ORIGINAL RESEARCH

Length of Stay and Short-Term Outcomes in Patients with ST-Segment Elevation Myocardial Infarction After Primary Percutaneous Coronary Intervention: Insights from the China Acute Myocardial Infarction Registry

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Background: Length of stay (LOS) in patients with ST-segment elevation myocardial infarction (STEMI) is directly associated with financial pressure and medical efficiency. This study aimed to determine impact of LOS on short-term outcomes and associated factors of LOS in patients with ST-segment elevation myocardial infarction (STEMI) after primary percutaneous coronary intervention (PPCI).

Methods: A total of 3615 patients with STEMI after PPCI in the China Acute Myocardial Infarction registry were included in the analysis. Predictors of prolonged LOS were analyzed by multivariate logistic regression model with generalized estimating equation. The impact of LOS on 30-day clinical outcomes was assessed.

Results: The median LOS was 9 (7, 12) days. Patients with a longer LOS (>7 days) were older, more often in lower-level hospitals, had more periprocedural complications and hospitalization expense. Fourteen variables, such as weekend admission and lower-level hospitals, were identified as independent associated factors of prolonged LOS. There were no significant difference in 30-day major adverse cardiac and cerebrovascular events (MACCE), readmission, and functional status between patients with LOS≤7d and LOS>7d after multivariate adjustment and propensity score matching. However, patients who discharged over one week had better medication adherence (adjusted odds ratio: 0.817, 95% confidence interval: 0.687–0.971, P=0.022). Significant interaction was observed in medication use between gender and LOS ($P_{interaction}$=0.038).

Conclusion: Patients with STEMI undergoing PPCI experienced a relatively long LOS in China, which resulted in more medical expenses but no improvement on 30-day MACCE, readmission, and functional recovery. Poor 30-day medication adherence with short LOS reflects unsatisfying transition of management from hospital to community. More efforts are needed to reduce LOS safely and improve the efficiency of medical care.

Keywords: length of stay, ST-segment elevation myocardial infarction, primary percutaneous coronary intervention, prognosis

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Introduction

Length of stay (LOS) is an important criterion to evaluate medical efficiency.[1,2] In some countries, LOS in patients with ST-segment elevation myocardial infarction

(STEMI) undergoing primary percutaneous intervention (PPCI) has decreased significantly in several decades.[3–5] China faces rising number of patients with STEMI,[6] and extremely large medical expenses.[7,8] It is of great importance to take more attention to LOS, as its critical role in saving hospital expenses and improving overall medical efficiency.

Reducing LOS was considered to be safe in studies from developed countries.[2,9–13] A series of risk assessment tools, such as the second Primary Angioplasty in Myocardial Infarction (PAMI-II) criteria and the Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complications (CADILLAC) risk score, were established and recommended to screen low-risk patients for early discharge.[10,14,15] However, few "real-world" studies focused on the impact of LOS on clinical outcomes comprehensively, especially for recovery of social function and medication adherence, which are also important for clinicians to make decisions.[16] Additionally, in developing countries with unbalanced medical resources and disparate medical insurance, patient characteristics and predictors of prolonged LOS may be totally different from those in developed countries. It is important to ascertain the impact of LOS on clinical outcomes in developing countries. Therefore, this study aimed to analyze impact of LOS on short-term outcomes and associated factors of LOS in STEMI patients after PPCI in China.

Methods
Study Population
The China Acute Myocardial Infarction registry is a prospective, nationwide, multicenter observational study.[17] Briefly, 108 hospitals that cover 27 provinces and 4 municipalities were included throughout Mainland China except Hong Kong and Macau. In China, hospital classification was based on Chinese vertical administrative model (province, prefecture, county, township, and village). One of the largest hospitals (province-level hospital), 1 to 3 prefecture-level hospitals, and 1 to 4 county-level hospitals in every province or municipality were included in the registry.[17] Participating hospitals were required to enroll AMI patients consecutively and the final inclusion criteria must meet third Universal Definition for Myocardial Infarction.[18] Types 4a and type 5 AMIs were not eligible for this registry. Patient demographics, clinical presentation, medical history, risk factors, laboratory results, medications, LOS, hospital expenses, hospital features, and clinical outcomes were collected by trained clinical cardiologist or

cardiovascular fellows. Definitions of elements were based on the ACC/AHA Task Force on clinical data standards and NCDR-ACTION-GWTG element dictionary.

