	1377 (53.3)
PCI, *n* (%)	340 (13.1)
CABG, *n* (%)	261 (10)
RHD, *n* (%)	183 (7.1)
AF, *n* (%)	408 (15.7)
VT/VF, *n* (%)	64 (2.5)
ICD, *n* (%)	229 (8.8)
CRT, *n* (%)	85 (3.3)
Stroke, *n* (%)	252 (9.7)
PAD, *n* (%)	99 (3.8)
Anaemia, *n* (%)	538 (20.7)
Chronic renal insufficiency, *n* (%)	771 (29.6)
Requiring dialysis, *n* (%)	72 (9.3)
Not on dialysis, *n* (%)	699 (90.7)
Chronic lung disease, *n* (%)	493 (19)
Risk factors	
Smoker and/or ex-smoker, *n* (%)	872 (33.4)
Hypertension, *n* (%)	1832 (70.6)
Dyslipidaemia, *n* (%)	894 (36.4)
DM, *n* (%)	1669 (64.1)
DM on diet, *n* (%)	41 (2.5)
DM on insulin, *n* (%)	703 (42.1)
DM on OHA, *n* (%)	656 (39.3)
DM on both, *n* (%)	251 (15)
Alcohol consumption, *n* (%)	43 (1.6)
Vital signs on presentation	
SBP, mean (SD)	128 (30.4)
DBP, mean (SD)	73.6 (17.2)
HR, mean (SD)	88.1 (20.3)
HF exacerbating factors	
STEMI, *n* (%)	276 (10.6)
NSTEMI, *n* (%)	711 (27.2)
Hypertension, *n* (%)	517 (19.8)
Infections, *n* (%)	537 (20.6)
COPD exacerbation, *n* (%)	101 (3.9)
Arrhythmia, *n* (%)	284 (10.9)
Worsening renal failure, *n* (%)	457 (17.5)
Non-compliance with low-salt diet, *n* (%)	659 (25.2)

Table 1 Continued

	Overall, $n = 2610$
Non-compliance with HF therapy, *n* (%)	549 (21)
Investigations	
Sodium in mmol/L, mean (SD)	135.1 (5.3)
Sodium <135 mmol/L, *n* (%)	1043 (40.1)
Urea in μmol/L, mean (SD)	11.8 (9.1)
Urea >7.5 μmol/L, *n* (%)	1613 (62.0)
Creatinine in μmol/L, mean (IQR)	109 (70)
eGRF <60 mL/min/1.73 m^2, *n* (%)[a]	1294 (49.6)
Haemoglobin in g/dL, mean (SD)	12.4 (2.2)
Haemoglobin <12 g/dL, *n* (%)	914 (35.2)
Random serum glucose in mmol/L, median (IQR)	8.3 (6)
NT-proBNP, *n* (%)	435 (16.7)
NT-proBNP in pg/mL, median (IQR)	5738 (5678)
Positive troponin, *n* (%)	867 (33.2)
AF, *n* (%)	449 (17.2)
QRS on ECG ≥120 ms, *n* (%)	389 (14.9)
LBBB, *n* (%)	305 (11.7)
Echo, *n* (%)	2495 (95.6)
Preserved LV function (EF ≥40%), *n* (%)	675 (27.1)
Moderate LV systolic dysfunction (EF 30–40%), *n* (%)	632 (25.3)
Severe LV systolic dysfunction (EF <30%), *n* (%)	1188 (47.6)
Coronary angiogram, *n* (%)	764 (29.3)
CAD, *n* (%)	
Left main	28 (3.7)
Single vessel	105 (13.7)
Double vessel	116 (15.2)
Triple vessel	255 (33.4)
Non-significant	82 (10.7)
Normal coronaries	183 (24)

CABG, coronary artery bypass graft; CCU, coronary care unit; DBP, diastolic blood pressure; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HF, heart failure; HR, heart rate; ICD, implantable cardioverter defibrillator; ICU, intensive care unit; IHD, ischaemic heart disease; OHA, oral hypoglycaemic agents; PAD, peripheral arterial disease; RHD, rheumatic heart disease; SBP, systolic blood pressure; VF, ventricular fibrillation; VT, ventricular tachycardia.
[a]eGFR was calculated based on the CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) formula.

case report forms (CRFs) in 'real-life' practice. Next, in phase I (the results of which are reported in the present study), we measured the baseline clinical features and case management practices of patients admitted with ADHF. We also assessed in-hospital outcomes, and short- and long-term all-cause mortality rates of these patients. This phase included online access to each hospital's own 'real-life' data, for comparison with those from other hospitals, with the aim of discovering knowledge–care gaps early in the study and allowing for timely improvement in clinical practice. Finally, phase II will measure the same data variables at a later time point to assess the effectiveness of this initiative in improving the quality of care.

