Clinical Investigation

Inpatient- versus Outpatient-Onset Acute Coronary Syndrome:

Comparison of Clinical Features and Outcomes

Kamran Zafar, MD
Nirav Patil, MBBS, MPH

The clinical characteristics and outcomes among patients with inpatient-onset non-ST-segment-elevation acute coronary syndrome have not been fully investigated. Therefore, we conducted a retrospective single-center analysis of patients who were ≥18 years old and diagnosed with acute coronary syndrome at our hospital during 2014. We performed logistic regression analysis to evaluate outcomes and made adjustments for age, race, family history of premature coronary artery disease, and comorbidities.

Our search through 31,274 hospital discharge records identified 683 cases of acute coronary syndrome: 32 were inpatient-onset and 651 were outpatient-onset. The inpatient-onset group was older (74.6 ± 9.6 vs 64 ± 12.8 yr; P <0.001), and patients were more likely to be black (28.1% vs 12.9%). Diagnoses at admission in the inpatient-onset group varied widely, including 4 cases of pneumonia and 3 of intestinal obstruction. The inpatient-onset group was less likely than the outpatient-onset group to undergo cardiac catheterization (34.4% vs 90.2%; adjusted odds ratio [AOR], 0.11; 95% CI, 0.05–0.28; P <0.001) or percutaneous coronary intervention (12.5% vs 61.6%; AOR, 0.16; 95% CI, 0.05–0.48; P=0.001), or to be discharged from the hospital (53.1% vs 88.9%; AOR, 0.26; 95% CI, 0.11–0.6; P=0.002). The inpatient-onset ACS group had longer hospital stays than did the outpatient-onset group (9.9 ± 8.9 vs 6.4 ± 5.2 d; P=0.03).

We found that inpatient-onset acute coronary syndrome was associated with less interventional management, a longer hospital stay, and a lower likelihood of discharge to home. **(Tex Heart Inst J 2018;45(3):136-43)**

From: *Departments of Medicine (Dr. Zafar) and Quality Management (Dr. Patil), Greenville Health System, Greenville, South Carolina 29605*

Address for reprints:
Kamran Zafar, MD, Department of Medicine, Greenville Health System, 701 Grove Rd., Greenville, SC 29605

E-mail: *kzafar@ghs.org*

Acute coronary syndrome (ACS) refers to a broad range of myocardial ischemic states that are associated with a wide variety of clinical presentations. In general, there are 2 categories of ACS—ST-segment elevation (STE-ACS) and non-ST-segment elevation (NSTE-ACS)—and each has distinct pathophysiologic mechanisms and management strategies.[1] An STE-ACS is caused by occlusion of an epicardial coronary artery, usually after rupture of an underlying atheromatous plaque and superimposed occlusive thrombus, resulting in ischemia of the myocardium served by that artery.[2] The diagnosis of STE-ACS warrants immediate coronary angiography and intervention to restore blood flow. In contrast, NSTE-ACS has many different clinical manifestations because its pathophysiologic mechanism involves atheromatous plaque disruption and varying combinations of overlying nonocclusive thrombosis, local vasospasm, and endothelial dysfunction.[2] This variant is further categorized as unstable angina or NSTE myocardial infarction (NSTEMI) depending on the severity of myocardial ischemia.[1]

In the United States, the incidence of STE-ACS has decreased; however, the incidence of NSTE-ACS has increased.[3] Despite improvement in the mortality rates associated with ACS, the condition continues to be associated with fatal outcomes, and it places a substantial financial burden on the healthcare system. In 2010, the primary diagnosis was ACS in an estimated 625,000 inpatient hospital discharges in the U.S. Of the total, 595,000 were for myocardial infarction, and 30,000 were for unstable angina.[4]

Most people experience the initial symptoms of NSTE-ACS outside the hospital and then go to a doctor's office or an emergency department for evaluation and treatment. Very few patients develop NSTE-ACS in the hospital after admission for unrelated conditions. We carefully searched the medical literature for studies on this specific group of patients to elucidate their demographic and clinical characteristics and found none.

Therefore, we retrospectively analyzed the discharge records of patients with NTSE-ACS who were treated at our hospital. We compared the clinical features and outcomes of inpatient-onset NSTE-ACS with those of outpatient-onset NTSE-ACS. In this report, the term ACS, without qualification, refers to NSTE-ACS.

