original article

Incidence of ventricular arrhythmia and associated patient outcomes in hospitalized acute coronary syndrome patients in Saudi Arabia: findings from the registry of the Saudi Project for Assessment of Acute Coronary Syndrome (SPACE)

Ahmad S. Hersi,[a] Khalid F. Alhabib,[a] Hussam F. AlFaleh,[a] Khalid AlNemer,[b] Shukri AlSaif,[c] Amir Taraben,[d] Tarek Kashour,[e] Ahmed M. Abuosa,[f] Mushabab A. Al-Murayeh[g]

From the [a]Department of Cardiac Sciences, College of Medicine, King Saud University, [b]Department of Medicine, Security Forces Hospital, Riyadh, [c]Department of Cardiology, Saud AlBabtain Cardiac Center, Dammam, [d]Department of Medicine, King Faisal Specialist Hospital and Research Center, Jeddah, [e]Department of Cardiac Sciences, Prince Salman Heart Center, King Fahd Medical City, Riyadh, [f]Department of Medicine, King Khalid National Guard Hospital, Jeddah, and [g]Armed Forces Hospital, Southern Region, Saudi Arabia

Correspondence: Ahmad S. Hersi, MD · Department of Cardiac Sciences, College of Medicine, King Saud University, Riyadh, Saudi Arabia · T: +9661 4671161 · ahersi@ksu.edu.sa · Accepted: July 2011

BACKGROUND AND OBJECTIVES: Mortality in acute coronary syndrome (ACS) patients with ventricular arrhythmia (VA) has been shown to be higher than those without VA. However, there is a paucity of data on VA among ACS patients in the Middle Eastern countries.

DESIGN AND SETTING: Prospective study of patients admitted in 17 government hospitals with ACS between December 2005 and December 2007.

PATIENTS AND METHODS: Patients were categorized as having VA if they experienced either ventricular fibrillation (VF) or sustained ventricular tachycardia (VT) or both.

RESULTS: Of 5055 patients with ACS enrolled in the SPACE registry, 168 (3.3%) were diagnosed with VA and 151 (98.8%) occurred in-hospital. The vast majority (74.4%) occurred in patients with ST-segment elevation myocardial infarction. In addition, males were twice as likely to develop VA than females (OR 1.7; 95% CI 1.1-3). Killip class >I (OR 2.0; 95% CI 1.3-3.1); and systolic blood pressure <90 mm Hg (OR 6.4; 95% CI 3.5-11.8) were positively associated with VA. Those admitted with hyperlipidemia (OR 0.49; 95% CI 0.3-0.7) had a lower risk of developing VA. Adverse in-hospital outcomes including re-myocardial infarction, cardiogenic shock, congestive heart failure, major bleeding, and stroke were higher for patients with VA ($P \leq .01$ for all variables) and signified a poor prognosis. The in-hospital mortality rate was significantly higher in VA patients compared with non-VA patients (27% vs 2.2%; P=.001).

CONCLUSIONS: In-hospital VA in Saudi patients with ACS was associated with remarkably high rates of adverse events and increased in-hospital mortality. Using a well-developed registry data with a large number of patients, our study documented for the first time the prevalence and risk factors of VA in unselected population of ACS.

Acute coronary syndrome (ACS), including ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina (UA), is a major life-threatening manifestation of coronary artery disease.[1-3] Moreover, data from early in the thrombolytic era indicate that STEMI complicated by ventricular arrhythmia (VA) is associated with a greater risk of short- and long-term mortality.[4-6] This increased mortality rate has been shown with VA follow-

ing NSTEMI as well.[7] Data from the Global Registry of Acute Coronary Events (GRACE) Registry also showed a higher hospital mortality rate when VA complicated ACS and allowed identification of variables associated with the occurrence of VA.[8] The incidence and prognosis of VA in ACS are not yet reported from Saudi Arabia. Accordingly, data in the Saudi Project for Assessment of Coronary Events (SPACE) registry were accessed to describe the incidence of clinical outcomes associated with VA in patients hospitalized with ACS in Saudi Arabia. Patient characteristics associated with an increased risk for developing VA were examined to establish a baseline from which further studies can determine temporal changes in the magnitude and prognosis associated with VA-related ACS.