Study organization

Throughout the hospital stay for each patient, a CRF with data variables of standard definitions[3,20] was completed online by dedicated research assistants, physicians, and/or trained heart failure clinic (HFC) nurses working in each hospital. In each hospital, a log book was filled out for all patients to ensure enrolment of >95% of consecutively admitted patients. All CRFs were verified by a cardiologist and sent to the principal coordinating centre, where the forms were checked for incomplete data and mistakes before submission for final analysis. Each patient's national identification number was used to avoid double counting.

Statistical methods

Continuous variables were summarized using means or medians based on the normality; normally distributed variables were summarized using the mean and standard deviation (SD), while the non-normally distributed variables were summarized using the median and interquartile range (IQR). Categorical variables were summarized using frequencies and percentages. Predictors of mortality were assessed using Cox regression; both univariate and multivariate regression models were used to obtain independent predictors. We used stepwise multiple regression models to select the independent predictors in the multivariate models. We reported summary statistics, *P*-values, the crude and adjusted hazard ratios (HRs), and 95% confidence intervals (CIs) from regression models. Kaplan–Meier curves were used to depict the survival pattern of the HF patients in our cohort. All analyses were performed using SPSS version 17 (SPSS Inc., Chicago, IL, USA).

Results

Over a 14-month period, 2610 patients with ADHF were enrolled from 18 hospitals in the Kingdom of Saudi Arabia. Hospitals were recruited from all geographical regions, and almost half were from the central region, which is the most heavily populated. Six hospitals had neither catheterization laboratories nor cardiac surgery facilities, four had HF clinics, and three were University hospitals. A total of 15 patients were lost to follow-up within 3 years after hospital discharge.

The main aetiologies of HF were CAD (55.7%), idiopathic dilated cardiomyopathy (16.5%), hypertension (11.8%), and primary valvular heart disease (7.7%). The overall cohort had a mean age (±SD) of 61.4 (±15) years, 65.8% were male, 85.5% were Saudis, and the mean body mass index (BMI) ± SD was 29.2 ± 6.7 kg/m^2. Only 5.2% of patients were transferred from home to hospital by ambulance, almost half were admitted to a CCU/ICU bed, and the mean (±SD) duration of hospital stay was 5 (±6) days. A review of medical history showed that 64% of patients had chronic HF, 53.3% ischaemic heart disease, 9.7% stroke, 15.7% AF, 20.7% anaemia, 19% chronic lung diseases (7% COPD), 29.6% chronic renal insufficiency, 64.1% diabetes mellitus, 70.6% hypertension, 36.4% dyslipidaemia, and 33.4% were current or ex-smokers (*Table 1*).

Upon admission, the mean ± SD systolic blood pressure (SBP) was 128 ± 30.4 mmHg and heart rate was 88.1 ± 20.3 b.p.m. Exacerbating factors for hospital admission were multifactorial, with 10.6% of patients exhibiting ST-segment elevation myocardial infarction (STEMI), 27.2% non-ST-segment elevation myocardial infarction (NSTEMI), 19.8% hypertension, 20.6% infections (84.5% of which were respiratory), 17.5% worsening renal function, 25.2% non-compliance with HF diet, and 20% non-compliance with HF medications. Additionally, 33.2% of patients exhibited positive

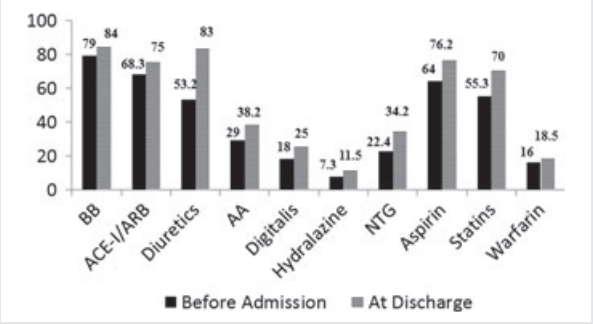

Figure 1 Evidence-based oral medications used before admission and at discharge in patients with acute decompensated heart failure. AA, aldosterone antagonist; ACE-I, ACE inhibitor; BB, beta-blockers; NTG, nitroglycerine.

serum troponin, 17.2% showed AF on ECG, and 15% had a QRS ≥120 ms. The level of NT-proBNP was measured in 16.7% of patients, and the median (IQR) level upon admission was 5738 (5678) pg/mL. Echocardiography revealed preserved LV function (EF >40%) in 27.1% of patients, and coronary angiogram was performed in 29.3%.

