CLINICAL RESEARCH STUDY

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Hospital Length of Stay in Patients with Non-ST-segment Elevation Myocardial Infarction

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ABSTRACT

PURPOSE: Substantial heterogeneity in hospital length of stay exists among patients admitted with non-ST-segment elevation myocardial infarction. Furthermore, little is known about the factors that impact length of stay.

METHODS: We examined 39,107 non-ST-segment elevation myocardial infarction patients admitted to 351 Acute Coronary Treatment Intervention Outcomes Network Registry-Get With The Guidelines hospitals from January 1, 2007-March 31, 2009 who underwent cardiac catheterization and survived to discharge. Length of stay was categorized into 4 groups ($\leq$2, 3-4, 5-7, and $\geq$8 days), where prolonged length of stay was defined as $>$4 days.

RESULTS: The overall median (25^{th}, 75^{th}) length of stay was 3 (2, 5) days. Patients with a length of stay of $>$2 days were older with more comorbidities, but were less likely to receive evidence-based therapies or percutaneous coronary intervention. Among the factors associated with prolonged length of stay $>$4 days were delay to cardiac catheterization $>$48 hours, heart failure or shock on admission, female sex, insurance type, and admission to the hospital on a Friday afternoon or evening. Hospital characteristics such as academic versus nonacademic or urban versus rural setting, were not associated with prolonged length of stay.

CONCLUSION: Patients with longer length of stay have more comorbidities and in-hospital complications, yet paradoxically, are less often treated with evidence-based medications and are less likely to receive percutaneous coronary intervention. Hospital admission on a Friday afternoon or evening and delays to catheterization appear to significantly impact length of stay. A better understanding of factors associated with length of stay in patients with non-ST-segment elevation myocardial infarction is needed to promote safe and early discharge in an era of increasingly restrictive health care resources.

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KEYWORDS: Hospital discharge; Length of stay; Non-ST-segment-elevation myocardial infarction

More than a half million patients are hospitalized annually for non-ST-segment elevation myocardial infarction in the US.[1] Among these patients, there is considerable variability in hospital length of stay for reasons that are not well defined. Previous studies have demonstrated that patients with uncomplicated ST-segment elevation myocardial infarction treated with fibrinolysis could be safely discharged as early as 3 days after presentation.[2] Studying the variability of length of stay in ST-segment elevation myocardial infarction patients has provided important insights into opportunities for safe earlier hospital discharge.[3-7] However, to date, no studies have investigated length of stay for patients with non-ST-segment elevation myocardial infarction, which is generally a more heterogeneous disease process with multiple possible underlying causes, and is often found in patients who are older and with more comorbidities than patients with ST-segment elevation myocardial infarction.

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Increasingly, hospitals and health care providers are pressured to reduce medical resource expenditures and shorten hospital length of stay. The importance of containing health care costs underscores the need to better understand the factors associated with longer hospital length of stay and to explore opportunities for safe early discharge in patients with non-ST-segment elevation myocardial infarction. Current treatment guidelines recommend a risk-tailored early invasive approach for the treatment of non-ST-segment elevation myocardial infarction and advocate for early discharge—especially in those patients who are considered low risk.[8] This analysis utilized data from the National Cardiovascular Data Registry (NCDR) Acute Coronary Treatment Intervention Outcomes Network Registry-Get With The Guidelines (ACTION Registry-GWTG) to explore and identify patient characteristics and clinical factors associated with hospital length of stay in patients admitted with non-ST-segment elevation myocardial infarction who underwent cardiac catheterization.

CLINICAL SIGNIFICANCE

- No previous studies have investigated length of stay for patients with non-ST-segment elevation myocardial infarction (NSTEMI).
- Examining almost 40,000 US patients admitted with NSTEMI, those with longer length of stay have more comorbidities, yet are less often treated with evidence-based medications.
- Hospital admission on a Friday afternoon or evening led to delays in cardiac catheterization that significantly impacted length of stay.
- A better understanding of length of stay in patients with NSTEMI is needed in an era of increasingly restrictive health care resources.

METHODS

The ACTION Registry-GWTG is a result of the merger between the American College of Cardiology Foundation's NCDR ACTION Registry and the American Heart Association's GWTG-Coronary Artery Disease Registry. The ACTION Registry-GWTG is a voluntary national quality improvement registry that began collecting data on January 1, 2007 on hospitalized ST-segment elevation myocardial infarction and non-ST-segment elevation myocardial infarction patients that are at least 18 years of age. This registry is now the largest national quality improvement initiative focusing on patients with myocardial infarction (MI).[9]

The full details of the registry operations, quality assurance, and data collected have been previously reported.[10] Briefly, data were entered at each site by a trained data collector. The NCDR employs a standard data set with uniform data entry and data quality checks.[9]

Patient Population

Between January 1, 2007 and December 31, 2009, 98,545 non-ST-segment elevation myocardial infarction patients at 384 hospitals were enrolled into the ACTION Registry-GWTG. To focus on a more homogeneous population of patients relative to treatment strategy, patients were excluded if: 1) they did not undergo cardiac catheterization or had missing catheterization status data (n = 24,899); 2) underwent coronary artery bypass grafting or had missing coronary artery bypass grafting status data (n = 10,581); 3) were transferred out (n = 2336) or transferred in to the reporting hospital (n = 20,815); 4) had a length of stay equal to zero or missing length of stay data (n = 59); or 5) died during their hospitalization (n = 748). After exclusions, our final study population included 39,107 non-ST-segment elevation myocardial infarction patients from 351 hospitals.

