Research Square

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Early and Long-Term Clinical Outcomes of Coronary Artery Bypass Grafting in Patients with Heart Failure and Reduced Ejection Fraction: A Cross-Sectional Study

Soroush Abedini
Babol University of Medical Sciences
Roghayeh Pourkia
Babol University of Medical Sciences
Hamidreza Vafaei
Babol University of Medical Sciences
Sepehr Ramezani
Sepehr.ramezany74@gmail.com
Babol University of Medical Sciences

Research Article

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Abstract

Background

Ischemic heart disease complicated by a reduced ejection fraction drastically increases morbidity and mortality following coronary artery bypass grafting (CABG). This study aims to evaluate the short-term and long-term clinical outcomes—specifically survival rates, readmissions, and stroke incidence—in this high-risk patient population.

Methods

This cross-sectional study analyzed 229 patients with heart failure (ejection fraction < 40%) who underwent CABG at Ayatollah Rouhani Hospital in Babol, Iran, between 2011 and 2019. Demographic information, medical history, and clinical outcomes were extracted from hospital records and follow-up interviews. Data were analyzed using SPSS software via descriptive statistics, Chi-square tests, ANOVA, and Kaplan-Meier survival analyses.

Results

The cohort consisted of 153 men (66.8%) and 76 women (33.2%) with a mean age of 64.48 ± 10.92 years. Baseline comorbidities included hypertension (57.6%), hyperlipidemia (49.8%), and diabetes (46.7%). Over the follow-up period, 45 patients (19.7%) died. The mean survival time was 58.36 months (95% CI: 55.78–60.95). Older age (> 65 years) was significantly associated with decreased survival ($p < 0.001$) and higher readmission rates ($p < 0.001$). Moderate-to-severe mitral regurgitation also significantly reduced survival ($p = 0.027$). Post-operative stroke occurred in 5.2% of patients. Higher educational levels correlated with lower readmission probabilities ($p = 0.004$).

Conclusions

CABG remains a critical intervention for heart failure patients with reduced ejection fraction, yielding a mean survival of over 58 months. However, advanced age and significant mitral regurgitation are profound predictors of mortality and readmission. Identifying these clinical factors can guide targeted postoperative monitoring and improve long-term survival in vulnerable cohorts.

Background

Cardiovascular diseases, particularly coronary artery disease (CAD), represent the leading cause of mortality worldwide, accounting for a massive global health burden [1]. While advancements in medical diagnostics and therapies have notably decreased sudden cardiac death rates, they have simultaneously increased the prevalence of chronic conditions such as severe left ventricular (LV) dysfunction and

ischemic cardiomyopathy [2, 3]. In Iran, cardiovascular diseases remain the primary cause of death, with ischemic heart diseases responsible for over 39.3% of total mortality [13].

Coronary artery bypass grafting (CABG) is one of the most definitive and highly valued interventions for treating extensive CAD [18, 19]. By creating a bypass around occluded arteries, it restores myocardial perfusion, severely reducing anginal symptoms and prolonging life [20]. However, the surgical process carries inherent risks, especially in patients with pre-existing left ventricular dysfunction [4, 6]. Reduced ejection fraction (EF) is broadly recognized as an independent predictor of poor prognosis following CABG, as impaired cardiac output can precipitate multi-organ failure and necessitate prolonged postoperative inotropic or mechanical support [4]. Managing these high-risk surgical patients requires navigating complex, intersecting comorbidities, akin to the multidisciplinary challenges seen in severe cardiovascular complications of immunocompromised states, such as HIV-related cardiac tamponade [31].

Despite the risks, CABG provides a significant survival advantage over medical therapy alone for patients suffering from combined CAD and heart failure with reduced ejection fraction (HFrEF) [3, 24]. Because robust longitudinal data concerning CABG outcomes in HFrEF populations within Northern Iran is scarce, this study aims to evaluate the short- and long-term clinical outcomes—including survival, cardiac readmissions, and stroke—among patients with an EF < 40% undergoing CABG at Ayatollah Rouhani Hospital in Babol.

Methods

Study Design and Population

This retrospective cross-sectional study evaluated patients who underwent CABG at Ayatollah Rouhani Hospital (Babol, Iran) between 2011 and 2019. The inclusion criteria strictly required patients to have undergone CABG and to possess a preoperative left ventricular ejection fraction (LVEF) of less than 40%, classifying them as having heart failure with reduced ejection fraction. Patients with incomplete hospital records were excluded from the analysis. Based on sample size calculations, a total of 229 eligible patients were successfully enrolled.