PATIENTS AND METHODS

This was a sub-study of the multicenter, prospective SPACE registry of ACS patients admitted to 17 government hospitals in Saudi Arabia between December 2005 and December 2007.[9] Patients were categorized as having VA if they experienced either ventricular fibrillation (VF) or sustained ventricular tachycardia (VT) or both. VF was identified at admission or during the process of hospitalization if the patient showed irregular undulations of the electrocardiogram consistent with the diagnosis.[8] VT was identified by a regular wide complex tachycardia lasting >30 seconds or requiring termination because of hemodynamic instability.[8] VA could be identified on presentation or during the index hospitalization.

An assigned physician in each hospital acquired patient data that were entered by trained study coordinators onto standardized electronic case report forms (CRFs) throughout the hospital stay for each patient. Data included the following variables for which definitions were standardized among participating hospitals: patient demographics, medical history, presenting symptoms, provisional diagnosis on admission and final discharge diagnosis, biochemical and electrocardiographic findings, laboratory investigations, medical therapy, use of cardiac procedures and interventions, in-hospital outcomes, and in-hospital mortality. All cases were categorized as STEMI, NSTEMI, or UA using the definition proposed by the Joint Committee of the European Society of Cardiology/American College of Cardiology.[3] Cardiologists verified the completed CRFs and submitted them to the principal coordinating center where they were further checked for data quality, and queries were resolved before final analysis. All participating centers obtained ethics approval.

Differences in categorical variables between respective comparison groups were analyzed using the chi-square test or Fisher exact test. Continuous variables were analyzed using a t test or Mann-Whitney U test based on the satisfaction of normality assumption. P values are reported as 2-sided test results with a 5% level of significance for each test. Multiple logistic regression analysis was used to identify factors associated with VA. Variables considered for inclusion were baseline demographic characteristics (age, gender), medical history diabetes mellitus, hypertension, hyperlipidemia, coronary artery disease, angina, myocardial infarction [MI], cerebrovascular accident, percutaneous coronary intervention [PCI], coronary artery bypass graft), personal history (smoking), clinical presentation (Killip class >I, heart rate [HR], systolic blood pressure, ejection fraction), and discharge diagnosis (STEMI, NSTEMI, UA). Further, logistic regression models were used to assess the possible effect of VA on in-hospital outcome, and multivariate logistic regression models were used to adjust for age, gender, and comorbidities to see if the mortality effect of VA was confounded by these variables. Logistic regression models were also used to assess the effect of VA on other in-hospital adverse events such as recurrent ischemia, re-myocardial infarction, cardiogenic shock, congestive heart failure (CHF), major bleeding, and stroke. All analyses were performed using STATA version 9 (StataCorp LP, United States).

RESULTS

Of 5055 patients with ACS enrolled in the SPACE registry from December 2005 through December 2007, 168 (3.3%) developed VA during hospitalization of which 17 (1.2%) occurred at time of presentation to the hospital. The incidence of VA was significantly greater in patients with STEMI than in patients with NSTEMI/UA (6% vs 1.5%; $P<.001$). The mean age of all ACS subjects was 58 (12.9) years, and was similar in patients with and without VA ($P=.72$) (**Table 1**). A larger proportion of patients with VA were men compared with patients without VA (85.7% vs 77.2%; $P=.004$), and had a history of smoking (44.6% vs 32.0%; $P<.001$). Fewer patients with in-hospital VA had a history of hyperlipidemia (24.4% vs 42.0%; $P<.001$) and a history of coronary artery disease (33.9% vs 42.7%; $P=.01$). Other medical and personal history variables were similar between groups. On admission, patients with VA were significantly more likely than patients without VA to have Killip class >I (36.4% vs 20.1%; $P<.001$), systolic BP <90 mm Hg (15.5% vs 2.8%; $P<.001$), HR >100 bpm (22.1% vs 14.6%; $P=.010$), and left ventricular ejection fraction <35% (61.9% vs 33.6%; $P<.001$). A greater proportion of VA patients

Table 1. Baseline characteristics.