The administered i.v. medications mainly included nitroglycerine in 27.8% of patients, dobutamine in 12.1%, dopamine in 18%, furosemide boluses in 89%, and furosemide infusion in 27.9%. At hospital discharge, evidence-based oral medications were used at a higher rate than the usage before admission (*Figure 1*). Appendix 1 shows the names of these medications and their rates of use. At hospital discharge, an aldosterone antagonist was used at an overall rate of 38.2%, and was prescribed more in hospitals without HF clinics than in those with HF clinics (43.6 vs. 38%, $P = 0.005$; respectively).

Table 2 shows the in-hospital clinical events, procedures, and short- and long-term mortality rates. In-hospital HF recurrence was found in around one-third of the patients, ventricular fibrillation or tachycardia in 4%, shock in 8.7%, and AF in 6%; the all-cause in-hospital mortality rate was 6.5%. The all-cause cumulative mortality rates at 30 days, 6 months, 1 year, 2 years, and 3 years after hospital discharge were 8.3, 13.7, 19.5, 23.5, and 24.3%, respectively. These mortality rates did not significantly differ between ADHF patients with ischaemic vs. non-ischaemic aetiologies. Independent predictors of mortality were advanced age, acute on chronic HF, history of stroke, SBP <90 mmHg, and heart rate >100 b.p.m. upon presentation, serum sodium <135 mmol/L, urea >7.5 mmol/L, estimated glomerular filtration rate (eGFR) <60 mL/min, and haemoglobin <10 g/dL (*Table 3*).

Table 2 In-hospital clinical events, procedures, and mortality rates in patients with acute decompensated heart failure

	Overall, $n = 2610$
Recurrent CHF, *n* (%)	816 (31.3)
Dialysis, *n* (%)	125 (4.8)
Ventilation, *n* (%)	290 (11.1)
IABP, *n* (%)	86 (3.3)
Sepsis, *n* (%)	196 (7.5)
Cardiac transplantation, *n* (%)	3 (0.1)
Shock, *n* (%)	228 (8.7)
VT/VF required Rx, *n* (%)	110 (4.2)
AF required Rx, *n* (%)	156 (6.0)
CRT, *n* (%)	68 (2.6)
ICD, *n* (%)	150 (5.7)
Major bleeding, *n* (%)	38 (1.5)
TIA/stroke, *n* (%)	48 (1.8)
All-cause mortality (overall), *n* (%)	
In-hospital	170 (6.5)
1 month[a]	215 (8.3)
6 months[a]	364 (13.7)
1 year[a]	509 (19.5)
2 years[a]	613 (23.5)
3 years[a]	634 (24.3)

CHF, congestive heart failure; IABP, intra-aortic balloon pump; ICD, implantable cardioverter defibrillator; Rx, treatment; TIA, transient ischaemic attack; VF, ventricular fibrillation; VT, ventricular tachycardia.
[a]Cumulative mortality rates.

Discussion

HEARTS is the first national multicentre prospective registry to study HF patients in an Arab population. Here we reported the overall clinical presentation, management, short- and long-term outcomes, and predictors of mortality rates of ADHF patients from this registry. Over the last two decades, several international observational HF studies have been performed, in the form of ongoing registries or a 1-day snapshot nationwide survey.[7–16] *Table 4* presents the salient features of our ADHF patients compared with patients from other HF registries worldwide. The average age of presentation in our patients was approximately one decade younger relative to other patients worldwide, and even two decades younger than in the recent HF survey in France.[12] This is probably explained by the extremely high rates of diabetes mellitus and hypertension, which were among the highest ever reported in the literature. The high rates of CAD risk factors might have been associated with the presence of ischaemic aetiology in more than half of our ADHF patients.

Our group has previously demonstrated similar findings of relatively young age at presentation and high rates of CAD risk factors in our national ACS registry,[21] which are probably related to the sedentary lifestyle and high calorie intake in the Arabian Gulf region over the last few decades.[22–25] In addition, ~15% of our patients are expatriates, most of whom are male manual workers, are smokers, and tend to present late with STEMI, and subsequently sustain ADHF at a relatively young age. Unsurprisingly, we found that only one-third of our ADHF patients were female and that one-third had preserved LV function, while other ADHF registries have shown that these groups each account for nearly half of the patient population.[7–16] The overall life expectancy in the developed world is longer than that in the developing world due

Table 3 Univariate and multivariate predictors of mortality in patients with acute decompensated heart failure