Data Collection

Data acquisition was conducted via comprehensive reviews of hospital medical records combined with structured telephone follow-up interviews up to the year 2022. The following variables were meticulously extracted:

- Demographic parameters: age, gender, body mass index (BMI), education level, and occupation.
- Clinical history: presence of diabetes mellitus, hypertension, hyperlipidemia, asthma, chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), prior stroke, and smoking

history.

- Preoperative medications: use of aspirin, statins, beta-blockers, ACE inhibitors, and diuretics.
- Echocardiographic parameters: LVEF (<30% vs. 30-40%), mitral regurgitation (MR) severity (<Moderate vs. ≥Moderate), LV dilatation, diastolic dysfunction grading, pulmonary artery pressure (PAP), and right ventricular function.

Statistical Analysis

Data processing and statistical testing were performed using SPSS version 26. Descriptive statistics, including means, standard deviations, and frequencies, were generated to summarize demographic and clinical profiles. The relationship between quantitative variables and readmission frequency was assessed using the One-way ANOVA test. Categorical variables were evaluated using Chi-square tests. Overall survival and the impact of covariates on survival time were calculated using Kaplan-Meier survival curves and Log-rank testing. A p-value of <0.05 was considered statistically significant.

Results

Baseline Demographics and Comorbidities

The study cohort comprised 229 patients, consisting of 153 men (66.8%) and 76 women (33.2%). The mean age of the participants was 64.48 ± 10.92 years (range: 30 to 86 years).

Regarding education, 34.1% of patients were illiterate, while only 2.8% held a university degree. Baseline clinical characteristics revealed high rates of comorbidities: hypertension was present in 132 patients (57.6%), hyperlipidemia in 114 (49.8%), and diabetes in 107 (46.7%). Additionally, 67 patients (29.3%) reported a history of smoking, and 13 patients (5.7%) had a history of prior stroke.

Variable	Frequency (%) or Mean ± SD
Age (Years)	64.48 ± 10.92
Body Mass Index (BMI)	26.12 ± 4.42
Hypertension	132 (57.6%)
Hyperlipidemia	114 (49.8%)
Diabetes Mellitus	107 (46.7%)
Smoking History	67 (29.3%)
Prior Stroke	13 (5.7%)

Echocardiographic Findings

Preoperative echocardiography demonstrated severe LV dysfunction (LVEF < 30%) in 136 patients (59.4%), whereas 93 patients (40.6%) presented with an LVEF between 30% and 40%. Left ventricular dilatation was noted in 46.3% of the cohort. Mitral regurgitation was classified as less than moderate in 166 patients (72.5%) and moderate or higher in 61 patients (26.6%). Concomitant right ventricular dysfunction was identified in 48 individuals (21.0%). Due to severe valvular pathology, 55 patients (24.0%) required concurrent Mitral Valve Repair (MVR) alongside CABG.

Long-Term Survival Outcomes

Over the follow-up period, 45 mortalities (19.7%) were recorded. Kaplan-Meier analysis estimated the overall mean survival time to be 58.36 months (95% CI: 55.78–60.95). Age emerged as a highly significant determinant of survival; mortality rates escalated drastically in older demographics, with 37 deaths occurring in patients over 65 years old compared to only 2 deaths in those under 50 ($p < 0.001$).

Furthermore, survival was significantly compromised by the severity of mitral regurgitation. Patients with moderate to severe MR exhibited a notably reduced mean survival of 50.31 months compared to 59.92 months in patients with mild or no MR ($p = 0.027$). Conversely, baseline comorbidities such as diabetes, hypertension, and BMI did not show statistically significant associations with overall survival in this cohort (all $p > 0.05$).

Variable	Number of Deaths	Mean Survival (Months)	p-value
Age < 50 years	2	60.47	< 0.001
Age 51 - 65 years	6	65.21	
Age > 65 years	37	49.17	
MR < Moderate	27	59.92	0.027
MR ≥ Moderate	18	50.31	

Readmissions and Postoperative Stroke

Cardiac-related hospital readmissions occurred in 143 patients (62.4%). Of these, 31.9% were readmitted once, 25.3% twice, and 5.2% required more than two readmissions. ANOVA testing confirmed that increasing age was robustly associated with higher readmission frequency ($p < 0.001$). Interestingly, higher educational attainment correlated significantly with a lower probability of readmission ($p = 0.004$).

