

De novo percutaneous coronary intervention after ST-elevation myocardial infarction in older patients with prior coronary artery bypass grafting: demographic characteristics and clinical outcomes

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Abstract

Introduction: Primary percutaneous coronary intervention (PCI) is the standard reperfusion strategy for ST-elevation myocardial infarction (STEMI). However, contemporary real-world outcomes of *de novo* PCI in older adults with a history of coronary artery bypass grafting (CABG) are not well described. We compared in-hospital outcomes and 30-day readmissions after STEMI-related *de novo* PCI among older patients with and without prior CABG.

Material and methods: Using the Nationwide Readmissions Database (2016–2022), we identified patients aged ≥ 65 years hospitalized with a primary diagnosis of STEMI who underwent *de novo* PCI. Patients were stratified by prior CABG status. Multivariable logistic regression assessed in-hospital adverse events (including mortality). Among survivors, Cox proportional hazards models were used to evaluate 30-day all-cause readmissions.

Results: Among 194,958 patients, 9,929 (5.09%) had prior CABG, and 185,029 (94.91%) did not. After adjustment, prior CABG was associated with lower odds of acute kidney injury (AKI), cardiac arrest, cardiogenic shock, and vasopressor use. There were no significant differences in mechanical circulatory support, AKI requiring hemodialysis, ischemic stroke, hemorrhagic stroke, or in-hospital mortality. Among survivors, 30-day readmissions were more frequent among patients with prior CABG (12.79% vs. 10.48%; HR = 1.145, 95% CI: 1.021–1.217; $p = 0.015$). Mean time to readmission was similar (10.66 vs. 10.54 days; $p = 0.757$).

Conclusions: In older STEMI patients undergoing *de novo* PCI, prior CABG was associated with similar in-hospital mortality and fewer in-hospital adverse events, but higher 30-day readmission risk. These findings suggest that while prior CABG may not worsen immediate outcomes, it identifies patients who may benefit from enhanced post-discharge follow-up and transitional care.

Key words: complications, coronary artery bypass grafting, outcomes, percutaneous coronary intervention, readmissions, geriatric.

Introduction

Cardiovascular disease (CVD) remains the leading cause of mortality worldwide, accounting for approximately 31% of all deaths. This bur-

den falls disproportionately on individuals aged 65 and older, who represent 60% of ST-segment elevation myocardial infarction (STEMI) cases and constitute the majority of STEMI-related deaths [1]. Despite advances in coronary recanalization therapy and broader access to coronary care units, older patients consistently experience worse outcomes than their younger counterparts [2]. This disparity reflects a confluence of factors: higher comorbidity burden, increased frailty, more extensive and calcified coronary artery disease, greater susceptibility to acute kidney injury (AKI), and atypical symptom presentation that frequently delays diagnosis and treatment. The underrepresentation of older patients in clinical trials further limits the available outcome data to guide management [3, 4].

Primary percutaneous coronary intervention (PCI) is the preferred revascularization strategy for STEMI; however, performing PCI in older patients carries unique procedural challenges. Altered vascular anatomy, tortuous and heavily calcified vessels, complex lesions, and difficult vascular access collectively contribute to longer procedure times and greater contrast and radiation exposure [5]. These difficulties are compounded in older STEMI patients with a history of prior coronary artery bypass grafting (CABG), who face an especially high-risk profile owing to advanced age, reduced physiological reserve, and surgically altered coronary anatomy [6, 7]. Engaging bypass grafts, particularly the left internal mammary artery (LIMA) via the subclavian artery, adds technical complexity, while multiple comorbidities such as chronic kidney disease, anemia, peripheral vascular disease, and heart failure heighten the risk of hemodynamic instability, AKI, and bleeding from anti-thrombotic therapy [8, 9]. Identifying the culprit vessel presents an additional challenge, as clinical presentation, electrocardiographic findings, and angiographic appearances may simultaneously reveal chronic occlusions, collateral circulation, and diffuse multivessel abnormalities.

Despite the prevalence of STEMI in older patients with prior CABG, data on outcomes after *de novo* PCI, defined as PCI performed in patients with no prior history of the procedure, remain limited. Recent meta-analyses demonstrate that prior CABG is associated with poorer outcomes following PCI, and large datasets reveal differences in management strategies and readmission risk based on CABG history. To address this knowledge gap, we analyzed the Nationwide Readmissions Database (NRD) (2016–2022) to compare in-hospital complications, including mortality, and 30-day readmission rates in older (aged ≥ 65 years) STEMI patients undergoing *de novo* PCI, stratified by prior CABG status.