Definitions

Length of stay was defined as the time interval between date of admission and date of discharge. Exact patient discharge times were not available, so all discharge times were recorded as 12:00 PM. For patients with partial days in their length of stay, we rounded to the nearest whole number. Patients were categorized into 4 groups based on hospital length of stay: ≤2 days; 3-4 days; 5-7 days; or ≥8 days. Patients also were grouped into the following 6 categories, based on the day of the week they were admitted: Monday-Wednesday; Thursday; Friday morning (12:00 AM-<12:00 PM); Friday afternoon or evening (12:00 PM-<12:00 AM); Saturday; or Sunday. Major bleeding was defined as an absolute hemoglobin (Hgb) drop of ≥4 g/dL, intracranial hemorrhage, witnessed retroperitoneal bleeding, red blood cell transfusion in a patient with a baseline Hgb ≥9 g/dL, or an RBC transfusion with a witnessed bleeding event in a patient with a baseline Hgb of <9 g/dL. In-hospital complications were defined as postadmission reinfarction, cardiogenic shock, heart failure, stroke, major bleeding, or blood transfusion.

Statistical Analysis

Demographic information was stratified among the 4 length-of-stay categories. Treatments such as acute and discharge medications and procedures were considered only among those without a documented contraindication. Continuous variables were reported as median values (with 25th, 75th percentiles) and categorical values were reported as percentages. Chi-squared tests were used to compare categorical variables, and the Kruskal-Wallis test was used for continuous variables. Where data were not normally distributed, median values with 25^{th}-75^{th} percentiles were reported.

To explore factors associated with prolonged length of stay (defined as >4 days vs ≤4 days), a logistic generalized

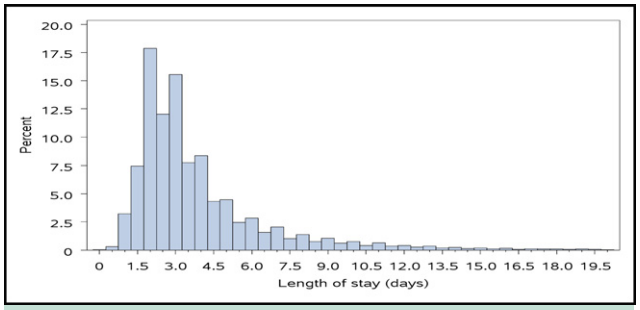

Figure 1 Distribution of length of stay. This figure displays the distribution of length of stay in days as a percentage of the entire population studied.

estimating equations method was used with exchangeable working correlation matrix to account for within-hospital clustering. This method produced estimates similar to those from logistic regression, but variances were adjusted for the correlation of outcomes within a hospital.[11]

Statistical significance was defined as $P < .05$. All analyses were conducting using SAS software version 9.2 (SAS Institute, Cary, NC).

RESULTS

Baseline Characteristics

For the 39,107 patients with non-ST-segment elevation myocardial infarction in our analysis cohort, the median age overall was 64 (54, 75) years. Women made up 37.0% of the population, and 82.1% of patients were white. The median length of stay for the overall cohort in our study population was 3 (2, 5) days, and the distribution of length of stay is displayed in **Figure 1**. There were 13,047 (33.4%) patients with length of stay ≤2 days; 15,870 (40.6%) with length of stay 3-4 days; 6325 (16.1%) with length of stay 5-7 days; and 3865 (9.9%) with length of stay ≥8 days. Twenty-six percent of patients had a length of stay >4 days.

The patient baseline and hospital characteristics of our population categorized by length of stay are displayed in **Table 1**, and display those that are clinically relevant and statistically significant. As length of stay increased, patients were older, more often female, and less frequently white. In addition, as length of stay increased, patients more frequently presented with heart failure symptoms and ST-segment depression on the initial electrocardiogram. They also had an increased number of comorbidities, including a history of prior MI, heart failure, hypertension, atrial fibrillation, coronary artery bypass grafting, stroke, or peripheral arterial disease. Patients with longer hospital length of stay presented with higher serum creatinine levels, had higher peak serum creatinine levels, and were more likely to be on hemodialysis. These patients also were less likely to be current smokers.

Patients with higher length of stay were more likely to be treated at an academic medical center, and at centers with larger bed volumes. Urban versus rural setting of the hospital did not seem to be associated with length of stay (**Table 1**).