Postoperative stroke was documented in 12 patients (5.2%), comprising 9 men and 3 women. While advanced age and hypertension are traditionally viewed as stroke risk factors, no significant statistical links were established between stroke and age, gender, or BMI in this study. Paradoxically, postoperative stroke occurred more frequently in non-diabetic patients ($p = 0.038$).

Discussion

Heart failure characterized by a reduced ejection fraction remains a pivotal independent risk factor for adverse outcomes following surgical revascularization [4]. This study evaluated the short- and long-term consequences of CABG in an Iranian cohort with LVEF < 40%. Our findings confirm that age and the severity of mitral regurgitation are primary drivers of mortality and morbidity, aligning with established global cardiovascular literature [31, 32].

In this cohort, the overall mortality rate was 19.7% over the follow-up period, with a mean survival exceeding 58 months. Advanced age (specifically > 65 years) was significantly associated with both decreased survival ($p < 0.001$) and increased hospital readmission ($p < 0.001$). This finding corroborates observations by Sun et al. and Marui et al., who reported that increasing age exponentially compounds the risk of postoperative complications and mortality in heart failure patients undergoing CABG [31].

We observed a post-CABG stroke incidence of 5.2%. While this is higher than the 1.7% incidence reported by Marui et al. in similar cohorts, it underscores the need for rigorous neurological monitoring in severely compromised patients [47]. Furthermore, moderate-to-severe mitral regurgitation significantly decreased survival times ($p = 0.027$). The necessity for concurrent MVR in 24% of our cohort highlights the complex valvular pathology often accompanying severe ischemic cardiomyopathy.

For patients with end-stage HFrEF who are ultimately deemed poor candidates for surgical revascularization, heart transplantation remains the definitive alternative. However, this route introduces its own severe risks, including acute allograft rejection often exacerbated by opportunistic pathogens like Cytomegalovirus [32]. Thus, meticulously optimizing CABG outcomes by stratifying for variables like MR and age remains paramount.

Despite the rich clinical insights provided, this study presents limitations. The absence of a control group featuring patients with preserved ejection fractions limits our ability to formulate comparative baseline risks. Additionally, reliance on a single-center design and retrospective follow-up may have introduced recall biases regarding hospital readmissions.

Conclusions

Coronary artery bypass grafting provides viable long-term survival (averaging 58.3 months) for high-risk patients suffering from CAD and concurrent heart failure with reduced ejection fraction. However, patients of advanced age (> 65 years) and those with moderate-to-severe mitral regurgitation suffer from significantly higher mortality and readmission rates. Identifying these prognostic markers preoperatively

allows cardiothoracic teams to stratify risk more effectively and optimize postoperative follow-up regimens.

Abbreviations

ANOVA: Analysis of Variance

BMI: Body Mass Index

CABG: Coronary Artery Bypass Grafting

CAD: Coronary Artery Disease

CI: Confidence Interval

EF: Ejection Fraction

HFrEF: Heart Failure with reduced Ejection Fraction

LV: Left Ventricle

LVEF: Left Ventricular Ejection Fraction

MR: Mitral Regurgitation

MVR: Mitral Valve Repair

OR: Odds Ratio

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Institutional Ethics Committee of Babol University of Medical Sciences. Informed consent was obtained from all subjects or, if subjects are under 18, from a parent and/or legal guardian.

Clinical trial number: not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SA collected the data and drafted the initial manuscript. RP and HV supervised the project, performed the surgeries, and managed the clinical cohort. SR conducted the critical statistical analyses, edited the manuscript for intellectual content, and finalized the paper. All authors read and approved the final manuscript.

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References

1. Ralapanawa U, Sivakanesan R. Epidemiology and the magnitude of coronary artery disease and acute coronary syndrome: A narrative review. Journal of Epidemiology and Global Health. 2021;11(2):169.
2. Bonow RO, Mann DL, Zipes DP, Libby P. Braunwald's heart disease: a textbook of cardiovascular medicine. 2011.
3. Howlett JG, Stebbins A, Petrie MC, Jhund PS, Castelvecchio S, Cherniavsky A, et al. CABG improves outcomes in patients with ischemic cardiomyopathy: 10-year follow-up of the STICH trial. JACC: Heart Failure. 2019;7(10):878-87.
4. Ascione R, Narayan P, Rogers CA, Lim KH, Capoun R, Angelini GD. Early and midterm clinical outcome in patients with severe left ventricular dysfunction undergoing coronary artery surgery. The