Patients and Methods

This retrospective study was approved by the relevant institutional review board of the Greenville Memorial Hospital (the referral and tertiary-care hospital for nearby suburban and rural hospitals), which waived the requirement for patients' informed consent.

We limited our search to medical records from the 2014 calendar year. Patients were included in the study if they were 18 years of age or older and their record contained International Classification of Diseases, 9th Revision (ICD-9) code 410.71 or 410.91, which are related to ACS. The diagnosis of ACS was determined solely from the treating physician's documentation. The presence of one of the ICD-9 codes at the time of admission indicated outpatient onset of ACS. Data were abstracted on forms specifically designed for the study.

Patients were excluded from the study if they were diagnosed with ST-segment-elevation myocardial infarction (STEMI) or if half of the data related to the study was missing from their records.

Patients with a current or past smoking history were considered to be smokers. Heart rates and blood pressures—recorded upon admission in the outpatient-onset group and upon onset of ACS symptoms in the hospitalized patients—were included in the analysis. When a range of left ventricular ejection fractions was mentioned in the records, the lower number was included in the study. Missing information regarding coronary artery disease (CAD) risk factors, previous cardiac catheterization or revascularization procedures, comorbidities, symptoms, and medications was marked on the data forms as "not present."

The length of hospital stay for patients with inpatient-onset ACS was calculated from the date of ACS diagnosis. To evaluate the direct contribution of ACS to in-hospital death, we calculated 3-day in-hospital mortality rates by limiting our analysis to deaths that occurred within 3 days of hospital admission in the outpatient-onset group and within 3 days of ACS development in the inpatient-onset group.

Statistical Analysis

Bivariate unadjusted comparisons between the inpatient- and outpatient-onset ACS groups were performed by using the t test for continuous variables and the χ^2 or Fisher exact test for categorical variables, as appropriate. Each patient with ACS was assigned a Thrombolysis in Myocardial Infarction (TIMI) risk score when at least one of these 7 variables was present: age ≥65 years, ≥3 CAD risk factors, known CAD (≥50% stenosis), aspirin use in the past 7 days, ≥2 episodes of chest pain within the past 24 hours, electrocardiographic changes of ST-segment depression ≥0.5 mm, and elevated cardiac biomarker levels.[5] Patients were then divided into 3 risk categories based on their TIMI score (low, 0–2; medium, 3–4; and high, 5–7) and according to whether they had inpatient- or outpatient-onset ACS.

Using multiple logistic regression, we adjusted comparisons between treatments (cardiac catheterization, percutaneous coronary intervention [PCI], and coronary artery bypass grafting) and outcomes (length of stay, in-hospital death, and discharge home from the hospital). We also adjusted for potential confounders that were statistically different between the 2 groups, including age, race, and family history of premature CAD; and the presence of comorbidities, including aortic aneurysm, atrial fibrillation, chronic obstructive pulmonary disease (COPD), cerebrovascular disease, end-stage renal disease, pneumonia, and gastrointestinal bleeding.

