Impact of Time of Presentation on the Care and Outcomes of Acute Myocardial Infarction

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Background—Prior studies have demonstrated an inconsistent association between patients' arrival time for acute myocardial infarction (AMI) and their subsequent medical care and outcomes.

Methods and Results—Using a contemporary national clinical registry, we examined differences in medical care and in-hospital mortality among AMI patients admitted during regular hours (weekdays 7 AM to 7 PM) versus off-hours (weekends, holidays, and 7 PM to 7 AM weeknights). The study cohort included 62 814 AMI patients from the Get With the Guidelines–Coronary Artery Disease database admitted to 379 hospitals throughout the United States from July 2000 through September 2005. Overall, 33 982 (54.1%) patients arrived during off-hours. Compared with those arriving during regular hours, eligible off-hour patients were slightly less likely to receive primary percutaneous coronary intervention (adjusted odds ratio [OR], 0.93; 95% confidence interval [CI], 0.89 to 0.98), had longer door-to-balloon times (median, 110 versus 85 minutes; $P<0.0001$), and were less likely to achieve door-to-balloon ≤90 minutes (adjusted OR, 0.34; 95% CI, 0.29 to 0.39). Arrival during off-hours was associated with slightly lower overall revascularization rates (adjusted OR, 0.94; 95% CI, 0.90 to 0.97). No measurable differences, however, were found in in-hospital mortality between regular hours and off-hours in the overall AMI, ST-elevated MI, and non–ST-elevated MI cohorts (adjusted OR, 0.99; 95% CI, 0.93 to 1.06; adjusted OR, 1.05; 95% CI, 0.94 to 1.18; and adjusted OR, 0.97; 95% CI, 0.90 to 1.04, respectively). Similar observations were made across most age and sex subgroups and with an alternative definition for arrival time (weekends/holidays versus weekdays).

Conclusions—Despite slightly fewer primary percutaneous coronary interventions and overall revascularizations and significantly longer door-to-balloon times, patients presenting with AMI during off-hours had in-hospital mortality similar to those presenting during regular hours. (***Circulation*. 2008;117:2502-2509.**)

Key Words: angioplasty ■ myocardial infarction ■ reperfusion ■ revascularization

Acute myocardial infarction (AMI) remains a leading cause of death in the United States.[1] Its associated mortality and morbidity can be altered, however, by proven, effective therapies.[2,3] Healthcare providers have been working to improve the consistency and timely delivery of evidence-based treatments. Despite these efforts, studies continue to demonstrate quality gaps in AMI care in routine clinical practice. Recently, several studies found that patients presenting on weekends or during "off-hours" (weekday nights, weekends, and holidays) were less likely to receive guideline-based medications and/or timely reperfusion after AMI.[4–6] However, these studies have been inconsistent in their findings and have been limited in part by reflecting noncontemporary clinical practices, regional results, and selected MI patients.[4–6]

Clinical Perspective p 2509

In the present report, we conducted a comprehensive analysis of the influence of regular versus off-hour AMI presentation on subsequent care and outcomes using the American Heart Association's Get With the Guidelines–Coronary Artery Disease (GWTG-CAD) national database.

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We specifically examined differences in reperfusion strategies, timeliness of reperfusion, use of invasive procedures, early medical treatments, and in-hospital mortality among AMI patients admitted during regular hours versus off-hours. We also corroborated our findings in patients with ST-segment MI (STEMI) and non-STEMI (NSTEMI), in age and sex subgroups, and with an alternative definition for arrival time. Finally, we used our data to estimate the likely health impacts of ongoing quality improvement initiatives,[7,8] focused primarily on reducing door-to-balloon (DTB) times, to improve outcomes after AMI.

Methods

Data Source and Study Population

The primary data source was the GWTG-CAD, a registry and performance-improvement initiative undertaken by the American Heart Association (AHA) to enhance guideline adherence among patients hospitalized with CAD. The overall GWTG program objectives were previously described.[9,10] The GWTG-CAD program uses a Web-based Patient Management Tool (Outcome, Cambridge, Mass), which allows the interactive assessment and reporting system. Automated electronic data checks were used to prevent out-of-range entry or duplicate patients. The GWTG-CAD database includes a variety of hospitals, including teaching and nonteaching, rural and urban, and large and small hospitals from all regions of the United States. The initial population for these analyses included all patients who were entered into the Patient Management Tool with ischemic heart disease diagnoses. Hospitals were required to submit data from consecutive patients. Standardized data were entered by highly trained personnel. Data quality reports were generated regularly to summarize quality problems and to provide feedback to the individual sites. Admission staff, medical staff, or both recorded race/ethnicity, usually as the patient was registered. Data were collected by participating hospitals without financial compensation. Case finding was based predominantly on clinical identification of patients with these diagnoses in most hospitals, frequently with additional confirmation by retrospective *International Classification of Diseases*, ninth revision, coding.