Annals of thoracic surgery. 2003;76(3):793-9.
5. Mickleborough LL, Carson S, Tamariz M, Ivanov J. Results of revascularization in patients with severe left ventricular dysfunction. The Journal of thoracic and cardiovascular surgery. 2000;119(3):550-7.
6. Isbir CS, Yildirim T, Akgun S, Civelek A, Aksoy N, Oz M, et al. Coronary artery bypass surgery in patients with severe left ventricular dysfunction. International journal of cardiology. 2003;90(2-3):309-16.
7. Reddy KS. Cardiovascular diseases in the developing countries: dimensions, determinants, dynamics and directions for public health action. Public health nutrition. 2002;5(1a):231-7.
8. Xiao J, Yong JN, Ng CH, Syn N, Lim WH, Tan DJH, et al. A meta-analysis and systematic review on the global prevalence, risk factors, and outcomes of coronary artery disease in liver transplantation recipients. Liver Transplantation. 2022;28(4):689-99.
9. Braunwald E, Fauci AS, Kasper DL, Hauser K, Longo DL, Jameson JL. Harrison's manual of medicine: McGraw Hill Professional; 2001.
10. Cole Mattson CM. Depression, Anxiety, and Social Support Fail to Predict Heart Rate Recovery in Exercise Stress Test Patients: Kent State University; 2011.
11. Roger VL, Go AS, Lloyd-Jones DM, Adams RJ, Berry JD, Brown TM, et al. Heart disease and stroke statistics 2011 update: a report from the American Heart Association. Circulation. 2011;123(4):e18-e209.
12. Malani PN. Harrison's principles of internal medicine. Jama. 2012;308(17):1813-4.
13. Khosravi A NF, Rahbar M, Atefi A, Motlagh, M, Kabir M.. Health profile indicators in the Islamic Republic of Iran. Tehran: Ministry of Health and Medical Education. Deputy for Health (Persian). 2009.
14. Kaptoge S, Pennells L, De Bacquer D, Cooney MT, Kavousi M, Stevens G, et al. World Health Organization cardiovascular disease risk charts: revised models to estimate risk in 21 global regions. The Lancet Global Health. 2019;7(10):e1332-e45.
15. Andreoli TE, Benjamin I. Andreoli and Carpenter's Cecil essentials of medicine: WB Saunders Company; 2007.
16. Libby P, Bonow RO, Mann DL, Tomaselli GF, Bhatt D, Solomon SD, et al. Braunwald's Heart Disease-E-Book: A Textbook of Cardiovascular Medicine: Elsevier Health Sciences; 2021.
17. Haghdoost Z NK, Hosseini M. Effect of Application of Continuous Care Model on Quality of Life and Prevention of Complications in Coronary Artery Bypass Graft Surgery Patients. Iranian Journal of Rehabilitation Research in Nursing (persian). 2015;1(2):1-9.
18. Locker C, Schaff HV, Dearani JA, Joyce LD, Park SJ, Burkhart HM, et al. Multiple arterial grafts improve late survival of patients undergoing coronary artery bypass graft surgery: analysis of 8622 patients with multivessel disease. Circulation. 2012;126(9):1023-30.

