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Early and Very Early Discharge After Uncomplicated Primary PCI: A Comparative Observational Study

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ABSTRACT

Acute Myocardial Infarction (AMI) continues to be a leading cause of mortality worldwide. The standard treatment involves prompt management with Primary Percutaneous Coronary Intervention (PPCI); however, the optimal duration of hospital stay following PPCI remains an area of ongoing investigation. This study aimed to assess the safety and outcomes associated with very early discharge (VED) in patients after uncomplicated PPCI. This prospective observational study included 148 STEMI patients treated at a leading cardiac center in Lahore, Pakistan, from August 2022 to August 2023. Participants were categorized into two groups: those discharged within 24 hours (very early discharge group) and those discharged between 24 and 48 hours (early discharge group) post-PPCI. Baseline characteristics, procedural details, and early outcomes were documented. The primary outcomes were Major Adverse Cardiac and Cerebrovascular Events (MACCE) at 7-day and 30-day follow-ups. Data analysis was performed using Student's t-tests, Chi-square tests, and logistic regression. A p-value of ≤0.05 was deemed statistically significant. The primary outcomes were assessed as Major Adverse Cardiac and Cerebrovascular Events (MACCE) at 7-day and 30-day follow-ups. The study found no significant differences in MACCE rates between the very early discharge group (5.43% at 7 days and 10.8% at 30 days) and the early discharge group (5.35% at 7 days and 10.7% at 30 days), with p-values of 0.98 and 0.97, respectively. VED criteria included successful PCI, LVEF ≥ 40%, and no major in-hospital complications. The discharge of low-risk patients within 24 hours after uncomplicated PPCI was found to be safe and feasible and indeed an effective strategy to improve bed utilization and reduce healthcare cost without increasing the risk for adverse outcome.

INTRODUCTION

Acute Myocardial Infarction is one of the most influential causes of mortality and morbidity across countries. In 2012-2022, as many as 1,522,669 deaths in the United States alone have been attributed to AMI (Tsao et al., 2023). It contributes to an in-hospital mortality rate of 10.3 % for an unadjusted AMI in Pakistan (Samad et al., 2022). AMI results from total or partial blockage of the coronary arteries. This no doubt calls for prompt and appropriate treatment (Roffi et al., 2016). According to the American Heart Association, AHA, primary percutaneous coronary intervention is ranked as the first and most common guideline in the management of myocardial infarction patients. According to Lawton et al. (2022), it is the most dominant and effective guideline in the management of such patients. Besides, PPCI is considered cost-effective despite being associated with increased healthcare costs (Aasa et al., 2010). These are multifactorial costs related to pre-procedure emergency transfer, procedural costs for drugs, equipment, and staff, and post-procedure in-hospital stay (Ding et al., 2017). The latter contributes to the increasingly belligerent pressure on healthcare systems, suggesting the need to improve bed utilization and reduce costs.

Lately, there has been a great deal of concerted effort to try to identify low-risk groups of patients among those with post-PPCI to make ED feasible and safe (Gong et al., 2018). However, there still is insufficient information available to provide recommendations regarding the criteria and timing for discharge of a STEMI patient to balance safety of our patients and use of the hospital bed. Previous studies showed the safety of early hospital discharge when the STEMI patient was discharged within 48 hours of their STEMI (Gong et al., 2018; Jones et al., 2012). Several published risk score models such as the Second Primary Angioplasty in Myocardial

Infarction (PAMI-II) and the Zwolle primary PCI Index have been developed to identify low-risk patients poised for early discharge, although they are not widely used in the clinical practice (European Society of Cardiology, 2018). The ESC guidelines suggest an ED strategy within 48-72 hours for the low-risk (Class IIa) AMI patients (European Society of Cardiology, 2018). On the contrary, the ACC guidelines do not provide recommendations for the best timing for discharge (Lawton et al., 2022).

The idea of next-day discharge for STEMI is not new and emerged over 10 years ago (Jirmár et al., 2008). The concept came from research showing that 24 hours after STEMI and hospital admission, the risk of major adverse cardiac events (MACE) was low in carefully selected patients suggesting that the hospital stay could be further decreased without compromising safety (Rubimbura et al., 2019; Howard et al., 2012). Moreover, the safety of discharge within 72 hours of uncomplicated primary PCI for STEMI patients has been evaluated in smaller studies, as previously described. However, evidence from clinical trials regarding the next-day discharge strategy (≤24 hours after the procedure) is lacking. Moreover, this early discharge strategy is particularly relevant in healthcare systems in low- and middle-income countries like Pakistan. The appropriate and evidence-based adoption of an early discharge strategy in clinical practice could have significant financial implications for both patients and hospitals. Therefore, in this study, we evaluated the outcome of very early hospital discharge (≤24 hours) in selected low-risk patients with AMI who underwent uncomplicated primary PCI with an organized follow-up program, compared to the early hospital discharge (24 to 48 hours) of other low-risk patients.