We evaluated the effect of age and TIMI risk category on outcomes and treatment strategies in the inpatient-onset group. Patients were divided into 2 groups for this purpose: <75 and ≥75 years of age.
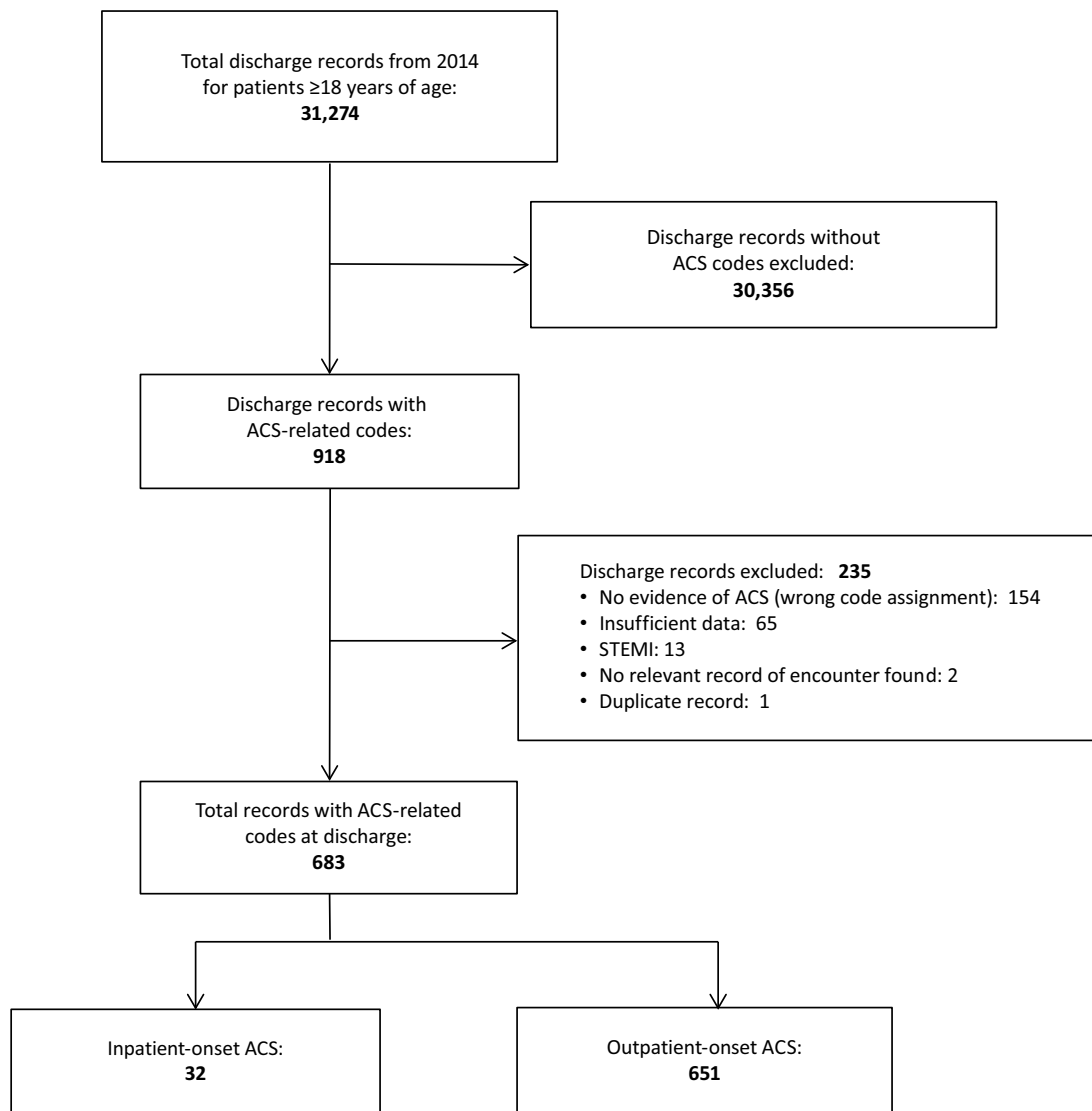
A P value <0.05 was considered statistically significant. We used SAS version 7.1 (SAS Institute, Inc.) for data analysis.

Results

During 2014, 31,274 adults were admitted to Greenville Memorial Hospital (Fig. 1). The discharge records for 918 of these patients included an ACS-related code; 235 of these records were excluded for reasons such as no evidence of ACS during a particular admission, insufficient study-related data, or STEMI wrongly coded as ACS. A total of 683 records were included in the analysis: 32 (4.7%) patients had inpatient-onset and 651 (95.3%) had outpatient-onset ACS. The incidence of inpatient-onset ACS was 1 per 1,000 discharges.

Baseline Demographic and Clinical Characteristics

Compared to patients with outpatient-onset ACS, those with inpatient-onset were older and were more often black (Table I). All traditional CAD risk factors were equally distributed between the 2 groups, except for family history of premature CAD. Overall, 127 (18.9%) patients had a family history: 126 (19.4%) were in the outpatient-onset group, and one (3.1%) was in the inpatient-onset group. Comorbidities on admission—including atrial fibrillation, aortic aneurysm, COPD, cerebrovascular disease, end-stage renal disease, gastrointestinal bleeding, and pneumonia—

```
┌─────────────────────────────┐
│  Total discharge records     │
│  from 2014 for patients      │
│  ≥18 years of age:           │
│  31,274                      │
└─────────────────────────────┘
```