Medication Use by Length of Stay

In the absence of documented contraindications, the administration of medications to treat acute coronary syndromes within 24 hours is shown in **Table 2** for each category of length of stay, as well as the use of anticoagulants at any time during the hospitalization. **Table 3** shows discharge medications by length of stay category. In general, patients with longer length of stay were less likely to be treated with evidence-based medications during the hospitalization and at the time of discharge.

Clopidogrel use in the first 24 hours after presentation was 77.1% in the ≤2 days group, 66.6% in the 3-4 days group, 56.7% in the 5-7 days group, and 51.8% in the ≥8 days group ($P < .0001$ for all comparisons). This pattern also was generally true for aspirin, beta-blockers, angiotensin-converting enzyme inhibitors or angiotensin receptor blockers, and statins. The use of anticoagulants such as unfractionated heparin, low-molecular-weight heparin, bivalirudin, or fondaparinux differed to a lesser degree (**Table 2**).

Patients who had longer length of stay also were less likely to be discharged home on evidence-based medications. Those with the longest length of stay (≥8 days) were the least likely to be discharged home on aspirin (95.8%), clopidogrel (76.0%), or a statin (83.0%); $P < .0001$ for all comparisons among length of stay groups for each medication (**Table 3**).

In-hospital Procedures, Complications, and Delays to Cardiac Catheterization

Longer length of stay was associated with higher rates of clinical complications, less use of percutaneous coronary intervention, and longer delays to cardiac catheterization and percutaneous coronary intervention when they were performed (**Table 4**). Patients with length of stay ≥8 days had the highest rates of MI (2.5%), shock (7.6%), heart failure (18.3%), stroke (2.1%), or major bleeding (38.8%) compared with all other groups; $P < .0001$. Nevertheless, patients with length of stay ≥8 days were the least likely to receive early cardiac catheterization or percutaneous coronary intervention (53.7%), and were most likely to receive a noninvasive stress test; $P < .0001$ for all comparisons. Furthermore, if they did receive cardiac catheterization or percutaneous coronary intervention, they had the longest delays in time from presentation to cardiac catheterization (49.3 hours, interquartile range 19.2, 110.0) or percutaneous coronary intervention (55.0 hours, interquartile range 18.4, 131.6) (**Table 4**).

Delays to cardiac catheterization and the presence of complications were both associated with longer length of stay (**Figure 2**). Almost 85% of patients (n = 33,010) had no complications. Less than 2% had 3 or more complications. Moreover, approximately 90% of patients (n = 35,037) went to the catheterization laboratory within 3 days. The shortest length of stay was among those patients with no complications who went to the catheterization laboratory within 3 days. The longest length of stay was in those

Table 1 Patient Baseline and Hospital Characteristics by LOS Category

Demographics	Overall (n = 39,107)	≤2 days (n = 13,047) 33.4%	3-4 days (n = 15,870) 40.6%	5-7 days (n = 6325) 16.1%	≥8 days (n = 3865) 9.9%	*P*-Value
Age (years)*	64 (54, 75)	60 (51, 70)	63 (53, 74)	70 (60, 79)	73 (63, 80.5)	<.0001
BMI (kg/m^2)*	28.7 (25.2, 33.1)	29.1 (25.7, 33.3)	28.9 (25.5, 33.2)	28.3 (24.6, 32.8)	28.0 (24.1, 32.8)	<.0001
Female sex	37.0	31.3	36.0	45.1	47.3	<.0001
Hospital characteristics						
Nonacademic hospital†	75.1	77.0	75.0	73.9	71.2	<.0001
Total hospital beds*	409 (281, 604)	390 (274, 570)	410 (281, 612)	411 (283, 612)	426 (294, 621)	<.0001
Urban setting	92.2	92.2	91.9	92.3	93.5	.0103
Region						
West	14.9	18.8	13.0	12.1	14.0	<.0001
Northeast	9.5	7.0	10.0	11.5	12.5	
Midwest	36.5	39.0	34.7	35.7	36.0	
South	39.2	35.1	42.3	40.7	37.6	
Race						<.0001
White	82.1	85.5	81.3	79.6	77.8	
Black	10.9	7.9	11.7	13.2	14.3	
Asian	1.3	1.2	1.3	1.2	1.8	
Hispanic	4.0	3.5	4.1	4.5	4.6	
Medical history						
Current smoker	32.4	37.5	33.4	26.3	20.8	<.0001
Hypertension	73.9	68.3	72.8	82.2	83.4	<.0001
Dyslipidemia	62.5	61.7	61.8	65.1	64.2	<.0001
Diabetes	32.6	24.7	30.7	41.9	51.7	<.0001
Currently on dialysis	2.6	0.9	2.1	4.5	7.3	<.0001
History of						
MI	28.6	25.1	27.9	34.0	34.1	<.0001
Heart failure	12.1	5.4	9.8	20.6	29.7	<.0001
AF	7.4	3.6	6.3	12.3	17.3	<.0001
PCI	28.7	28.7	28.3	29.6	29.4	.18
CABG	20.6	16.1	20.2	26.5	27.7	<.0001
Stroke	7.6	4.5	6.5	11.6	15.4	<.0001
PAD	10.6	7.1	9.1	15.5	20.8	<.0001
Signs and symptoms at presentation						
Heart failure	14.4	5.1	11.1	25.7	40.4	<.0001
Shock	0.9	0.2	0.4	1.2	4.4	<.0001
Heart rate (beats per minute)*	81 (70, 96)	78 (68, 91)	80 (69, 94)	86 (72, 103)	91 (76, 109)	<.0001
Systolic blood pressure (mm Hg)*	148 (129, 168)	149 (131, 168)	149 (130, 169)	145 (125, 167)	140 (118, 164)	<.0001
Renal function						
Initial creatinine value (mg/dL) [nondialysis pts]*	1.00 (0.90, 1.30)	1.00 (0.80, 1.20)	1.00 (0.90, 1.20)	1.10 (0.90, 1.40)	1.30 (1.00, 1.70)	<.0001
Peak creatinine value (mg/dL) [nondialysis pts]*	1.10 (0.90, 1.40)	1.00 (0.90, 1.20)	1.10 (0.90, 1.30)	1.20 (1.00, 1.60)	1.60 (1.20, 2.30)	
ECG findings (NSTEMI)						<.0001
ST depression	10.8	9.1	10.9	12.8	13.2	
Transient ST elevation	1.7	2.0	1.7	1.3	1.1	