Patients with STEMI undergoing PPCI from January 2013 to September 2014 in China Acute Myocardial Infarction registry were included in this study. Following patients were excluded: patients with in-hospital death; patients who were transferred in from other hospitals; patients who were discharged for further medications; patients who received any repeated revascularization during hospitalization; and patients with no follow-up data or invalid LOS.

Clinical Outcomes
The primary endpoint was 30-day major adverse cardiac and cerebrovascular events (MACCE), including cardiac death, recurrent myocardial infarction, stroke, and cardiovascular readmission. The second endpoints included all-cause readmission, functional status, and medication use within 30 days after discharge. Readmission was counted as a cardiovascular readmission unless a clear non-cardiac cause was documented. Poor functional recovery was defined as keeping resting at home after discharge. Poor medication adherence was defined as stopping at least one drug which were used at discharge.

Statistical Analysis
Patients were divided into 2 groups based on the first quartile of LOS. Continuous variables in normal distribution were presented as mean ± standard deviation and compared by Student t-test. Mann–Whitney U-test was used to compare continuous variables in non-normal distribution, which were presented as medians (quartiles), and examine differences in distribution of LOS stratified by hospital level and location. Categorical variables were described using frequencies (percents) and compared by Chi-square test.

Binary logistic regression model was used to analyze the independent associated factors of LOS and clustering among hospitals was adjusted by general estimating equation method. To avoid omitting factors, variables including patient demographics, medical history, presenting characteristics, procedural and angiographic characteristics, and hospital features were used to fit the model. We further performed multivariate logistic regression models to evaluate association between LOS and clinical outcomes. Propensity score matching based on 1:1 nearest-neighbor matching was also used to compare outcomes between patients discharged in short and long LOS. This logistic regression-based propensity score model was adjusted for age, gender, hospital

level, weekend admission, creatinine, left ventricular ejection fraction (LVEF), new-onset heart failure, recurrent myocardial infarction, stroke, intra-aortic balloon pump insertion, symptom onset to admission time, cardiac arrest at admission, Killip class, three-vessel or left main disease, left main or left anterior descending related infarction, stent type, glycoprotein (GP) IIb/IIIa inhibitor, postprocedural Thrombolysis In Myocardial Infarction (TIMI) flow grade, periprocedural complications, previous myocardial infarction, previous heart failure, previous stroke, and previous renal dysfunction. With a caliper of 0.02, 1038 patients with LOS≤7d (87.0%) were matched successfully. The covariate balance was tested by standardized mean difference plot with a threshold of 0.1 (Supplementary Figure 1). Because the standard mean difference of stent type exceeded 10%, it was further adjusted by logistic regression model in the propensity-matched cohort as an additional analysis. Subgroup analyses were carried out based on hospital level, age, gender, PAMI-II criteria, and CADILLAC risk score. Results were expressed using odds ratios (OR) with 95% confidence intervals (CI). Statistical analysis was performed using R software (version 4.0.2, R Foundation for Statistical Computing, Vienna, Austria) and SPSS for Windows (version 23.0, IBM, New York, USA). Two-tailed P<0.05 was considered statistically significant. More details of the statistical analysis were shown in Supplementary Method.

Results
Baseline Characteristics
A total of 3615 patients with STEMI undergoing PPCI who survived at discharge were included in the analysis (Supplementary Figure 2). Distribution of LOS is shown in Supplementary Figure 3. The median LOS was 9 (7, 12) days. Of all patients, 1193 (33.0%) discharged within 7 days and 2422 (67.0%) over one week.

As presented in Table 1, patients with LOS>7d were more often older, non-smokers, and more commonly to pay with health insurance compared with patients with shorter LOS. Systolic blood pressure, hemoglobin, and LVEF were higher in patients discharged earlier compared with those in longer LOS group. Higher Killip class and prevalence of cardiac arrest at admission were mainly seen in patients with longer LOS. Besides, patients were more likely to have an intra-aortic balloon pump, three-vessel or left main disease, periprocedural complications, and in-hospital adverse events in longer LOS group.

As for hospital characteristics and expenses, patients in province-level hospitals experienced significantly shorter LOS than those in lower-level hospitals (P<0.001), while there was no difference between hospitals in the North and South (P=0.103) (Supplementary Figures 4 and 5). Not surprisingly, expenses were significantly higher in longer LOS patients (Table 1).