Material and methods

Data source

We conducted our retrospective analysis using hospitalization data from the 2016–2022 NRD, a component of the Healthcare Cost and Utilization Project (HCUP) sponsored by the Agency for Healthcare Research and Quality (AHRQ). Data from the NRD represent around 60% of all US hospitalizations and are derived from hospitals participating in the HCUP project. The data can then be weighted to create national estimates. In addition, the NRD applies patient linkage numbers, allowing users to identify the first readmission event within the same year. For this study, since we aimed to track 30-day readmission events, index admissions were restricted to those occurring between January and November. The NRD also contains details regarding patients, including age, sex, insurance form, as well as hospital information. Users can also explore diagnoses and procedures via the International Classification of Diseases, Tenth Revision, Clinical Modification/Procedure Coding System (ICD-10-CM/PCS) [10].

Study population and patient selection

We identified all hospitalized patients aged 65 years and older with a primary diagnosis of STEMI who underwent PCI. The age threshold of 65 years was selected to focus on the geriatric population, as this represents the commonly accepted definition for older adults in clinical practice [11]. To isolate patients undergoing their first revascularization procedure, we excluded individuals with a documented history of prior PCI. Patients were then stratified into two cohorts based on the presence or absence of prior CABG. Only non-elective admissions were included to ensure that the study population reflected acute clinical presentations requiring urgent intervention. All patients with COVID-19 were excluded.

Study outcomes

The primary outcome was 30-day all-cause readmission of survivors following index hospitalization. Secondary outcomes included in-hospital clinical events during the index hospitalization: mortality, cardiac arrest, cardiogenic shock, ventricular tachycardia, supraventricular tachycardia, acute ischemic stroke, hemorrhagic stroke, AKI, AKI requiring hemodialysis, arterial dissection, vasopressor use, and mechanical circulatory support. All outcomes were identified using validated ICD-10-CM/PCS diagnostic and procedural codes.

Statistical analysis

Baseline characteristics were compared between patients with and without prior CABG using

appropriate statistical tests. Categorical variables were reported as percentages and compared using χ^2 tests, while continuous variables were expressed as means $\pm$ standard error and compared using *t*-tests.

To assess the association between prior CABG and study outcomes, we performed multivariable logistic regression for in-hospital events and Cox proportional hazards regression for 30-day readmission. Covariates for inclusion in the adjusted models were selected based on clinical relevance and statistical significance ($p < 0.20$) in univariable analysis. The final models adjusted for patient demographics (age, sex), hospital characteristics (teaching status, weekend admission), comorbidities (dyslipidemia, smoking, diabetes, chronic kidney disease, prior stroke, alcohol abuse, prior myocardial infarction, obesity, chronic obstructive pulmonary disease, hypertension, liver cirrhosis, congestive heart failure, peripheral vascular disorders, valvular disease, rheumatoid arthritis, coagulopathy), and socioeconomic factors (insurance type, median household income quartile). Results were reported as adjusted odds ratios (aOR) with 95% confidence intervals (CI) for logistic regression and hazard ratios (HR) with 95% CI for Cox regression. Statistical significance was defined as a two-sided p -value < 0.05 . All analyses were conducted using STATA 18.0.

Results

Study population and baseline demographics and comorbidities

Our analysis involved 194,958 older patients (age ≥ 65 years) who underwent *de novo* PCI for STEMI between 2016 and 2022. Of these, 9,929 patients (5.09%) had prior CABG, while 185,029 patients (94.91%) had no history of prior CABG.

Patients with prior CABG differed significantly from those without prior CABG across multiple demographic and clinical parameters (Table I). The prior CABG group was older (mean age: 75.43 $\pm$ 0.10 years vs. 74.16 $\pm$ 0.03 years, $p < 0.001$), with a higher proportion of patients aged 75 years or older, and had a lower proportion of women (24.14% vs. 38.16%, $p < 0.001$). Hospital characteristics, including metropolitan teaching status and weekend admission rates, were comparable between groups.

