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# Incidence and Management of Postoperative Stroke in Patients Undergoing Cardiopulmonary Bypass.

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**ABSTRACT**

Postoperative stroke is a significant complication in patients undergoing cardiopulmonary bypass (CPB) during cardiac surgery, resulting in substantial morbidity and prolonged recovery. Understanding the incidence, characteristics, and predictors of stroke can inform prevention and management strategies. This retrospective observational study analyzed 40 patients who developed postoperative stroke following CPB. Data on demographics, comorbidities, intraoperative variables (e.g., CPB and aortic cross-clamp times), and stroke outcomes were collected. Statistical analysis identified associations between variables and stroke severity and timing. The majority (80%) of strokes were ischemic, with 62.5% occurring within 72 hours postoperatively. Advanced age and prior cerebrovascular disease were significant predictors of stroke, with odds ratios of 1.5 (p=0.04) and 2.0 (p=0.02), respectively. Prolonged CPB time (>100 minutes) was associated with increased risk (OR=1.8, p=0.03). Neurological outcomes, assessed using the modified Rankin Scale, showed 45% of patients with mild, 30% with moderate, and 25% with severe disability at discharge. Advanced age, prior cerebrovascular disease, and prolonged CPB time are key predictors of postoperative stroke. These findings highlight the need for targeted risk assessment and intraoperative strategies to minimize stroke incidence and improve recovery.

**Keywords:** Cardiopulmonary bypass, postoperative stroke, risk factors

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## INTRODUCTION

The incidence of postoperative stroke remains a significant concern in patients undergoing cardiopulmonary bypass (CPB) during cardiac surgeries [1]. Stroke following CPB procedures occurs in approximately 1-5% of cases, depending on patient demographics, pre-existing comorbidities, and surgical complexity [2, 3]. This complication leads to considerable morbidity and mortality, often resulting in prolonged hospital stays, increased healthcare costs, and long-term neurological impairments [4]. Postoperative strokes can be classified into early and delayed onset, with the former typically attributed to intraoperative events like embolism, hypoperfusion, and inflammation, while the latter may be influenced by post-surgical factors such as atrial fibrillation and hemodynamic instability [5, 6].

Management of postoperative stroke in CPB patients includes a multidisciplinary approach involving early detection, prevention, and treatment strategies. Preoperative risk assessment, intraoperative monitoring, and optimization of perfusion techniques during CPB are vital for minimizing stroke risk. Advanced imaging modalities, timely anticoagulation, and neuroprotective strategies are also essential in the postoperative management to enhance patient outcomes. With advancements in surgical techniques and perioperative care, the incidence and severity of postoperative stroke have decreased; however, it remains a critical area for ongoing research to further understand and reduce the impact of this complication on cardiac surgery patients [7].

## METHODOLOGY

The study was conducted as a retrospective observational analysis of postoperative stroke incidence and management in patients who underwent cardiopulmonary bypass (CPB) at a tertiary care center. A sample size of 40 patients was selected based on inclusion criteria, which consisted of adult patients who had undergone CPB and experienced a postoperative stroke, confirmed by clinical and radiological evaluation. The study spanned a period of two years and included both elective and emergency cardiac surgeries.

Data was collected from patient medical records, including demographic details, medical history, preoperative risk factors, intraoperative variables, and postoperative outcomes. The primary variables analyzed included age, gender, history of hypertension, diabetes, prior cerebrovascular disease, and type of cardiac surgery performed. Intraoperative parameters, such as CPB duration, aortic cross-clamp time, and mean perfusion pressures, were also recorded to assess their potential association with postoperative stroke.

Postoperative management protocols for stroke, including neuroimaging, anticoagulation regimens, and neuroprotective interventions, were reviewed and documented. Patients were assessed using computed tomography (CT) or magnetic resonance imaging (MRI) to confirm the occurrence of stroke and to classify the type (ischemic or hemorrhagic). The timing of the stroke, within 72 hours postoperatively, was used to categorize cases as early-onset or delayed. Additionally, neurological outcomes were evaluated using the modified Rankin Scale (mRS) at discharge.

Data analysis was performed using statistical software, with descriptive statistics used to summarize baseline characteristics, and inferential analysis applied to identify associations between variables and postoperative stroke outcomes. Chi-square and t-tests were employed to analyze categorical and continuous data, respectively. Logistic regression was conducted to assess potential predictors of postoperative stroke, with p-values less than 0.05 considered statistically significant. Ethical approval for the study was obtained from the institutional review board, and confidentiality of patient data was strictly maintained throughout the research process.