MATERIAL AND METHODS

Following ethical approval from the ethical review committee of the researchers' institution, the observational study was performed prospectively from August 2022 to August 2023 at Cardiac Care Unit, Punjab Institute of Cardiology Lahore, Pakistan. a consecutive sampling method was implemented in recruiting patients who had been admitted to the emergency department with typical chest pain and diagnosed with STEMI. They were included only when primary PCI was performed within 12 hours after symptom onset, whereas all gave their informed consent. Inclusion criteria consisted of patients of any gender, aged 18 to 80 years, classified as Killip class I or II, and discharged within 72 hours post-PCI. Patients with a history of cardiac surgery or intervention, those who left against medical advice, those with AV block, or those who refused participation were excluded.

Comprehensive demographic data and medical histories, including comorbidities, were collected using a structured proforma at baseline. All primary PCI procedures were performed via transradial or transfemoral access by skilled cardiologists following institutional protocols. Manual compression was used for femoral sheath removal, as no vascular closure devices were employed. Complications, such as major bleeding (based on TIMI bleeding criteria) and arrhythmias, were recorded. The Zwolle risk score (ZRS) was calculated for each patient to classify them into low-risk (ZRS $\leq$ 3) and high-risk (ZRS $\geq$ 4) categories, guiding post-PCI management and discharge planning.

Patients were considered for early discharge based on several low-risk criteria, including successful PCI outcomes, left ventricular ejection fraction (LVEF) $\geq$ 40% or higher, absence of major adverse cardiac events during the hospital stay, stable hemodynamic status, no significant arrhythmias, and overall low-risk scores. To create two distinct groups, the criteria for very early discharge were stricter; only the lowest-risk patients who met all low-risk criteria and showed exceptional stability were discharged within 24 hours, forming the very early discharge group. Patients who did not meet these strict criteria but still qualified as low-risk were discharged within 72 hours, forming the early discharge group, adhering to hospital protocols aimed at optimizing bed utilization. Standard post-PCI medications, including dual antiplatelet therapy, beta-blockers, ACE inhibitors or ARBs, and statins, were prescribed. Follow-up assessments were scheduled at one week and 30 days post-procedure, primarily conducted in person.

The primary outcome measured was the incidence of Major Adverse Cardiac and Cerebrovascular Events (MACCE) at 7-day and 30-day follow-ups. MACCE included non-fatal myocardial infarction, congestive heart failure, all-cause mortality, stroke, target vessel revascularization, major bleeding, and readmission rates. The secondary outcome was the readmission rate.

Baseline characteristics of patients, procedural data, and post-procedural outcomes were compared between groups. Comparison of continuous variables was performed by Student's t-test, while categorical data were compared by the Pearson chi-square test. Logistic regression was used to investigate the relationship between the time of discharge and occurrence of MACCE with odds ratios (OR) and 95% confidence intervals presented. Differences between groups were checked for statistical significance using the Wald test, defining significance with $p < 0.05$.

RESULTS

Demographic and baseline characteristics for the 148 enrolled patients are listed in Table 1. The average age of participants was 50.5 years (SD = 10.3 years). As indicated by the p value 0.338, no statistical difference in age existed between the very early discharge group,

49.95 years ± 10.14 years, and the early discharge group, 51.6 years ± 10.6 years. The gender distribution in the groups was much similar, with males constituting 88% of the very early discharge group and 87.5% of the early discharge group, which had a p-value of 0.922.

Diabetes mellitus (DM) and hypertension were prevalent in 30.4% and 43.2% of patients, respectively, with no significant differences between the two discharge groups for DM (p=0.922) or hypertension (p=0.341). Smoking was reported by 42.6% of the total cohort, with comparable rates in both groups (p=0.774). A family history of cardiovascular disease was noted in 27.2% of the very early discharge group and 39.3% of the early discharge group, showing a trend towards significance (p=0.125). Hyperlipidaemia and claudication were relatively infrequent and were similarly distributed across the groups.