Total discharge records from 2014
for patients ≥18 years of age:
31,274

Discharge records without
ACS codes excluded:
30,356

Discharge records with
ACS-related codes:
918

Discharge records excluded: **235**
• No evidence of ACS (wrong code assignment): 154
• Insufficient data: 65
• STEMI: 13
• No relevant record of encounter found: 2
• Duplicate record: 1

Total records with ACS-related
codes at discharge:
683

Inpatient-onset ACS:
32

Outpatient-onset ACS:
651

Fig. 1 *Chart shows identification of study cohort.*

ACS = acute coronary syndrome; STEMI = ST-segment-elevation myocardial infarction

were reported more frequently in the inpatient-onset group. There were no other significant differences in comorbidities between the groups. The distribution of TIMI risk scores was also similar between groups. Chest pain was more frequently reported as the main symptom of ACS in the outpatient-onset group. Patients in both groups were equally likely to be taking anti-platelet agents, β-blockers, calcium channel blockers, angiotensin-converting enzyme inhibitors, and statins on hospital admission; however, the inpatient-onset group was more likely to be taking nitrates than the outpatient-onset group (31.3% vs. 14.1%, P=0.01).

Admission Diagnoses in
Patients with Inpatient-Onset ACS

Table II lists the primary reasons for hospitalization among the patients with inpatient-onset ACS. These in-cluded pneumonia, intestinal obstruction, gastrointesti-nal bleeding, long-bone fracture, COPD exacerbation, and acute ischemic stroke. One third of the patients were admitted to the surgical service for intestinal ob-struction, long-bone fracture, incarcerated inguinal her-nia, aortic or femoral pseudoaneurysm, herniated disk, gallstones, or renal cell carcinoma.

Treatments and Outcomes
According to Location at Onset

The inpatient-onset ACS group was less likely to re-ceive standard treatment—including medications to treat ACS, cardiac catheterization, and revasculariza-tion—than were those in the outpatient-onset group (Table III).

After adjusting the results for age, race, family his-tory of premature CAD, and comorbidities, we found

TABLE I. Comparison of Baseline Demographic and Clinical Characteristics of Patients with Acute Coronary Syndrome According to Location at Onset

