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PERIOPERATIVE PREDICTORS LINKED WITH PROLONGED ICU STAY & SUBSEQUENT MORBIDITY AND MORTALITY AFTER CARDIAC SURGERY

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ABSTRACT

Aim: *The aim of the present study was to evaluate the perioperative predictors linked with prolonged icu stay and subsequent morbidity and mortality after CABG (coronary artery bypass grafting) surgery.*

Settings and design: *This retrospective analytical study was conducted in a tertiary cardiac center.*

Subjects and Methods: *A total of 500 CABG surgery patients were recruited in the study over a period of 1.5 years & were retrospectively analysed for perioperative factors which included Preoperative, Intraoperative and Postoperative variables . Prolonged ICU stay was defined as > 96 hours and these patients were included in group I (n=50). Patients requiring less than 60 hours (n=450) stay were included in group II. Stepwise logistic regression analysis was performed.* ***Results:*** *The overall perioperative mortality was 6% (30 patients) with Group I showing a mortality rate of 44% (22 patients) and group II showing 4 % (18 patients). In multivariate analysis, predictors of prolonged ICU stay were found to be EF < 40% (odds ratio(OR) 13.38), prolonged ventilation [OR 13.31], preoperative renal dysfunction [OR 4.06 (serum creatinine > 1.2mg%)] , prolonged CPB(cardio pulmonary bypass) time >120 min (OR 9.6) and reintervention-re-exploration/reintubation in the ICU (OR 13.8).*

Conclusion-*Identification of such perioperative variables may allow the development of strategies to optimize the patient's condition and ICU management.*

KEYWORDS : Coronary artery bypass grafting, Prolonged ICU stay, morbidity, mortality

Introduction

Fast-tracking after after coronary artery bypass grafting (CABG) surgery is beneficial for both the patients as well as the health-care facility. In an increasing trend towards minimizing intensive care stay following open-heart surgery[1,2,] there remains a group of patients who may require prolonged ventilation and prolonged ICU stay. Current economic constraints in the health care system have led to significant efforts to shorten length of hospitalization and reduce health care costs.[3,4] A number of factors have been identified which increase the morbidity and length of stay (LOS) after CABG surgery. Among all the preoperative factors, emergency operation, type of procedure, age, diabetes mellitus (DM), renal dysfunction, cerebrovascular accidents, reoperation and left ventricular dysfunction are described as significant predictors of morbidity and prolonged Intensive Care Unit (ICU) stay. [17] Although majority of patients in the intensive care unit (ICU) stay for 48-60hours post CABG, this study mainly concentrates on the group of patients whose ICU stay was prolonged >96 hrs. Previous data have shown that mortality increases significantly in patients staying for 7 days in the ICU after cardiac surgery[5] Respiratory failure and pneumonia have been traditionally the leading causes of postoperative complications.[6]Prolonged mechanical ventilation is known to result in increased ICU stay, increased hospital stay, increased resource utilization and health care costs. Patients with prolonged mechanical ventilation experience worse physiological outcome due to atelectasis and intrapulmonary shunting.[7] Recently The clinical advantages of early extubationare mainly that it minimizes associated patient discomfort, eventually decreasing the incidence of infection and facilitates early ambulation. The early extubation itself helps to reduce ICU stay and hospitalization costs.[3,8.]

Aims and objectives-

The primary goal of the study is to evaluate preoperative characteristics as well as intraoperative and postoperative variables that are associated with prolonged ICU stay following CABG surgery

Methods

500 patients undergoing CABG surgery were reviewed retrospectively. The following preoperative variables were analyzed: age, gender, ejection fraction (EF), renal function, diabetes, angina status, severity of the disease (New York heart association, NYHA) classification, number of diseased vessels, urgency of the procedure, renal dysfunction, cerebrovascular accidents, left ventricular dysfunction, reoperation and history of chronic lung disease. Intraoperative variables analyzed were off pump vs on pump, cardiopulmonary bypass (CPB) duration, aortic cross clamp (ACC) time, intra-aortic balloon counter-pulsation (IABP) and inotrope usage. The postoperative variables included: temperature on arrival at intensive care unit (ICU), IABP usage, prolonged ventilation ,organ dysfunction, high inotropes and reintervention-reintubation and re-exploration. The average patients age was 54±10 years with male predominance (85%). Patients were divided into two group ,based on the duration of ICU stay of >96 hours included in group I & those requiring <60 hours were included in group II.

Anaesthesia and analgesia were standardized for all patients as per our institutional practice. Pulmonary artery catheter was inserted after induction of anaesthesia in all patients with EF < 40% and postoperatively in patients with haemodynamic instability.

