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Research Article

Clinical Outcomes and Factors Affecting in-Hospital Mortality among Coronary Artery Bypass Graft Patients with Intra-aortic Balloon Pump – Implications for Nursing Care

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Abstract

Aim: Intra-aortic balloon pump (IABP) is the most widely used acute mechanical circulatory support device in patients undergoing coronary artery bypass graft (CABG). The objectives of the study were to assess the clinical outcomes, risk factors, and variables predictive of in-hospital mortality in these patients.

Materials and Methods: Retrospective analysis of the medical records of all the 96 patients who underwent isolated on-pump CABG with IABP inserted during the period from January 2016 to January 2020 in a selected tertiary care center. The risk factors and variables predictive of in-hospital mortality were analyzed.

Results: The mean age of participants was 64 ± 7.9 years. In-hospital mortality occurred in 28.2% of study subjects. Those who were hypertensive ($P = 0.012$, OR = 5.85, 95%CI – 1.27–26.93), pre-operative renal insufficiency ($P = 0.02$, OR=2.83, 95% CI – 1.12–7.12), developed new-onset atrial and or ventricular arrhythmia($P < 0.001$, OR = 31.87, 95%CI - 4.09–248.28), post-operative renal insufficiency($P < 0.001$, OR = 6.72, 95% CI – 2.51–18.02), and thromboembolic events ($P = 0.006$, OR = 6.28, 95% CI – 2.51–18.02) had a higher odds of in-hospital mortality which was statistically significant. The variables predictive of in-hospital mortality were hypertension (Adjusted OR – 7.12, 95% CI – 1.25–40.38), occurrence of new-onset arrhythmia (Adjusted OR – 22.08, 95% CI 2.54–190.48), post-operative renal insufficiency (Adjusted OR – 7.38, 95% CI – 2.17–25.09), and thromboembolic events (Adjusted OR – 2.08, 95% CI – 0.33–12.83).

Conclusion: Patients requiring IABP support belong to a high-risk group with significant risk of early post-operative mortality. Assessment and understanding of patient and clinical factors affecting outcomes should be one of the core nursing responsibilities in caring these patients.

Keywords: Clinical outcomes, coronary artery bypass grafting, intra-aortic balloon pump, low cardiac output syndrome, mortality

Introduction

An intra-aortic balloon pump (IABP), widely used in critical care units, is an external mechanical circulatory assist device that helps to achieve higher levels of hemodynamic support than can be accomplished using pharmacological interventions alone.[1] There has been an increased frequency in the usage of IABP over the years due to a decrease in complication rate as well as better clinical outcomes.[2]

Counter pulsation is the fundamental principle underlying IABP. The main physiological effects of IABP are an increase in coronary blood flow, by increasing perfusion pressure during diastole and the reduction of the left ventricular afterload during systole.[3] The main indication for IABP insertion in coronary artery bypass graft (CABG) patients is to improve cardiac output in those with low cardiac output syndrome or as an aid to wean from cardiopulmonary bypass during

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the intraoperative phase. The insertion of IABP commonly done through the femoral artery approach has become a safe and quick procedure and can be inserted at the bedside in emergencies.

The use of IABP is not without complications, which occur in 11–33% of cases. The commonly reported complications include bleeding, vascular complications including limb ischemia, vascular dissection or perforation, and thrombocytopenia. In addition, these patients are also at high risk for complications such as renal failure, pneumonia, sepsis, and finally leading to multiorgan failure.[4] Cohen et al., in a prospective study among 1119 patients on complications after percutaneous IABP insertion, reported that major complications occurred in 11% of patients and female gender, history of peripheral vascular disease, and decreased body surface area were independent predictors of major complications.[5]

Overall mortality in patients receiving IABPs ranges from 21% to 73%.[4] Several studies have investigated factors affecting mortality and morbidity in these patients. Parissis *et al*. reported an overall 30-day mortality of 35.3% in adult cardiac surgery patients requiring IABP. The significant risk factors of early mortality were female gender, smoking habit, increased pre-operative creatinine level, cross-clamp time >80 min, and post-operative insertion of IABP.[6] Ergüneş *et al*. reported an in-hospital mortality rate of 35.8% in isolated CABG patients with IABP support and post-operative renal insufficiency, prolonged ventilatory support, and post-operative atrial fibrillation were independent predictors of mortality in these patients.[7]

Due to the complexity involved in caring for CABG patients with IABP, nurses must have advanced assessment and analytical skills and a strong understanding of hemodynamics for the early identification of complications and factors associated with outcome. In this context, this study was undertaken. The objectives of the study were to assess the clinical outcomes of IABP insertion in patients undergoing CABG and determine the risk factors and variables predictive of in-hospital mortality in these patients.