The prior CABG cohort demonstrated a substantially higher burden of cardiovascular comorbidities and risk factors. These patients had higher rates of dyslipidemia (83.33% vs. 69.71%, $p < 0.001$), diabetes (42.84% vs. 30.78%, $p < 0.001$), chronic kidney disease (24.97% vs. 15.90%, $p < 0.001$), prior stroke (9.94% vs. 6.12%, $p < 0.001$), prior myocardial infarction (27.24% vs. 7.40%,

$p < 0.001$), chronic obstructive pulmonary disease (16.27% vs. 12.41%, $p < 0.001$), hypertension (90.08% vs. 77.48%, $p < 0.001$), congestive heart failure (43.91% vs. 38.03%, $p < 0.001$), peripheral vascular disorders (15.90% vs. 7.77%, $p < 0.001$), and valvular disease (17.87% vs. 11.23%, $p < 0.001$). The overall comorbidity burden, as reflected by the Charlson Comorbidity Index, was significantly higher in patients with prior CABG (3.23 $\pm$ 0.03 vs. 2.63 $\pm$ 0.01, $p < 0.001$). Frailty was comparable between the two cohorts (8.57% vs. 8.97%, $p = 0.400$). However, we noted that liver cirrhosis was less common in the prior CABG group (1.83% vs. 2.64%, $p = 0.001$).

Some differences were also reported based on socioeconomic factors. Patients with prior CABG were more likely to have Medicare coverage (87.74% vs. 86.02%, $p < 0.001$) and were more frequently in the lowest income quartile (28.65% vs. 25.14%, $p < 0.001$).

In-hospital outcomes and mortality

Despite their higher baseline comorbidity burden, patients with prior CABG had lower odds of several in-hospital complications compared to those without prior CABG, including cardiac arrest (aOR = 0.846, 95% CI: 0.737–0.972, $p = 0.018$), cardiogenic shock (aOR = 0.896, 95% CI: 0.804–0.999, $p = 0.048$), AKI (aOR = 0.859, 95% CI: 0.785–0.940, $p = 0.001$), and vasopressor use (aOR = 0.695, 95% CI: 0.565–0.856, $p = 0.001$).

There were no significant differences between groups in the odds of ventricular tachycardia (aOR = 0.938, 95% CI: 0.850–1.035, $p = 0.202$), supra-ventricular tachycardia (aOR = 0.891, 95% CI: 0.717–1.107, $p = 0.298$), acute ischemic stroke (aOR = 0.963, 95% CI: 0.738–1.256, $p = 0.780$), hemorrhagic stroke (aOR = 1.378, 95% CI: 0.686–2.768, $p = 0.367$), AKI requiring hemodialysis (aOR = 0.837, 95% CI: 0.611–1.145, $p = 0.265$), arterial dissection (aOR = 1.152, 95% CI: 0.547–2.424, $p = 0.710$), or mechanical circulatory support use (aOR = 0.947, 95% CI: 0.810–1.107, $p = 0.493$).

The crude in-hospital mortality rate was similar between groups (6.07% in prior CABG vs. 6.00% in no prior CABG, $p = 0.865$). After multivariable adjustment, prior CABG was not associated with in-hospital mortality (aOR = 0.980, 95% CI: 0.858–1.121, $p = 0.773$) (Table II).

30-day readmission

Patients with prior CABG had a significantly higher 30-day all-cause readmission rate compared to those without prior CABG (12.79% vs. 10.48%). After adjustment for demographics, hospital characteristics, comorbidities, and socioeconomic factors, prior CABG remained independently

Table I. Demographics of elderly patients with vs. without prior CABG undergoing *de novo* PCI following STEMI