Associated factors of LOS
In multivariate analysis, age, body mass index, prior heart failure, weekend admission, Killip class, systolic blood pressure, left ventricular ejection fraction, leukocyte count, cardiac arrest at admission, left main or left anterior descending related infarction, GPIIb/IIIa inhibitor, intra-aortic balloon pump insertion, hospital levels, and number of beds in department of cardiology were independent associated factors of LOS (Table 2). It should be noted that self-paying lost statistical significance in the multivariate analysis (OR: 0.773, 95% CI: 0.567–1.054, P=0.104). Among hospital-related factors, hospital level was strongly associated with LOS (OR: 5.979, 95% CI: 3.308–10.807, P<0.001).

Association Between LOS and 30-Day Outcomes
MACCE, all-cause readmission, and functional status in different LOS groups are depicted in Figure 1A–C. The overall rates of MACCE, all-cause readmission, and resting at home were 4.0%, 4.1%, and 60.5%, respectively. Patients in longer LOS group had significantly higher rates of poor functional recovery compared with those with short LOS (63.2% and 55.0%, P<0.001). The rates of MACCE and all-cause readmission only showed a higher trend in patients with LOS>7d as compared with those with LOS≤7d (MACCE: 4.0% and 3.3%; all-cause readmission: 4.3% and 3.6%, respectively, both P>0.05). Table 3 shows association between LOS and 30-day outcomes. Longer LOS did not affect the risk of 30-day MACCE (adjusted OR: 1.085, 95% CI: 0.710–1.657, P=0.706) and all-cause readmission (adjusted OR: 1.060, 95% CI: 0.704–1.594, P=0.781) after multivariate adjustment. Furthermore, no difference was observed after propensity score matching (MACCE, OR: 1.541, 95% CI: 0.971–2.445, P=0.067; all-cause readmission, OR: 1.299, 95% CI: 0.828–2.037, P=0.255). Similar results were obtained after adjusting for stent type in the propensity-matching cohort (MACCE, OR: 1.565, 95% CI: 0.985–

Table 1 Baseline Characteristics for Patients Stratified by LOS

Variables	LOS≤7d (n=1193)	LOS>7d (n=2422)	P value
Patient demographics			
Age, yrs	58.52±11.53	60.56±11.87	<0.001
Female	210 (17.6)	489 (20.0)	0.064
Currently single	27 (2.3)	93 (3.9)	0.015
Self-paying medication	111 (9.8)	169 (7.2)	0.008
BMI, kg/m^2	24.45 (22.57, 26.04)	24.22 (22.49, 26.12)	0.217
Medical history			
Diabetes	221 (19.3)	425 (18.1)	0.407
Hypertension	552 (47.1)	1147 (48.1)	0.593
Hyperlipidemia	71 (6.6)	157 (7.2)	0.493
Current smoker	680 (57.2)	1209 (50.1)	<0.001
Previous Angina	229 (19.2)	456 (18.8)	0.791
Previous myocardial infarction	49 (4.1)	117 (4.8)	0.329
Previous heart failure	2 (0.2)	23 (0.9)	0.008
Previous stroke	90 (7.5)	162 (6.7)	0.342
Previous PCI	58 (4.9)	107 (4.4)	0.548
Previous CABG	2 (0.2)	5 (0.2)	—
Previous renal dysfunction	4 (0.3)	13 (0.5)	0.566
Chronic obstructive pulmonary disease	10 (0.8)	36 (1.5)	0.102
Presenting characteristics			
Weekend admission	306 (25.6)	696 (28.7)	0.051
Symptom onset to admission time >12h	100 (8.4)	181 (7.5)	0.340
Heart rate	75.78±15.41	75.14±17.56	0.263
Systolic blood pressure, mmHg	131.70±24.84	127.79±25.86	<0.001
Killip class >1	158 (13.3)	452 (18.7)	<0.001
Cardiac arrest	6 (0.5)	36 (1.5)	0.009
LVEF (%)	55.75±8.50	53.54±9.71	<0.001
Creatinine, μmol/L	73.00 (62.00, 86.00)	73.00 (61.00, 87.33)	0.826
Hemoglobin, g/L	143.12±17.80	140.41±19.32	<0.001
Leukocyte count, ×10^9/L	10.63±3.46	10.71±3.44	0.508
Na$^+$, mmol/L	139.37±3.65	139.30±4.51	0.621
K$^+$, mmol/L	3.89±0.49	3.93±0.50	0.019
Procedural and angiographic characteristics			
Transfemoral approach	193 (16.4)	282 (12.1)	<0.001
Three-vessel or left main disease	365 (31.2)	834 (36.1)	0.004
Left main or LAD related-infarction	557 (46.8)	1239 (51.5)	0.008
Preprocedural TIMI flow grade 0	845 (70.8)	1786 (73.7)	0.064
Stent type			<0.001
DES	940 (79.1)	2079 (86.2)	
BMS	191 (16.1)	186 (7.7)	
Without stent implantation	57 (4.8)	148 (6.1)	
Postprocedural TIMI flow grade 3	1153 (97.3)	2294 (95.4)	0.007
Periprocedural complications	49 (4.1)	185 (7.6)	<0.001
GP IIb/IIIa inhibitor	435 (36.7)	1209 (50.2)	<0.001
IABP insertion	12 (1.0)	151 (6.2)	<0.001