Materials and Methods

This retrospective study was conducted in one of the tertiary level referral centers for cardiac and neurologic disorders in South India. During the period from January 2016 to January 2020, a total of 116 patients had IABP inserted after open-heart surgery. Of this, 96 patients who had IABP inserted after isolated on-pump CABG were included in the study. Data on demographic and clinical variables, complications, and clinical outcomes were recorded into a structured pro forma by reviewing medical records.

The indications for IABP in these patients were postcardiotomy low cardiac output syndrome and/or failure to be weaned off from cardiopulmonary bypass. IABP was introduced percutaneously through the common femoral artery. Correct placement of the device was confirmed with a routine chest X-ray in the intensive care unit and by transesophageal echo in operation theatre. After insertion, patients were anticoagulated with heparin infusion and we monitor aPTT values and keep between 40 and 60 s.

Data analysis

The data were coded and entered in the Microsoft Excel. Categorical variables were summarized using frequency and proportion and quantitative variables were summarized by mean and standard deviation. Risk factors of in-hospital mortality were computed using Odds ratio. Factors predictive of mortality were assessed using binary logistic regression analysis. $P < 0.05$ was considered to be statistically significant.

Results

Section 1 – Demographic and clinical details of study subjects

The demographic and clinical details are described in Table 1.

Section 11 – Complications and clinical outcomes

Table 2 shows complications and clinical outcomes in the study subjects. In-hospital mortality was reported in 28.2% of study subjects. The most common complication was the occurrence of new-onset arrhythmias, in which atrial fibrillation was most common.

Section 111 – Variables affecting in-hospital mortality

Bivariate analysis using Chi-square test and odds ratio was computed to determine the risk factors of in-hospital mortality and selected variables. $P < 0.05$ was considered to be statistically significant. Table 3 shows that those who were hypertensive ($P = 0.012$, OR = 5.85, 95%CI – 1.27–26.93), pre-operative renal insufficiency ($P = 0.02$, OR = 2.83, 95%

Table 1: Demographic and clinical details of study participants (*n*=96)

Demographic and clinical details	(%)
Mean (SD) age	64±7.9
Male	78 (81.3)
Overweight/Obese (≥25 kg/m^2)	37 (38.6)
Comorbidities	
Diabetes mellitus	84 (87.5)
Hypertension	72 (75.1)
Dyslipidemia	55 (57.3)
COPD	4 (4.2)
Peripheral arterial disease	6 (6.3)
Pre-operative factors	
Reduced ejection fraction (<55%)	46 (47.9)
≥3 vessel disease	90 (93.8)
Renal insufficiency (Serum creatinine level>1.2 mg %)	32 (33.3)
Intraoperative factors	
CPB time 1.89±0.7 h (mean value)	
Aortic cross-clamp Time 55.9±15.2 min (mean value)	
Time of insertion of IABP	
Early insertion (intraoperative)	69 (71.9)
Late insertion (post-operative)	27 (28.1)
Duration of IABP*(based on median value)	
Short duration (≤3 days)	52 (54.2%)

IABP: Intra-aortic balloon pump, COPD: Chronic obstructive pulmonary disease, CPB: Cardiopulmonary bypass

CI – 1.12–7.12), those who developed new-onset arrhythmia ($P \leq 0.001$, OR = 31.87, 95%CI – 4.09–248.28), post-operative renal insufficiency (P = <0.001, OR = 6.72, 95% CI – 2.51–18.02), and thromboembolic events (P = 0.006, OR = 6.28, 95% CI – 2.51–18.02) had a higher odds of in-hospital mortality which was statistically significant.

Section 1V – Predictors of in-hospital mortality

Assessed using Binary logistic regression analysis shown in Table 4.

Discussion

This study assessed clinical outcomes and risk factors of in-hospital mortality in patients who had IABP inserted during or immediately after CABG surgery. In recent years, patients who undergo CABG are more older and have more associated comorbidities and poor LV function which affects the outcome of surgery. In this study, the mean age of the participants was 64 ± 7.9 years and the majority (81.3%) were male. The comorbidity status shows that 87.5% were diabetic, 75% were hypertensive, and 57 % were dyslipidemic. Nearly half of the study subjects (48%) had decreased Ejection Fraction (EF <55%).