Variable	Overall (n=683)	Inpatient Onset (n=32)	Outpatient Onset (n=651)	P Value
Age (yr)	64.5 ± 12.8	74.6 ± 9.6	64 ± 12.8	<0.001
Female	256 (37.5)	16 (50)	240 (36.9)	0.13
Race	—	—	—	0.04
White	575 (84.2)	23 (71.9)	552 (84.8)	—
Black	93 (13.6)	9 (28.1)	84 (12.9)	—
Other	15 (2.2)	0	15 (2.3)	—
CAD risk factors				
Diabetes mellitus	306 (44.8)	13 (40.6)	293 (45)	0.62
Hypertension	569 (83.3)	27 (84.4)	542 (83.3)	0.86
Hyperlipidemia	534 (78.2)	23 (71.9)	511 (78.5)	0.37
Smoking	381 (55.8)	14 (43.8)	367 (56.4)	0.16
BMI >30 kg/m^2	325 (47.6)	13 (40.6)	312 (47.9)	0.47
Family history of premature CAD	127 (18.6)	1 (3.1)	126 (19.4)	0.02
History of CAD	423 (61.9)	19 (59.4)	404 (62.1)	0.76
Prior PCI	290 (42.5)	9 (28.1)	281 (43.2)	0.09
Prior CABG	163 (23.9)	8 (25)	155 (23.8)	0.87
Comorbidities				
Aortic aneurysm	7 (1)	2 (6.3)	5 (0.8)	0.04
Atrial fibrillation	79 (11.6)	8 (25)	71 (10.9)	0.02
Acute renal failure	58 (8.5)	4 (12.5)	54 (8.3)	0.34
Anemia	52 (7.6)	4 (12.5)	48 (7.4)	0.29
Chronic CHF	73 (10.7)	5 (15.6)	68 (10.4)	0.37
Chronic kidney disease	119 (17.4)	6 (18.8)	113 (17.4)	0.83
COPD	98 (14.3)	11 (34.4)	87 (13.4)	<0.01
Cerebrovascular disease	67 (9.8)	7 (21.9)	60 (9.2)	0.02
End-stage renal disease	20 (2.9)	4 (12.5)	16 (2.5)	0.01
Gastrointestinal bleeding	4 (0.6)	2 (6.3)	2 (0.3)	0.01
Hypothyroidism	82 (12)	5 (15.6)	77 (11.8)	0.57
Obstructive sleep apnea	83 (12.2)	7 (21.9)	76 (11.7)	0.08
Peripheral artery disease	56 (8.2)	4 (12.5)	52 (8)	0.32
Pneumonia	12 (1.8)	4 (12.5)	8 (1.2)	<0.01
Symptoms of ACS				
Chest pain	613 (89.8)	18 (56.3)	595 (91.4)	<0.001
Dyspnea	304 (44.5)	15 (46.9)	289 (44.4)	0.78
Syncope	16 (2.3)	2 (6.3)	14 (2.2)	0.13
Findings upon admission				
Heart rate (beats/min)	77.3 ± 17	91.4 ± 19	76.7 ± 16.6	<0.001
Systolic BP (mmHg)	138.5 ± 26.7	132.6 ± 29.4	138.9 ± 26.6	0.24
Diastolic BP (mmHg)	76 ± 14.8	67.1 ± 16.1	76.3 ± 14.7	0.003
New ECG ischemic changes	185 (27.1)	11 (34.4)	174 (26.7)	0.44
Stress testing				
Performed	47 (6.9)	2 (6.3)	45 (6.9)	0.88
Positive for ischemia*	39 (83)	2 (100)	37 (82.2)	0.99
LVEF <0.40	96 (14.1)	7 (21.9)	89 (13.7)	0.18
Medications at admission				
Antiplatelet agent	395 (57.8)	16 (50)	379 (58.2)	0.19
ACEI	234 (34.3)	13 (40.6)	221 (33.9)	0.57
β-blocker	314 (46)	17 (53.1)	297 (45.6)	0.57
Calcium channel blocker	138 (20.2)	9 (28.1)	129 (19.8)	0.33
Nitrate	102 (14.9)	10 (31.3)	92 (14.1)	0.01
Statin	343 (50.2)	18 (56.3)	325 (49.9)	0.68
TIMI risk score	—	—	—	0.49
0–2 (low)	56 (8.2)	1 (3.1)	55 (8.4)	—
3–4 (medium)	346 (50.7)	15 (46.9)	331 (50.8)	—
5–7 (high)	281 (41.1)	16 (50)	265 (40.7)	—

ACEI = angiotensin-converting enzyme inhibitor; ACS = acute coronary syndrome; BMI = body mass index; BP = blood pressure; CABG = coronary artery bypass grafting; CAD = coronary artery disease; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; ECG = electrocardiographic; LVEF = left ventricular ejection fraction; PCI = percutaneous coronary intervention; TIMI = Thrombolysis in Myocardial Infarction

*The percentages are based on the number of stress tests performed.

Data are presented as mean ± SD or as number and percentage. *P* <0.05 was considered statistically significant.

that the inpatient-onset group was less likely to undergo cardiac catheterization than were those in the outpatient-onset group (34.4% vs 90.2%; adjusted odds ratio [AOR]=0.11; 95% CI, 0.05–0.28; P <0.001) or PCI (12.5% vs 61.6%; AOR=0.16; 95% CI, 0.05–0.48; P=0.001) (Tables III and IV). There was no difference between the groups in regard to the likelihood of undergoing coronary artery bypass grafting: 3.1% of inpatients had surgery compared with 16.9% of outpatients (AOR=0.17; 95% CI, 0.02–1.4; P=0.1).

The inpatient-onset ACS group had longer hospital stays than did the outpatient-onset group (9.9 ± 8.9 vs 6.4 ± 5.2 d; P=0.03) (Table V), as well as hospital stays longer than 7 days (46.9% vs 26.9%; AOR=1.6; 95% CI, 0.7–3.5; P <0.001) (Table IV). Patients in the inpatient-onset group were less likely to be discharged home (53.1% vs 88.9%; AOR=0.26; 95% CI, 0.11–0.6; P=0.002). The unadjusted analysis showed that the in-hospital mortality rate was significantly higher among patients with inpatient-onset ACS (9.4% vs 1.8%; P=0.03); however, after adjustment for age, race, family history of premature CAD, and comorbidities, the difference was not statistically significant (AOR=3.17; 95% CI, 0.69–14.6; P=0.14). In the outpatient-onset ACS group, the maximum time to death was 28 days (mean, 12.5 d), compared with a maximum of 9 days (mean, 3.66 d) in the inpatient-onset group. After adjustment for comorbidities, the 3-day in-hospital mortality rate was not statistically different between the groups (6.3% inpatient-onset vs 0.6% outpatient-onset; AOR=4.68; 95% CI, 0.51–42.6; P=0.17). The unadjusted rates of congestive heart failure development in the hospital were similar (21.9% inpatient-onset vs 12.7% outpatient-onset; P=0.17).