(*Continued*)

Table 1 (Continued).

Variables	LOS≤7d (n=1193)	LOS>7d (n=2422)	P value
In-hospital adverse events			
New-onset heart failure	33 (2.8)	256 (10.6)	<0.001
Recurrent myocardial ischemia	3 (0.3)	24 (1.0)	0.026
Recurrent myocardial infarction	3 (0.3)	2 (0.1)	0.419
Stroke	2 (0.2)	12 (0.5)	0.227
Major bleeding	6 (0.5)	49 (2.0)	<0.001
Medications at discharge			
Dual antiplatelet therapy	1173 (99.0)	2376 (98.4)	0.151
Statins	1106 (98.8)	2241 (98.8)	0.968
ACE inhibitors/ARB	758 (64.2)	1423 (59.5)	0.007
β-blockers	848 (71.7)	1792 (74.7)	0.051
Hospital characteristics			
Province-level hospitals	802 (67.2)	888 (36.7)	<0.001
Number of beds			
≤100	418 (35.0)	1155 (47.7)	<0.001
101–300	719 (60.3)	1059 (43.7)	
>300	56 (4.7)	208 (8.6)	
Hospital region			
North	796 (66.7)	1615 (66.7)	0.980
South	397 (33.3)	807 (33.3)	
Hospital expenses, ¥	76,749.34 (64,407.56, 90,846.00)	88,438.50 (72,440.30, 107,972.81)	<0.001

Note: Data are presented as n (%), mean ± SD or median (quartiles).
Abbreviations: LOS, length of stay; BMI, body mass index; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft; LVEF, left ventricular ejection fraction; LAD, left anterior descending; TIMI, Thrombolysis In Myocardial Infarction; DES, drug-eluting stents; BMS, bare-metal stents; GP, glycoprotein; IABP, intra-aortic balloon pump; ACE, angiotensin converting enzyme; ARB, angiotensin II receptor blocker.

2.486, P=0.058; all-cause readmission, OR: 1.336, 95% CI: 0.850–2.099, P=0.210).

Medication adherence was examined by comparing medications at different time points between LOS groups (Figure 2A–D). Within 30 days after discharge, proportion of patients not taking at least one drug prescribed at discharge was 26.2% (948 patients). In multivariate analysis, patients with longer LOS displayed significantly better medication adherence (OR: 0.817, 95% CI: 0.687–0.971, P=0.022). Similar result was gained from propensity-matching analysis (OR: 0.815, 95% CI: 0.671–0.989, P=0.038), even after further adjusting for stent type (OR: 0.815, 95% CI: 0.670–0.990, P=0.040).

Subgroup Analysis
The impact of LOS was further evaluated in different subgroups (Supplementary Figure 6). For patients meeting PAMI-II criteria or with CADILLAC RS 0–2, median LOS were both 8 (7, 11) days. There were no significant interactions between factors (hospital level, age, gender, PAMI-II criteria, and CADILLAC risk score) and LOS in 30-day MACCE, all-cause readmission, and functional status ($P_{interaction}$>0.05). However, we observed a significant interaction between gender and LOS on medication adherence ($P_{interaction}$=0.038).

Discussion
In this study, we found a relatively long LOS in patients with STEMI undergoing PPCI in China, even in low-risk patients selected by validated tools. Fourteen variables were identified as independent associated factors of LOS. Longer LOS had no improvement on primary outcome. However, our result revealed an unexpected impact of LOS on medication compliance.

