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NT-proBNP as a Predictor of Early Recovery in Elective Off-Pump CABG Patients

Dr. Mohammad Samir Azam Sunny[*1], Dr. Md. Amirul Islam[2], Dr. Ashiqur Rahman[3], Md. Noor-E-Elahi Mozumder[4], Dr. Md. Alauddin[5], Dr. Khan Mohammad Amanur Rahman[6]

[1]Associate Professor, Department of Cardiac surgery, Bangladesh Medical University, Dhaka, Bangladesh

[2]Assistant professor, Department of Anesthesiology, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh

[3]Assistant Registrar, Department of Cardiac surgery, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh

[4]Medical Officer, Department of Cardiac Surgery, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh

[5]Associate Professor, Department of Cardiac surgery, Bangladesh Medical University, Dhaka, Bangladesh

[6]Associate Professor, Department of Cardiac surgery, Bangladesh Medical University, Dhaka, Bangladesh

***Corresponding Author**

Dr. Mohammad Samir Azam Sunny, Associate Professor, Department of Cardiac surgery, Bangladesh Medical University, Dhaka, Bangladesh

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ABSTRACT

Background: N-terminal pro–B-type natriuretic peptide (NT-proBNP) is a biomarker of myocardial stress and has been investigated for its prognostic utility in cardiac surgery. However, limited data exist on its role in predicting early recovery outcomes following elective off-pump coronary artery bypass grafting (OPCAB). This study aimed to evaluate the predictive value of preoperative NT-proBNP levels on postoperative recovery parameters in OPCAB patients. ***Methods:*** This prospective observational study was conducted at the Department of Cardiac Surgery, Al Helal Specialized Hospital, Dhaka, from June 2024 to January 2025. A total of 100 adult patients undergoing elective OPCAB were enrolled. Patients with preserved left ventricular function (LVEF ≥ 40%) were included, while those with prior cardiac surgery, emergency indications, severe renal impairment, or recent myocardial infarction were excluded. NT-proBNP levels were measured preoperatively and on postoperative days 1 and 3. Postoperative outcomes, including extubation time, ICU stay, inotrope requirement, and complications, were recorded and analyzed based on NT-proBNP quartiles. ***Results:*** The mean preoperative NT-proBNP level was 684 ± 310 pg/mL, which peaked at 1250 ± 430 pg/mL on postoperative day 1. Patients with higher preoperative NT-proBNP (>800 pg/mL) had significantly prolonged ICU stays (3.6 ± 1.4 days) and higher inotrope use (68%) compared to those with lower levels (<400 pg/mL), who had shorter ICU stays (2.1 ± 0.7 days) and less inotrope requirement (12%). ***Conclusion:*** Elevated preoperative NT-proBNP levels are associated with delayed recovery and increased hemodynamic support following OPCAB. NT-proBNP may serve as a valuable tool for early postoperative risk stratification.

Keywords: *NT-proBNP, off-pump CABG, postoperative recovery, ICU stay, inotrope requirement, cardiac surgery biomarkers.*

INTRODUCTION

Coronary artery disease (CAD) remains one of the leading causes of morbidity and mortality worldwide. Coronary artery bypass grafting (CABG) is a well-established surgical intervention for patients with complex or multivessel coronary disease, particularly those with reduced myocardial perfusion or failed medical management [1]. Off-pump coronary artery bypass (OPCAB) surgery, which avoids the use of cardiopulmonary bypass, has gained popularity due to its association with reduced inflammatory response, shorter ICU stay, fewer postoperative complications, and quicker recovery [2]. However, predicting postoperative recovery trajectories remains a clinical challenge, particularly in identifying patients at risk for delayed recovery or complications [3].