	Univariate		Multivariate	
	Crude HR (95% CI)	***P*-value**	**Adjusted HR (95% CI)**	***P*-value**
Age (per 1 year)	1.03 (1.02–1.03)	<0.001	1.02 (1.01–1.03)	<0.001
Gender				
Male (reference)	1.0			
Female	1.1 (0.9–1.3)	0.385		
AHF type				
De novo (reference)	1.0		1.0	
Acute on chronic	1.6 (1.3–1.9)	<0.001	1.4 (1.1–1.7)	0.001
Hx of DM (reference)				
No	1.0			
Yes	1.04 (0.9–1.2)	0.661		
Hx of HTN				
No (reference)	1.0			
Yes	1.4 (1.1–1.6)	0.001		
Hx of dyslipidaemia				
No (reference.)	1.0			
Yes	1.2 (0.99–1.4)	0.066		
Hx of smoking				
Never smoked (reference)	1.0			
Ex-smoker	1.03 (0.8–1.3)	0.791		
Smoker	0.7 (0.5–0.8)	0.001		
Hx of IHD (angina/MI)				
No (reference)	1.0			
Yes	1.2 (1.004–1.4)	0.044		
Hx of PCI				
No (reference)	1.0			
Yes	0.8 (0.6–1.01)	0.060		
Hx of CABG				
No (reference)	1.0			
Yes	1.4 (1.09–1.7)	0.007		
Hx of stroke				
No (reference)	1.0		1.0	
Yes	2.0 (1.3–3.2)	0.004	1.96 (1.2–3.2)	0.008
Hx of AF				
No (reference)	1.0			
Yes	1.3 (1.1–1.6)	0.004		
Hx of chronic renal insufficiency				
No (reference)	1.0			
Yes	1.8 (1.5–2.1)	<0.001		
Hx of COPD				
No (reference)	1.0			
Yes	1.4 (0.98–1.97)	0.067		
SBP on admission				
<90	2.0 (1.5–2.7)	<0.001	1.7 (1.3–2.4)	0.001
≥90 (reference)	1.0		1.0	
Heart beats on admission (b.p.m.)				
≤100 (reference)	1.0		1.0	
>100	1.01 (0.9–1.3)	0.241	1.2 (1.006–1.5)	0.043
Sodium				
>135 (reference)	1.0		1.0	
<135	1.3 (1.1–1.5)	0.001	1.2 (1.1–1.5)	0.01
Urea				
≤7.5 (reference)	1.0	<0.001	1.0	
>7.5	2.1 (1.7–2.5)		1.3 (1.047–1.7))	0.019

Table 3 Continued

	Univariate		Multivariate	
	Crude HR (95% CI)	***P*-value**	**Adjusted HR (95% CI)**	***P*-value**
eGFR				
<60	2.1 (1.8–2.5)	<0.001	1.5 (1.2–1.9)	<0.001
≥60 (reference)	1.0		1.0	
Random blood glucose				
≤11.1 (reference)	1.00	0.049		
>11.1	1.2 (1.001–1.4)			
Haemoglobin				
<10	1.9 (1.5–2.4)	<0.001	1.5 (1.2–1.95)	0.001
≥10 (reference)	1.0		1.0	
LBBB (on ECG)				
No	1.0			
Yes	1.2 (0.99–1.6)	0.059		
EF on Echo				
Normal	1.0			
Mild LV dysfunction	1.0 (0.7–1.4)	0.914		
Moderate LV dysfunction	1.1 (0.8–1.4)	0.684		
Severe LV dysfunction	1.1 (0.8–1.4)	0.5		
Aetiology (ischaemic vs. not)				
No	1.0			
Yes	1.01 (0.86–1.18)	0.932		

CABG, coronary artery bypass graft; CI, confidence interval; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HR, hazard ratio; HTN, hypertension; Hx, history; IHD, ischaemic heart disease; MI, myocadial infarction; SBP, systolic blood pressure.

to overall better socio-economic levels, lifestyle behaviours, and educational and healthcare systems; thus, developed countries are more likely to have greater proportions of ADHF patients who are elderly, female, and have preserved LV function. Our present findings indicate an urgent need to undertake major national health policy initiatives in the field of primary cardiovascular prevention, such as educational campaigns about a healthy lifestyle, regular exercise, and smoking cessation. This could potentially reduce the burden of ischaemic heart disease (acute and chronic) and, subsequently, the incidence of ADHF cases. Almost half of our patients had evidence of non-compliance with either a low-salt diet or HF medications, which represents an important opportunity for improving care through increased patient education prior to hospital discharge and establishment of HF disease management programmes.

The rate of NT-proBNP testing in our patients was 16.7%, compared with 1% in England and Wales,[26] 30% in Italy,[13] and 93% in Japan.[14] These large differences might reflect differing opinions regarding the diagnostic role of BNP testing in ADHF patients. Local reimbursement regulations within each country's healthcare system probably also play an important role. The recent American College of Cardiology/American Heart Association guidelines give BNP testing a class I indication to support clinical judgement for ADHF diagnosis, especially in the setting of uncertain diagnosis.[27]

The high rates of inotrope use (18%) and ICU/CCU admissions (54.3%) were probably related to the high prevalence of ACS and significant LV systolic dysfunction in our patient population. The reported use of evidence-based oral medications was high compared with major international HF registries. Our analysis revealed, however, that hospitals with HF clinics were less likely to prescribe an aldosterone antagonist than those without. The long-term safety of this clinical practice requires further evaluation.