AWMI was the most common type of MI in 56.1% of all the patients and occurred more commonly in the early discharge group with 64.3% versus 51.1% in the very early discharge group, though not statistically significant with a p value of 0.153. Left anterior descending artery involvement as the most common culprit artery was found in 58.1% of overall population and did not differ between both groups, with p=0.212.

Radial access was the predominant method used in 93.2% of procedures. Pre-procedural TIMI flow grades showed no significant differences between the groups (p=0.19), with similar distributions across the grades: 0 (31.5% vs. 32.1%), I (49% vs. 44.6%), II (5.43% vs. 14.2%), and III (3.26% vs. 8.92%) for the very early and early discharge groups, respectively. Post-procedural TIMI flow grades also showed no significant differences, with the majority achieving grade III flow (81.5% in the very early discharge group and 85.7% in the early discharge group, p=0.79), shown in Table 1.

The study assessed patient outcomes following percutaneous coronary intervention (PCI), dividing participants into two groups based on discharge timing: very early discharge (within 24 hours) and early discharge (24-72 hours). The analysis included both 7-day and 30-day follow-ups, as demonstrated in Table 2.

At the 7-day follow-up, the rates of major adverse cardiac and cerebrovascular events (MACCE) were 5.43% for the very early discharge group and 5.35% for the early discharge group, with no significant difference observed (p=0.98). Additionally, the incidence of non-fatal myocardial infarction, all-cause death, stroke, target vessel revascularization (TVR), major bleeding, and readmissions were similar between the groups, showing no statistically significant differences.

By the 30-day follow-up, this pattern persisted. MACCE rates were 10.8% for the very early discharge group and 10.7% for the early discharge group. Other outcomes, such as non-fatal myocardial infarction, all-cause death, stroke, TVR, major bleeding, and readmissions, continued to show no significant differences, suggesting that patient outcomes remained comparable between the two discharge timings over time.

As anticipated, the mean hospitalization duration differed significantly between the groups, with the very early discharge group averaging 20.14 ± 2.86 hours and the early discharge group averaging 31.98 ± 7.17 hours, with a p-value of less than 0.001.

The logistic regression analysis presented in Tables 3 and 4 explores the relationship between Major Adverse Cardiac and Cerebrovascular Events (MACCE) at 7- and 30-days post-discharge and the timing of discharge, specifically comparing the very early discharge group (within 24 hours) to the reference group (discharged between 24-72 hours).

For the 7-day follow-up, the coefficient for the very early discharge group is 0.015 with a standard error of 0.751, indicating a minimal effect size. The Wald statistic is almost zero (0.0004), reflecting a non-significant impact, which is further supported by a high p-value of 0.984. This suggests that being in the very early discharge group does not significantly alter the odds of experiencing MACCE within 7 days of PCI compared to the reference group. The odds ratio (OR) is 1.015, with a wide 95% confidence interval of 0.233 to 4.423, highlighting the statistical uncertainty regarding the effect.

At the 30-day follow-up, the coefficient for the very early discharge group is 0.016 with a standard error of 0.547, again showing a minimal and non-significant effect (Wald statistic of 0.001, p-value of 0.976). This indicates that discharge timing has no significant long-term impact on the occurrence of MACCE. The corresponding odds ratio is 1.016, with a 95% confidence interval ranging from 0.348 to 2.967, reiterating the non-significant finding.

Table 1

Baseline and procedural characteristics of the patients planned to discharge early and very early

Characteristic	Total n = 148	Discharge post PPCI		p-value
		Very early (≤ 24 hrs) n = 92	Early (24-72 hrs) n = 56	
Age, yrs. (mean ± SD)	50.5 ± 10.3	49.95 ± 10.14	51.6 ± 10.6	0.338
Gender, n (%)				
Male	130 (87.8%)	81 (88%)	49 (87.5%)	0.922
Female	18 (12.2%)	11 (12.0%)	7 (12.5%)	
Comorbidities				
DM	45 (30.4%)	28 (30.4%)	17 (30.4%)	0.922
Hypertension	64 (43.2%)	37 (40.2%)	27 (48.2%)	0.341
Smoking	63 (42.6%)	40 (43.5%)	23 (41.1%)	0.774