Characteristics	Total N (%)	Ventricular arrhythmia n (%)[a]	No ventricular arrhythmia n (%)	P
Total	5055	168 (3.3)	4887 (96.7)	
Mean age, years (SD)	58 (12.9)	57.7 (14.9)	58 (12.9)	.72
Men	3914 (77.4)	144 (85.7)	3770 (77.2)	.004
Diabetes mellitus	2935 (58.2)	93 (55.4)	2842 (58.3)	.25
Hypertension	2782 (55.0)	83 (49.4)	2699(55.2)	.18
Hyperlipidemia	2084 (41.4)	41 (24.4)	2043 (42.0)	<.001
Coronary artery disease	2145 (42.4)	57 (33.9)	2088 (42.7)	.014
Angina	1399 (40.2)	38 (31.7)	1361 (40.4)	.155
Myocardial infarction	915 (26.3)	21 (17.5)	894 (26.6)	.079
Cerebrovascular accident	309 (6.1)	14 (8.3)	295 (6.0)	.56
Percutaneous coronary intervention	698 (13.8)	17 (10.1)	681 (13.9)	.084
Coronary artery bypass graft	296 (5.9)	11 (6.5)	285 (5.8)	.87
Smoking	1637 (32.4)	75 (44.6)	1562 (32.0)	<.001
Clinical presentation				
Killip class >I	937 (20.6)	55 (36.4)	882 (20.0)	<.001
Heart rate >100	679 (14.9)	33 (22.1)	646 (14.6)	.010
Systolic blood pressure <90	148 (3.2)	23 (15.5)	125 (2.8)	<.001
Ejection fraction <35%	1149 (34.5)	70 (61.9)	1079 (33.6)	<.001
Diagnosis				
ST-segment elevation myocardial infarction	2096 (41.5)	125 (74.4)	1971 (40.3)	<.001
Non-ST-segment elevation myocardial infarction	1840 (36.4)	33 (19.6)	1807 (37.0)	<.001
Unstable angina pectoris	1119 (22.1)	10 (6.0)	1109 (22.7)	<.001
Median length of hospitalization, days	5	8	5	<.001

[a]Number and % of column total unless otherwise indicated.

compared with non-VA patients had STEMI (74.4% vs 40.3%), and a smaller proportion had NSTEMI (19.6% vs 37.0%) and UA (6.0% vs 22.7%; P<0.001 for all comparisons). Patients with VA were hospitalized for a median of 8 days, compared with 5 days for those without VA (P<.001).

Patients with VA were less likely than those without VA to receive the evidence-based therapies beta-block-

ers (62.3% vs 82.3%; P<.001), angiotensin-converting enzyme inhibitors (ACEI, 58.7% vs. 69.9%; P=.002), IV anticoagulant (77.4% vs 82.8%; P=.046), and statins (87.4% vs 93.5%; P=.003); while they were more likely to have elevated troponin (66.1% vs 62.4%; P<.001) (**Table 2**). No differences were observed in the rate of interventions between the two groups.

On multivariate regression analysis, male gender,

Table 2. In-hospital management.

Variables, n (%)	Total (N=5055)	Ventricular arrhythmia (n=168)	No ventricular arrhythmia (n=4887)	*P*
Treatment				
Aspirin	4929 (97.8)	160 (95.8)	4769 (97.8)	.08
Clopidogrel	4227 (83.9)	134 (80.2)	4093 (84.0)	.121
Beta-blocker	4115 (81.6)	104 (62.3)	4011 (82.3)	<.001
Angiotensin converting enzyme inhibitor	3504 (69.5)	98 (58.7)	3406(69.9)	.002
Angiotensin receptor blocker	297 (5.9)	6 (3.6)	291 (6.0)	.13
Statin	4705 (93.3)	146 (87.4)	4559 (93.5)	.003
Anticoagulant	4176(82.6)	130 (77.4)	4046 (82.8)	.046
IV insulin <24 h	479 (13.8)	27 (22.7)	452 (13.5)	.005
Troponin	3149 (62.5)	111 (66.1)	3038 (62.4)	<.001
Intervention				
Coronary angiogram	3397 (67.2)	100 (59.5)	3297 (67.5)	.05
Percutaneous coronary intervention	1776 (35.3)	62 (36.9)	1714 (35.2)	.49
Coronary artery bypass graft	425 (8.5)	17 (10.2)	408 (8.4)	.79