Table 2: Complications and clinical outcomes of IABP (*n*=96)

Complications	(%)
New onset arrhythmia	57 (59.3)
Atrial arrhythmia	29/57 (50.8)
Post-operative renal insufficiency#	37 (38.6)
Hematoma (Local site/Regional)	18 (18.7)
Post-operative infection	23 (23.6)
Respiratory infection*	19 (19.7)
Sternal wound infection**	4 (4.1)
Thromboembolic events	
Stroke	6 (6.3)
Lower extremity ischemia	2 (2.1)
Mesenteric ischemia	1 (1.1)
Mortality (during hospital stay)	27 (28.2)
Length of ICU stay+	
Short ICU stay (<8 days)	60 (62.5)
Length of hospital stay+	
Short hospital stay(<14 days)	56 (58.4)

#Based on the progressive increase in serum creatinine level (>1.5 mg/dl), *Based on positive sputum culture, ** Based on positive pus culture. +Cutoff into long and short duration based on the median value

The in-hospital mortality reported in this study is 28.2%. The significant variables associated with in-hospital mortality were being hypertensive, the occurrence of new-onset arrhythmias, post-operative renal insufficiency, and the development of thromboembolic events. Ergunes *et al*.[7] in a similar study reported an in-hospital mortality rate of 35.8%, which was comparatively high compared to our study. Post-operative renal insufficiency, prolonged ventilatory support, and post-operative atrial fibrillation were independent predictors of mortality in these patients, similar to the finding in our study. Parissis *et al*.[6] also reported an overall 30-day mortality of 35.3% which was high compared to our study. The significant risk factors of early mortality were female gender, smoking habit, pre-operative creatinine level, increased cross-clamp time >80 min, and post-operative insertion of IABP.

The in-hospital mortality reported in this study is less compared to other reported similar studies, which may be explained by the increased experience and coordinated care of the cardiac surgical team in managing patients with IABP. In our study, participants in the older age group (age >64 years) had a higher odds of in-hospital mortality compared to the younger age group, similar to that reported by Yumun *et al*.[8] In this study, the most common complication was the occurrence of new-onset arrhythmia in nearly 60% of the study subjects. Atrial fibrillation was the most common followed by ventricular arrhthymias. Occurrence of arrhythmias was significantly associated with early mortality, similar to study findings by Ergüneş *et al*.[7].The vascular complications identified in this study included local site or regional hematoma (18.7%) and development of thromboembolic events in nine patients (9.4%), in which stroke occurred in six patients, lower extremity ischemia in 2 and mesenteric ischemia in one patient. Arafa *et al*.[9] in a study to assess IABP related vascular complications and their implications reported that 8% of study participants developed major complications such

Table 3: Patient characteristics associated with in-hospital mortality (*n*=96)

Variables (*n*=96)	Total	Mortality (%)	*P*-value	Odds Ratio (with 95%CI)
Age≥64	36	14 (38.8)	0.069	2.3 (0.93–5.71)
Female gender	18	8 (44.5)	0.087	2.48 (0.86–7.2)
Hypertension	72	25 (34.8)	0.012	5.85 (1.27–26.93)
Previous history of MI	52	17 (32.7)	0.280	1.65 (0.63–4.11)
Pre-operative renal insufficiency	32	14 (43.7)	0.02	2.83 (1.12–7.12)
Reduced EF (<55%)	46	14 (30.4)	0.629	1.24 (0.51–3.03)
Long duration of CPB time (≥1.6 h)	49	17 (36.1)	0.064	2.34 (0.93–5.85)
Early insertion	69	17 (73.9)	0.24	0.56 (0.21–1.44)
Long duration of IABP (>3 days)	44	15 (34)	0.23	1.72 (0.70–4.22)
Complications				
New–onset arrhythmias	57	26 (45.7)	<0.001	31.87 (4.09–248.28)
Renal insufficiency	37	19 (51.4)	<0.001	6.72 (2.51–18.02)
Post-operative infection	23	10 (43.5)	0.060	2.53 (0.94–6.79)
Thromboembolic event	9	6 (66.7)	0.006	6.28 (1.44–27.34)

IABP: Intra-aortic balloon pump, EF: Ejection fraction, MI: Myocardial infarction, CPB: Cardiopulmonary bypass

Table 4: Binary logistic regression analysis of risk factors influencing mortality

Factors/Variables	Odd's Ratio and 95% Confidence Interval	
	Unadjusted OR 95% CI	Adjusted OR 95% CI
Hypertension		
No	1.00	
Yes	5.85 (1.27–26.23)	7.12 (1.25–40.38)
Renal Insufficiency		
No	1.00	
Yes	11.59 (3.99–33.65)	7.38 (2.17–25.09)
New-onset arrhythmia		
No	1.00	
Yes	31.87 (4.09–248.27)	22.03 (2.54–190.48)
Thromboembolic event		
No	1.00	
Yes	6.28 (1.44–27.34)	2.08 (0.33–12.83)

as limb ischemia, aortoiliac dissection, and aortic perforation. The limitations of this study are due to its retrospective nature with a relatively small sample size. Despite this limitation, the study involved systematic collection of good quality data.

Conclusion

The CABG patients requiring IABP support belong to a high-risk group with a significant risk of early post-operative mortality. Critical care nurses caring these patients require skill and knowledge for prompt recognition of factors affecting complications to ensure good clinical outcomes.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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