Family history	47 (31.8%)	25 (27.2%)	22 (39.3%)	0.125
Hyperlipidaemia	11 (7.4%)	6 (6.5%)	5 (8.9%)	0.588
Claudication	12 (8.1%)	7 (7.6%)	5 (8.9%)	0.775
MI type				
AWMI	83 (56.1%)	47 (51.1%)	36 (64.3%)	0.153
IWMI	59 (39.9%)	42 (45.7%)	17 (30.4%)	
Lateral wall MI	4 (2.7%)	1 (1.1%)	3 (5.4%)	
Posterior wall MI	1 (0.7%)	1 (1.1%)	0 (0.0%)	
Infero-postero-lateral MI	1 (0.7%)	1 (1.1%)	0 (0.0%)	
Culprit Artery				
LAD	86 (58.1%)	51 (55.4%)	35 (62.5%)	0.212
LCX	16 (10.8%)	8 (8.7%)	8 (14.3%)	
RCA	46 (31.1%)	33 (35.9%)	13 (23.2%)	
Access route				
Femoral	10 (6.8%)	8 (8.7%)	2 (3.6%)	0.228
Radial	138 (93.2%)	84 (91.3%)	54 (96.4%)	
Pre-procedural TIMI flow grade				
0	47 (31.7%)	29 (31.5%)	18 (32.1%)	0.19
I	70 (47.2%)	45 (49%)	25 (44.6%)	
II	13 (8.78%)	5 (5.43%)	8 (14.2%)	
III	8 (5.40%)	3 (3.26%)	5 (8.92%)	
Post-procedural TIMI flow grade				
0	1 (0.67%)	1 (1.08%)	0 (0.0%)	0.79
I	4 (2.70%)	3 (3.26%)	1 (1.78%)	
II	20 (13.5%)	13 (14.1%)	7 (12.5%)	
III	123 (83.1%)	75 (81.5%)	48 (85.7%)	

Table 2

Comparison of study outcomes between early and very early discharge group

Outcomes	Total n = 148	Discharge post PPCI		p-value
		Very early (≤ 24 hrs) n = 92	Early (24-72 hrs) n = 56	
Hospitalization time (hours), mean ± SD	24.6 ± 7.60	20.14 ± 2.86	31.98 ± 7.17	<0.001*
7-day follow up				
MACCE	8 (5.40%)	5 (5.43%)	3 (5.35%)	0.98
Non-fatal myocardial infarction	3 (2.02%)	2 (2.17%)	1 (1.78%)	0.87
congestive heart failure	1 (0.67%)	1 (1.08%)	0 (0.0%)	0.43
all-cause death	3 (2.02%)	2 (2.17%)	1 (1.78%)	0.87
stroke	2 (1.35%)	1 (1.08%)	1 (1.78%)	0.72
target vessel revascularisation (TVR)	4 (2.70%)	2 (2.17%)	2 (3.57%)	0.61
Major bleeding	2 (1.35%)	1 (1.08%)	1 (1.78%)	0.72
Readmission	3 (2.02%)	2 (2.17%)	1 (1.78%)	0.87
30-day follow up				
MACCE	16 (10.8%)	10 (10.8%)	6 (10.7%)	0.97
Non-fatal myocardial infarction	8 (5.40%)	5 (5.43%)	3 (5.35%)	0.98
congestive heart failure	1 (0.67%)	1 (1.08%)	0 (0.0%)	0.43
all-cause death	5 (3.37%)	3 (3.26%)	2 (3.57%)	0.91
stroke	3 (2.02%)	2 (2.17%)	1 (1.78%)	0.87
target vessel revascularisation (TVR)	11 (7.43%)	7 (7.60%)	4 (7.14%)	0.91
Major bleeding	2 (1.35%)	1 (1.08%)	1 (1.78%)	0.72
Readmission	11 (7.43%)	7 (7.60%)	4 (7.14%)	0.91

*Statistically significant

Table 3

Association of MACCE at 7th day with discharge timing

Variable	B	S.E.	Wald	df	P value	OR	95% C.I for OR	
							Lower	Upper
Group (Very Early Discharge)	0.015	0.751	0.0004	1	0.984	1.015	0.233	4.423
Constant	-2.872	0.593	23.414	1	<0.001	0.057		

Table 4

Association of MACCE at 30th day with discharge timing

Variable	B	S.E.	Wald	df	P value	OR	95% C.I for OR	
							Lower	Upper
Group (Very Early Discharge)	0.016	0.547	0.001	1	0.976	1.016	0.348	2.967
Constant	-2.120	0.432	24.083	1	<0.001	0.120		