AF = atrial fibrillation; BMI = body mass index; CABG = coronary artery bypass grafting; ECG = electrocardiogram; MI = myocardial infarction; NSTEMI = non-ST-segment elevation myocardial infarction; PAD = peripheral artery disease; PCI = percutaneous coronary intervention; pts = patients.

*Continuous variables displayed as median values with 25th, 75th percentiles.

†Member of the Council of Teaching Hospitals.

patients with at least one complication who went to the catheterization laboratory after 3 days. Irrespective of complications, length of stay was longer in the cohort who got catheterized after 3 days, as compared with those who got catheterized within 3 days (6.66 vs 2.89, respectively).

The risk of mortality calculated by the ACTION Registry-GWTG mortality risk score also was associated positively with hospital length of stay.[12] **Figure 3** demonstrates that as the risk increases, there is a consistent increase in length of stay.

Day of Week Admitted to the Hospital and Length of Stay

Depicted in **Table 5** is the time to cardiac catheterization and hospital length of stay based on the day of the week admitted to the hospital. Admission to the hospital on a Friday

Table 2 Medications within 24 Hours or Anytime* by LOS Category

	Overall (n = 39,107)	≤2 days (n = 13,047)	3-4 days (n = 15,870)	5-7 days (n = 6325)	≥8 days (n = 3865)	*P*-value
Aspirin	97.6	98.5	98.2	96.0	95.0	<.0001
Clopidogrel	67.2	77.1	66.6	56.7	51.8	<.0001
Beta-blocker	91.8	92.5	92.6	90.6	87.7	<.0001
ACE inhibitor or ARB	51.5	51.7	52.4	52.7	44.7	<.0001
Statin	63.0	68.2	62.8	58.7	53.0	<.0001
GPIIb/IIIa	43.8	48.8	47.0	33.8	28.4	<.0001
Any heparin*	88.6	86.8	90.4	88.5	87.9	<.0001
UFH*	61.9	62.1	62.0	60.1	63.5	<.0001
LMWH*	36.9	31.9	38.7	41.1	39.3	<.0001
Bivalirudin*	20.9	22.4	20.2	20.4	19.6	<.0001
Fondaparinux*	0.2	0.2	0.2	0.2	0.5	.01

ACE = angiotensin-converting enzyme; ARB = angiotensin receptor blocker; GPIIb/IIIa = glycoprotein IIb/IIIa; LOS = length of stay; LMWH = low-molecular-weight heparin; UFH = unfractionated heparin.

*Denotes administered anytime during the hospitalization.

afternoon or evening was studied for its association with prolonged length of stay as a way to describe possible delays in care from the upcoming weekend. Those admitted on a Friday afternoon or evening had the longest delays to catheterization (median [25th-75th]) (58.5 [13.8-67.1] hours) and longest length of stay (3.8 [2.8-4.9] days). Those admitted on Friday morning had a very short time to catheterization (10.6 [4.5-72.0] hours), but this did not translate to earlier discharge (3.5 [2.2-5.1] days).

Factors Associated with Prolonged Length of Stay

Baseline demographic, clinical factors, and hospital features associated with prolonged length of stay (>4 days vs ≤4 days) are displayed in **Table 6**. The factors most strongly associated with length of stay >4 days in the adjusted model were undergoing cardiac catheterization >48 hours after presentation (odds ratio [OR] 4.87; 95% confidence interval [CI], 4.54-5.22), shock at presentation (OR 7.82; 95% CI, 6.01-10.17), or heart failure without shock (OR 2.09; 95% CI, 1.93-2.26). Older age also was strongly associated with length of stay >4 days, with an OR of 1.14 (95% CI, 1.13-1.16) per every 5-year increase in age.