Cardiopulmonary bypass if required Normothermic perfusion was generally practiced, but drifting to 32°C was used in few patients, if required. Standard antegrade intermittent cold blood cardioplegia was used for myocardial protection. While weaning from CPB, if systolic blood pressure was < 90 mm Hg, central venous pressure >12 mm Hg, or pulmonary capillary wedge pressure > 15 mm Hg, and if high doses of inotropes were required (dobutamine >5 µg/Kg/min, adrenaline >0.1 µg/Kg/min), IABP was inserted.

Clinical decision making (Extubation criteria) were individualised patient to patient based on the protocol followed in our institution. Once the patient was warm, awake, cooperative, haemodynamically stable and achieved good clinical neuromuscular recovery, ventilatory weaning was started with synchronized intermittent mandatory ventilation (respiratory rate 12/min) and pressure support of 15 mm Hg followed by reduction in intermittent mandatory ventilation rate by 2 every half hour till 5 per minute. Simultaneously pressure support was reduced to 10 mm Hg. Patients were extubated if arterial oxygen tension was > 90 mm Hg, arterial carbon dioxide tension was < 45 mm Hg and pH > 7.34 with fractional inspired oxygen concentration< 0.5 for half hr

Prolonged ventilator support Patients were generally not extubated if urine output was <0.5 ml/Kg/hour, cardiac index was <1.5 L/min/m2, two or more inotropes or IABP support was required or multi-organ dysfunction was suspected.

Inotropes were used to maintain cardiac index of atleast 2.5 L/min/m2 and mean arterial pressure of atleast 60 mm Hg.

RE-exploration conducted for mediastinal bleeding when the chest tube drainage was > 400 ml for the first hour or > 200 ml/hour for consecutive 4 hours.

Data analysis

Data were analysed using student's t' test, analysis of variance 'F' test and the Chi-square test of variance. P value of < 0.05 was considered to be significant.

Results

Patient characteristics

Preoperative patient demographic data and perioperative findings are shown in table 1.

Patients were predominantly male with an average age of 54 ± 10 years (with 37% being over 60 years) and 56.4% having diabetes. Mean EF in Group I was 40.77± 12.04 vs 53.6±10.9 in group II (p<0.02). Blood urea, serum creatinine, on pump vs off pump CABG, CPB time, number of diseased vessels, patients requiring IABP support, patients with organ dysfunction, patients requiring prolonged ventilation, reintervention, emergency surgery, reoperation and belonging to NYHA class III, IV were significantly higher in group I as compared with group II. 67% patients had triple vessel disease and 17% of them were in functional class III and IV. 23%percent of patients had an ejection fraction of less than 40%.

Table 1.Demographic and perioperative data in the two groups.

VARIABLES	GROUP I	GROUP I I	P value
No. Of patients	50	450	
Age (years)	55 ± 11	54 ± 9	0.19
Ejection fraction (%)	40.77±12.04	53.6±10.9	0.02
Urea (mg/ dl)	53.0 ± 22.2	31 ± 9.03	0.001
Creatinine (mg/ dl)	1.24 ± 0.438	0.89 ± 0.32	0.001
OP CABG (off pump)	38 (76%)	422 (93%)	0.001
CPB (mins)	126.55 ± 55	78.44 ± 12.44	0.001
ACC (mins)	40.34 ± 21.23	36.68 ± 18.42	0.0 56
Temperature (Deg C)	34.8 ± 1.066	34.6 ± 1.12	0.121
No. Of diseased vessels	3.2 ± 0.8	2.9 ± 1.1	0.04
Females	12 (24%)	96(21.3 %)	0.95
Diabetes Mellitus	28 (56%)	250 (50%)	0.76
USA	15 (30 %)	124 (27.5%)	0.66
NYHA (Class I I I, I)	8(17%)	79 (17.55%)	0.001
MI	28 (56%)	210 (46%)	0.053
CVA	6 (12%)	28 (6.22%)	0.061
COPD	12 (24%)	158 (35%)	0.86
IABP I	18 (36%)	22 (4.88%)	0.001
IABP I I	14(28%)	12 (2.66%)	0.001
IABP I I I	6 (12%)	8 (1.77%)	0.001
Inotropes	38 (76%)	134 (29.76%)	0.041
Organ Dysfunction	24 (48%)	64 (14.22%)	0.001
Re intervention	12 (24%)	68 (15%)	0.001
Emergency surgery	8 (16%)	24 (5.33%)	0.001
Reoperations	6 (12%)	22 (4.88%)	0.043
Prolonged ventilation (>24hrs)	22 (44%)	96 (21.33%)	0.001