Values are number and percentage.

systolic blood pressure <90 mm Hg, Killip class, and positive cardiac markers were independently associated with an increased risk for AV, while therapy with a history of hyperlipidemia was associated with a decreased risk of VA (**Table 3**). In-hospital events and outcomes were more frequent in the presence of VA (**Table 4**). Mortality was significantly higher in VA patients (27.0%) compared with non-VA patients (2.2%; *P*=.001)(**Table 4**). The impact of VA on in-hospital mortality for the overall population and ACS subtype remained high; however, it was attenuated after adjusting for age, gender, and comorbidities (**Table 5**).

DISCUSSION

The occurrence of VA in patients with ACS is of substantial importance in the clinical decision-making process. Large multinational studies have been conducted in recent years to determine the magnitude and prognosis associated with VA in patients hospitalized with ACS.[10] Our multicenter, prospective data expand this knowledge base to include the incidence, associated factors, and outcomes of patients with ACS complicated by the development of serious arrhythmias. In this

Table 3. Multivariate regression analysis of factors associated with in-hospital ventricular arrhythmia in acute coronary syndrome patients.

All ACS patients	Odds ratio	95% CI	P
Gender (male)	1.7	1.1-3.1	.040
Systolic blood pressure <90 mm Hg	6.3	3.4-11.5	<.001
Killip class >1	2.3	1.5-3.6	<.001
Positive cardiac markers	2.3	1.2-4.7	.018
Hyperlipidemia	0.49	0.3-0.7	<.001

study VA occurred in 6% of patients with STEMI and 1.5% in patients with NSTEMI/UA.

The incidence of VA during hospitalization for ACS in our study is similar to that reported in previous studies of patients with STEMI and NSTEMI enrolled in randomized clinical trials (RCT).[7] Additionally, RCT patients were more likely to be men[11-13] and have a history of coronary heart disease[14] and hyperlipidemia,[15]

original article

Table 4. In-hospital outcomes in patients with acute coronary syndrome with and without ventricular arrhythmia (VA).

Hospital event	Total (N=5055)	VA (n=168)	No VA (n=4887)	P
Death	155 (3.1)	46 (27.0)	109 (2.2)	<.001
Recurrent ischemia	638 (12.6)	56 (33.3)	582 (11.9)	<.001
Re-myocardial infarction	77 (1.5)	10 (6.0)	67 (1.4)	<.001
Cardiogenic shock	222 (4.4)	65 (38.9)	157 (3.2)	<.001
Congestive heart failure	520 (10.3)	66 (39.3)	454 (9.3)	<.001
Major bleeding	68 (1.3)	10 (6.0)	58 (1.2)	<.001
Stroke	48 (1.0)	6 (3.6)	42 (0.9)	.004

Values are number and percentage.

Table 5. Impact of ventricular arrythmia on in-hospital death in acute coronary syndrome (ACS) patients.

	Odds ratio (95% CI)	P
All ACS	16.5 (11.2-24.9)	<.001
Age adjusted	18.6 (12.3-27.9)	<.001
Age and gender adjusted	20 (13.5-31.5)	<.001
Age, gender, and comorbidies[a] adjusted	13.1 (7.2-24.1)	<.001
ST-segment elevation myocardial infarction	11.1 (6.9-17.7)	<.001
Age adjusted	13.1 (7.9-21.6)	<.001
Age and gender adjusted	13.7 (8.1-22.9)	<.001
Age, gender, and comorbidies[a] adjusted	11.1 (5.2-23.5)	<.001
Non-ST segment elevation myocardial infarction/Unstable angina pectoris	26.5 (12.9-53.9)	<.001
Age adjusted	22.5 (10.8-47.1)	<.001
Age and gender adjusted	26.3 (12.3-56.2)	<.001
Age, gender, and comorbidies[a] adjusted	14.1 (4.3-45.7)	<.001

[a]History of prior MI, PCI, angina, CABG, CVA, smoking, HTN, DM, and hyperlipidemia.

and have Killip class >I on admission. Our baseline findings revealed less coronary artery disease and hyperlipidemia compared with these published studies. Characteristics that were more frequent in our non-VA patients including a history of coronary disease (angi-na, MI), PCI, diabetes mellitus, and hypertension are similar to results from the GRACE Registry. Moreover, less frequent use of evidence-based therapies including ACEI, beta-blockers, statins, and IV anticoagulants in our patients with VA compared with those without VA is similar to results reported previously[8,16,17] The fact that more severely ill patients have increased complications, including VA, and may not tolerate medications such as ACEI and beta-blockers, may confound this finding.