Nationwide data showed that the median LOS of patients with STEMI in China was 7 days in 2018, and

Table 2 Independent Predictors of Prolonged Length of Stay (LOS>7d)

Variables	Adjusted OR	95% CI	P value
Patient characteristics			
Age (per 1 year increase)	1.012	(1.006, 1.019)	<0.001
BMI (per 1kg/m^2 increase)	0.985	(0.970, 0.999)	0.042
Medical history			
Prior heart failure	5.593	(1.587, 19.715)	0.007
Presenting characteristics			
Weekend admission	1.386	(1.232, 1.559)	<0.001
Systolic blood pressure (per 1mmHg increase)	0.996	(0.994, 0.999)	0.004
Killip class>1	1.263	(1.015, 1.571)	0.036
Cardiac arrest at admission	1.782	(1.017, 3.121)	0.044
LVEF (per 1% increase)	0.978	(0.965, 0.990)	0.001
Leukocyte count (per 10^9/L increase)	1.031	(1.004, 1.058)	0.025
Procedural and angiographic characteristics			
Left main or LAD related infarction	1.187	(1.039, 1.357)	0.012
GP IIb/IIIa inhibitor	1.259	(1.031, 1.537)	0.024
IABP insertion	3.529	(2.195, 5.675)	<0.001
Hospital characteristics			
Prefecture- and county-level hospitals	5.979	(3.308, 10.807)	<0.001
Number of beds			
101–300 vs ≤100	1.262	(0.721, 2.209)	0.416
>300 vs ≤100	3.609	(1.127, 11.557)	0.031

Abbreviations: LOS, length of stay; BMI, body mass index; LVEF, left ventricular ejection fraction; LAD, left anterior descending; GP, glycoprotein; IABP, intra-aortic balloon pump; OR, odds ratio; CI, confidence interval.

mean LOS was significantly shorter than that in 2017 (7.66d vs 9.09d).[19] For patients undergoing PPCI, previous study showed that the median LOS was 9 days during 2007–2010,[20] which was in line with our result. Additionally, our analysis indicated significantly more expenses of patients with longer LOS. The post hoc analysis of the Assessment of Pexelizumab in Acute Myocardial Infarction study that enrolled patients from July 2004 to May 2006 showed short median LOS in the United States (3 days), New Zealand (4 days), and Australia (4 days).[21] There are several potential reasons for the relatively long LOS in China. First, limitations in medical efficiency including management processes deviated from standard still exist in China, particularly in lower-level hospitals.[22,23] Second, patients with STEMI still have the certain risk of short-term adverse events following PPCI. Thus, early discharge forces doctors to face more concern. Third, the proportion of in-hospital reimbursement is higher than that of outpatient reimbursement in some regions, which may lead to the longer LOS as the wish of patients.[24]