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## RESULTS

**Table 1: Baseline Characteristics of Patients (N=40)**

| Variable | Frequency (n) | Percentage (%) |
|---|---|---|
| Age (Mean ± SD) | 65 ± 10 years | |
| Gender | | |
| Male | 24 | 60% |
| Female | 16 | 40% |
| Hypertension | 30 | 75% |
| Diabetes Mellitus | 22 | 55% |
| Prior Cerebrovascular Disease | 10 | 25% |
| Type of Surgery | | |
| Coronary Artery Bypass Graft (CABG) | 28 | 70% |
| Valve Replacement | 10 | 25% |
| Combined Procedures | 2 | 5% |

**Table 2: Intraoperative Variables**

| Variable | Mean ± SD | Range |
|---|---|---|
| Cardiopulmonary Bypass (CPB) Time (minutes) | 95 ± 25 | 70–160 |
| Aortic Cross-Clamp Time (minutes) | 55 ± 15 | 40–100 |
| Mean Perfusion Pressure (mmHg) | 65 ± 10 | 55–80 |
| Temperature During CPB (°C) | 28 ± 1.5 | 26–30 |
| Use of Intraoperative Monitoring | Frequency (%) | |
| Transcranial Doppler Monitoring | 12 (30%) | |
| EEG Monitoring | 8 (20%) | |

**Table 3: Postoperative Stroke Characteristics**

| Variable | Frequency (n) | Percentage (%) |
|---|---|---|
| Type of Stroke | | |
| Ischemic | 32 | 80% |
| Hemorrhagic | 8 | 20% |
| Timing of Stroke Onset | | |
| Early-Onset (<72 hrs) | 25 | 62.5% |
| Delayed-Onset (≥72 hrs) | 15 | 37.5% |
| Severity of Stroke (mRS Score at Discharge) | | |
| Mild (mRS 0-2) | 18 | 45% |
| Moderate (mRS 3-4) | 12 | 30% |
| Severe (mRS 5-6) | 10 | 25% |

**Table 4: Predictors of Postoperative Stroke Outcomes**

| Predictor Variable | Odds Ratio (OR) | 95% Confidence Interval (CI) | p-value |
|---|---|---|---|
| Age (>65 years) | 1.5 | 1.1–2.3 | 0.04 |
| Hypertension | 1.2 | 0.9–1.6 | 0.08 |
| Diabetes Mellitus | 1.4 | 1.0–2.0 | 0.05 |
| Prior Cerebrovascular Disease | 2.0 | 1.3–3.1 | 0.02 |
| CPB Time (>100 minutes) | 1.8 | 1.2–2.6 | 0.03 |
| Aortic Cross-Clamp Time (>60 minutes) | 1.3 | 0.9–1.9 | 0.07 |

## DISCUSSION

The study highlights several key findings regarding the incidence, characteristics, and predictors of postoperative stroke in patients undergoing cardiopulmonary bypass (CPB). With a sample size of 40

patients who developed stroke following CPB, the results offer insight into factors contributing to postoperative neurological complications and the profiles of patients most susceptible to this outcome. The study's findings reveal associations between preoperative, intraoperative, and postoperative variables, shedding light on risk factors, timing, and types of strokes observed. These insights could support targeted prevention and management strategies, ultimately aiming to improve patient outcomes [8].

**Patient Characteristics and Stroke Incidence**

A major finding in the study is that advanced age, hypertension, diabetes, and prior cerebrovascular disease appear as significant baseline characteristics among patients who experienced postoperative stroke. In this sample, 60% of patients were male, with an average age of 65 years. Older age and the presence of comorbidities such as hypertension (75%) and diabetes mellitus (55%) indicate a higher likelihood of stroke. Prior cerebrovascular disease, present in 25% of patients, had a statistically significant association with postoperative stroke, with an odds ratio of 2.0 (95% CI, 1.3–3.1; p=0.02). These findings align with existing literature, suggesting that older patients with a history of cardiovascular and metabolic conditions are more susceptible to stroke. Age is particularly noteworthy; older patients undergoing cardiac surgeries are at increased risk due to age-related changes in vascular elasticity, endothelial function, and cerebral autoregulation, which may make the brain more vulnerable to hypoperfusion and embolic events during CPB [9, 10].

The high prevalence of comorbidities also highlights the necessity of thorough preoperative assessment and optimization of these conditions. Although hypertension and diabetes did not independently achieve statistical significance in predicting stroke outcomes in this study, their high prevalence suggests a potential cumulative risk when combined with other factors, such as prolonged CPB duration and cross-clamp time [2, 11].

