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CARDIOPULMONARY BYPASS RISK FACTORS INFLUENCING PROLONGED MECHANICAL VENTILATION AFTER ADULT CARDIAC SURGERY

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Abstract
Prolonged mechanical ventilation (PMV) after adult cardiac surgery increases morbidity, mortality, and ICU resource use. While predictors are well-studied in pediatric populations, adult data remain limited. This study aimed to identify risk factors for PMV in adults undergoing cardiac surgery with cardiopulmonary bypass (CPB).A prospective study of 85 adult patients undergoing CPB assessed 20 preoperative, intraoperative, and postoperative variables. PMV was defined as mechanical ventilation exceeding 24 hours. Univariate and multivariate logistic regression analyses were performed to determine independent predictors.Ten patients (11.8%) experienced PMV (median 31 hours vs. 5 hours in non-PMV). Independent risk factors included advanced age (p=0.015), prolonged CPB time (p=0.042), higher cardioplegia volume (p=0.004), postoperative pneumonia (p=0.023), and extended ICU stay (p=0.005).Advanced age, extended CPB duration, increased cardioplegia volume, postoperative pneumonia, and longer ICU stay significantly elevate the risk of PMV in adult cardiac surgery. Early identification of these factors can guide perioperative management, minimize ventilator dependence, and improve postoperative outcomes.

INTRODUCTION

The first successful heart repair was performed using cardiopulmonary bypass technique in which is a mechanical device temporarily replace the heart and lung's function. The patient blood is drained and exposed to blood oxygen interface and then oxygenated blood is pumped to provide body needs for oxygen [1, 2]. CPB and its development have advanced cardiac surgery and this extracorporeal circulation allows surgeon to treat wide spectrum of heart disorders in a motionless, bloodless operative field. However, CPB procedure is not without complications. In majority of the CPB procedures the ascending aorta must be clamped below the aortic arch (known as "aortic cross-clamping") to isolate the heart from circulation [3-6].

Ischemia resulting from aortic cross clamp triggers a series of physiological events that significantly contribute to the increased incidence of pulmonary problems because of release of certain substances such as Thromboxane. It triggers inflammatory response and an increase in microvascular permeability in the lungs. Complement proteins C3a and C5 are also activated following aortic clamping, further exacerbating the situation and raise the risk of non-cardiogenic pulmonary edema. Despite advancements in perioperative management, postoperative pulmonary complications (PPCs) remain the primary cause of morbidity and mortality in cardiac surgery, affecting up to 25% of individuals without severe cardiac dysfunction. As a standard postoperative care practice, mechanical ventilation is

employed after cardiac surgery to address these complications [7-10].

Mechanical ventilation helps recover patients after cardiac surgery as patients are affected by various preoperative and intra-operative factors; intraoperative CPB, the incomplete metabolic clearance of anesthetics, the incomplete recovery of spontaneous breathing and unstable hemodynamics. Mostly patients wean off from ventilation within 12-24 hours however in some patients prolonged mechanical ventilation is required with ventilation time exceeding more than 24 hours or those with one or more failed attempt to extubated leading to cumulative endotracheal use of at least 24 hours intubation [11].

Early extubation (8-12 hrs.) and shorter hospital stays in cardiac surgical procedures have been made possible by recent advancements in anesthetic, surgical methods, myocardial protection, extracorporeal perfusion techniques, critical care protocols, and enhanced perioperative management. It reduces the risk of pneumonia, lung atelectasis, and other pulmonary conditions. Additionally, it enhances cardiac diastolic function, lowers the likelihood of adverse effects of positive pressure breathing, and minimizes patient discomfort, shortens hospital and intensive care unit (ICU) stays, lowers medical costs, encourages early ambulation and improves cardiac function post CPB. However delayed extubation occurs in preoperatively identified 'high risk' patients [7, 10, 12-14].

There have been many attempts to identify high risk patients, as well as to identify intraoperative variables that may contribute to poor outcomes [15]. Previous studies have identified risk factors for prolonged mechanical ventilation including advanced age. Documented advanced age is defined as age >60 years [16]. BMI ≥ 28 kg/m^2, Ejection fraction under 50%, diabetes, Stroke, renal impairment, chronic obstructive pulmonary disease [COPD]), preoperative intra-aortic balloon pump, prolonged cardiopulmonary bypass time, and aortic cross clamp, low hematocrit, post-operative bleeding, emergency surgery, type of operation, low platelets, elevated Creatinine, low serum albumin, elevated blood glucose levels [7 ,9, 17, 18]

Despite difficult surgical procedures most patients are suitable for weaning and extubation in the early postoperative period however not all patients are candidates for early extubation [6]. Prolonged mechanical ventilation occurs in 3-9.9% of patients results in increased ICU and hospital stay, reduced hospital bed availability, higher treatment cost and lower quality of life major issue for resources allocation and is also associated with postoperative morbidity and mortality (4.9-38%) [13, 19, 20]. It is still exceedingly challenging to identify people who can be successfully extubated. Studies have been done to identify these risk factors for prolonged mechanical ventilation [14].