In this study, weekend admission was an independent predictor of prolonged LOS, which was similar with result from Chin and colleagues,[25] reflecting gaps of medical care quality between weekday and weekend. Our result indicated that patients with LOS>7d had more serious presenting characteristics at admission, including lower systolic blood pressure, higher Killip class, and cardiac arrest, which could be used to identify patients at higher probability of prolonged LOS. Lower LVEF was also an important predictor of longer LOS. Previous studies have demonstrated prognostic value of renal function in patients with STEMI.[26–28] In present study, we found no significant impact of chronic renal dysfunction or creatinine on LOS. Interestingly, although numerous studies proved more advantages of transradial approach than transfemoral access in percutaneous coronary intervention (PCI),[29] even for STEMI patients with cardiogenic shock,[30] transradial approach was not an independent associated factor of LOS in this analysis. This result might reflect serious LOS redundancy in a different way. That is to say, despite lower risk of bleeding complications and periprocedural death, patients who
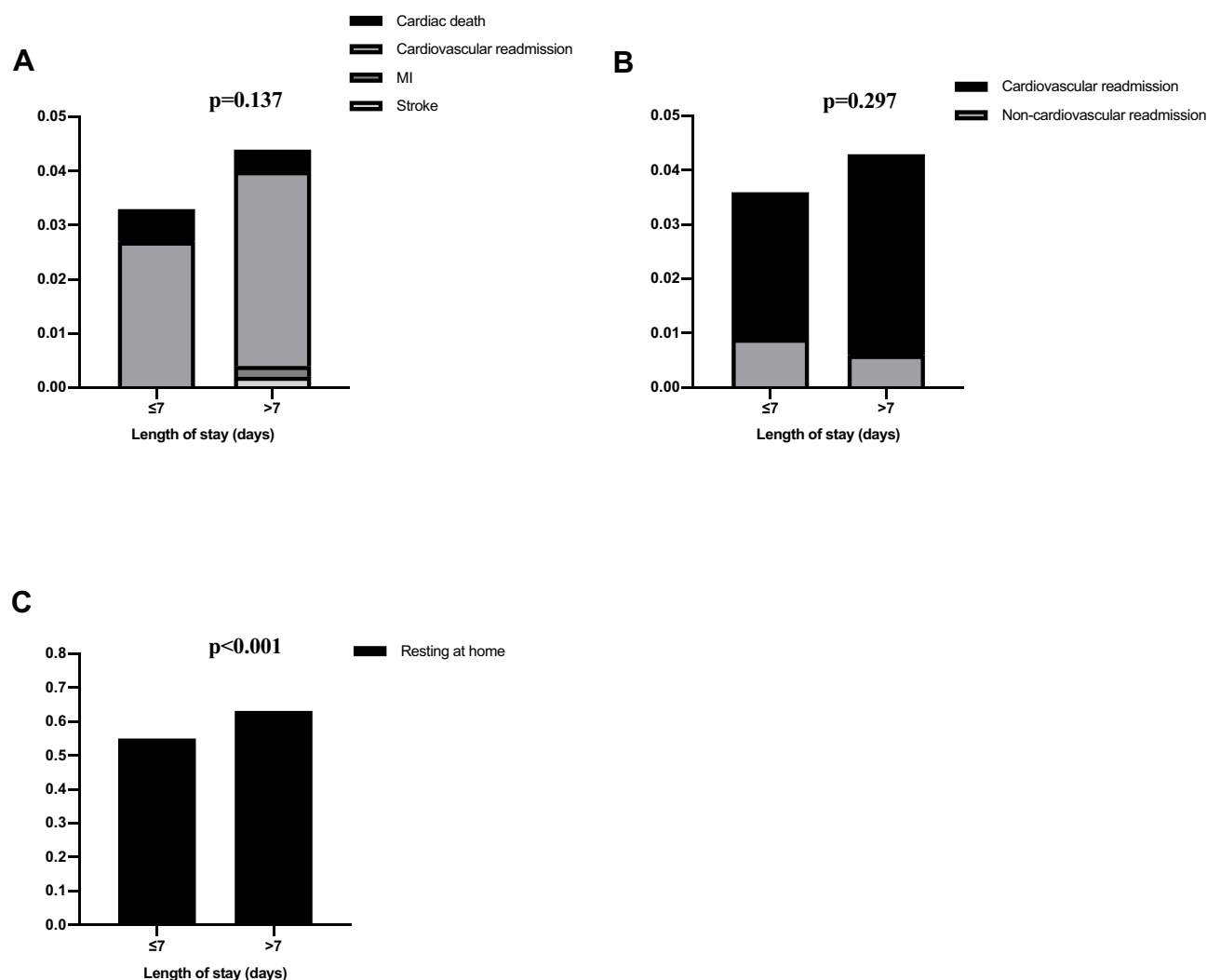
A

B

C

Figure 1 30-day clinical outcomes in different LOS groups. (**A**) MACCE. (**B**) Readmission. (**C**) Functional status. MACCE was defined as the composite of cardiac death, cardiovascular readmission, recurrent myocardial infarction, and stroke.
Abbreviations: MACCE, major adverse cardiac and cerebrovascular events; LOS, length of stay; MI, myocardial infarction.

underwent PPCI with transradial approach experienced excessive in-hospital observation in current situation. We also found that usage of drug-eluting stents, which had shown more benefits in patients with STEMI over bare-metal stents,[31,32]

was not associated with LOS. For the hospital-related factors, our work showed that prefecture- and county-level hospitals, instead of hospital locations, were strongly associated with longer LOS, which was opposite to the results from others.[2,25]

Table 3 Association Between LOS and 30-Day Outcomes

Outcomes	Univariate Analysis		Multivariate Analysis	
	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
MACCE	1.328 (0.913, 1.931)	0.138	1.085 (0.710, 1.657)*	0.706
All-cause readmission	1.212 (0.844, 1.740)	0.298	1.060 (0.704, 1.594)*	0.781
Resting at home	1.404 (1.215, 1.623)	<0.001	1.003 (0.849, 1.185)*	0.973
Medication adherence	0.825 (0.706, 0.964)	0.015	0.817 (0.687, 0.971)†	0.022