At the time of the analysis, the GWTG-CAD database contained data on 93 595 AMI patients treated at 379 hospitals between July 2000 and September 2005. From this total, we excluded 4568 patients with missing or invalid arrival dates or times and 26 213 transfer-in patients because initial treatments could not be ascertained with accuracy in these patients. The final study population included 62 814 AMI patients. Of those 62 814 AMI patients, 20 279 (32.3%) had STEMI, defined as having an initial ECG on arrival showing diagnostic ST-segment elevation or left bundle-branch block. The remaining 67.7% of AMI patients with no such ECG changes constituted the NSTEMI cohort (n=42 535).

Study Measures and Outcomes

Arrival time (regular versus off-hours) was the primary independent variable. Regular hours were defined as weekdays (Monday through Friday) 7 AM to 7 PM. Off-hours were defined as weeknights (7 PM to 7 AM), weekends, and holidays. Holidays included New Year's (December 31 and January 1), Christmas (December 24 and 25), and Memorial, Independence, Labor, and Thanksgiving days.

Guideline-recommended acute medical therapies included aspirin use within 24 hours of arrival in AMI patients with no contraindication to the medication (n=56 491) and β-blocker use within 24 hours of arrival in AMI patients with no contraindication to the medication (n=52 343). Invasive procedures were analyzed in the overall AMI population and in the STEMI and NSTEMI subpopulations and included cardiac catheterization, percutaneous coronary intervention (PCI), coronary artery bypass graft surgery (CABG), and overall revascularization. Acute reperfusion therapies were analyzed among the reperfusion-eligible STEMI cohort only and included PCI, fibrinolytic therapy, and any reperfusion. Measures of timeliness of reperfusion included the proportion of STEMI patients who received fibrinolytic therapy within the American College of Cardiology (ACC)/AHA guideline–recommended 30-minute door-to-needle (DTN) time and the proportion of STEMI patients who received primary PCI within the ACC/AHA guideline–recommended 90-minute DTB time. Door-to-needle time was defined as the time from hospital arrival to initiation of fibrinolytic therapy; DTB time was defined as the time from hospital arrival to first balloon inflation.

In-hospital mortality was analyzed in the overall AMI cohort and in the STEMI and NSTEMI subpopulations. Patients discharged to other medical facilities (n=6444) were excluded from the analyses on in-hospital mortality and invasive procedures.

Statistical Analysis

All statistical analyses were conducted independently by the Duke Clinical Research Institute (Durham, NC). For the descriptive analysis, patients' sociodemographic and medical history variables, baseline clinical characteristics, invasive procedures, quality of care measures, and in-hospital mortality were compared among patients arriving during off-hours versus regular hours. Percentages and means±SD were reported to describe the distributions of the categorical and continuous variables, respectively. Medians and interquartile ranges (25th to 75th) were reported for DTB and DTN times. Categorical and continuous variables were compared by use of the χ^2 and the Wilcoxon rank-sum tests, respectively.

Multivariable logistic regression analyses, using the generalized estimating equations method,[11] were performed to determine whether off-hour arrival independently influenced each measure and outcome. The regression model adjusted for the following covariates: age, sex, race, body mass index, insurance type, systolic blood pressure, cardiac diagnosis, initial ECG with diagnostic ST-segment elevation or left bundle-branch block, diabetes mellitus, hypertension, hyperlipidemia, smoking, renal insufficiency, chronic obstructive pulmonary disorder, heart failure, stroke, peripheral artery disease, and previous MI. The generalized estimating equations approach was used to adjust for clustering within hospitals. Odds ratios (ORs) and their 95% confidence intervals (CIs) were reported to compare patients arriving during off-hours versus regular hours for each measure and outcome. Values of $P<0.05$ were considered statistically significant in all tests. All analyses were performed with SAS software (version 8.2, SAS Institute, Inc, Cary, NC).