19. Doenst T, Haverich A, Serruys P, Bonow RO, Kappetein P, Falk V, et al. PCI and CABG for treating stable coronary artery disease: JACC review topic of the week. Journal of the American College of Cardiology. 2019;73(8):964-76.
20. Melly L, Torregrossa G, Lee T, Jansens J-L, Puskas JD. Fifty years of coronary artery bypass grafting. Journal of thoracic disease. 2018;10(3):1960.
21. Pačarić S, Turk T, Erić I, Orkić Ž, Petek Erić A, Milostić-Srb A, et al. Assessment of the quality of life in patients before and after coronary artery bypass grafting (CABG): a prospective study. International journal of environmental research and public health. 2020;17(4):1417.
22. Windecker S, Neumann F-J, Jüni P, Sousa-Uva M, Falk V. Considerations for the choice between coronary artery bypass grafting and percutaneous coronary intervention as revascularization strategies in major categories of patients with stable multivessel coronary artery disease: an accompanying article of the task force of the 2018 ESC/EACTS guidelines on myocardial revascularization. European heart journal. 2019;40(2):204-12.
23. Members WC, Lawton JS, Tamis-Holland JE, Bangalore S, Bates ER, Beckie TM, et al. 2021 ACC/AHA/SCAI guideline for coronary artery revascularization: executive summary: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Journal of the American College of Cardiology. 2022;79(2):197-215.
24. Spadaccio C, Benedetto U. Coronary artery bypass grafting (CABG) vs. percutaneous coronary intervention (PCI) in the treatment of multivessel coronary disease: quo vadis?-a review of the evidences on coronary artery disease. Annals of cardiothoracic surgery. 2018;7(4):506.
25. Juilliere Y, Cambou JP, Bataille V, Mulak G, Galinier M, Gibelin P, et al. Heart failure in acute myocardial infarction: a comparison between patients with or without heart failure criteria from the FAST-MI registry. Revista Española de Cardiología (English Edition). 2012;65(4):326-33.
26. Kumar A, Khatri G, Hasan MM. CABG versus PCI: What is the optimal strategy for multi-vessel disease? Annals of Medicine and Surgery. 2022;81.
27. Godoy LC, Rao V, Farkouh ME. Diabetes and multivessel disease: coronary artery bypass grafting remains king. Current Opinion in Cardiology. 2018;33(5):551-7.
28. Rizzello V, Lucci D, Maggioni AP, Giampaoli S, Greco C, Pasquale GD, et al. Clinical epidemiology, management and outcome of acute coronary syndromes in the Italian network on acute coronary syndromes (IN-ACS Outcome study). Acute Cardiac Care. 2012;14(2):71-80.
29. Dalén M, Ivert T, Holzmann MJ, Sartipy U. Coronary artery bypass grafting in patients 50 years or younger: a Swedish nationwide cohort study. Circulation. 2015;131(20):1748-54.
30. Groenewegen A, Rutten FH, Mosterd A, Hoes AW. Epidemiology of heart failure. European journal of heart failure. 2020;22(8):1342-56.
31. Keyvanfar A, Najafiarab H, Ramezani S, Tehrani S. Cardiac tamponade in people living with HIV: a systematic review of case reports and case series. BMC Infectious Diseases. 2024;24(1):882.
32. Keyvanfar A, Tehrani S, Falah Tafti M, Talebian N, Mohammadi Z, et al. Cytomegalovirus infection contributes to acute rejection in solid organ transplant recipients: a systematic review and meta-

analysis. BMC Infectious Diseases. 2025;25(1):1205.