The median length of hospital stay (8 days) was comparable with (and even slightly shorter than) that shown in recent data from Europe.[12,13] The highest ever reported was 21 days in Japan.[14] A recent analysis of clinical trial data showed that countries with a longer length of hospitalization for HF had significantly lower rates of re-admission within 30 days of randomization.[28] In light of the younger age of presentation of our patients, the all-cause in-hospital mortality (6.5%) was high compared with that in other registries. Most of the proportional increases in long-term mortality rates after hospital discharge occurred at 1 year of follow-up, with these rates being almost triple the in-hospital mortality rate. Our registry is unique in reporting long-term mortality rates (24.3% after 3 years). Recent ADHF data from the Czech Republic showed a 3-year mortality rate of 35.5%, but the average age on presentation was a decade older than that of our patients.[29] The independent predictors of mortality in our registry were similar to those reported previously in the literature, and highlighted the fact that clinical variables that were readily available upon clinical presentation were more predictive than LVEF and aetiology of ADHF.

Our study has some limitations. As with most other registries, hospital enrolment was voluntary; thus, our findings may not be representative of clinical practice in all hospitals of the country.

Table 4 Comparison between HEARTS and worldwide data in patients with acute decompensated heart failure

	HEARTS	ADHERE[7]	ADHERE-AP[8]	OPTIMIZE-HF[9]	ESC-HF Pilot[10,11]	OFICA[12]	IN-HF[13]	ATTEND[14]
	Saudi Arabia 18 centres 2009–2010	USA 274 centres 2002–2004	Asia-Pacific 43 centres 2006–2008	USA 259 centres 2003–2004	Europe 136 centres 2009–2010	France 170 centres 1-day snapshot (12-03-2009)	Italy 61 centres 2007–2010	Japan 52 centres 2007–2011
ADHF classification	NA[a]	NA	NA	NA	ESC Guidelines	ESC Guidelines PEF vs. REF	ESC Guidelines DN vs. WHF	HTN/DM vs. none Excluded ACS
Patients, *n*	2610	105 388	10 171	48 612	1892	1658	1855	4842
Age, years	61.4	75	67	73	69	79.3	72	73
Females, %	34.2	51	43	52	37.4	45.2	40	42
LVEF ≥0.40, %	27.1	46	47	51	35.5	36.2	41.6	46.6
Ischaemic aetiology, %	55.7	65	50	46	50.7	43.6	42	31.1
Prior HF, %	64	65	64	88	NA	45.1	57	36.2
DM, %	64	44	45	41	35.1	31.1	40	33.8
HTN, %	71	73	64	71	61.8	61.7	58	69.4
COPD, %	7	31	NA	NA	15.2	21	30	9.5
AF, %	15.7	31	24	31	43.7	45.1	38	39.6
SBP in mmHg, median (IQR)/mean ± SD	128 (30.4)	144 ± 33	NA	143 ± 33	133 (29)	129 (110–150)	134 ± 33	145.5 (36.7)
HR, median (IQR)/mean ± SD	88.1 (20.3)	NA	NA	87 ± 21	88 (24)	85 (71–102)	90 (73–110)	98.6 (29.1)
NT-proBNP testing done, %	16.7	35–63	16	8	37	81	15.3–30	93
I.v. diuretics, %	89 (bolus) 28 (infusion)	92	85	NA	84.6	84.8	NA	76.3
I.v. inotropes, %	18	15	15	11	10.5	NA	NA	18.5
Beta-blockers, %	84	59	41	64	81	55.9	65	65
ACE inhibitor/ARB, %	75	69	63	65	78	67.7	78	78
Aldosterone inhibitor, %	38.2	NA	31	NA	54	18	55	42
CCU/ICU admission, %	54.3	19	NA	NA	48	42.9	46	NA
Days of hospital stay, median (IQR)	8 (9)	4 (2–9)	6	6	8 (5–11)	13 (8–20)	10 (7–15)	30 ± 39[b] 21 (14–32)[c]
In-hospital mortality, %	6.5	4	4.8	3.8	3.8	8.2	6.4	6.4
30-day mortality, %	8.1	NA	NA	NA	NA	NA	NA	NA
1-year mortality, %	19.5	NA	NA	NA	17.4	NA	24	NA
2-year mortality, %	23.6	NA	NA	NA	NA	NA	NA	NA
3-year mortality, %	24.3	NA	NA	NA	NA	NA	NA	NA

ACS, acute coronary syndrome; ADHF, acute decompensated heart failure; CCU, coronary care unit; DM, diabetes mellitus; DN, *de novo*; HF, heart failure; HTN, hypertension; IQR, interquartile range; ICU, intensive care unit; NA, not available; PEF, preserved ejection fraction; REF, reduced ejection fraction; SBP, systolic blood pressure; WHF, worsening heart failure.