Figure 1

Graphical representation of Comparison of study outcomes between early and very early discharge group at 7-day follow-up

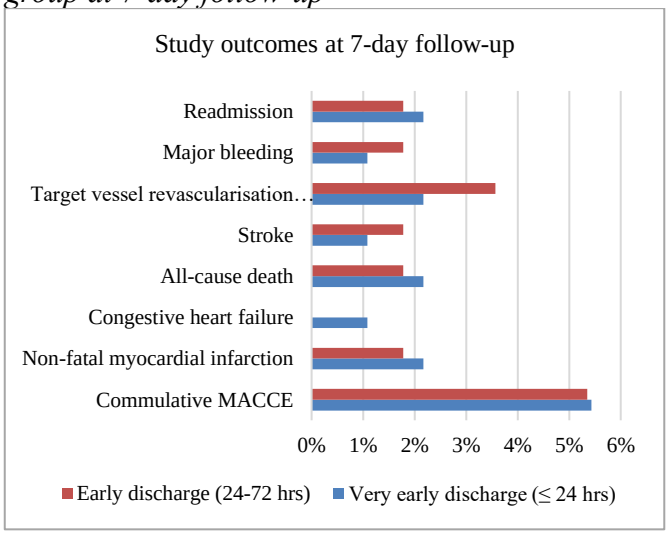
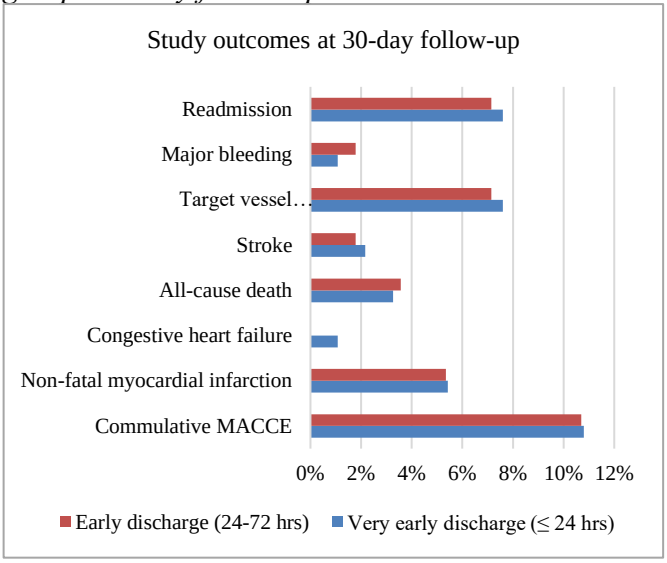


Figure 2
Graphical representation of Comparison of study outcomes between early and very early discharge group at 7-day follow-up



DISCUSSION

Recent advancements in the care and management of patients with STEMI have contributed to a reduction in hospital stay durations for uncomplicated cases. Earlier discharge of MI patients can lower hospitalization costs, decrease hospital bed occupancy, and reduce the risk of contact with infectious diseases during the hospital stay. This study aimed to evaluate the outcomes of very early discharge (within 24 hours) compared to early discharge (24-72 hours) in a low-risk cohort after PPCI. The findings suggest that very early discharge can be a viable option without compromising patient safety, although careful patient selection remains essential.

Low risk patients with STEMI who underwent primary PCI should be discharged at 48-72 hours as mentioned in current metanalyses and large observational studies by Gong et al. (2018); Ibanez et al. (2018); Satılmısoglu et al. (2016); Jones et al. (2012). However, there is scant data on safety of same-day (within 24h) discharge after primary PCI with even fewer reports on safety of ad hoc or elective PCI discharged within 24 hrs. (Rubimbura Mazimpaka et al., 2017; Shroff et al., 2016; Brayton et al., 2013; Shah et al., 2021). The present study illustrated that very early discharge, defined as discharge within 24 hours after primary PCI, is possible combined with careful risk assessment. We showed that the mean length of stay for early discharge was 20.14 hours, which is significantly lower compared to our study group for early discharge, with a mean length of stay of 31.9 hours, and a mean of 65.9 hours in those patients who were discharged following standard care pathways, as reported by Rathod et al. (2021). This overall strategy was associated with a reduction in mean hospital stay for all patients treated with primary PCI, thus freeing up the beds for other patients in need at our Heart Attack Centre. Such a strategy may provide financial and logistical benefits to both the patients and the health systems. The extra day of stay in the hospital after primary PCI alone will cost an average as high as PKR 25,000; it will also increase the bed occupancy in a busy center like the one used in this study.