To assess the generalizability of our findings, we repeated the analysis using an alternative definition by reclassifying patients' hospital arrival time into weekends (from 6 PM on Friday until 7 AM on Monday) and holidays (as described) versus weekdays (from 7 AM on Monday until 6 PM on Friday). Subgroup analyses were performed by sex and age (subdivided into 3 intervals: <55, 55 to 75, and >75 years). The interaction of age and sex subgroups with arrival time was tested first for each measure and outcome. When the interaction was found to be statistically significant ($P<0.10$), the ORs for comparing the measure/outcome during off-hours versus regular hours were computed for each of the corresponding subgroups. These analyses used most but not all measures and outcomes.

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results

Of all AMI patients (n=62 814), 54.1% (n=33 982) arrived during off-hours. Patients arriving during off-hours were younger, were more likely to belong to minority groups, and had slightly higher body mass index. They also were less likely to have a history of atrial fibrillation but more likely to have diabetes mellitus, heart failure, previous MI, and adult history of smoking and to present with STEMI (Table 1).

Table 1. Baseline Characteristics

Description	Overall (N=62 814)	Regular Hours (N=28 832)	Off-Hours (N=33 982)	P
Sociodemographic characteristics				
Age, mean±SD, y	67.9±14.6	68.2±14.4	67.6±14.7	<0.0001
Male	60.5 (38 018)	60.8 (17 524)	60.3 (20 494)	0.23
Race, % (n)				<0.0001
White	74.2 (46 575)	75.1 (21 654)	73.3 (24 921)	
Black	7.1 (4457)	6.7 (1934)	7.4 (2523)	
Asian or Pacific Islander	4.1 (2554)	4.0 (1150)	4.1 (1404)	
Hispanic	6.8 (4273)	6.8 (1945)	6.9 (2328)	
American Indian or Alaskan native	0.2 (107)	0.2 (46)	0.2 (61)	
Other	2.1 (1305)	1.9 (541)	2.3 (764)	
Unknown	5.6 (3543)	5.4 (1562)	5.8 (1981)	
BMI, mean±SD, kg/m^2	28.0±6.5 (55 791)	28.0±6.5 (25 713)	28.1±6.5 (30 078)	0.0001
Health insurance, % (n)				
Medicare	42.4 (26 617)	43.4 (12 498)	41.6 (14 119)	<0.0001
Medicaid	5.9 (3705)	5.7 (1646)	6.1 (2059)	0.03
No insurance/not documented	6.8 (4249)	6.7 (1916)	6.9 (2333)	0.16
Other insurance	38.1 (23 952)	38.3 (11 035)	38.0 (12 917)	0.80
Medical history, % (n)				
Hypertension	61.9 (38 852)	62.1 (17 896)	61.7 (20 956)	0.30
Hyperlipidemia	31.6 (19 815)	31.3 (9033)	31.7 (10 782)	0.26
Diabetes mellitus	30.8 (19 360)	30.1 (8670)	31.5 (10 690)	0.0001
Previous MI	20.6 (12 923)	19.8 (5697)	21.3 (7226)	<0.0001
Angina	10.3 (6460)	10.4 (2984)	10.2 (3476)	0.63
Heart failure	16.2 (10 179)	15.5 (4472)	16.8 (5707)	<0.0001
Chronic renal insufficiency	10.9 (6847)	10.8 (3117)	11.0 (3730)	0.50
Renal dialysis	2.2 (1404)	2.3 (649)	2.2 (755)	0.81
Atrial fibrillation	8.3 (5222)	8.6 (2470)	8.1 (2752)	0.03
Stroke	8.6 (5370)	8.6 (2472)	8.5 (2898)	0.85
COPD	13.2 (8274)	13.1 (3781)	13.2 (4493)	0.68
PVD	8.6 (5420)	8.8 (2536)	8.5 (2884)	0.17
Adult history of smoking	27.8 (17 469)	26.6 (7667)	28.8 (9802)	<0.0001
Clinical characteristics				
STEMI diagnosis, % (n)	32.3 (20 279)	31.6 (9122)	32.8 (11 157)	0.001
Systolic blood pressure, mean±SD, mm Hg	123±28	123±28	123±28	0.76
Diastolic blood pressure, mean±SD, mm Hg	67±17	67±16	67±17	0.27
Total cholesterol, mean±SD, mg/dL	176±48	175±48	176±48	0.04
Ejection fraction, mean±SD, %	47±15	47±15	47±15	0.38

BMI indicates body mass index; COPD, chronic obstructive pulmonary disease; and PVD, peripheral vascular disease.