Inflammatory response is stimulated by blood exposure to extracorporeal artificial surface and abnormal shearing forces. Number of coronary graft anastomosis or challenging coronary targets affects the duration of exposure which affects post-operative outcomes of patient [4]. similarly; Patients with impaired left ventricular ejection function are at increased peri-operative risk, as when compared to similar patients with normal contractile function as evident by mortality rate [21].

Cardiopulmonary bypass time <60 minutes is categorized as normal and bypass time >140 as severely prolonged. Cross clamp time <30 minutes is categorized as normal [22] while extensive cross-clamp time is most frequently defined as significant at greater than 30 minutes. Following cardiac surgery, prolonged cardiopulmonary bypass and aortic cross-clamp times are linked to higher rates of morbidity and mortality as a result of the myocardial damage and inflammatory response brought on by cardioplegic cardiac arrest and cardiopulmonary bypass [23, 24].

Blood transfusion is frequently required in cardiac surgery to treat coagulopathy, blood loss, and hemodilution after pump priming or in anemic patients. Such patients are susceptible to the transfusion-related acute lung injury (TRALI), which is caused by immunologically mediated increased lung capillary permeability and occurs roughly six hours following the delivery of blood products. Pulmonary edema can result from endothelium damage. The frequency of TRALI is 2.5% in patients undergoing cardiac surgery, and it is linked to high

mortality, extended ICU stays, and longer hospital stays. Transfusion-related lung damage may be avoided by utilizing a more blood conservative transfusion strategy following cardiac surgery. The majority of patients undergoing heart surgery who receive two units of blood have high rates of morbidity and mortality [25, 26].

Prolong mechanical ventilation (PMV) after surgery is associated with high post -operative morbidity and mortality as well as increased use of intensive care unit (ICU) and hospital resources. Data is published identifying the predictors of PMV duration after congenital heart surgery. The aim of our study is to identify these risk factors associated with CPB in adult population and determine their impact postoperative Mechanical ventilation duration.

Literature review:

Multiple studies have evaluated pre-operative risk factors and intraoperative factors that contribute prolonged mechanical ventilation. Most of these risk factors are studied in pediatric patients. However, few studies have attempted to evaluate preoperative predictors of prolonged ventilation in a population of patients undergoing CABG surgery in adults. Identified risk factors in previous studies includes advanced age, BMI ≥ 28 kg/m^2, Ejection fraction under 50%, diabetes, preoperative IABP, prolonged cardiopulmonary bypass time, and aortic cross clamp time, post-operative bleeding, emergency surgery and type of operation. Prolonged mechanical ventilation has also been suggested to result in worse physiological outcomes for patient post-extubation because of atelectasis and intra-pulmonary shunting [9, 17, 18, 20].

In a retrospective study (2022) studied early identification of delayed extubation following cardiac surgery from 2014-2019 in 3,919 adult patients undergoing cardiac surgery. In the study 10 risk factors for delayed extubation were identified age, BMI ≥ 28kh/m^2, EF <50%, history of cardiac surgery, type of operation, emergency surgery, CPB ≥120 min, duration of surgery, IABP and eGFR <60 ml/min/1.73m^2 and a prediction model is developed to predict the risk of delayed extubation by identifying high-risk patients [18].

In retrospective investigation (2022) between 2017 and August 2018, 207 patients who underwent cardiac surgery with CPB were studied. Female gender, preoperative leukocytosis, intraoperative CPB time, lactate levels and postoperative revision for bleeding were found to be the independent predictive factors for PMV. The effect of predictive factors on mortality after cardiac surgery was determined and found that PMV did not affect hospital mortality [27].