As compared with admission to the hospital on a Monday-Wednesday, admission on a Friday afternoon or evening (OR 1.13; 95% CI, 1.02-1.25) or on a Thursday (OR 1.50; 95% CI, 1.40-1.61) was associated with length of stay >4 days. Those patients admitted to the hospital on a Saturday were less likely to have a prolonged length of stay (OR 0.88; 95% CI, 0.81-0.96) when compared with those admitted to the hospital Monday-Wednesday.

Other comorbidities such as anemia, prior MI, diabetes, heart failure, stroke, peripheral arterial disease, and hypertension all were linked to length of stay >4 days. Patients with a history of prior percutaneous coronary intervention were less likely to have prolonged length of stay (OR 0.82; 95% CI, 0.77-0.88). Additionally, patients with private/health maintenance organization insurance also were less likely to have a prolonged length of stay as compared with patients with all other types of insurance (Medicare, Medicaid), or no insurance at all (none/self-pay). Treatment at an academic medical center versus a nonacademic center, a rural hospital versus an urban setting hospital, race of the patient, smoking status, and a history of coronary artery bypass grafting were variables tested and not associated with a prolonged length of stay >4 days (**Table 6**).

Table 3 Discharge Medications by LOS Category

	Overall (n = 39,107)	≤2 Days (n = 13,047)	3-4 days (n = 15,870)	5-7 days (n = 6325)	≥8 days (n = 3865)	*P*-Value
Aspirin	97.6	97.9	97.9	97.0	95.8	<.0001
Clopidogrel	84.9	86.7	87.0	80.7	76.0	<.0001
Coumadin	7.7	3.0	6.4	13.8	18.7	<.0001
Beta-blocker	95.2	94.2	96.1	95.3	94.3	<.0001
ACE inhibitor or ARB	73.0	70.1	74.9	75.6	70.8	<.0001
Statin	89.6	90.9	90.8	87.3	83.0	<.0001

ACE = angiotensin-converting enzyme; ARB = angiotensin receptor blocker; LOS = length of stay.

Table 4 In-hospital Procedures and Complications by LOS Category

	Overall (n = 39,107)	≤2 days (n = 13,047)	3-4 days (n = 15,870)	5-7 days (n = 6325)	≥8 days (n = 3865)	*P*-Value
In-hospital procedures						
Noninvasive stress test	4.2	2.7	3.9	6.6	6.8	<.0001
Cath within 48 hours of arrival	79.5	99.1	80.6	54.8	48.9	<.0001
PCI	66.0	70.3	68.2	58.9	53.7	<.0001
PCI within 48 hours of arrival	53.7	70.0	56.1	31.7	25.0	<.0001
Time from presentation to:						
Cath (hours)*	21.1 (8.7, 42.0)	13.9 (4.5, 22.3)	23.0 (11.7, 43.5)	42.2 (17.2, 73.5)	49.3 (19.2, 110.0)	<.0001
PCI (hours)*	19.8 (6.7, 38.5)	12.2 (4.3, 21.5)	22.2 (10.1, 42.3)	42.5 (16.0, 78.2)	55.0 (18.4, 131.6)	<.0001
Clinical complications						
MI	0.9	0.3	0.7	1.5	2.5	<.0001
Cardiogenic shock	1.2	0.2	0.4	1.7	7.6	<.0001
CHF	4.5	1.0	2.8	7.9	18.3	<.0001
Stroke	0.4	0.0	0.2	0.6	2.1	<.0001
Overall RBC transfusion	6.2	0.6	2.5	11.7	31.3	<.0001
Overall major bleeding	8.6	1.1	4.6	15.9	38.8	<.0001

Cath = cardiac catheterization; CHF = congestive heart failure; LOS = length of stay; MI = myocardial infarction; PCI = percutaneous coronary intervention; RBC = red blood cell.

*Continuous variables displayed as median values with 25th, 75th percentiles.

Geographical Variations in Hospital Length of Stay

Shown in **Figure 4** are the differences in hospital length of stay among 4 regions in the US. The Northeast appears to have the highest percentage of patients with a length of stay of at least 5 days. On the other hand, the West appears to have the lowest percentage of those with length of stay ≥5 days and the highest percentage of those with the shortest length of stay ≤2 days. The median (25^{th}, 75^{th}) lengths of stay were significantly different among the regions, although only to a mild degree. The shortest length of stay was in the West