CPB: cardiopulmonary bypass; ACC: aortic cross clamp; USA: unstable angina:

NYHA: New York Heart Association; MI: myocardial infarction; CVA: cerebrovascular accident; COPD: chronic obstructive pulmonary disease; IABP1: intra aortic balloon pump (preoperative); IABP2: intra aortic balloon pump (intraoperative), IABP 3 (postoperative)

Patient outcome

The overall mortality rate was 6% (30/500 patients) with group I showing mortality rate as high as 44% (22/50patients). In group I, 8 patients died of low cardiac output, 4 due to intractable ventricular arrhythmias and 5 of sudden cardiorespiratory arrest, 5 due to fulminant sepsis. In Group II, 4 patients died of low cardiac output, 8 due to malignant arrythmias 6 patients died due to sudden cardiorespiratory arrest. Patients were ventilated for an average of 78.56 ± 44.22 hours in group I and 14.05 ± 9.16 hours in group II. The overall median length of ICU stay was 48-60 hrs & hospitalisation- 7 days. Out of 50 patients in group I, 18 needed preoperative placement of IABP, 14 needed intra operative IABP placement, 6 needed post operative IABP placement and 12 needed reintervention in the ICU, which included reexploration for mediastinal bleeding (8 patients) and reintubation (4 patients).

Univariate predictors

Preoperative patient characteristics, intraoperative and postoperative variables were then evaluated. These are listed in order of decreasing odds ratio in table 2. The strongest univariate predictors for prolonged ICU stay were the preoperative usage of IABP , prolonged ventilation followed by reintervention, preoperative renal dysfunction, low ejection fraction, emergency surgery, CPB duration and organ dysfunction. The number of diseased vessels, diabetes, age, severity of disease (NYHA class), chronic obstructive pulmonary disease (COPD) and diabetes mellitus were not significantly associated with prolonged ICU stay.

Table 2. Univariate predictors of prolonged ICU stay

VARIABLES	OR	CI	SIGNIFI CANCE
Prolonged ventilation(>24hrs)	15.61	6.66 – 42.56	S
Reintervention	14.52	5.41-36.37	S
Creatinine (>1.2 mg/dl)	13.68	5.14-34.33	S
EF	10.79	4.42-28.60	S
Emergency	7.72	1.65-28.60	S
CPB	7.69	3.15-18.01	S
Urea(>40 mg/dl)	6.84	2.97-15.81	S
Organ dysfunction	6.65	2.81-15.31	S
Severity of disease (NYHA)	2.21	0.74-8.90	NS
DM	1.38	0.605-3.304	NS
Temperature	1.34	0.55-3.12	NS
COPD	1.21	0.52-2.77	NS
MI	1.20	0.48- 5.77	NS
CVA	1.19	0.42-2.72	NS
USA	1.13	0.42-2.72	NS
Inotropes	1.1	0.3-2.6	NS
Age	0.92	0.04- 5.19	NS
ACC	0.88	0.05-7.24	NS

OR: odds ratio, CI: confidence interval; NS non significant; S: significant; IABP: intraaorrtic balloon pump; EF: ejection fraction; CPB cardiopulmonary bypass; NYHA: New York Heart Association; DM: diabetes mellitus; COPD: chronic obstructive airway disease; MI: myocardial infarction; CVA: cerebrovascular
Accident ; USA: unstable angina; ACC: aortic cross clamp

Multivariate predictors

Table 3 shows the logistic regression model for predicting the occurrence of prolonged ICU stay. The most powerful predictors were preoperative low ejection fraction (<40%), reintervention, prolonged ventilation, CPB duration (>120 min), renal dysfunction (serum creatinine > 1.2 mg/dl) and emergency operation.

Table 3. Multivariate predictors of prolonged ICU stay

Variables	OR	Significance	CI
EF	13.38	0.0000*	3.9595 – 15.2484
Prolonged ventilation	13. 31	0.0001*	3.8655 – 22.3454
Re-intervention	13.8	0.0002*	3.5165 – 54.3783
CPB	9.6	0.0003*	2.8332 – 32.8433
Creatinine	4.06	-0.0410*	1.0593 – 15.5851
Emergency	1.37	0.1918*	0.5019 – 31.1132

*P value < 0.05: significant; CI: confidence Interval; OR: odds ratio; EF: ejection fraction ACC- aortic cross clamp.