Notes: *Adjusted for patient demographics, medical history, presenting characteristics, procedural and angiographic characteristics, in-hospital adverse events, medications at discharge, and hospital characteristics; †Adjusted for patient demographics, medical history, presenting characteristics, procedural and angiographic characteristics, in-hospital adverse events, and hospital characteristics.
Abbreviations: LOS, length of stay; MACCE, major adverse cardiac and cerebrovascular events; OR, odds ratio; CI, confidence interval.
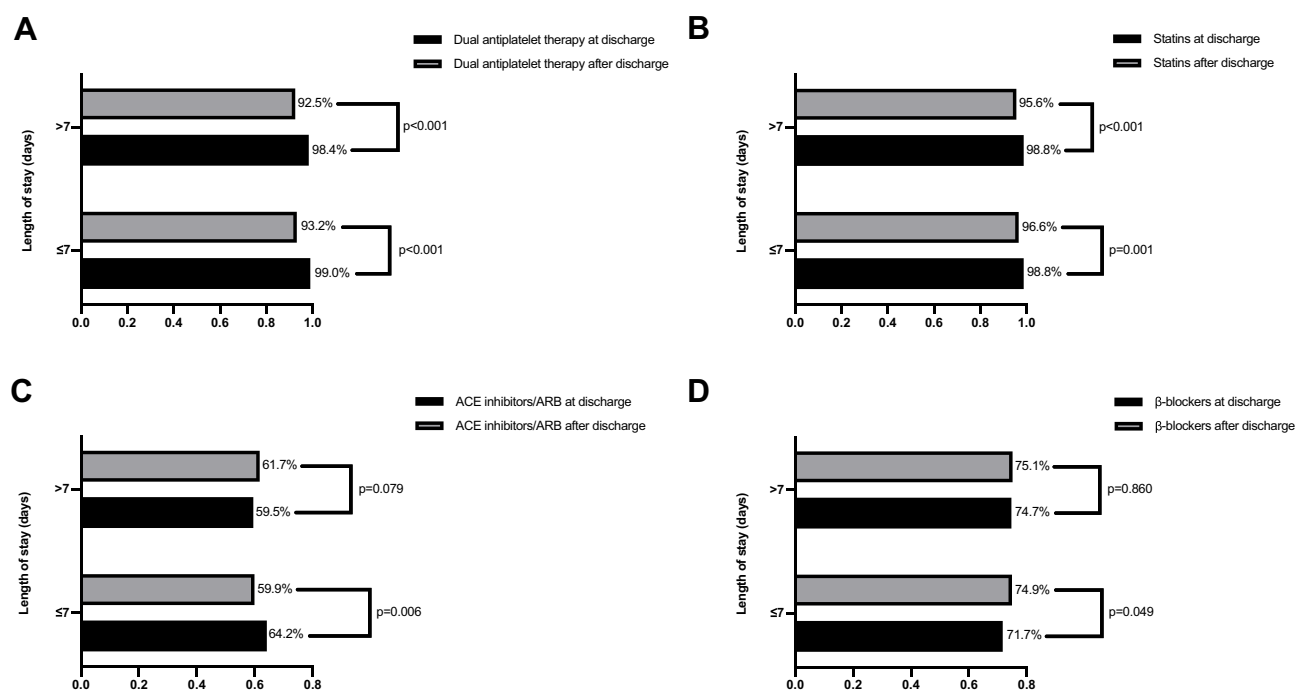
Figure 2 Comparison of medication usage between at and after discharge in different LOS groups. (**A**) Dual antiplatelet therapy. (**B**) Statins. (**C**) ACE inhibitors/ARB. (**D**) β-blockers.
Abbreviations: LOS, length of stay; ACE, Angiotensin Converting Enzyme; ARB, angiotensin receptor blockers.

The disparity of LOS in different level hospitals may be influenced by various factors such as care capability and quality, care efficiency and philosophy of disease management.

Early study suggested that shortening LOS in patients with myocardial infarction had no impact on prognosis, and significantly saved medical expenses.[10] Subsequently, some small randomized control trials supported the early discharge strategy.[11,12] However, a few studies showed that shorter LOS was related to a higher rate of readmission,[21] and for older patients, very early discharge strategy was associated with an increase in 30-day mortality.[2] In European Society of Cardiology Guidelines for the management of STEMI, only low-risk patients identified using appropriate criteria were recommended to discharge within 48-72 hours.[15] For countries with limited medical resources, clinical decisions for early discharge should be made more cautiously to balance the benefit and risk. Chinese patients experienced longer LOS, and the consequences of reducing LOS within a short period of time are unknown. To date, this is the largest study to assess association between LOS and prognosis in a developing country. This "real world" study showed that shorter LOS had no impact on 30-day MACCE or readmission.

