

Predictors of Mortality After Valve Replacement Surgery

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Abstract-

Introduction: Valve replacement surgery remains the definitive treatment for severe valvular heart disease. Despite advances in surgical techniques and perioperative care, postoperative mortality remains a concern. Identifying predictors of mortality is crucial for risk stratification and improving outcomes. **Materials and Methods:** A prospective observational study was conducted among 200 patients undergoing valve replacement surgery at a tertiary care center over 24 months. Demographic variables, comorbidities, echocardiographic parameters, laboratory values, operative details, and postoperative complications were recorded. Primary outcome was 30-day mortality. Statistical analysis included univariate and multivariate logistic regression. **Results:** Overall 30-day mortality was 9%. Significant predictors of mortality included age >65 years ($p=0.01$), left ventricular ejection fraction (LVEF) <40% ($p<0.001$), preoperative renal dysfunction ($p=0.002$), prolonged cardiopulmonary bypass time ($p=0.004$), emergency surgery ($p=0.01$), and postoperative low cardiac output syndrome ($p<0.001$). **Conclusion:** Advanced age, reduced LVEF, renal dysfunction, prolonged bypass time, and postoperative complications independently predict mortality after valve replacement surgery. Early identification of high-risk patients may improve perioperative management and survival.

Keywords: Valve replacement; Mortality predictors; Cardiopulmonary bypass; Left ventricular dysfunction; Renal dysfunction; Cardiac surgery outcomes.

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INTRODUCTION

Valvular heart disease (VHD) remains a significant contributor to global cardiovascular morbidity and mortality, particularly in low- and middle-income countries where rheumatic heart disease is still prevalent¹. In high-income countries, degenerative valvular disease predominates due to aging populations². Surgical valve replacement, including mechanical and bioprosthetic valves, continues to be the gold standard treatment for severe symptomatic aortic and mitral valve disease³.

Despite technological advancements in cardiopulmonary bypass (CPB), myocardial protection strategies, minimally invasive approaches, and improved postoperative critical care, perioperative mortality remains a serious concern⁴. Contemporary studies report early mortality rates ranging between 3–12%, depending on patient profile and procedural complexity⁵. Mortality risk is influenced by patient-related, disease-related, and procedure-related factors⁶.

Advanced age has consistently been associated with poorer surgical outcomes due to reduced physiological reserve and higher prevalence of comorbidities⁷. Reduced left ventricular ejection fraction (LVEF) is another established predictor, reflecting impaired myocardial contractility and limited compensatory capacity during surgical stress⁸. Preoperative renal dysfunction significantly increases operative risk due to fluid shifts, inflammatory response, and risk of acute kidney injury⁹.

Operative factors such as prolonged cardiopulmonary bypass time and aortic cross-clamp duration are associated with systemic inflammatory response and multiorgan dysfunction¹⁰. Emergency surgeries, often performed in unstable hemodynamic states, further increase mortality risk¹¹. Postoperative complications such as low cardiac output syndrome, arrhythmias, stroke, and sepsis are major contributors to early mortality¹².

Risk prediction models such as EuroSCORE II and the Society of Thoracic Surgeons (STS) score have been developed to stratify operative risk¹³. However, regional variations in patient demographics and disease patterns necessitate institution-specific evaluation of mortality predictors¹⁴.

In developing countries, delayed presentation, rheumatic etiology, and limited access to healthcare contribute to higher surgical risk¹⁵. Understanding local predictors of mortality is essential to optimize perioperative management, allocate resources, and counsel patients effectively.

Therefore, this study aims to evaluate clinical, echocardiographic, and operative predictors of 30-day mortality following valve replacement surgery at a tertiary care center.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational study was conducted in the Department of Cardiothoracic Surgery at a tertiary care teaching hospital over a period of 24 months.

Study Population

A total of 200 consecutive adult patients undergoing elective or emergency valve replacement surgery were included.