[a]Planned in a separate future report.

[b]mean.

[c]median.

Additionally, the study results could have been affected by unmeasured confounding variables, such as socio-economic strata, patient preferences, and post-hospital care. We were unable to include BNP testing in the predictors of mortality model since it was performed in only a minority of our patients. The factors influencing the long-term mortality rates are unknown, and we did not measure re-admission rates or outpatient use of evidence-based medications. However, our registry has the major strength of being the first multicentre prospective observational report of ADHF patients in the Arab world, and including excellent long-term follow-up of all-cause mortality rates in one of the largest countries in the Middle East.

In conclusion, analysis of our national registry revealed that patients with ADHF in Saudi Arabia presented at a relatively younger age and had higher rates of CAD risk factors compared with developed countries. Most patients exhibited reduced LV systolic function, mostly due to ischaemic aetiology, and had poor long-term prognosis. These findings indicate that nationwide primary prevention programmes are greatly needed, in addition to the establishment of HF disease management programmes to improve patient compliance and outcomes.

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Appendix: Evidence-based medications and their rates of use before admission and at discharge ($n = 2610$)

Medication	BA, *n* (%)	AD, *n* (%)
Beta-blockers		
Bisoprolol	1042 (39.9)	1059 (40.6)
Carvedilol	767 (29.4)	881 (33.8)
Atenolol	95 (3.6)	59 (2.3)
Metoprolol	157 (6.0)	181 (2.6)

Appendix: Continued

Medication	BA, *n* (%)	AD, *n* (%)
ACE inhibitor		
Lisinopril	788 (30.2)	899 (34.4)
Captopril	344 (13.2)	343 (13.1)
Perindopril	130 (4.9)	160 (6.1)
Fosinopril	49 (1.9)	48 (1.8)
Enalapril	113 (4.3)	105 (4.1)
ARB		
Candesartan	153 (5.8)	179 (6.9)
Irbesartan	73 (2.8)	76 (2.9)
Valsartan	55 (2.1)	53 (2.0)
Telmisartan	23 (0.8)	33 (1.2)
Losartan	42 (1.7)	41 (1.6)
Olmesartan	3 (0.1)	6 (0.2)
Aldosterone antagonist (spironolactone)	747 (28.6)	999 (38.2)

AD, after discharge; BA, before admission.

References

1. Najafi F, Jamrozik K, Dobson AJ. Understanding the 'epidemic of heart failure': a systematic review of trends in determinants of heart failure. *Eur J Heart Fail* 2009;**11**:472–479.
2. Hunt SA, Abraham WT, Chin MH, Feldman AM, Francis GS, Ganiats TG, Jessup M, Konstam MA, Mancini DM, Michl K, Oates JA, Rahko PS, Silver MA, Stevenson LW, Yancy CW. 2009 focused update incorporated into the ACC/AHA 2005 guidelines for the diagnosis and management of heart failure in the adults: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol* 2009;**53**:e1–e90.
3. Dickstein K, Cohen-Solal A, Filippatos G, McMurray JJV, Ponikowski P, Poole-Wilson PA, Stromberg A, van Veldhuisen DJ, Atar D, Hoes AW, Keren A, Mebazaa A, Nieminen M, Priori SG, Swedberg K. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2008. The Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2008 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association of the ESC (HFA) and endorsed by the European Society of Intensive Care Medicine (ESICM). *Eur J Heart Fail* 2008;**10**:933–989.
4. Gheorghiade M, Zannad F, Sopko G, Klein L. Acute heart failure syndromes: current state and framework for future research. *Circulation* 2005;**112**:3958–3968.
5. McMurray JJ, Adamopoulos S, Anker SD, Auricchio A, Bohm M, Dickstein K, Falk V, Filippatos G, Fonseca C, Gomez-Sanchez MA, Jaarsma T, Kober L, Lip GY, Maggioni AP, Parkhomenko A, Pieske BM, Popescu BA, Ronnevik PK, Rutten FH, Schwitter J, Seferovic P, Stepinska J, Trindade PT, Voors AA, Zannad F, Zeiher A, Bax JJ, Baumgartner H, Ceconi C, Dean V, Deaton C, Fagard R, Funck-Brentano C, Hasdai D, Hoes A, Kirchhof P, Knuuti J, Kolh P, McDonagh T, Moulin C, Reiner Z, Sechtem U, Sirnes PA, Tendera M, Torbicki A, Vahanian A, Windecker S, Bonet LA, Avraamides P, Ben Lamin HA, Brignole M, Coca A, Cowburn P, Dargie H, Elliott P, Flachskampf FA, Guida GF, Hardman S, Iung B, Merkely B, Mueller C, Nanas JN, Nielsen OW, Orn S, Parissis JT, Ponikowski P. ESC guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: the Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. *Eur J Heart Fail* 2012;**14**:803–869.
6. Lloyd-Jones D, Adams R, Carnethon M, Simone DG, Ferguson TB, Flegal K, Ford E, Furie K, AGo A, Greenlund K, Haase H, Hailpern H, Ho M, Howard V, Kissela B, Kittner S, Lackland D, Lisabeth L, Marelli A, McDermott M, Meigs J, Mozaffarian D, Nichol G, O'Donnell C, Roger V, Rosamond W, Sacco R, Sorlie P, Stafford R, Steinberger J, Thom T, Wasserthiel-Smoller S, Wong N, Wylie-Rosett J, Hong Y. American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2009 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation* 2009;**119**:480–486.
7. Adams KF Jr, Fonarow GC, Emerman CL, LeJemtel TH, Costanzo MR, Abraham WT, Berkowitz RL, Galvao M, Horton DP, ADHERE Scientific Advisory Committee and Investigators. Characteristics and outcomes of patients hospitalized for