Figures

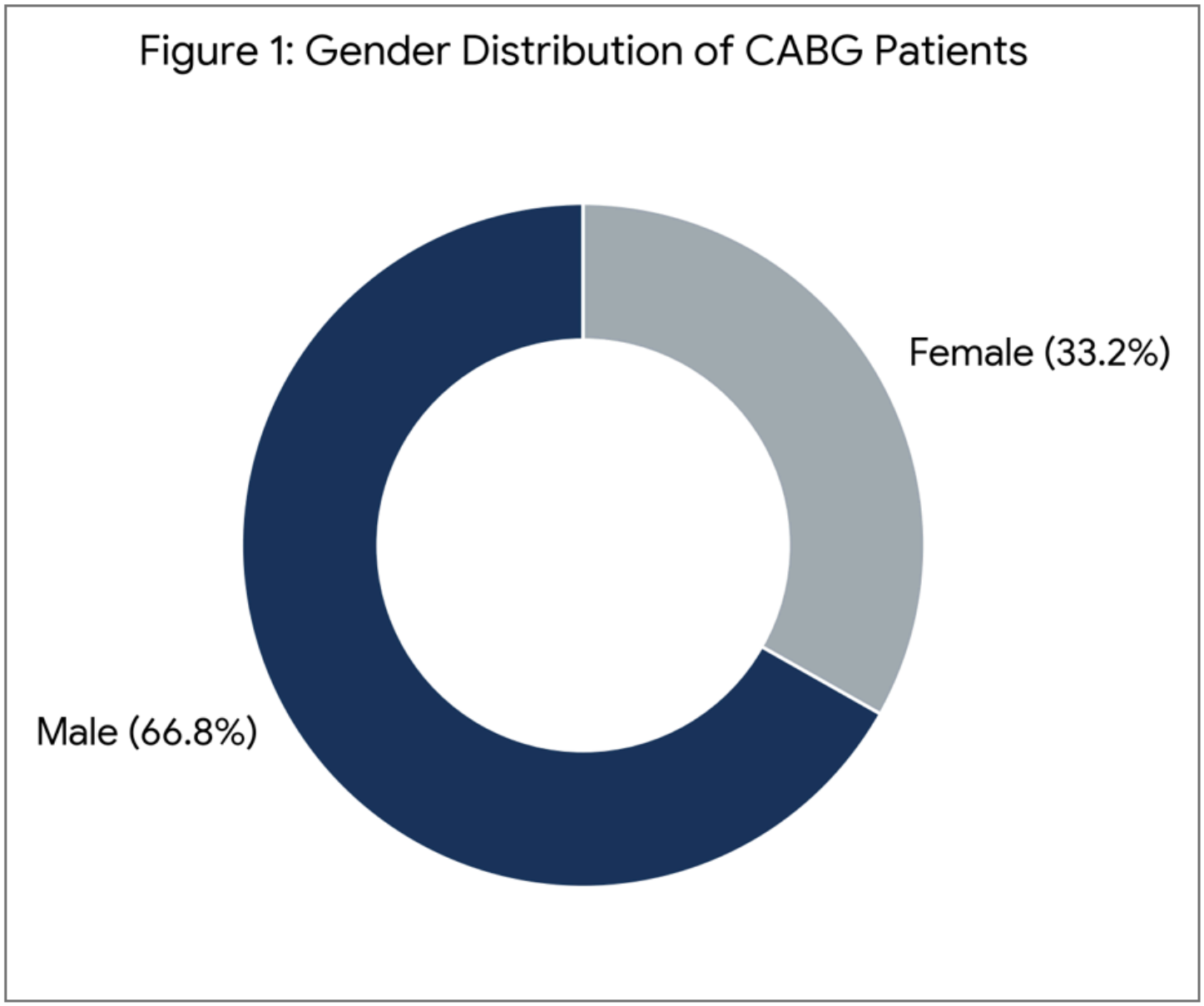


Figure 1

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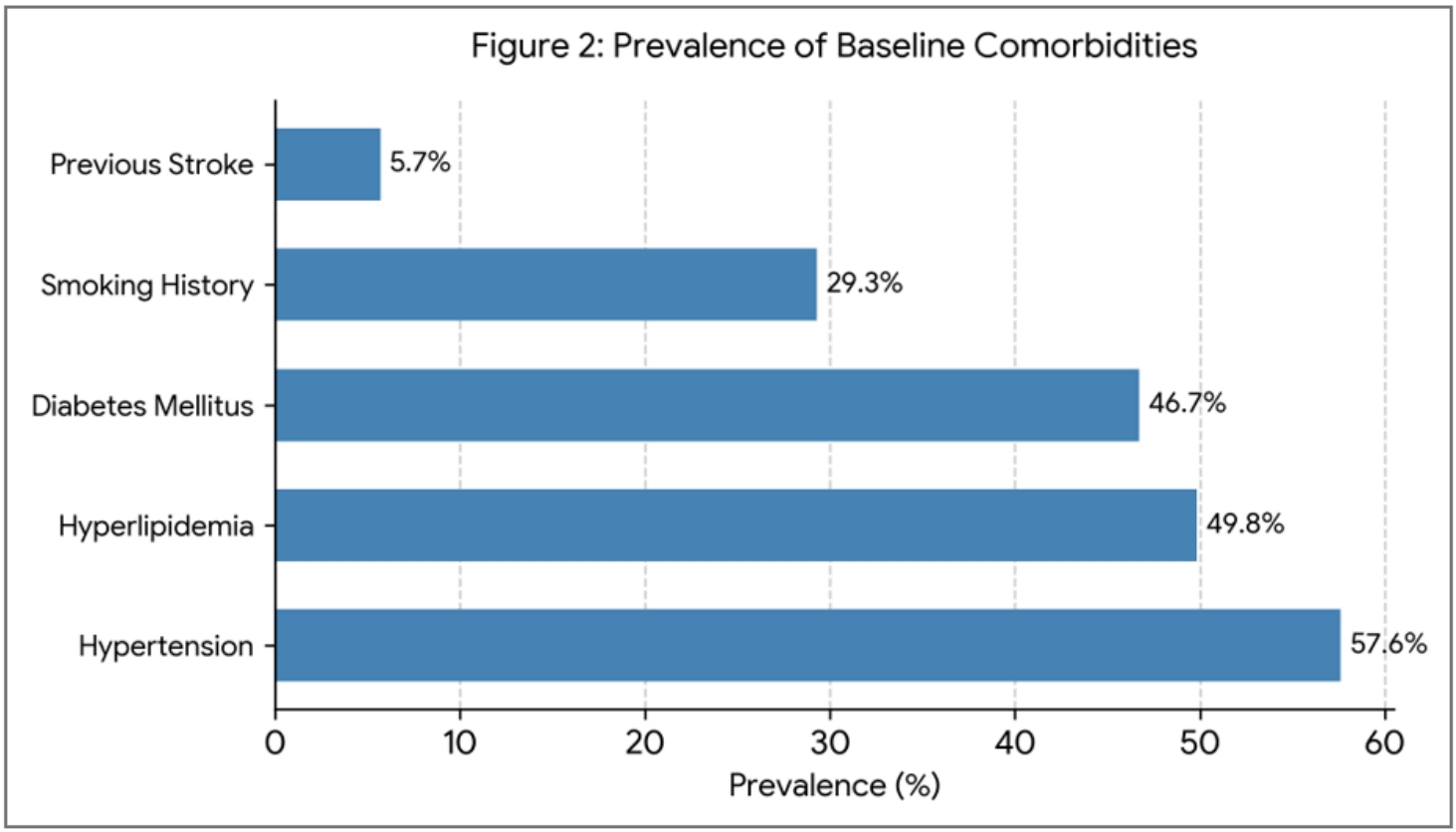