Discussion

Cost containment and efficient resource use have forced the pendulum back to the debate of early tracheal extubation and fast-tracking in cardiac surgical patients. [18],[19] In this era of cost containment and physician report cards, doctors are held accountable for patients' outcome in terms of mortality, morbidity, quality of life, long ICU stay, and costs of care. It has recently been demonstrated that early tracheal extubation and fast-track anesthesia is safe, cost beneficial, and can improve resource use in cardiac surgery. [7],[21] Prolonged mechanical ventilation has been shown to result in worse physiological outcome as a result of atelectasis and intrapulmonary shunting.[7] The main goals of this study were to identify the patient characteristics and operative variables that are capable of predicting prolonged ICU stay in CABG patients and to identify the possibility of modification that may allow early discharge. Patients undergoing isolated CABG surgery at our institution are usually mechanically ventilated for less than 24 hours, shifted from ICU within 36 – 60 hours and often discharged from hospital within 10 days of surgery. We have defined prolonged ventilation as greater than 24 hours because it approximates most closely to the current clinical practice.[9–11] Because CABG is a commonly performed operation and represents a significant burden on health care resources, an ability to predict which patients may require prolonged ICU stay and length of hospitalization, could help allocate adequate resources and lead to the development of preventive strategies.[13] A significant proportion of patients in the present series were older than 60 years (37%) and 17% were in NYHA functional class III or IV. Fifty patients (10%) required prolonged ICU stay, which was associated with significant mortality (44%) as compared with patients who did not require ventilation for more than 24 hours (4%). This finding identifies a group of patients at increased risk of morbidity and mortality following CABG. The multivariate predictors identified were preoperative low ejection fraction, preoperative renal dysfunction, CPB duration , prolonged ventilation and any reintervention. Non-predictive variables included age, gender, reoperation, diabetes, COPD and number of vessels diseased. Female gender was not found to be associated with prolonged ventilation in contrast to some other studies, which showed that female patients have longer intubation times, ICU stay and length of hospitalization.[12,14] Age has been suggested by others to be predictor of prolonged intubation14 resulting in prolonged ventilation and independently associated with long term morbidity and mortality. However in our study we found that age is not a significant factor in predicting prolonged ICU stay. We believe that more than the chronological age, functional status is an important factor in predicting prolonged ICU stay. In contrast to other studies, several variables like diabetes mellitus, COPD, emergency surgery, number of diseased vessels and severity of disease were not found to be independent risk factors for prolonged mechanical ventilation & hence ICU stay.[12,16] Some studies have shown that low ejection fraction is an independent risk factor for prolonged mechanical ventilation.[10,11] Patients with EF < 40% included most of patients with moderate to severe left ventricular dysfunction. Our results show that EF continues to be a very strong predictor of mortality and morbidity in CABG patients. Patients with preoperative renal dysfunction defined as serum creatinine greater than 1.2 mg/dl were found to have a 13-fold increased incidence of prolonged ICU stay (odds ratio 13.68). Renal failure has been shown to be associated with worst outcome following cardiac surgery with prolonged length of hospitalization often associated with prolonged mechanical ventilation.[13] Certain intraoperative variables are known to have significant impact on postoperative mortality and morbidity. To evaluate this we have included in our analysis the off pump vs on pump CABG, CPB duration, ACC time, and usage of IABP, and inotropes. Among these variables, on pump surgeries, duration of CPB and usage of IABP were identified as strong predictors of increased ICU stay. The duration of ACC did not differ between the groups but duration of CPB was significantly longer in group I. This may be due to the need for prolonged support on CPB and need for insertion of IABP before coming off bypass in sick patients. In univariate analysis, increased requirement of intraoperative and postoperative inotropic support resulted in prolonged ICU stay. Also postoperative need for IABP usage, prolonged ventilation, organ dysfunction, and reintervention like re-exploration for mediastinal bleeding, resulted in significant prolongation of ICU stay. In our study the evidence of postoperative organ dysfunction was 48% (stroke 12%, renal dysfunction 24%). The temperature at arrival in ICU significantly delayed extubation time but did not prolong the ICU stay. Intervention like re-exploration for mediastinal bleeding after CABG and postoperative organ dysfunction significantly delayed the extubation and increased the length of ICU stay.

Conclusion

Many perioperative variables are found to be linked with predicting increased length of ICU and hospital stay and subsequent morbidity and mortality in patients undergoing CABG, these may be considered as alarming to predict postoperative outcome. Identification of these factors may allow the development of pre-emptive strategies with appropriate resources utilization.

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