heart failure in the United States: rationale, design, and preliminary observations from the first 100,000 cases in the Acute Decompensated Heart Failure National Registry (ADHERE). *Am Heart J* 2005;**149**:209–216.
8. Atherton JJ, Hayward CS, Wan Ahmad WA, Kwok B, Jorge J, Hernandez AF, Liang L, Kociol RD, Krum H, ADHERE International–Asia Pacific Scientific Advisory Committee. Patient characteristics from a regional multicenter database of acute decompensated heart failure in Asia Pacific (ADHERE International–Asia Pacific). *J Card Fail* 2012;**18**:82–88.
9. Abraham WT, Fonarow GC, Albert NM, Stough WG, Gheorghiade M, Greenberg BH, O'Connor CM, Sun JL, Yancy CW, Young JB, OPTIMIZE-HF Investigators and Coordinators. Predictors of inhospital mortality in patients hospitalized for heart failure: insights from the Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients With Heart Failure (OPTIMIZE-HF). *J Am Coll Cardiol* 2008;**52**:347–356.
10. Maggioni AP, Dahlström U, Filippatos G, Chioncel O, Leiro MC, Drozdz J, Fruhwald F, Gullestad L, Logeart D, Metra M, Parissis J, Persson H, Ponikowski P, Rauchhaus M, Voors A, Nielsen OW, Zannad F, Tavazzi L. Heart Failure Association of ESC (HFA). EURObservational Research Programme: the Heart Failure Pilot Survey (ESC-HF Pilot). *Eur J Heart Fail* 2010;**12**:1076–1084.
11. Maggioni AP, Dahlström U, Filippatos G, Chioncel O, Leiro MC, Drozdz J, Fruhwald F, Gullestad L, Logeart D, Fabbri G, Urso R, Metra M, Parissis J, Persson H, Ponikowski P, Rauchhaus M, Voors AA, Nielsen OW, Zannad F, Tavazzi L. Heart Failure Association of the European Society of Cardiology (HFA). EURObservational Research Programme: regional differences and 1-year follow-up results of the Heart Failure Pilot Survey (ESC-HF Pilot). *Eur J Heart Fail* 2013;**15**:808–817.
12. Logeart D, Isnard R, Resche-Rigon M, Seronde MF, de Groote P, Jondeau G, Galinier M, Mulak G, Donal E, Delahaye F, Juilliere Y, Damy T, Jourdain P, Bauer F, Eicher JC, Neuder Y, Trochu JN, Heart Failure of the French Society of Cardiology. Current aspects of the spectrum of acute heart failure syndromes in a real-life setting: the OFICA study. *Eur J Heart Fail* 2013;**15**:465–476.
13. Tavazzi L, Senni M, Metra M, Gorini M, Cacciatore G, Chinaglia A, Di Lenarda A, Mortara A, Oliva F, Maggioni AP, IN-HF (Italian Network on Heart Failure) Outcome Investigators. Multicenter prospective observational study on acute and chronic heart failure: one-year follow-up results of IN-HF (Italian Network on Heart Failure) outcome registry. *Circ Heart Fail* 2013;**6**:473–481.
14. Sato N, Kajimoto K, Keida T, Mizuno M, Minami Y, Yumino D, Asai K, Murai K, Muanakata R, Aokage T, Sakata Y, Mizuno K, Takano T, ATTEND Investigators. Clinical features and outcome in hospitalized heart failure in Japan (from the ATTEND Registry). *Circ J* 2013;**77**:944–951.
15. Siirilä-Waris K, Lassus J, Melin J, Peuhkurinen K, Nieminen MS, Harjola VP, FINN-AKVA Study Group. Characteristics, outcomes, and predictors of 1-year mortality in patients hospitalized for acute heart failure. *Eur Heart J* 2006;**27**:3011–3017.
16. Zannad F, Briancon S, Juilliere Y, Mertes PM, Villemot JP, Alla F, Virion JM. Incidence, clinical and etiologic features, and outcomes of advanced chronic heart failure: the EPICAL Study. Epidémiologie de l'Insuffisance Cardiaque Avancée en Lorraine. *J Am Coll Cardiol* 1999;**33**:734–742.