N-terminal pro–B-type natriuretic peptide (NT-proBNP) is a cardiac neurohormone secreted by ventricular myocytes in

response to myocardial stretch and volume overload [4]. It is widely used as a biomarker for diagnosing and managing heart failure and has also shown prognostic value in a variety of cardiovascular settings, including acute coronary syndrome, valvular disease, and cardiac surgery [5]. Elevated levels of NT-proBNP are known to correlate with left ventricular dysfunction, myocardial ischemia, and poor outcomes in both surgical and non-surgical cardiac patients [6].

Several studies have demonstrated that perioperative NT-proBNP levels are associated with postoperative outcomes following cardiac surgery, including increased risk of mortality, arrhythmias, renal dysfunction, and prolonged hospitalization [7]. However, most of these studies have focused on conventional on-pump CABG or mixed cardiac surgery populations. Data specific to off-pump CABG, particularly in elective settings where patients are generally more stable and outcomes more predictable, are relatively limited [8, 9]. Understanding the prognostic value of NT-proBNP in this subset may aid in early risk stratification and resource allocation.

In the context of OPCAB, where hemodynamic stress is reduced but not entirely eliminated, it remains unclear how NT-proBNP levels reflect myocardial stress and predict short-term recovery [10]. Identifying a reliable biomarker that correlates with early extubation, reduced ICU stay, and fewer postoperative complications could enhance clinical decision-making, optimize postoperative care, and improve patient counseling [11].

This study aimed to evaluate the role of NT-proBNP as a predictor of early recovery in patients undergoing elective off-pump coronary artery bypass surgery. By assessing perioperative NT-proBNP levels and correlating them with key clinical outcomes such as time to extubation, ICU and hospital stay, and postoperative complications, we aim to establish whether NT-proBNP can serve as a useful tool in anticipating recovery patterns in this surgical population. The findings of this study could provide valuable insight into the perioperative management of cardiac surgery patients and contribute to the growing body of evidence supporting biomarker-guided postoperative care.

METHODOLOGY & MATERIALS

This prospective observational study was conducted at the Department of Cardiac Surgery, Al Helal Specialized Hospital, Dhaka, Bangladesh, over a period of eight months, from June 2024 to January 2025. A total of 100 adult patients undergoing elective off-pump coronary artery bypass grafting (OPCAB) were enrolled consecutively based on predefined inclusion and exclusion criteria. Inclusion criteria included patients aged 18 years or above, with preserved left ventricular function (LVEF ≥ 40%), and scheduled for elective OPCAB. Patients with prior cardiac surgery, significant valvular heart disease, emergency procedures, severe renal impairment (eGFR <30 mL/min/1.73 m²), or recent myocardial infarction (within 2 weeks) were excluded.

All patients underwent standard preoperative assessments including history, physical examination, ECG, chest X-ray, echocardiography, and laboratory tests. Serum NT-proBNP levels were measured at three time points: preoperatively (within 24 hours before surgery), on postoperative day 1, and on postoperative day 3, using a standardized immunoassay technique. The surgical procedure and perioperative management followed institutional protocols, with all surgeries performed by the same surgical team to minimize variability.

Postoperative recovery outcomes were closely monitored, including time to extubation, length of ICU stay, total hospital stay, use of inotropic support, and development of complications such as atrial fibrillation and renal dysfunction. Early recovery was defined based on a combination of short ICU stay (<3 days), hospital discharge within 7 days, and minimal postoperative complications.

Data were collected using a structured case record form and entered into a secured database. Statistical analysis was performed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages.

RESULTS

Table 1: Socio-Demographic and Clinical Characteristics (n = 100)

Characteristics	Frequency / Mean ± SD	Percentage (%)
Age (years)	61.4 ± 9.2	
Male sex	74	74%
Female sex	26	26%
BMI (kg/m²)	26.1 ± 3.4	
Hypertension	68	68%

Diabetes mellitus	52	52%
Dyslipidemia	45	45%
Smoking history	40	40%
LVEF (%)	48.3 ± 6.7	

Table 1 presents the socio-demographic and clinical characteristics of the 100 patients who underwent elective off-pump coronary artery bypass grafting (OPCAB). The mean age of the study population was 61.4 ± 9.2 years, with a male predominance (74%). The mean body mass index (BMI) was 26.1 ± 3.4 kg/m². A significant proportion of patients had common cardiovascular risk factors, including hypertension (68%), diabetes mellitus (52%), dyslipidemia (45%), and a history of smoking (40%). The mean left ventricular ejection fraction (LVEF) was 48.3 ± 6.7%, indicating preserved to mildly reduced cardiac function in the majority of participants.