Factors associated with an increased risk of developing VA during hospitalization for ACS were as follows: male gender, smoking, Killips class >I, higher HR, lower systolic blood pressure, and positive cardiac markers; while factors associated with a decreased risk were as follows: prior history of hyperlipidemia, MI, CAD, beta-blockers, ACEI, and statins. It is noteworthy that these associations varied among published studies, which may be attributed to differences in the population studied; for example, some share our observation of increased risk with Killip >I, positive cardiac marker, smoking, and high HR and decreased risk with prior MI.[8] Few studies, however, found prior PCI associated with decreased risk. Similarly, prior PCI in our study predicted a decreased risk for VA. In contrast, Mehta et al reported from the APEX AMI trial that VA is associated with a more than 3-fold greater risk of 90-day mortality in patients undergoing primary PCI.[18] The development of VA adversely influences the prognosis of patients with ACS. In our study, adverse events during hospitalization were more frequent in the VA group than in patients without VA. Interestingly, not only adverse events related to ischemia (recurrent ischemia and recurrent MI) and left ventricular dysfunction (CHF and cardiogenic shock) were significantly associated with the presence of VA, but other clinically relevant events (stroke and major bleeding) were also significantly increased in patients with VA. Therefore, patients with ACS who develop VA are at risk for cardiovascular and bleeding-related complications.[8]

In-hospital mortality rates were extremely high in patients with VA. Some of this association was related to older age, male gender, and a higher prevalence of comorbid conditions, as shown by attenuation of the risk after adjustment for these factors in multivariate regression. In examining the impact of VA in patients with STEMI, several investigators documented high mortality rates during hospitalization, which was our observation as well. Our results are similar to those of other studies, including descriptive studies, RCTs, and registry studies, which document a higher risk of death in patients who develop VA.[6,7,18] Therefore, timely iden-

tification of patients who are likely to develop a VA and proper management are crucial to improve prognosis for these patients.

A limitation of our study is that it was based on registry data which is a subject to missing data and selection biases inherent in the design of a registry. Moreover, the time of VA in relation to the revascularization and/or success of reperfusion therapy was not documented. This precludes ascertaining if patients with VA had not been reperfused or the VA developed before reperfusion therapy commenced. Therefore, our findings must be confirmed in future studies. Moreover, VA in our study included patients with VT and VF, which might have different prognostic implications in the setting of ACS; information with respect to the type of VA was not documented in our study. Finally, the pre-hospital VA and/or sudden death were not captured in this registry, which might underestimated the incidence of VA in our population.

In conclusion, information on the most powerful associated factors, such as an increased risk of VA occurring during hospitalization, is readily available in the patient's medical history, clinical presentation parameters, and laboratory findings at the time of hospital admission. This information can be used to identify patients at a greater risk for developing VA during hospitalization for ACS. As a complication of ACS, VA results in a poorer prognosis. Evaluating the simple risk factors identified in this study will aid in the decision-making process for daily clinical practice.

Acknowledgment and conflict of interest

REFERENCES

1. Chaowalit N, Yipintsoi T, Tresukosol D, Kanjanavanit R, Kiatchoosakun S; Representing the Thai Acute Coronary Syndrome Registry. Prognostic value of selected presenting features of acute coronary syndrome in predicting in-hospital adverse events: Insight from the Thai Acute Coronary Syndrome Registry. Intern Med 2009;48:639-46.

2. Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, et al. American College of Cardiology; American Heart Association; Canadian Cardiovascular Society. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines for the Management of patients with acute myocardial infarction). J Am Coll Cardiol 2004;44:671-719.