Inclusion Criteria

- Age ≥ 18 years
- Patients undergoing isolated aortic or mitral valve replacement
- Double valve replacement
- Patients providing informed consent

Exclusion Criteria

- Patients undergoing concomitant CABG
- Congenital heart disease surgery
- Redo valve surgeries
- Active infective endocarditis with septic shock
- Incomplete clinical data

Data Collection

Preoperative variables recorded:

- Age, gender
- Hypertension, diabetes mellitus
- Renal dysfunction (serum creatinine >1.5 mg/dL)
- LVEF by echocardiography
- NYHA functional class

Intraoperative variables:

- Type of valve replaced
- CPB time
- Aortic cross-clamp time
- Emergency vs elective surgery

Postoperative variables:

- Low cardiac output syndrome
- Acute kidney injury
- Arrhythmias
- Stroke
- Sepsis

Outcome Measure

Primary outcome: 30-day postoperative mortality.

Statistical Analysis

Data were analyzed using SPSS version 25. Continuous variables expressed as mean \pm SD. Categorical variables expressed as percentages. Chi-square test for categorical variables. Independent t-test for continuous variables. Variables with $p < 0.05$ in univariate analysis were included in multivariate logistic regression.

RESULTS

Table 1: Demographic Characteristics

Variable	Survivors (n=182)	Non-Survivors (n=18)	p-value
Age >65 yrs	30%	61%	0.01
Male	54%	58%	0.75
Diabetes	22%	44%	0.03
Hypertension	40%	56%	0.18

Interpretation: Advanced age and diabetes were significantly associated with mortality.

Table 2: Preoperative Echocardiographic Findings

Variable	Survivors	Non-Survivors	p-value
LVEF <40%	18%	67%	<0.001
Severe Pulmonary HTN	20%	50%	0.01

Interpretation: Reduced LVEF was a strong predictor of mortality.

Table 3: Operative Variables

Variable	Survivors	Non-Survivors	p-value
CPB time >120 min	28%	72%	0.004
Emergency surgery	10%	39%	0.01

Interpretation: Prolonged bypass time and emergency surgery significantly increased mortality risk.

Table 4: Postoperative Complications

Complication	Survivors	Non-Survivors	p-value
Low cardiac output	8%	78%	<0.001
AKI	12%	56%	0.002
Stroke	3%	17%	0.04

Interpretation: Postoperative low cardiac output syndrome was the strongest predictor.

Table 5: Multivariate Logistic Regression

Variable	Odds Ratio	95% CI	p-value
Age >65	2.8	1.2–6.5	0.01
LVEF <40%	4.6	2.1–10.2	<0.001
Renal dysfunction	3.2	1.5–7.1	0.002
CPB >120 min	2.9	1.3–6.7	0.004

Interpretation: LVEF <40% was the strongest independent predictor.

Table 6: Overall Mortality

Total Patients	Mortality (%)
200	9%

Interpretation: The 30-day mortality rate was 9%.

DISCUSSION

The present study identified advanced age, reduced LVEF, renal dysfunction, prolonged CPB time, emergency surgery, and postoperative low cardiac output syndrome as significant predictors of early mortality following valve replacement surgery.

Advanced age has been widely recognized as an independent risk factor in cardiac surgery outcomes¹⁶. Aging is associated with diminished physiological reserve and higher prevalence of comorbidities. Similar findings were reported by Glaser et al.¹⁷ who observed increased mortality among elderly valve surgery patients.

Reduced LVEF emerged as the strongest independent predictor in our study. Impaired systolic function limits myocardial tolerance to ischemia-reperfusion injury during CPB¹⁸. A large registry analysis demonstrated that patients with LVEF <35% had nearly threefold increased mortality risk¹⁹.

Preoperative renal dysfunction significantly increased mortality risk, consistent with findings by Thakar et al.²⁰. Renal impairment predisposes to postoperative acute kidney injury and systemic complications.

Prolonged CPB time contributes to systemic inflammatory response and multiorgan dysfunction²¹. Studies suggest that each additional 30 minutes of bypass increases mortality risk²².

Emergency surgery patients had worse outcomes, likely due to hemodynamic instability and limited preoperative optimization²³. Postoperative low cardiac output syndrome was the most powerful predictor, similar to reports by Algarni et al.²⁴.

The observed mortality rate of 9% aligns with data from similar tertiary centers in developing nations²⁵. Risk stratification using clinical and operative variables remains essential for improving outcomes.

CONCLUSION

Mortality after valve replacement surgery is influenced by multiple preoperative, intraoperative, and postoperative factors. Advanced age, reduced LVEF, renal dysfunction, prolonged CPB time, and postoperative low cardiac output syndrome independently predict early mortality. Early risk identification and optimized perioperative management may significantly reduce mortality rates.

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