Table 2: Perioperative NT-proBNP Levels

Variable	Mean ± SD
Pre-op NT-proBNP (pg/mL)	684 ± 310
Post-op Day 1 NT-proBNP	1250 ± 430
Post-op Day 3 NT-proBNP	920 ± 360

Table 2 shows the perioperative NT-proBNP levels measured at three key time points. The mean preoperative NT-proBNP level was 684 ± 310 pg/mL. A marked increase was observed on postoperative day 1, with NT-proBNP levels rising to a mean of 1250 ± 430 pg/mL, indicating a significant cardiac stress response following surgery. By postoperative day 3, NT-proBNP levels declined to a mean of 920 ± 360 pg/mL, suggesting partial recovery of cardiac function.

Table 3: Postoperative Recovery Outcomes

Variable	Mean ± SD	Percentage (%)
Time to extubation (hours)	6.2 ± 2.1	
ICU stay (days)	2.8 ± 1.3	
Hospital stay (days)	7.1 ± 2.4	
Inotropic support required	36	36%
Atrial fibrillation	14	14%
Renal dysfunction	10	10%

Table 3 summarizes the postoperative recovery outcomes of the study population. The mean time to extubation was 6.2 ± 2.1 hours, indicating early ventilator weaning in most patients. The average length of ICU stay was 2.8 ± 1.3 days, while the mean total hospital stay was 7.1 ± 2.4 days. Inotropic support was required in 36% of patients, suggesting moderate hemodynamic instability in over one-third of the cohort. Atrial fibrillation occurred in 14% of cases, and renal dysfunction was noted in 10%, reflecting common but manageable postoperative complications in the context of elective off-pump CABG surgery.

Table 4: Preoperative NT-proBNP Quartiles and Outcomes

Variable	Mean ± SD	Percentage (%)
Q1 (<400 pg/mL)	ICU stay: 2.1 ± 0.7	Inotropes: 12%
Q2 (400–600 pg/mL)	ICU stay: 2.4 ± 1.0	Inotropes: 22%
Q3 (600–800 pg/mL)	ICU stay: 3.0 ± 1.2	Inotropes: 40%
Q4 (>800 pg/mL)	ICU stay: 3.6 ± 1.4	Inotropes: 68%

Table 4 illustrates the relationship between preoperative NT-proBNP quartiles and postoperative outcomes, specifically ICU stay duration and the need for inotropic support. Patients in the lowest quartile (Q1, NT-proBNP <400 pg/mL) had the shortest ICU stay (2.1 ± 0.7 days) and the lowest inotrope requirement (12%). As NT-proBNP levels increased across quartiles, both ICU stay and inotropic support needs progressively rose. In Q2 (400–600 pg/mL), the mean ICU stay was 2.4 ± 1.0 days with 22% requiring inotropes. Q3 (600–800 pg/mL) patients had a longer ICU stay (3.0 ± 1.2 days) and 40% needed inotropes. The highest quartile (Q4, >800 pg/mL) showed the most prolonged ICU stay (3.6 ± 1.4 days) and the greatest inotrope usage (68%).

DISCUSSION

This study evaluated the prognostic value of preoperative NT-proBNP levels in predicting early postoperative outcomes among patients undergoing elective off-pump coronary artery bypass grafting (OPCAB) in a Bangladeshi population. The

findings highlight a clear association between elevated preoperative NT-proBNP levels and prolonged ICU stay, delayed extubation, and increased inotrope requirement—suggesting its utility as a practical biomarker for early risk stratification.