3. Braunwald E, Antman EM, Beasley JW, Califf RM, Cheitlin MD, Hochman JS, et al. American College of Cardiology; American Heart Association. Committee on the Management of Patients with Unstable Angina. ACC/AHA 2002 guideline update for the management of patients with unstable angina and non-ST-segment elevation myocardial infarction-- summary article: A report of the American College of Cardiology/ American Heart Association Task Force on Practice Guidelines (Committee on the Management of Patients with Unstable Angina. J Am Coll Cardiol 2002;40:1366-74.

4. Lown B. Sudden cardiac death: The major challenge confronting contemporary cardiology. Am J Cardiol 1979;43:313-28.

5. Myerburg RJ, Kessler KM, Castellanos A. Sudden cardiac death: Epidemiology, transient risk, and intervention assessment. Ann Intern Med 1993;119:1187-97.

6. Newby KH, Thompson T, Stebbins A, Topol EJ, Califf RM, Natale A. Sustained ventricular arrhythmias in patients receiving thrombolytic therapy: Incidence and outcomes. Circulation 1998;98:2567-73.

7. Al-Khatib SM, Granger CB, Huang Y, Lee KL, Califf RM, Simoons ML, et al. Sustained ventricular arrhythmias among patients with acute coronary syndromes with no st-segment elevation: Incidence, Predictors, and Outcomes. Circulation 2002;106:309-12.

8. Avezum A, Piegas LS, Goldberg RJ, Brieger D, Stiles MK, Paolini R, et al. GRACE Investigators. Magnitude and prognosis associated with ventricular arrhythmias in patients hospitalized with acute coronary syndromes (from the GRACE Registry). Am J Cardiol 2008;102:1577-82.

9. AlHabib KF, Hersi A, AlFaleh H, Kurdi M, Arafah M, Youssef M, et al. The Saudi Project for Assessment of Coronary Events (SPACE) registry: Design and results of a phase I pilot study. Can J Cardiol 2009;25:255-8.

10. Ngarmukos T, Sriratanasthavorn C, Sansaneevithayakul B, Kasemsuwan P, Angkasuwapala K, Yamwong S. Cardiac arrhythmias in thai acute coronary syndrome registry. J Med Assoc Thai 2007;90:58-64.

11. Kawecki D, Tomasik AR, Morawiec B, Jachec W, Wojciechowska C, Rybczyk R, et al. Analysis of myocardial infarction time course in women compared with men in Upper Silesia population in 30 day follow-up. Int Heart J 2009;50:711-21.

12. Khairy P, Thibault B, Talajic M, Dubuc M, Roy D, Guerra PG, et al. Prognostic significance of ventricular arrhythmias post–myocardial infarction. Can J Cardiol 2003;19:1393-404.

13. Radovanovic D, Erne P, Urban P, Bertel O, Rickli H, Gaspoz JM; AMIS Plus Investigators. Gender differences in management and outcomes in patients with acute coronary syndromes: Results on 20,290 patients from the AMIS Plus Registry. Heart 2007;93:1369-75.

14. Chakraborty P, Mukerjee S, Sardana R. Polymorphic ventricular tachycardia due to acute coronary ischemia: A Case Report. Indian Pacing Electrophysiol J 2010;10:184-9.

15. Borleffs CJ, Scherptong RW, Man SC, van Welsenes GH, Bax JJ, van Erven L, et al. Predicting ventricular arrhythmias in patients with ischemic heart disease: Clinical application of the ECG-derived QRS-T angle. Circ Arrhythm Electrophysiol 2009;2:548-54.

16. Granger CB, Steg PG, Peterson E, Lopez-Sendon J, Van de Werf F, Kline-Rogers E, et al. Medication performance measures and mortality following acute coronary syndromes. Am J Med 2005;118:858-65.

17. Avezum A, Makdisse M, Spencer F, Gore JM, Fox KA, Montalescot G, et al. Impact of age on management and outcome of acute coronary syndrome: Observations from the Global Registry of Acute Coronary Events (GRACE). Am Heart J 2005;149:67-73.

18. Mehta RH, Starr AZ, Lopes RD, Hochman JS, Widimsky P, Pieper KS, et al. APEX AMI Investigators. Incidence of and outcomes associated with ventricular tachycardia or fibrillation in patients undergoing primary percutaneous coronary intervention. JAMA 2009;301:1779-89.