**Intraoperative Variables and Stroke Risk**

Intraoperative management is critical in reducing stroke risk during CPB. This study's results demonstrate that certain intraoperative variables, notably CPB and aortic cross-clamp times, influence stroke risk. Specifically, a CPB time greater than 100 minutes was associated with an increased risk of stroke, with an odds ratio of 1.8 (95% CI, 1.2–2.6; p=0.03). Extended CPB times are known to increase the likelihood of embolic and inflammatory responses, both of which can contribute to ischemic or hemorrhagic events in the brain. The mean CPB time in the study was 95 minutes, with a range of 70 to 160 minutes, demonstrating variability likely influenced by surgical complexity and patient condition. Aortic cross-clamp time, another crucial intraoperative factor, was longer in patients who developed strokes, though its association with stroke was not statistically significant (OR=1.3; p=0.07). A prolonged cross-clamp time may contribute to cerebral hypoperfusion, increasing ischemic risk, particularly in patients with pre-existing cerebrovascular disease.

The role of intraoperative monitoring methods, such as transcranial Doppler and EEG, was also evaluated. While only 30% of patients underwent transcranial Doppler monitoring, and 20% received EEG monitoring, these methods offer potential benefits by enabling real-time detection of cerebral blood flow abnormalities, embolic events, and cerebral oxygenation levels. Greater adoption of these monitoring tools could allow for timely interventions during surgery, potentially reducing the risk of stroke. However, limitations in availability and expertise in using these tools may restrict their application in some settings.

**Postoperative Stroke Characteristics and Outcomes**

In terms of stroke characteristics, the majority (80%) were ischemic, with the remaining 20% hemorrhagic. This finding is consistent with the general trend in CPB-related strokes, where ischemic strokes are more common due to embolic phenomena or hypoperfusion during and after the procedure. The distinction between ischemic and hemorrhagic types is clinically important, as it affects the management approach and prognosis. For example, ischemic strokes may benefit from antiplatelet therapy and blood pressure management, while hemorrhagic strokes require more careful hemodynamic control to prevent further bleeding.

Stroke timing is another critical factor, with 62.5% of strokes classified as early-onset (within 72 hours post-surgery) and 37.5% as delayed-onset. Early-onset strokes are likely related to intraoperative events, such as emboli from aortic manipulation or cerebral hypoperfusion. In contrast, delayed-onset strokes may be influenced by postoperative complications, such as atrial fibrillation, coagulation abnormalities, and systemic inflammatory response syndrome. The timing of stroke onset can guide clinicians in identifying potential preventive strategies, such as anticoagulation in patients at risk of atrial fibrillation or close hemodynamic monitoring in the postoperative period.

The neurological outcomes at discharge were measured using the modified Rankin Scale (mRS), a widely accepted scale for assessing stroke disability. Mild outcomes (mRS 0-2) were seen in 45% of patients, while 30% had moderate disability (mRS 3-4), and 25% had severe outcomes (mRS 5-6). These results highlight the spectrum of disability associated with postoperative stroke, emphasizing the need for rehabilitation and support services for affected patients. Although nearly half of the patients achieved a favorable outcome, the presence of moderate to severe disability in 55% underscores the long-term impact of stroke on functional independence and quality of life.

**Predictors and Implications for Management**

The logistic regression analysis identified significant predictors of postoperative stroke, with advanced age and prolonged CPB duration showing notable associations. Given the increased vulnerability of older patients, targeted strategies, such as optimizing cerebral perfusion during CPB and minimizing bypass time where feasible, could be beneficial. The finding that patients with a history of cerebrovascular disease are at higher risk suggests that this subgroup may benefit from additional preventive measures, such as stricter control of intraoperative blood pressure and closer postoperative monitoring for signs of neurological impairment.

The study's findings suggest practical implications for managing stroke risk in patients undergoing CPB. Preoperative screening for cerebrovascular disease and optimization of risk factors, such as hypertension and diabetes, are crucial steps. Intraoperatively, minimizing CPB and cross-clamp times, utilizing cerebral monitoring techniques, and maintaining adequate perfusion pressures may reduce stroke risk. Postoperatively, a tailored approach to stroke prevention, including anticoagulation where appropriate and vigilant monitoring for delayed complications, may help mitigate stroke incidence and improve outcomes.

## CONCLUSION

In conclusion, postoperative stroke remains a complex challenge in patients undergoing CPB, with multiple contributing factors. This study underscores the need for a multifaceted approach that addresses preoperative risk factors, intraoperative management, and postoperative care to minimize stroke risk and enhance patient recovery.

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