Figure 2

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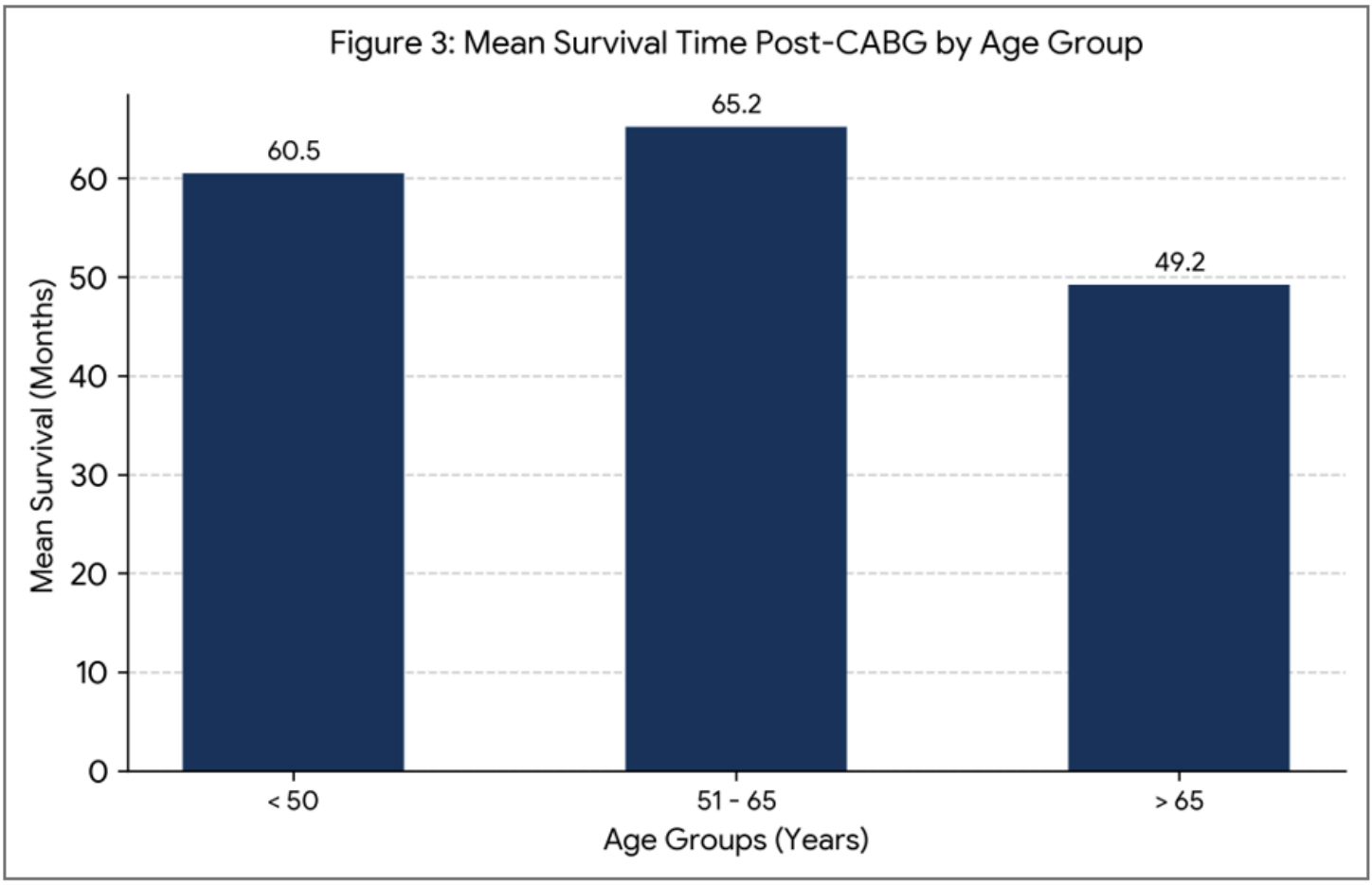