Effect of Age and TIMI Risk on Resource Use and Clinical Outcomes

Among the patients with inpatient-onset ACS, 18 (56%) were younger than 75 years of age, and 14 (44%) were 75 years or older. The older patients underwent fewer cardiac catheterizations, were less likely to be discharged home, and had a higher 3-day in-hospital mor-

TABLE II. Diagnosis at Admission in the 32 Inpatients Who Developed Acute Coronary Syndrome

Diagnosis	Number
Acute gastritis	1
Acute ischemic stroke	2
Aortic pseudoaneurysm	1
Cellulitis	1
CLABSI	1
COPD exacerbation	2
Disk herniation	1
Diverticulitis	1
Femoral pseudoaneurysm	1
Foot ulcer	1
Gallstones	1
Gastrointestinal bleeding	2
Incarcerated inguinal hernia	1
Intestinal obstruction	3
Long-bone fracture	2
Noncardiac syncope	1
Pneumonia	4
Pulmonary embolism	1
Renal cell cancer	1
Septic shock	1
Subarachnoid hemorrhage	1
Substance overdose	1
Urinary tract infection	1

CLABSI = central line-associated bloodstream infection; COPD = chronic obstructive pulmonary disease

TABLE III. Comparison of Treatments According to Location at Onset of Acute Coronary Syndrome

Treatment	Overall (n=683)	Inpatient Onset (n=32)	Outpatient Onset (n=651)	P Value
Medications				
Antiplatelet agent	668 (97.8)	28 (87.5)	640 (98.3)	<0.01
ACEI	391 (57.2)	11 (34.4)	380 (58.4)	<0.01
β-blocker	626 (91.7)	26 (81.3)	600 (92.2)	0.04
Calcium channel blocker	144 (21.1)	7 (21.9)	137 (21)	0.91
Nitrate	357 (52.3)	19 (59.4)	338 (51.9)	0.42
Statin	624 (91.4)	26 (81.3)	598 (91.9)	0.04
Anticoagulant	382 (55.9)	10 (31.3)	372 (57.1)	<0.01
Cardiac catheterization	598 (87.6)	11 (34.4)	587 (90.2)	<0.001
PCI	405 (59.3)	4 (12.5)	401 (61.6)	<0.001
CABG	111 (16.3)	1 (3.1)	110 (16.9)	0.04

ACEI = angiotensin-converting enzyme inhibitor; CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention

Data are presented as number and percentage. P <0.05 was considered statistically significant.

tality rate (Fig. 2) than the younger patients. Hospital stay longer than 7 days was slightly higher in patients younger than 75 years of age than in the older patients.
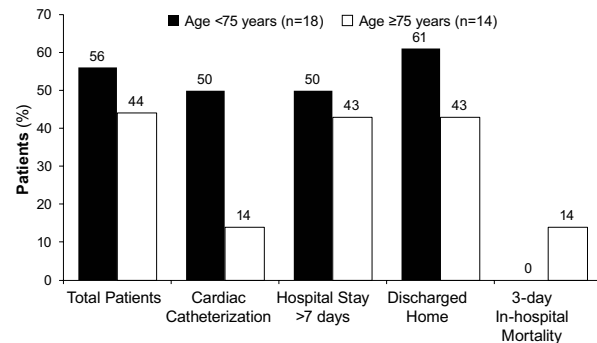
Of the patients with inpatient-onset ACS, 15 (47%) had a moderate TIMI risk score, and 16 (50%) had a high TIMI risk score. The rates of interventional treatment, 3-day in-hospital mortality, and hospital discharge between these groups were similar. In contrast, the likelihood of a hospital stay longer than 7 days was higher among patients with a medium TIMI risk score (Fig. 3).