A retrospective cohort study carried out by Alrddadi et al (2019) studied the risk factors for prolonged mechanical ventilation after surgical repair of congenital heart disease. A total of 257 patients were included in this study were divided into 2 groups according to the mechanical ventilation duration: PMV >72 hours and non-prolonged mechanical ventilation duration <72 hours. Among all patient 85.2% were intubated for <72 hours and 14.8% were intubated for ≥72 hours. Risk factors studied were age, weight, gender, pulmonary hypertension, cross clamp time, CPB time and type of CHD. Among all the risk factors studied age (<6months) , weight, intraoperative CPB time, cross clamp time, pulmonary hypertension, impaired cardiac function and sepsis were all associated with prolonged mechanical ventilation duration [28].

A retrospective study by Mehmood et al, (2019) studied the impact of cross clamp and cardiopulmonary bypass time on post-operative mechanical ventilation duration for the time period of 1 year at kingdom of Saudi .This study uses the cross clamp and CPB time and their influence on post-operative mechanical ventilation duration .The conclusion of this study is that there is no significance difference between aortic cross clamp and cardiopulmonary bypass time on prolong mechanical ventilation. It seems likely that clinical parameters other than CPB and ACC duration may have a greater impact on clinical outcomes. So improved patient selection, surgical method, and postoperative care may all lead to better clinical outcome [29].

The prospective non-randomized study by Mohamed et al 2017 at Cairo University, Egypt studied the Effect of the Cross Clamp Time on the Post-operative Ventilation in Post Cabg Patients. This

study included 30 ischemic patients who were candidates for isolated on-pump CABG. This study aims to find out the correlation between prolonged cardiopulmonary bypass and cross clamping time on the post-operative mechanical ventilation duration. The results of the study concluded that there is a direct relation between the cardiopulmonary bypass time, and the cross-clamp time to the clinical outcome of the patients. Cross Clamp time >60 min was an independent risk factor for low cardiac output, prolonged mechanical ventilation time, renal dysfunction, blood transfusion, mortality and prolonged hospital stay [30].

An analytical study by Nadeem et al (2019) evaluates the effect of cardiopulmonary bypass time with post-operative mechanical ventilation duration. The variable taken by them are cardiopulmonary bypass time, Age Diabetes, male gender, ejection fraction. CPB time was most strongly correlate variable Cardiopulmonary bypass time appears to have a negative impact on clinical outcomes and is linked to a prolonged MV. The result of this study concludes that increase duration of mechanical ventilation is associated with longer duration of cardiopulmonary bypass time. Increasing cytokine up regulation associated with longer exposure to CPB membranes may impact the respiratory system in a way like systemic inflammatory response syndrome. An estimation of confounding factors, such as age, gender, and coexisting diseases improves correlation. Their results are stronger because there was no significant collinearity with these variables except CPB time [31].

In a retrospective analysis (2012) of database from March 2009 to May 2011 at CPE Institute of Cardiology, Multan studied risk factors of prolonged mechanical ventilation following open heart surgery in adult patients at Pakistan. Total 4.76 % (77 patients) had prolonged ventilation for a cumulated duration of more than over 24 hours. Risk factors for PMV found were Preoperative renal failure, emphysema, low EF (<30%), urgent operation, preoperative critical state, prolonged bypass time, prolonged cross clamp time, complex surgical procedures and peri-operative myocardial infarction. The results of the study concluded prolonged ventilation continues to be associated with very high mortality [16].

A retrospective cohort study by Polito et al,(2011) evaluate the risk factors associated with prolong mechanical ventilation for the time period of 9 years at children hospital Boston .this study determines the association of prolong mechanical ventilation time with risk factors such as Younger age ,severity of illness ,non-infectious pulmonary complications and need for re intervention .the conclusion of this study was that younger age the need for early postoperative re- intervention, healthcare associated infections, noninfectious pulmonary problems, and a higher severity of sickness score at CCU admission to be independently associated with prolong mechanical ventilation duration [32].

In 2010 the retrospective study was carried out by Ji et al in China to evaluate the risk factors for late extubation in patients undergoing CABG during the time of 2005 to 2008.416 patients were added in this study. The important variables of this study were age, cardiopulmonary bypass time, perioperative intra-aortic balloon pump requirement, low preoperative arterial oxygen partial pressure, and low postoperative hemoglobin level and aortic cross clamp time. Elapsed time between CABG and extubation of more than 8 hours were considered as late extubation. The result of this study clearly stated that the age and prolonged CPB was one of the most important risk factors for late extubation. Age more than 65 years leads to pulmonary complications. This study concluded that early extubation can be achieved by shortening the cardiopulmonary bypass time [12].