Early Medical Therapies Among AMI Patients

AMI patients arriving during off-hours were only slightly more likely to receive early β-blocker treatment (84.7% versus 84.0%; $P=0.02$; adjusted OR, 1.05; 95% CI, 1.01 to 1.10; $P=0.03$) but not early aspirin (Tables 2 and 3).

Reperfusion Therapies and Timeliness of Reperfusion Among STEMI Patients

Eligible STEMI patients had similar overall rates of reperfusion therapy regardless of the timing of their presentation (Table 2). However, those arriving during off-hours were more likely to receive fibrinolytic therapies and slightly less likely to undergo PCI. After multivariable adjustment, patients arriving during off-hours remained more likely to receive fibrinolytics (adjusted OR, 1.40; 95% CI, 1.28 to 1.54; $P<0.0001$) and less likely to undergo PCI (adjusted OR, 0.93; 95% CI, 0.89 to 0.98; $P=0.004$; Table 3).

The median DTB time was significantly slower (110 versus 85 minutes; $P<0.0001$) and the proportion of patients achieving timely DTB times was much less during off-hours (Table 2). After multivariable adjustment, STEMI patients arriving during off-hours remained less likely to achieve DTB times ≤90 minutes (adjusted OR, 0.34; 95% CI, 0.29 to 0.39; $P<0.0001$; Table 3). DTN times and the proportions of

Table 2. Invasive Procedures and Quality of Care Measures in Patients During Off-Hours Versus Regular Hours

Treatment/Measure	Overall Rate	Regular Hours	Off-Hours	*P*
Early medical therapy (all AMI patients), % (n)				
Aspirin within 24 h	91.3 (51 562)	91.2 (23 634)	91.3 (27 928)	0.65
β-Blocker within 24 h	84.4 (44 162)	84.0 (20 177)	84.7 (23 985)	0.02
Reperfusion therapy (STEMI), % (n)				
Any reperfusion therapy	65.9 (13 354)	65.5 (5970)	66.2 (7384)	0.21
PCI	59.6 (12 086)	60.5 (5516)	58.9 (6570)	0.03
Fibrinolytic therapy	12.2 (2467)	9.8 (893)	14.1 (1574)	<0.0001
Timeliness of reperfusion (STEMI patients)				
DTN time, median (25th–75th), min	40 (25–65)	40 (23–65)	40 (25–65)	0.59
DTB time, median (25th–75th), min	99 (71–144)	85 (60–127)	110 (83–157)	<0.0001
DTN time ≤30 min, % (n)	34.1 (756)	35.4 (271)	33.5 (485)	0.36
DTB time ≤90 min, % (n)	41.8 (2281)	54.2 (1390)	30.9 (891)	<0.0001
Invasive procedures (all AMI patients), % (n)				
Cardiac catheterization	52.8 (29 736)	52.8 (13 764)	52.8 (15 972)	0.84
PCI	44.8 (25 241)	45.2 (11 800)	44.4 (13 441)	0.07
CABG	7.8 (4384)	8.0 (2083)	7.6 (2301)	0.10
Any revascularization	51.5 (29 053)	52.2 (13 620)	51.0 (15 433)	0.006
Invasive procedures (STEMI patients), % (n)				
Cardiac catheterization	60.2 (11 073)	60.3 (5027)	60.2 (6046)	0.93
CABG	7.5 (1384)	7.1 (596)	7.8 (788)	0.07
Any revascularization	70.0 (12 876)	70.2 (5855)	69.9 (7021)	0.67
Invasive procedures (NSTEMI patients) , % (n)				
Cardiac catheterization	49.1 (18 663)	49.2 (8737)	49.1 (9926)	0.96
PCI	35.4 (13 424)	36.1 (6403)	34.7 (7021)	0.009
CABG	7.9 (3000)	8.4 (1487)	7.5 (1513)	0.002
Any revascularization	42.6 (16 177)	43.7 (7765)	41.6 (8412)	<0.0001

patients receiving timely fibrinolytic therapy were similar during regular and off-hours (Tables 2 and 3).