Figure 3

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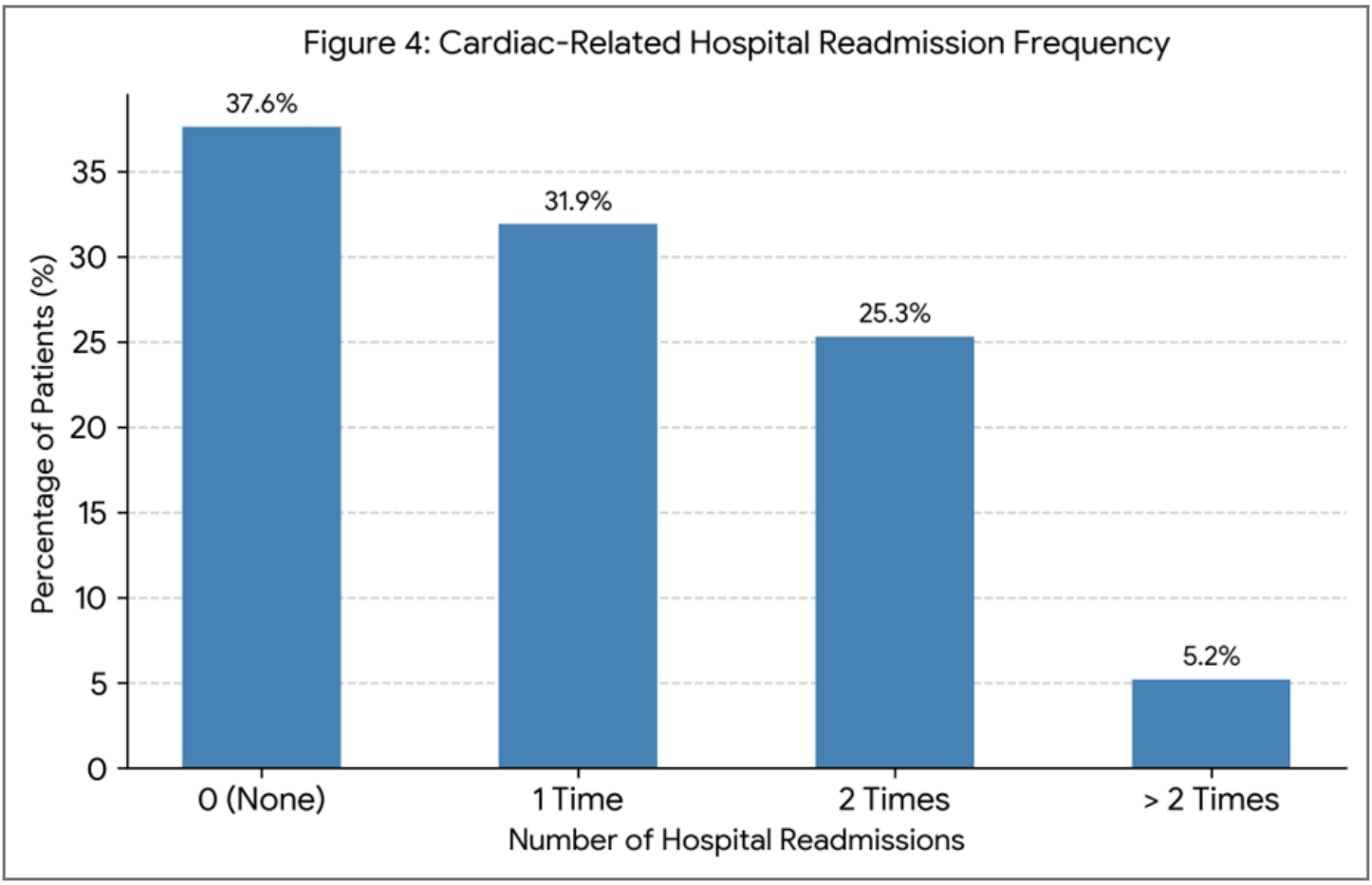


Figure 4

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