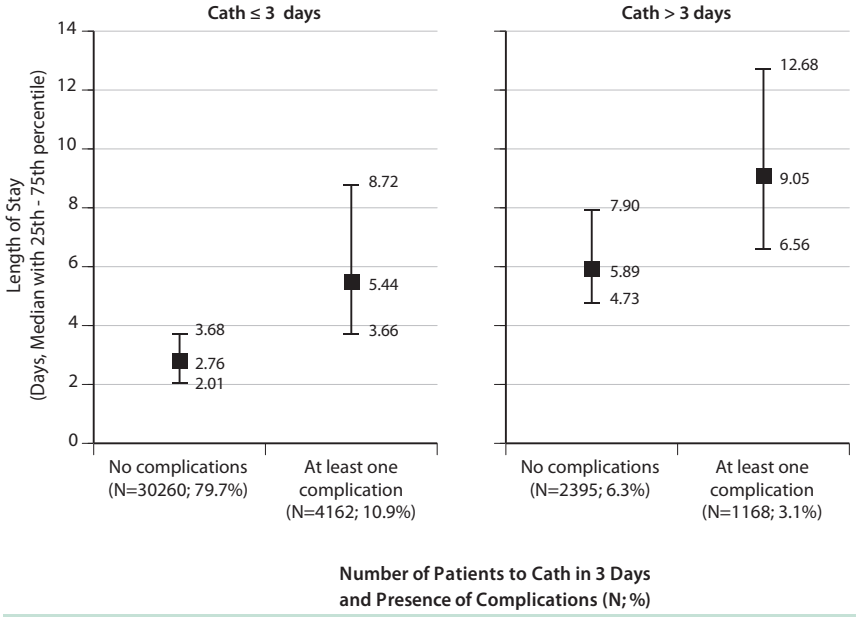

Figure 2 Length of stay based on time to catheterization and occurrence of complications. This figure displays the median length of stay based on whether or not the patients had cardiac catheterization (cath) within 3 days of admission, or at least one complication. Regardless of the presence of complications, those who received cardiac catheterization after 3 days from admission had a longer hospital length of stay.

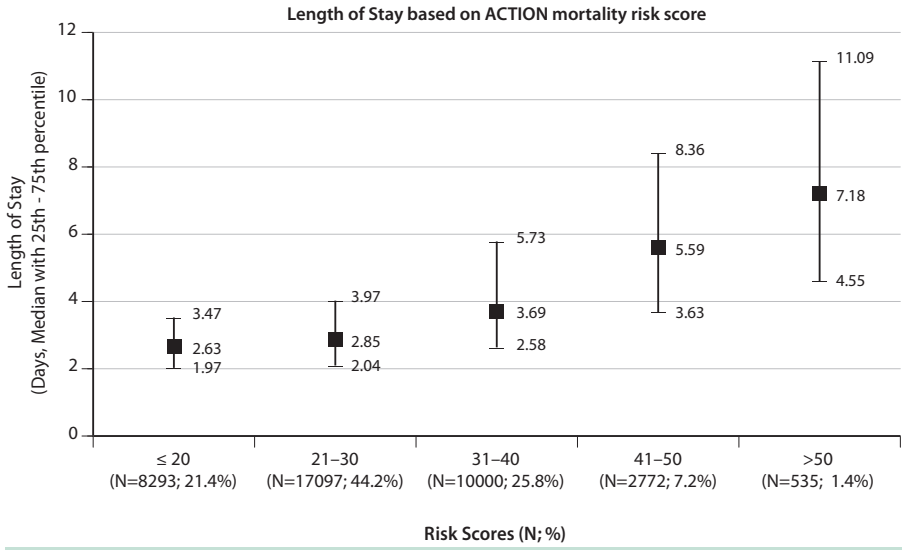

Figure 3 Length of stay based on Acute Coronary Treatment Intervention Outcomes Network Registry-Get With The Guidelines (ACTION Registry-GWTG) mortality risk score. There is a consistent trend of increased length of stay with increased mortality risk, based on the ACTION Registry-GWTG mortality risk score.

region, at 2.77 days (1.98-4.14), while the longest length of stay was in the Northeast at 3.34 (2.52-5.14). The South had a median length of stay of 3.10 days (2.22-4.63), and the Midwest had a median length of stay of 2.97 (2.08-4.56); $P < .0001$ for all comparisons.

DISCUSSION

This study examined national patterns of hospital length of stay for over 39,000 non-ST-segment elevation myocardial infarction patients in the ACTION Registry-GWTG. In our analysis, we found that patients with longer length of stay were older, more likely to have comorbidities and in-hospital complications, and were at a higher calculated baseline risk of death. However, these patients were less often treated with evidence-based medications despite a lack of documented contraindications, and were less likely to receive cardiac catheterization or percutaneous coronary intervention within 48 hours, or percutaneous coronary intervention in general. We also found that hospital admission on a Friday afternoon or evening and delays to cardiac catheterization were among the factors most highly associated with prolonged length of stay. Interestingly, hospital characteristics such as an academic medical center versus non-academic center, and a rural versus urban setting had no association with length of stay after adjusting for other variables in the model. However, there does appear to be a geographic variation within the US in length of stay for reasons that are not clearly defined.