Invasive Procedures

In the overall AMI cohort, arrival during off-hours was associated with similar rates of use of cardiac catheterization but slightly lower rates of revascularization compared with arrival during regular hours (Table 2). After multivariable adjustment, AMI patients arriving during off-hours were slightly less likely to undergo PCI (adjusted OR, 0.96; 95% CI, 0.92 to 0.99; $P=0.02$), CABG (adjusted OR, 0.92; 95% CI, 0.86 to 1.00; $P=0.04$), and any revascularization procedure (adjusted OR, 0.94; 95% CI, 0.90 to 0.97; $P=0.0006$) (Table 3).

STEMI patients showed no significant differences in rates of cardiac catheterization, CABG, and any revascularization with respect to arrival time (Tables 2 and 3). Compared with those arriving during regular hours, NSTEMI patients arriving during off-hours also were slightly less likely to undergo CABG (adjusted OR, 0.87; 95% CI, 0.80 to 0.93; $P=0.0002$) and any revascularization (adjusted OR, 0.93; 95% CI, 0.89 to 0.97; $P=0.002$; Table 3).

In-Hospital Mortality

Among the overall AMI cohort, 4035 deaths (7.16%) occurred, with an in-hospital mortality rate of 7.5% for STEMI and 7.0% for NSTEMI patients. No significant differences were found in in-hospital mortality with respect to arrival time in the overall AMI population or among those with STEMI or NSTEMI (off-hours versus regular hours: 7.1% versus 7.2%, $P=0.62$; 7.6% versus 7.5%, $P=0.80$; 6.9% versus 7.1%, $P=0.41$, respectively; Figure 1). After multivariable adjustment, in-hospital mortality rates for AMI, STEMI, and NSTEMI patients arriving during off-hours also were similar to those arriving during regular hours (adjusted OR, 0.99; 95% CI, 0.93 to 1.06; $P=0.82$; adjusted OR, 1.05; 95% CI, 0.94 to 1.18; $P=0.39$; and adjusted OR, 0.97; 95% CI, 0.90 to 1.04; $P=0.42$, respectively).

No differences in early in-hospital mortality, especially within the first 24 and 48 hours, were found in the overall AMI population and among patients with STEMI or NSTEMI (data not shown). Hence, the aforementioned intergroup disparities in treatments were unlikely to be related to variations in the timing of in-hospital mortality.

Sensitivity and Subgroup Analyses

We assessed whether our findings were altered by the definition of arrival time. When the definition of off-hours was changed to weekends and holidays versus weekdays, 21 496 patients (34%) arrived during weekends and holidays. This alternative definition produced similar differences in care, predominantly in DTB times (median DTB time, week-

Table 3. Adjusted ORs* for Invasive Procedures and Quality of Care Measures in Patients Arriving During Off-Hours Versus Regular Hours

Treatment/Measure	n	OR (95% CI), Off-Hours vs Regular Hours	*P*
Early medical therapy (all AMI patients)			
Aspirin within 24 h	56 491	1.03 (0.98–1.09)	0.28
β-Blocker within 24 h	52 343	1.05 (1.01–1.10)	0.03
Reperfusion procedures (STEMI patients)			
Any reperfusion therapy	19 848	1.03 (0.98–1.09)	0.25
PCI	19 848	0.93 (0.89–0.98)	0.004
Fibrinolytic therapy	19 848	1.40 (1.28–1.54)	<0.0001
Timeliness of reperfusion (STEMI patients)			
DTN time ≤30 min	2216	0.93 (0.77–1.12)	0.44
DTB time ≤90 min	5454	0.34 (0.29–0.39)	<0.0001
Invasive procedures (all AMI patients)			
Cardiac catheterization	54 383	0.98 (0.94–1.01)	0.17
PCI	54 383	0.96 (0.92–0.99)	0.02
CABG	54 383	0.92 (0.86–1.00)	0.04
Revascularization	54 383	0.94 (0.90–0.97)	0.0006
Invasive procedures (STEMI patients)			
Cardiac catheterization	18 048	0.97 (0.92–1.02)	0.18
CABG	18 048	1.07 (0.95–1.22)	0.26
Any revascularization	18 048	0.96 (0.90–1.01)	0.11
Invasive procedures (NSTEMI patients)			
Cardiac catheterization	36 335	0.99 (0.95–1.04)	0.71
PCI	36 335	0.97 (0.93–1.01)	0.18
CABG	36 335	0.87 (0.80–0.93)	0.0002
Any revascularization	36 335	0.93 (0.89–0.97)	0.002