17. Ibrahim BS. The frequency of systolic vs. diastolic heart failure in an Egyptian cohort. *Eur J Heart Fail* 2003;**5**:41–45.
18. Agarwal AK, Venugopalan P, de Bono D. Prevalence and aetiology of heart failure in an Arab population. *Eur J Heart Fail* 2001;**3**:301.
19. Al Suwaidi J, Al-Qahtani A, Asaad N, Al-Mulla AW, Singh R, Albinali HA. Comparison of women versus men hospitalized with heart failure (from a 20-year registry in a middle-eastern country 1991–2010). *Am J Cardiol* 2012;**109**:395–400.
20. AlHabib KF, Elasfar AA, AlBackr H, AlFaleh H, Hersi A, AlShaer F, Kashour T, AlNemer K, Hussein GA, Mimish L. Design and preliminary results of the heart function assessment registry trial in Saudi Arabia (HEARTS) in patients with acute and chronic heart failure. *Eur J Heart Fail* 2011;**13**:1178–1184.
21. AlHabib KF, Hersi A, AlFaleh H, AlNemer K, AlSaif S, Taraben A, Kashour T, Bakheet A, Al Qarni A, Soomro T, Malik A, Ahmed WH, Abuosa AM, Butt MA, AlMurayeh MA, Al Zaidi A, Hussein GA, Balghith MA, Abu-Ghazala T. Baseline characteristics, management practices, and in-hospital outcomes of patients with acute coronary syndromes: Results of the Saudi project for assessment of coronary events (SPACE) registry. *J Saudi Heart Assoc* 2011;**23**:233–239.
22. Al-Elq AH. Current practice in the management of patients with type 2 diabetes mellitus in Saudi Arabia. *Saudi Med J* 2009;**30**:1551–1556.
23. Eledrisi M, Alhaj B, Rehmani R, Alotaibi M, Mustafa M, Akbar D. Quality of diabetes care in Saudi Arabia. *Diabetes Res Clin Pract* 2007;**78**:145–146.
24. Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F, McQueen M, Budaj A, Pais P, Varigos J, Lisheng L; INTERHEART Study Investigators. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case control study. *Lancet* 2004;**364**: 937–952.
25. Guy GW, Nunn AVW, Thomas LE, Bell JD. Obesity, diabetes, and longevity in the Gulf: is there a Gulf Metabolic Syndrome? *IJDM* 2009;**1**:43–54.
26. Cleland JGF, McDonagh T, Rigby AS, Yassin A, Whittaker T, Dargie HJ, on behalf of the National Heart Failure Audit Team for England and Wales. The national heart failure audit for England and Wales 2008–2009. *Heart* 2011;**97**: 876–886.
27. Yancy CW, Jessup M, Bozkurt B, Masoudi FA, Butler J, McBride PE, Casey DE Jr, McMurray JJ, Drazner MH, Mitchell JE, Fonarow GC, Peterson PN, Geraci SA, Horwich T, Januzzi JL, Johnson MR, Kasper EK, Levy WC, Riegel B, Sam F, Stevenson LW, Tang WH, Tsai EJ, Wilkoff BL; ACCF/AHA Task Force Members. 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. *Am Coll Cardiol* 2013;**62**:e147–e239.
28. Eapen ZJ, Reed SD, Li Y, Kociol RD, Armstrong PW, Starling RC, McMurray JJ, Massie BM, Swedberg K, Ezekowitz JA, Fonarow GC, Teerlink JR, Metra M, Whellan DJ, O'Connor CM, Califf RM, Hernandez AF. Do countries or hospitals with longer hospital stays for acute heart failure have lower readmission rates? Findings from ASCEND-HF. *Circ Heart Fail* 2013;**6**:727–732.
29. Parenica J, Spinar J, Vitovec J, Widimsky P, Linhart A, Fedorco M, Vaclavik J, Miklik R, Felsoci M, Horakova K, Cihalik C, Malek F, Spinarova L, Belohlavek J, Kettner J, Zeman K, Dušek L, Jarkovsky J, AHEAD Main investigators. Long-term survival following acute heart failure: the Acute Heart Failure Database Main registry (AHEAD Main). *Eur J Intern Med* 2013;**24**:151–160.