NT-proBNP, a well-established marker of myocardial wall stress, has previously demonstrated predictive capacity in various cardiac surgical contexts. Our results align with the findings of Krzych et al., who showed that higher preoperative NT-proBNP levels were associated with increased postoperative complications and longer ICU stays in coronary surgery patients [12]. Similarly, Jiang et al., found that NT-proBNP effectively predicted postoperative heart failure and complications, emphasizing its role as a non-invasive and cost-effective prognostic tool [13].

In our study, the mean preoperative NT-proBNP was 684 ± 310 pg/mL, rising to a peak of 1250 ± 430 pg/mL on postoperative day 1 before declining. This pattern is consistent with findings by Kim et al., who noted that NT-proBNP levels typically peak within 24–48 hours post-surgery and reflect the degree of myocardial strain induced by operative stress [14]. The gradual normalization by postoperative day 3 in our cohort may reflect satisfactory myocardial recovery among most patients.

Patients stratified into higher NT-proBNP quartiles experienced significantly longer ICU stays and a greater need for inotropic support. For example, those in the highest quartile (>800 pg/mL) required inotropes in 68% of cases and had a mean ICU stay of 3.6 ± 1.4 days. In contrast, patients in the lowest quartile (<400 pg/mL) had a lower inotrope requirement (12%) and shorter ICU stay (2.1 ± 0.7 days). This dose-response relationship underscores the prognostic gradient of NT-proBNP levels, similar to results reported by Hutfless et al., who found that BNP levels correlated with both cardiac function and major postoperative complications [15].

Although many previous studies focus on on-pump CABG procedures, recent research, including by Su et al., emphasizes the role of biomarkers like periostin and NT-proBNP in predicting adverse outcomes even in off-pump surgeries [16]. The current study reinforces this trend in the context of OPCAB, where hemodynamic fluctuations still present significant clinical challenges despite avoiding cardiopulmonary bypass.

Postoperative complications in our study, such as atrial fibrillation (14%) and renal dysfunction (10%), were also more common among those with elevated NT-proBNP. Ghorbani et al. similarly observed that high pre- and postoperative BNP levels were associated with higher rates of morbidity, including arrhythmias and renal complications [17]. These findings support the hypothesis that NT-proBNP not only reflects cardiac stress but may also serve as a systemic marker of overall vulnerability.

Our observed mean time to extubation (6.2 ± 2.1 hours) and hospital stay (7.1 ± 2.4 days) are comparable with prior findings in OPCAB cohorts [18, 19]. However, NT-proBNP appears to identify a subset of patients at risk of delayed recovery. This is crucial in Bangladeshi settings, where resource allocation for ICU care remains a significant concern. Early identification of high-risk patients using NT-proBNP could enable more efficient triaging and postoperative planning, optimizing bed utilization and outcomes.

Moreover, while NT-proBNP is not a novel marker, its application in low-resource settings such as Bangladesh has not been well explored. As Reyes et al., noted, incorporating NT-proBNP into cardiac surgical protocols can assist clinicians in early decision-making, particularly when complex scoring systems are impractical [20]. Given its availability and interpretability, NT-proBNP may serve as a cost-effective alternative for perioperative risk stratification in our healthcare context.

Limitations of the study

The strength of this study lies in its prospective observational design and focus on an underrepresented population. However, we acknowledge limitations, including a relatively small sample size and the absence of long-term follow-up data. Larger multicentric studies are warranted to validate cutoff values and enhance generalizability.

CONCLUSION

In conclusion, our findings demonstrate that preoperative NT-proBNP levels are significantly associated with early recovery outcomes following elective OPCAB. Elevated levels predict longer ICU stay, increased inotrope use, and higher complication rates. These results suggest that NT-proBNP can be a valuable, accessible biomarker for risk stratification and postoperative management in Bangladeshi cardiac surgery patients.

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