The results showed similar rates of MACCE and all-cause mortality at 7-day and 30-day follow-ups between the very early discharge (within 24 hours) and early discharge (24-72 hours) groups. Specifically, at the 7-day follow-up, MACCE rates were 5.43% and 3.57% for the very early and early discharge groups, respectively. At the 30-day follow-up, these rates were 10.8% for the very early group and 10.7% for the early group. The analysis found no statistically significant differences between the two groups for both the 7-day and 30-day follow-ups.

Comparing the results of this study with previous studies provides a cohesive view of the safety and feasibility of early discharge after primary PCI. Our study, observing 7-day and 30-day MACCE rates post-PCI without significant differences between the very early (within 24 hours) and early (24-72 hours) discharge groups, aligns well with broader clinical research. A study from Iran also found that discharge within 48 hours for STEMI patients was safe, reinforcing the notion that reduced hospital stays do not significantly compromise patient outcomes (Hosseini et al., 2021). Similarly, a study from Karachi demonstrated that even same-day discharge post-PCI in selected low-risk patients could be safe, with minimal MACCE rates up to 30 days post-discharge (Shah et al., 2023). Additionally, another study confirmed the feasibility of early discharge within 24 to 48 hours in a setting heavily impacted by the COVID-19 pandemic, which required efficient hospital resource management without increasing patient risk (Rathod et al., 2021). These studies collectively support the trend toward shorter hospital stays for certain patient demographics, provided there is rigorous pre-discharge assessment and adequate follow-up, aligning closely with the findings from our analysis.

The all-cause mortality rates at the 7-day and 30-day follow-ups for very early discharge (within 24 hours) were 2.17% and 3.26%, respectively. This data suggests that very early discharge after primary PCI does not significantly increase the risk of mortality, affirming the safety of this approach when patients are well-monitored. The Karachi study also showed all-cause mortality rates of 1.4% at 7 days and 2.3% at 30 days for same-day discharge, demonstrating that such early discharges can be safe with proper patient selection and care. Moreover, while shorter hospital stays have been associated with an increased 30-day readmission rate

(Kociol et al., 2012), our study found no such difference between the two groups (p = 0.91).

The existing guidelines recommend evaluating each patient's risk separately, based on cardiac risk, comorbidities, functional status, and social support (Ibanez et al., 2018). Cardiac risk is usually determined via the so-called classification variables, such as age, LVEF, predominance of single or 2-vessel disease, and the achievement of effective PCI with no lasting arrhythmias. The criteria used in the reference cohort were already based on the pre-existing scoring systems for risk assessment after primary PCI (De Luca et al., 2004; Halkin et al., 2005; Schellings et al., 2014), and reflected the local hospital protocol for 24-hour discharge. Our study confirms the use of the criteria that include patients with successful and uncomplicated primary PCI procedures, stable cardiac rhythm and hemodynamics, LVEF >40%, and no need for inpatient revascularization as safe for discharge at the 24-hour mark..

This study is among the few in the region to explore the viability of very early discharge (VED) following primary percutaneous coronary intervention (PPCI) in low-risk patients. The findings highlight the potential for significant improvements in hospital resource management and patient care within local healthcare frameworks, particularly in low- and middle-income countries like Pakistan. Despite the promising outcomes, the study's limitations should be acknowledged. Firstly, the observational design and specific patient selection criteria may limit the generalizability of the results. The study focused on a carefully selected group of patients who met strict low-risk criteria, which may not represent the broader population of STEMI patients. Secondly, the follow-up period was relatively short, and longer-term outcomes of very early discharge were not assessed, which could provide further insights into the sustainability of benefits and potential late adverse events. Lastly, the study was conducted in a single, high-volume center, which might introduce center-specific biases that could influence the results. Future studies with a randomized controlled design, broader selection criteria, and longer follow-up periods are needed to validate these findings and potentially revise discharge protocols more universally

CONCLUSION

This study presents persuasive evidence that discharging selected low-risk patients within 24 hours after an uncomplicated primary PCI is both safe and effective in reducing healthcare costs and improving hospital bed management. The results demonstrate that careful patient selection based on well-established low-risk criteria can maintain safety standards without compromising the quality of care.

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