*ORs, which are for arrival during off-hours compared with regular hours, were adjusted for age, sex, race, body mass index, insurance type, systolic blood pressure, cardiac diagnosis, initial ECG with diagnostic ST-segment elevation or left bundle-branch block, diabetes mellitus, hypertension, hyperlipidemia, smoking, renal insufficiency, chronic obstructive pulmonary disorder, heart failure, stroke, peripheral artery disease, and previous MI. The generalized estimating equations approach also was used to adjust for clustering within hospitals.

end/holidays versus weekdays: 108 versus 93 minutes; $P<0.0001$). No significant differences, however, were found in weekend/holiday versus weekday mortality rates in the overall MI cohort (adjusted OR, 0.98; 95% CI, 0.91 to 1.05; $P=0.6$) and the STEMI (adjusted OR, 0.97; 95% CI, 0.86 to 1.10; $P=0.7$) and NSTEMI (adjusted OR, 0.98; 95% CI, 0.91 to 1.06; $P=0.6$) subpopulations (see the Appendix in the online-only Data Supplement).

In subgroup analyses, no significant interaction was found between age and care with respect to regular hours versus

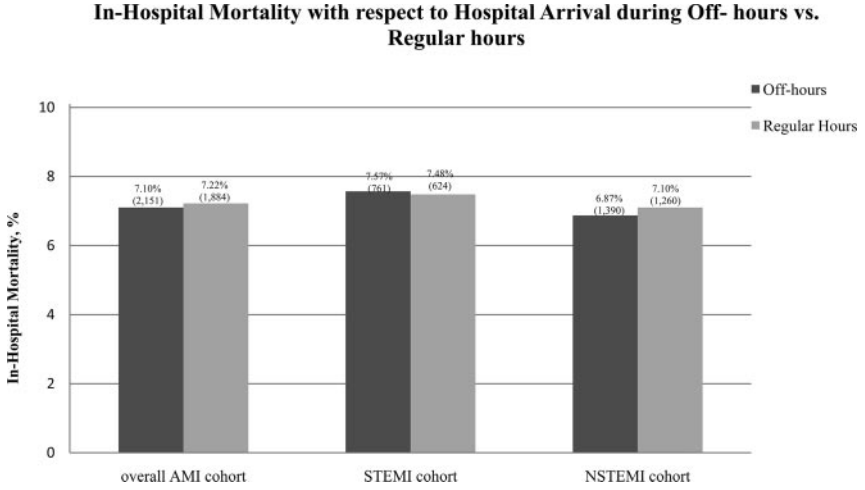

Figure 1. In-hospital mortality with respect to hospital arrival during off-hours vs regular hours.

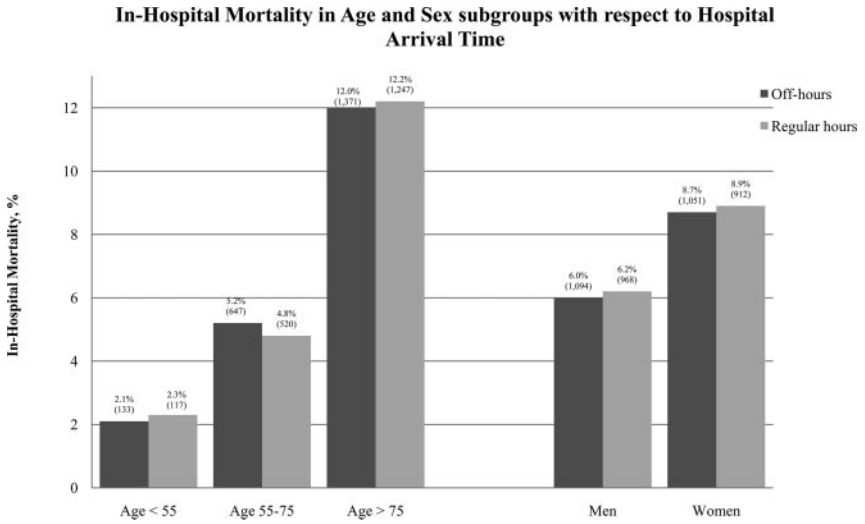

Figure 2. In-hospital mortality in age and sex subgroups with respect to hospital arrival during off-hours vs regular hours.

off-hours for most measures and outcomes, including timeliness of reperfusion in the STEMI cohort, early medical therapies in the overall AMI cohort, and in-hospital mortality in the STEMI, NSTEMI, and overall AMI cohorts (Figure 2). Similarly, no significant interaction between sex and care was found with respect to arrival time for most measures and outcomes.