Discussion

To our knowledge, no other published reports have described the clinical characteristics or followed the outcomes of patients in whom NSTE-ACS developed while they were hospitalized for unrelated conditions. Our study provides some insight into this patient population.

The incidence of inpatient-onset ACS in our study was more than 3 times higher than that in a recent report of inpatient-onset STEMI (1 vs 0.27 per 1,000 discharges) in patients hospitalized for non-ACS-related conditions.[6] The ratio between the incidence of inpatient-onset NSTE-ACS and STEMI was consistent with the reported overall incidence rates of NSTE-ACS and STEMI in the U.S. (150 vs 50 cases per 100,000 person-years in 2008).[3]
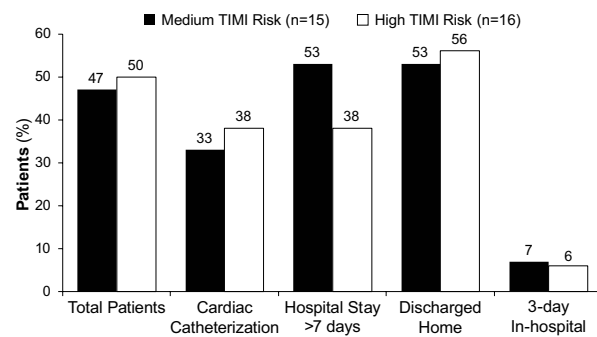

Fig. 2 *Chart compares interventional treatment and clinical outcomes by age in the 32 patients with inpatient-onset acute coronary syndrome. Percentages are rounded to the nearest whole number.*

TABLE IV. Adjusted Odds Ratios for Outcomes and Treatments

Variable	Odds Ratio (95% CI)	P Value
Hospital death	3.17 (0.69–14.6)	0.14
3-day hospital death	4.68 (0.51–42.6)	0.17
Length of stay (>7 d)	1.6 (0.7–3.5)	<0.001
Discharged home	0.26 (0.11–0.6)	0.002
Cardiac catheterization	0.11 (0.05–0.28)	<0.001
PCI	0.16 (0.05–0.48)	0.001
CABG	0.17 (0.02–1.4)	0.1

CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention

P <0.05 was considered statistically significant.

Fig. 3 *Chart compares interventional treatment and clinical outcomes by Thrombolysis in Myocardial Infarction (TIMI) risk score in the 32 patients with inpatient-onset acute coronary syndrome. Percentages are rounded to the nearest whole number.*

TABLE V. Comparison of Outcomes According to Location at Onset of Acute Coronary Syndrome

Variable	Overall (n=683)	Inpatient Onset (n=32)	Outpatient Onset (n=651)	P Value
Length of stay (d)	6.6 ± 5.5	9.9 ± 8.9	6.4 ± 5.2	0.03
Length of stay >7 d	190 (27.8)	15 (46.9)	175 (26.9)	0.01
Hospital death	15 (2.2)	3 (9.4)	12 (1.8)	0.03
3-day hospital death	6 (0.9)	2 (6.3)	4 (0.6)	0.03
CHF during hospitalization	90 (13.2)	7 (21.9)	83 (12.7)	0.17
Discharged home	596 (87.3)	17 (53.1)	579 (88.9)	<0.001

CHF = congestive heart failure

Data are presented as mean ± SD or as number and percentage. *P* <0.05 was considered statistically significant.

In our study, a disproportionately high number of patients who developed ACS in the hospital had been admitted with a primary surgical condition (Table II). Most of the other conditions that led to the hospitalization were associated with substantial systemic inflammation, strengthening the theory that systemic inflammation contributes to instability of atheromatous plaque and precipitates ACS.[7]

Patients with inpatient-onset ACS were less likely to receive medications for treating ACS or to undergo cardiac catheterization or PCI. The avoidance of medical therapy may have been due to the absolute or relative contraindication of drugs that can have substantial anticoagulative and hemodynamic effects in critically ill patients. Similarly, cardiac catheterization and PCI may not have been performed because of contraindications associated with comorbid conditions or because of patient or family wishes.