Admission on a Friday and Prolonged Length of Stay

This analysis suggests that those patients admitted on a Friday after 12:00 PM have the longest delays to cardiac catheterization and longest length of stay. This fact is pre-

Table 5 Arrival to Catheterization Laboratory and LOS Based on Day and Time of Hospital Admission

Time of Presentation	Number of Patients (%)	Median (25^{th}-75^{th}) Time to Cath Lab (Hours)	Median (25^{th}-75^{th}) LOS (days)
Friday afternoon or evening*	3038 (7.8%)	58.5 (13.8-67.1)	3.8 (2.8-4.9)
Monday-Wednesday*	17,652 (45.1%)	19.5 (7.8-31.4)	2.8 (2.0-4.2)
Thursday	5429 (13.9%)	17.8 (7.1-26.6)	3.0 (2.0-4.8)
Saturday	5350 (13.7%)	41.1 (13.9-52.5)	3.3 (2.7-4.7)
Sunday	5288 (13.5%)	23.2 (13.2-36.5)	3.0 (2.2-4.3)
Friday morning	2350 (6.0%)	10.6 (4.5-72.0)	3.5 (2.2-5.1)

Cath = cardiac catheterization; LOS = length of stay.
*$P < .0001$ for comparing Friday afternoon or evening (12:00 PM-<12:00 AM) to Monday-Wednesday.

Table 6 Factors Associated with Prolonged LOS (>4 Days vs ≤4 Days)*

Variable	OR	95% CI	Chi-squared	*P*-Value
Catheterization >48 hours (vs ≤48 hours)	4.87	4.54-5.22	1953	<.0001
HF only on admission (vs none)	2.09	1.93-2.26	518	<.0001
Shock only or HF with shock on admission (vs none)	7.82	6.01-10.17		
Age (per 5-year increase)	1.14	1.13-1.16	338	<.0001
Baseline Hgb (per 1 g/dL decrease & Hgb <15 g/dL)	1.18	1.16-1.20	279	<.0001
Baseline Hgb (per 1 g/dL increase & Hgb ≥15 g/dL)	1.04	0.99-1.09		
HR (per 10 bpm decrease & HR <70 bpm)	1.08	1.01-1.14	263	<.0001
HR (per 10 bpm increase & HR ≥70 bpm)	1.12	1.11-1.14		
Baseline troponin (per 5× ULN increase)	1.03	1.03-1.04	178	<.0001
Fri morning (vs Mon-Wed)	0.97	0.86-1.09	156	<.0001
Fri afternoon or evening (vs Mon-Wed)	1.13	1.02-1.25		
Sat (vs Mon-Wed)	0.88	0.81-0.96		
Sun (vs Mon-Wed)	0.97	0.90-1.06		
Thurs (vs Mon-Wed)	1.50	1.40-1.61		
Baseline serum creatinine (per 1 mg/dL increase)	1.18	1.15-1.22	120	<.0001
SBP (per 10 mm Hg decrease & SBP <160 mm Hg)	1.07	1.05-1.09	78	<.0001
SBP (per 10 mm Hg increase & SBP ≥160 mm Hg)	1.01	0.99-1.04		
Medicaid (vs HMO/private)	1.57	1.37-1.79	69	<.0001
Medicare (vs HMO/private)	1.19	1.12-1.27		
Other insurance (vs HMO/private)	1.07	0.86-1.33		
Self/none (vs HMO/private)	1.23	1.09-1.39		
Diabetes mellitus	1.29	1.21-1.37	61	<.0001
Prior HF	1.33	1.24-1.43	59	<.0001
Prior stroke	1.41	1.27-1.56	45	<.0001
Prior PCI	0.82	0.77-0.88	29	<.0001
Prior PAD	1.24	1.14-1.34	25	<.0001
Weight (per 5-kg decrease & weight <100 kg)	1.02	1.01-1.03	16	0.0004
Weight (per 5-kg increase & weight ≥100 kg)	1.02	1.00-1.03		
Female (vs male)	1.13	1.06-1.20	14	0.0001
Prior MI	1.11	1.04-1.18	12	0.0007
Hypertension	1.11	1.04-1.19	10	0.0020
Total # of beds (per 100 beds increase)	1.03	1.00-1.05	4	0.0370

bpm = beats per minute; CI = confidence interval; Fri = Friday; HF = heart failure; Hgb = hemoglobin; HMO = health maintenance organization; HR = heart rate; MI = myocardial infarction; Mon-Wed = Monday-Wednesday; OR = odds ratio; PAD = peripheral arterial disease; PCI = percutaneous coronary intervention; Sat = Saturday; SBP = systolic blood pressure; Sun = Sunday; Thurs = Thursday; ULN = upper limit of normal.

*Race, history of prior coronary artery bypass grafting, rural vs urban location of the hospital, current/recent smoker, and academic versus nonacademic hospital are included in this model but not displayed, as they were not statistically significant in the adjusted model.

sumably due to the upcoming weekend and reduced services available in most US hospitals on Saturday and Sunday. Interestingly, those admitted on Friday morning had the shortest delays to cardiac catheterization but also had the second longest length of stay, behind only the Friday afternoon or evening group. This may reflect that there is a push to perform the cardiac catheterization before the upcoming weekend when a patient is admitted on a Friday morning, but that discharges are still delayed because of the weekend. A better understanding of the impact of diminished weekend services on discharge patterns could provide important insights into areas for improved health care resource utilization. For example, would routinely performing cardiac catheterizations during the weekend reduce hospital length of stay? Would this be cost-effective? Although our study raises this possibility, this important question remains to be answered.