Characteristic	No prior CABG (%)	Prior CABG (%)	P-value
Demographics			
Female (vs. male)	38.16	24.14	< 0.001
Age [years] (mean ± SE)	74.16 ±0.03	75.43 ±0.10	< 0.001
Age group			< 0.001
65–74	58.53	49.93	
75–84	30.04	37.06	
85 and older	11.43	13.01	
Hospital factors			
Hospital type			0.318
Metropolitan non-teaching	19.93	20.16	
Metropolitan teaching	74.20	73.43	
Non-metropolitan	5.86	6.41	
Weekend admissions	27.79	26.96	0.217
Comorbidities			
Dyslipidemia	69.71	83.33	< 0.001
Smoking	43.46	46.56	< 0.001
Diabetes	30.78	42.84	< 0.001
Chronic kidney disease	15.90	24.97	< 0.001
Prior stroke	6.12	9.94	< 0.001
Alcohol abuse	1.94	1.54	0.059
Prior myocardial infarction	7.40	27.24	< 0.001
Obesity	14.90	13.92	0.061
COPD	12.41	16.27	< 0.001
Hypertension	77.48	90.08	< 0.001
Liver cirrhosis	2.64	1.83	0.001
Congestive heart failure	38.03	43.91	< 0.001
Peripheral vascular disorders	7.77	15.90	< 0.001
Valvular disease	11.23	17.87	< 0.001
Rheumatoid arthritis	2.93	2.67	0.321
Coagulopathy	3.96	4.52	0.052
Frail	8.97	8.57	0.400
Charlson Comorbidity Index (mean ± SE)	2.63 ±0.01	3.23 ±0.03	< 0.001
Insurance and socioeconomic characteristics			
Insurance type			< 0.001
Medicare	86.02	87.74	
Medicaid	1.27	0.71	
Private	9.60	7.67	
Median income quartile			< 0.001
0–25 th (lowest)	25.14	28.65	
26 th –50 th	28.57	28.60	
51 st –75 th	26.05	26.23	
76 th –100 th (highest)	20.24	16.52	
Hospital charges (mean ± SE)	\$117,060 ±\$874	\$118,999 ±\$1,570	0.147
Length of stay [days] (mean ± SE)	3.57 ±0.02	3.61 ±0.06	0.501

Table II. Outcomes in patients with prior CABG vs. without (reference) undergoing *de novo* PCI following STEMI

Outcome	AOR	95% CI	P-value
Mortality and cardiac events			
Mortality	0.980	0.858–1.121	0.773
Cardiac arrest	0.846	0.737–0.972	0.018
Cardiogenic shock	0.896	0.804–0.999	0.048
Ventricular tachycardia	0.938	0.850–1.035	0.202
Supraventricular tachycardia	0.891	0.717–1.107	0.298
Neurological events			
Acute ischemic stroke	0.963	0.738–1.256	0.780
Hemorrhagic stroke	1.378	0.686–2.768	0.367
Renal outcomes			
Acute kidney injury	0.859	0.785–0.940	0.001
AKI requiring hemodialysis	0.837	0.611–1.145	0.265
Procedural and supportive outcomes			
Arterial dissection	1.152	0.547–2.424	0.710
Vasopressor use	0.695	0.565–0.856	0.001
Mechanical circulatory support	0.947	0.810–1.107	0.493

AOR – adjusted odds ratio, CI – confidence interval, CABG – coronary artery bypass grafting, PCI – percutaneous coronary intervention, STEMI – ST-elevation myocardial infarction, AKI – acute kidney injury.

associated with increased risk of 30-day readmission (HR = 1.145, 95% CI: 1.021–1.217, $p = 0.015$). Among patients who were readmitted, the mean time to readmission was similar between groups (10.66 days for prior CABG vs. 10.54 days for no prior CABG, $p = 0.757$).

Discussion

In our large nationwide cohort study, patients with a history of CABG paradoxically exhibited lower odds of experiencing multiple in-hospital adverse events. Despite carrying significantly higher comorbidity burdens, their risk of acute in-hospital outcomes, including AKI, cardiac arrest, cardiogenic shock, and need for vasopressors, was notably lower. Conversely, these patients demonstrated higher 30-day readmission rates. This unexpected divergence between acute and early outcomes in STEMI patients challenges conventional risk assumptions and carries key implications for their in-hospital treatment and follow-up care.

Our patients with a history of CABG were older and presented with a greater burden of comorbidities, including dyslipidemia, smoking, diabetes mellitus, chronic kidney disease, prior stroke, prior myocardial infarction, chronic obstructive pulmonary disease, hypertension, congestive heart failure, peripheral vascular disease, and valvular disease. These findings align with findings from the observational study by Rathod *et al.* [12] and are further supported by evidence demonstrating that the incidence of multivessel coronary artery disease increases with advancing age, particularly

in individuals older than 75 years [13]. Additionally, the proportion of female patients was lower in the prior CABG group. This may be attributed to the later presentation of coronary artery disease in women, who often have a higher comorbidity burden [14], as well as poorer outcomes following CABG, including higher mortality rates [15]. A higher proportion of patients with prior CABG had Medicare insurance, consistent with previously reported associations between CABG and insurance status [16]. CABG was more frequently observed among patients in the lowest income quartile, aligning with previous studies that reported an inverse relationship between CABG incidence and income percentile [17–19], although these studies also included younger adults (over 18 years). The higher prevalence of CABG in lower-income groups may reflect the increased burden of coronary artery disease associated with lower socioeconomic status [20].