To evaluate how inpatient-onset ACS affected the length of hospital stay, we calculated the time from ACS onset to hospital discharge or to in-hospital death. Inpatient onset of ACS was one, but certainly not the only, factor responsible for prolonged hospitalization in this group. The severity of the clinical condition responsible for hospitalization played a major role in determining length of hospital stay, as did age, physical debility, and complications arising from treatment.

The unadjusted analysis of our data showed that the in-hospital mortality rate was significantly higher among patients with inpatient-onset ACS than in those with outpatient-onset; however, the difference was not significant after adjustment for age, race, family history of premature CAD, and comorbidities. In patients with outpatient-onset ACS, the mean time to death (12.5 d) was significantly longer than their mean hospital stay (6.4 d). They most likely developed conditions unrelated to ACS, such as pneumonia, sepsis, and septic shock, which led to longer hospital stays and, ultimately, death. To determine the direct effect of ACS on death, we analyzed the 3-day in-hospital mortality rate; however, we found no significant difference between the groups, even after adjustment for other factors. The lack of significance was due primarily to a wide 95% CI, most likely a result of the small size of the inpatient-onset ACS group.

Patients 75 years and older made up almost half of the inpatient-onset ACS group (44%), and they were primarily responsible for the notable difference in the use of cardiac catheterization and in most of the studied outcomes between the inpatient- and outpatient-onset ACS groups. Also notable in the inpatient-onset group is that patients with medium TIMI risk scores were more likely than those with high risk scores to stay in the hospital longer than 7 days, whereas the use of cardiac catheterization, the 3-day in-hospital mortality rate, and the likelihood of discharge to home were similar.

These outcomes were most likely driven by factors other than the TIMI score alone, such as age, diagnosis upon admission, and comorbidities.

Currently, no universally accepted guidelines are in place to expedite the recognition and management of inpatient-onset ACS. The development and implementation of such guidelines may improve outcomes in this patient population.

Study Limitations

Our study had several limitations. It was a single-center study with all the constraints inherent in a retrospective analysis, including inconsistent documentation of study-related information. The diagnosis of ACS was based on documentation from the treating physicians, which could have led to a nonhomogeneous study cohort. The inpatient-onset ACS group was very small, which might have confounded the results. The factors contributing to ACS onset in patients hospitalized for unrelated conditions were not studied, because data on hospitalized patients who did not have inpatient-onset ACS were not collected. Although we adjusted for all the measured variables in our analysis, residual confounding from unmeasured factors might also have affected our results.

Conclusion

Our study identified important factors that may influence the outcome of patients with inpatient-onset ACS. A prospective study in a larger, multicenter cohort of inpatient-onset ACS would provide better control of patient enrollment and comprehensive recording of the adjudicated outcomes, as well as the means to evaluate the financial burden imposed on the healthcare system. A larger study would also help in devising guidelines to improve outcomes in this patient group.

References

1. Amsterdam EA, Wenger NK, Brindis RG, Casey DE Jr, Ganiats TG, Holmes DR Jr, et al. 2014 AHA/ACC guideline for the management of patients with non-ST-elevation acute coronary syndromes: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines [published erratum appears in Circulation 2014; 130(25):e433-4]. Circulation 2014;130(25):e344-426.
2. Libby P. Current concepts of the pathogenesis of the acute coronary syndromes. Circulation 2001;104(3):365-72.
3. American College of Emergency Physicians, Society for Cardiovascular Angiography and Interventions, O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2013;61(4):e78-140.
4. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, et al. Heart disease and stroke statistics--2013 update: a report from the American Heart Association [pub-

lished erratum appears in Circulation 2013;127(23):e841]. Circulation 2013;127(1):e6-245.

5. Antman EM, Cohen M, Bernink PJ, McCabe CH, Horacek T, Papuchis G, et al. The TIMI risk score for unstable angina/non-ST elevation MI: a method for prognostication and therapeutic decision making. JAMA 2000;284(7):835-42.

6. Kaul P, Federspiel JJ, Dai X, Stearns SC, Smith SC Jr, Yeung M, et al. Association of inpatient vs outpatient onset of ST-elevation myocardial infarction with treatment and clinical outcomes. JAMA 2014;312(19):1999-2007.

7. Packard RR, Libby P. Inflammation in atherosclerosis: from vascular biology to biomarker discovery and risk prediction. Clin Chem 2008;54(1):24-38.