Importance of Understanding Factors Associated with Length of Stay

In an era of increasing pressure to save costs and focus on efficient use of resources, there is an important need to better understand factors that contribute to prolonged hospital stays and to appropriately limit their influence. Identifying the characteristics that predict length of stay may provide insight into methods to reduce them in a safe manner.

The findings in this study raise the question as to whether a strategy of earlier cardiac catheterization could result in a reduction in length of stay for patients admitted with non-ST-segment elevation myocardial infarction. It is unclear whether or not a more aggressive strategy to perform cardiac catheterization on a higher portion of these patients would translate into a decreased length of stay. However, for those in whom cardiac catheterization is felt to be

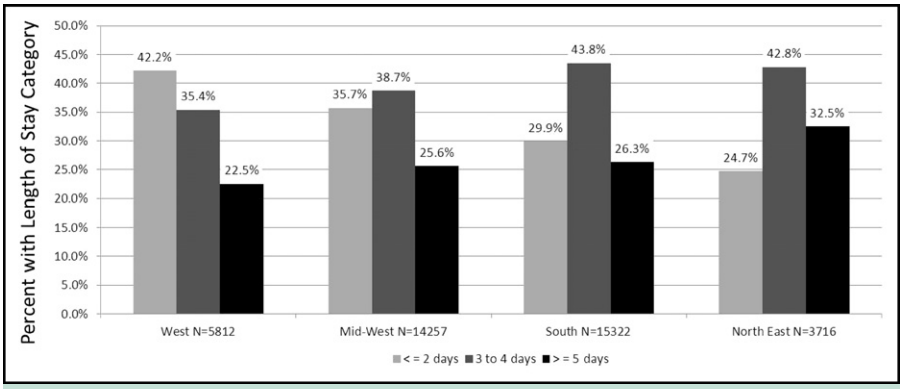

Figure 4 Geographical variation in hospital length of stay. There are important variations in the lengths of stay based on geographical variations in the US. The Northeast has the highest percentage of patients with length of stay ≥5 days, while the West has the highest percentage of patients with length of stay ≤2 days and the lowest percentage with length of stay ≥5 days.

appropriate, decreasing the time from admission to cardiac catheterization may result in shorter hospital stays.

Length of Stay and Evidence-based Treatment

A better understanding is needed of our observation that there is a decreased use of evidence-based medications in patients with longer length of stay who had more comorbidities and in-hospital complications. This finding is not inconsistent with previously published data. Wang et al[13] demonstrated that patients who experience bleeding complications after percutaneous coronary intervention are less likely to be discharged home on appropriated antiplatelet medications, and that this discrepancy continues well after the bleeding event for at least 6 months.[13] Importantly, studies have demonstrated that participation in systematic processes (such as the ACTION Registry-GWTG from which this study is conducted) is associated with improved adherence to evidence-based medicines. Nevertheless, efforts to better characterize medication use in this particularly vulnerable cohort, as well as increase the use of evidence-based medications where appropriate, are needed.

Limitations

The ACTION Registry-GWTG provides retrospective observational data and, therefore, has a number of limitations. First, data are collected during acute hospitalizations only and do not provide longitudinal follow-up. Thus, we cannot examine the association of length of stay with posthospital outcomes. Second, exact discharge times were not available. Because most patients are discharged during daytime business hours, we assumed a discharge time of 12:00 PM for all patients. As opposed to using strictly the dates of admission and discharge, it was felt that this would minimize the amount of error in calculating length of stay for those admitted late in the day. Third, we restricted our analysis to only patients who received cardiac catheterization at the facility to which they initially presented. Finally, the data collected in this registry captures contraindications to treatment and allows for exclusion of those patients in these analyses; however, relative or undocumented contraindications are not captured and cannot be accounted for.

CONCLUSIONS

This is one of the largest studies ever performed to examine the characteristics of patients admitted with non-ST-segment elevation myocardial infarction and their association with hospital length of stay. Patients with longer length of stay were older and had more comorbidities and in-hospital complications but were less likely to receive evidence-based medications and had delays in cardiac catheterization. Additionally, hospital admission on a Friday afternoon or evening and delays to cardiac catheterization were associated with prolonged length of stay. A considerable amount of the heterogeneity was not accounted for by these variables, supporting the concept that there may be the opportunity to reduce length of stay by simply applying consistent practice. Applying the results of this study to drive the development of processes to reduce heterogeneity in hospital length of stay and associated treatment disparities in non-ST-segment elevation myocardial infarction patients, as well as to promote safe and early discharge in an era of increasingly restrictive health care resources, should lead to more appropriate and efficient care.

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