Discussion

In this large cohort study of 62 814 patients with AMI from the multicenter GWTG-CAD database, we found that arrival during off-hours was associated with slightly lower rates of primary PCI and revascularization during the initial hospitalization and significantly longer DTB times. No measurable differences, however, were found in in-hospital mortality in the overall AMI cohort and in the STEMI and NSTEMI subpopulations.

Earlier studies reported that off-hours presentation had limited impact on in-hospital mortality among patients presenting with AMI[4,12] and among STEMI patients receiving PCI.[13,14] In contrast, Magid and colleagues[5] recently reported in a large analysis of hospitals participating in the National Registry of Myocardial Infarction that off-hours presentation was associated with higher in-hospital mortality. These differences were thought to be attributable to delayed reperfusion because the mortality difference became nonsignificant after adjustment for time to reperfusion. However, the aforementioned analysis was limited only to STEMI patients undergoing early reperfusion and included transfer-out patients who were assumed to be alive. Most recently, the Myocardial Infarction Data Acquisition System (MIDAS)[6] analysis demonstrated greater mortality after AMI during weekend admission. In the most contemporary 1999 to 2002 cohort of 59 786 patients from MIDAS,[6] higher in-hospital mortality persisting up to 1 year was observed among patients admitted during weekends. However, differences in outcome became nonsignificant after adjustment for invasive procedure use.[6] Moreover, this study was limited to data from a single state, had markedly low rates of catheterization and revascularization reflecting older clinical practice, did not report the timeliness of primary reperfusion therapy, and found significant differences in adjusted mortality in only 1 of 3 time periods examined.[6] Although the in-hospital mortality rate in our analysis appears to be higher than that of other contemporary data sets,[4,5] we attribute this to differences in the patient populations, in-hospital treatments, and other interrelated factors. Despite the seemingly higher event rates in our analysis, we were unable to detect differences in in-hospital mortality with respect to arrival time.

In our analysis, STEMI patients arriving during off-hours were more likely to receive fibrinolytic therapy and slightly less likely to undergo primary PCI. This resulted in no net differences in overall reperfusion rates and may reflect an appropriate clinical decision on the part of "off-hour" physicians to select fibrinolytic therapy when prompt PCI is not feasible.[3] Regardless of the soundness of these triage decisions, the timeliness of primary PCI, when selected, was suboptimal, pointing out the ongoing system challenges in achieving rapid system activation and staff mobilization during off-hours. Although the differences in primary PCI were too small to be clinically relevant and were offset by an increase in the use of fibrinolytic therapy during off-hours, it is particularly interesting to note that the observed differences in the timeliness of primary PCI did not translate into measurable differences in hospital outcome. This seems to be counterintuitive to several prior patient-level observational analyses associating shorter DTB times with lower mortality risks.[15–19] Several potential explanations exist. First, the time differential between off-hours and regular hours was modest (median differences, 25 minutes) and perhaps may not translate into measurable differences in in-hospital mortality. Alternatively, it is conceivable that there may be a threshold effect in the DTB time beyond which no further improvement in outcome can be observed; however, this remains to be proved. Our findings are particularly relevant to the Door to Balloon (D2B): An Alliance for Quality[7,20] campaign, a new initiative undertaken by the ACC to achieve timely mechanical reperfusion among STEMI patients, and to Mission: Lifeline,[8] an AHA initiative addressing multiple care processes to promptly activate the appropriate chain of events and to achieve timely use of all evidence-based therapies in the STEMI population. Interestingly, the gap between current

practice and some of the goals of the aforementioned program for DTB[7] is comparable in magnitude to what our study found exists between regular and off-hours care. We thus argue that, although the aforementioned campaigns to reduce time to reperfusion are laudable,[7,8] improvements in DTB times should be complemented by multifaceted approaches to optimize multiple levels of medical care in parallel and thus impart the largest influence on national AMI mortality.