Previous studies have reported that a history of CABG is associated with poorer clinical outcomes, as these patients often present with more complex coronary anatomy and a higher burden of comorbidities [21]. In contrast, our study revealed that patients with prior CABG experienced better in-hospital outcomes, including lower rates of AKI, cardiac arrest, cardiogenic shock, and reduced need for vasopressors. Several potential explanations may account for this finding. First, well-developed coronary collaterals in these patients may provide alternative blood supply pathways that mitigate the severity of ischemic insults during acute events [22]. Second, clinical decision-mak-

ing may also play a role, as physicians might preferentially avoid aggressive interventions, such as PCI in sicker patients with prior CABG, potentially influencing the observed outcomes [23]. Furthermore, prior CABG patients who did not survive the initial STEMI to undergo PCI were excluded from our cohort, meaning the frailest patients were excluded; our cohort may therefore represent a physiologically more resilient subset of the prior CABG population. Finally, the confidence intervals for these outcomes approached unity, suggesting that while the association is noteworthy, it should be interpreted cautiously.

However, 30-day readmission rates were higher in the prior CABG group, which may reflect the underlying vulnerability of this population and reveal the “true” clinical risk not apparent during the index hospitalization. This increase in readmissions could be attributed to several factors: the persistence or progression of underlying comorbidities, incomplete revascularization during the index event, or the delayed consequences of complex coronary anatomy [21]. Additionally, these patients may experience recurrent ischemic events or heart failure exacerbations despite initially favorable in-hospital outcomes, underscoring the importance of careful post-discharge monitoring and optimized transitional care. Medication adherence, cardiac rehabilitation, and close outpatient follow-up are likely critical in mitigating these short-term risks, emphasizing that in-hospital stability does not always translate to sustained clinical benefit.

First, the retrospective design limits the ability to establish causality between prior CABG status and PCI-related complications or outcomes. Because data are derived from existing records, the analysis is subject to documentation inaccuracies, coding variability, and missing data. Additionally, important clinical variables such as lesion complexity, graft age, conduit type (arterial vs. venous), time since CABG, medication adherence, frailty status, and operator experience may not be fully captured, introducing residual confounding. Second, selection bias is inherent in observational analyses. Patients with prior CABG who undergo *de novo* PCI may represent a highly selected subgroup with specific anatomical or clinical characteristics. Similarly, excluding patients with prior PCI may limit the generalizability of the findings, as many patients with prior CABG may undergo repeat revascularization procedures over time. Third, although the study focuses on non-elective PCI in patients presenting with STEMI, variations in clinical management such as door-to-balloon time, use of mechanical circulatory support, choice of vascular access, antithrombotic regimens, and adjunctive imaging (e.g., intravascular ultra-

sound or optical coherence tomography) could significantly influence outcomes but may not be uniformly controlled for in the dataset. Fourth, the geriatric focus (age ≥ 65 years) improves relevance to an aging population but also introduces heterogeneity within this group. Chronological age alone does not fully capture biological age, comorbidity burden, cognitive status, or frailty. Without formal frailty indices or geriatric assessments, the analysis may not fully account for differences in vulnerability among older adults. Fifth, long-term outcomes may not be adequately assessed because follow-up duration is limited to in-hospital or short-term endpoints. Important outcomes such as repeat revascularization, heart failure progression, graft failure, stent thrombosis, and long-term mortality may therefore be unassessed.

Finally, unmeasured confounders, including access to care, hospital PCI volume, and regional practice variation, may influence both procedural decisions and outcomes. These factors limit the ability to generalize findings across different healthcare systems or populations.

In conclusion, in this national cohort of patients aged ≥ 65 years with STEMI undergoing non-elective *de novo* PCI, prior CABG was not associated with higher in-hospital mortality compared with no prior CABG. Instead, patients with prior CABG had lower odds of several in-hospital adverse events, while 30-day readmissions were more frequent among survivors. Together, these findings suggest that a history of CABG was not associated with worse immediate in-hospital outcomes after *de novo* PCI in older adults, but it may identify a subgroup at increased risk for early post-discharge rehospitalization. Accordingly, enhanced transitional care including careful discharge planning, optimization of guideline-directed medical therapy, and early outpatient follow-up may be warranted. Future prospective studies should clarify the drivers of readmission and evaluate targeted strategies to improve longer-term outcomes in this population.

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Ethical approval

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Conflict of interest

The authors declare no conflict of interest.

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