Unexpectedly, our results showed that patients discharged within one week had poorer medication compliance.

Moreover, there was difference in subgroup analysis stratified by gender. Prior to this study, only Safe-Depart trial enrolled 54 patients who underwent primary or rescue PCI examined the effect of early discharge on 6-week medication compliance.[11] In this small, single-center, randomized controlled trial, no difference in medication compliance were observed. The opposite conclusions can be partly explained by sample size, and type of study which may affect the facilitation of health education. More importantly, a number of patients lack correct cognition of their own health status and related knowledge. Data from the China Patient-Centered Evaluative Assessment of Cardiac Events (China PEACE)-Retrospective CathPCI study showed that in the first month after discharge, nearly 30% of patients did not take the medicine as prescribed.[33] They analyzed the main reason was that patients considered their condition had improved significantly. For patients with shorter LOS, this misunderstanding may be more common. Health education and medical transition from hospital to home should be further improved. Previous studies also indicated gender disparity in medication adherence.[34,35] One of important reasons for this phenomenon is that women are more likely to serve as caregivers among family members.[35] Therefore, the interaction between gender and LOS in medication

adherence might be explained by women's tendency to work for family earlier.

The Coronavirus Disease 2019 (COVID-19) Pandemic has become a serious public health crisis worldwide. Previous study showed that the pandemic had significant impact on STEMI care, even in a non-COVID-19 epicenter.[36] During the early part of 2020, many hospitals in China adopted a fibrinolysis-first strategy considering the in-hospital delay to exclude coronavirus infection.[37] Data from our institution showed that usage of PPCI for patients with STEMI decreased markedly, and LOS of patients with STEMI was significantly longer than that in 2019,[37] and LOS in this work. More studies are needed to investigate associated factors of LOS and its impact on clinical outcomes during the pandemic, while the present work aims to explore these issues under normal mode of STEMI management.

Limitations

The study has several important limitations. First, this analysis is based on a cohort from observational study. Therefore, despite using multivariate analysis, confounding factors may exist. Large-scale randomized controlled trials are further needed.[16] Second, compared with those in western countries, a significantly smaller proportion of patients discharged within 72 hours. Thus, we cannot evaluate the effect of very early discharge. Third, experience of invasive cardiologists and hospital volume were not included in the CAMI registry. Previous studies have found significant expertise-outcome and volume-outcome relationships for PCI.[38–40] However, it should be noted that the requirements of operator and hospital volume were different in different countries. According to European Society of Cardiology Guidelines on myocardial revascularization, PCI for acute coronary syndromes should be performed by operators with volumes of ≥75 per year at high-volume institutions (≥400 per year),[41] while Chinese Society of Cardiology guidelines recommended PPCI should be performed by operators with annual volumes of ≥50 procedures in cardiac catheterization laboratory with volumes of ≥100 PCIs per year.[42] More efforts are still needed to clarify the threshold and the impact of hospital volume on clinical outcomes of PCI. Finally, since the study population is entirely composed of Chinese patients, it is uncertain that this conclusion can be applied to other countries. Nevertheless, few studies examined the association between LOS and prognosis in "real-world" practice comprehensively, particularly for developing countries. In this perspective, we think this study is an important supplement.

Conclusions

Our study showed that the LOS was relatively long against growing number of STEMI patients in China. Prolonging LOS brought no significant improvement in main adverse outcomes. Poorer medication adherence in patients discharged within one week called for raising health awareness of patients and better management after discharge. More efforts should be made to reduce LOS without affecting disease management quality. Health education and medical transition from hospital to home are needed to be highlighted.

Data Sharing Statement

Data are available on reasonable request from the corresponding authors.

Ethics Approval and Informed Consent

The study protocol conformed to the ethical guidelines of the Declaration of Helsinki and was approved by the institutional review board central committee at Fuwai Hospital, National Center for Cardiovascular Diseases of China (No. 2012-431). Written informed consent was obtained from eligible patients before registration.

Disclosure

The authors have no conflicts of interest to declare in this work.

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