Our study also demonstrates that the slight differences in the use of revascularization among patients during off-hours versus regular hours had no impact on in-hospital mortality. Although our findings are consistent with those from another large NSTEMI–acute coronary syndrome registry,[4] they tend to conflict with those from MIDAS.[6] It is important to note, however, that the differences in revascularization with respect to arrival time in our study were much smaller than those observed in MIDAS.[6] In fact, these differences, although statistically significant because of the large number of patients examined, may not be as clinically relevant. Moreover, although most trials have supported the benefits of early revascularization on composite cardiovascular end points, they have generally found no impact on acute mortality. In addition, the slightly less frequent use of early intervention among patients presenting during off-hours also can be attributed to the fact that physicians are usually capable of triaging these resources to those who may benefit the most.[4] Finally, the overall increases in the use of revascularization and acute medical therapies reflect the general improvement in medical care for AMI observed across the United States.

Overall, our analysis has several strengths, including its inclusion of a community-based contemporary patient population, inclusion of all regions of the United States, use of detailed clinical data, comprehensive evaluation of multiple processes of care and their adjusted associations with in-hospital mortality, and the robustness and consistency of our findings. On the other hand, our study has several shortcomings. The GWTG hospitals are self-selected and may not be fully representative of national care patterns and clinical outcomes. We also did not have data on prehospital delay or treatments, hospital status, or postdischarge mortality and morbidity. Moreover, eligibility for treatment was based on documentation in the medical record and was thus dependent on the accuracy of this documentation. Finally, there might be other measured or unmeasured confounding variables that, had they been adjusted for, would have revealed a relationship between off-hours arrival and in-hospital mortality.

Conclusions

AMI patients arriving during off-hours were only slightly less likely to undergo revascularization or primary PCI, were more likely to receive fibrinolytic therapy, and had no differences in the use of overall reperfusion therapy compared with those arriving during regular hours. STEMI patients, in particular, were less likely to receive timely mechanical reperfusion. No measurable differences, however, were found in in-hospital mortality in the overall AMI cohort or in the STEMI and NSTEMI subpopulations. Healthcare providers should continue to work to enhance the healthcare system during regular and off-hours and to reduce existing disparities in cardiac care through multifaceted initiatives aiming to improve the timely delivery of evidence-based therapies.

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Disclosures

Dr Jneid has received a database research seed grant from the Council on Clinical Cardiology. Dr Fonarow serves as chair of the Get With the Guidelines Steering Committee of the American Heart Association. Dr Cannon serves as the chair of the Get With the Guidelines Steering Science Subcommittee. Dr Peterson is the associate director and director of cardiovascular research at the Duke Clinical Research Institute, which also receives funding from the American Heart Association. The other authors report no conflicts.

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CLINICAL PERSPECTIVE

Previous studies showed an inconsistent association between patients' arrival time for acute myocardial infarction (AMI) and their subsequent medical care and outcomes. Using a contemporary national clinical registry, we examined differences in medical care and in-hospital mortality among AMI patients admitted during regular hours (weekdays 7 AM to 7 PM) versus off-hours (weekends, holidays, and 7 PM to 7 AM weeknights). In the current large cohort study of 62 814 patients with AMI from the multicenter Get With the Guidelines–Coronary Artery Disease database, we found that AMI patients arriving during off-hours were slightly less likely to undergo revascularization or primary percutaneous coronary intervention, more likely to receive fibrinolytic therapy, and had no differences in the use of overall reperfusion therapy compared with those arriving during regular hours. ST-elevation MI patients, in particular, were less likely to receive timely mechanical reperfusion. Despite the slight disparities in revascularization rates and especially the larger differences in timely mechanical reperfusion, no measurable differences were found in in-hospital mortality in the overall AMI cohort and in the ST-elevation MI and non–ST-elevation MI subpopulations. Similar observations were made across most age and sex subgroups and using an alternative definition for arrival time (weekends/holidays versus weekdays). Healthcare providers should continue to work to enhance the healthcare system during regular hours and off-hours and to reduce existing disparities in cardiac care through multifaceted initiatives aiming to improve the timely delivery of evidence-based therapies.

Impact of Time of Presentation on the Care and Outcomes of Acute Myocardial Infarction

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