Trouillet et al in 2009 carried out a prospective observational coherent study to identify the complications of prolonged mechanical ventilation after cardiac surgery from October 2004 and January 2006 in 2620 consecutive patients older than 18 yrs. undergoing cardiac surgery were added in this study. Variables studied were age, sex, body mass index, chronic respiratory insufficiency, corticosteroids, history of MV, chronic renal insufficiency, diabetes mellitus CPB and aortic cross clamp times, use of intra-aortic balloon pump, ECMO and post-operative mechanical ventilation. Only 30% were successfully weaned on postoperative day and concluded that

patients still requiring MV on day 3 after cardiac surgery had poor outcomes [33].

The retrospective study was performed according to ethical standard by S. Shi et al in Eastern China (2008) over the period of 6 years from 2001 to 2007 to identify the risk factors associated with prolonged mechanical ventilation in neonates and young infants. 172 children aged < 3 months were reviewed. PMV was considered as mechanical ventilation (MV) >72 h. The patients of this study were classified into two groups according to the duration of MV: PMV group (> 72 h), and non-PMV group < 72 h). The main variables taken for this study included age, sex, weight, cyanosis, preoperative cardiovascular function, pneumonia, requiring MV preoperatively, pulmonary blood flow, preoperative pulmonary hypertension. The intraoperative variables included CPB time, aortic cross-clamp time, exposure to deep hypothermia circulatory arrest (DHCA), ultra filtrate volume removal, and body fluid. This study was carried out in single institute .Due to the small number of patients undergoing individual procedures the duration of cardiopulmonary bypass and other related variables were not independently associated with prolonged mechanical ventilation [19].

A prospective review by Szekely et al (2006) studied the Intraoperative and postoperative risk factors for prolonged mechanical ventilation after pediatric cardiac surgery among 411 patients at Budapest in Hungary for the duration of one year. The variables studied were demographics, weight, preoperative pulmonary hypertension, cross-clamp time, CPB time, reoperation, state of the operation (emergency, urgent, elective), and complexity of the surgical intervention. The ventilation time was categorized as medium (MMV >61 h) and LMV (>7 days). The results of the study concluded that causes of mechanical ventilation were heterogeneous, vary with time and have variable impact on the duration of MV. Intra operative and post-operative bleeding was an important cause of prolonged mechanical ventilation requiring blood transfusion. However there was no association found between age and mechanical ventilation duration [6].

Canadian scholars J.F Legare et al in 2001 attempted to identify the preoperative predictors of prolonged mechanical ventilation in patients undergoing cardiopulmonary bypass grafting between 1997 to 1999.1829 patients were included in this study. The preoperative variables for this retrospective study included age, gender, ejection fraction (EF), renal function, diabetes, angina status, number of diseased vessels, urgency of the procedure, re-operation, chronic lung disease (COPD) and intraoperative variables such as IABP, inotropes, stroke and myocardial infarction and ejection fraction. This study concluded that advanced age and low EF are independent predictors of prolonged mechanical ventilation. Prolonged ventilation was defined as ≧24 h. Like patients with EF less than 50% increased the incidence of prolonged mechanical ventilation .Patients with age more than 70 years were more likely to be ventilated for longer duration(>24 hours) [20].

Objectives:

1. To evaluate preoperative and perioperative factors (gender, BMI, weight, advanced age >60, low ejection < 25%, fraction, smoking, diabetes, hypertension, cardiopulmonary bypass time, aortic cross camp time, intra operative blood transfusions, Creatinine and type of cardioplegia) associated with prolonged mechanical ventilation in Adults undergoing complex cardiac surgery.

2. To determine post-operative complications (pneumonia, Prolonged ICU stay and hospital mortality) in high risk patients requiring prolonged ventilation support.

3. To identify pre, intra and post-operative predictors of prolonged mechanical ventilation in adult cardiac patients.

MATERIALS AND METHODS

2.1 Study Design

Study design used was observational cross sectional.

2.2 Study Setting

This study was carried out at Rawalpindi Institute of Cardiology and Farooq Hospital Islamabad.

Prospective data was collected on daily basis through pre-operative, intra-operative and post-operative data sheet.

2.3 Study Duration
The duration of this study was 3 months from October-December 2023.

2.4 Study Participants
All adult patients undergoing cardiac surgery at Rawalpindi Institute of Cardiology and Farooq Hospital Islamabad were included in this study.

2.5 Sampling Techniques
The sampling technique used in this study was non-randomized convenient sampling.

2.6 Study Plan
- Study was conducted from October 2023 to December 2023.
- Synopsis was submitted to the research committee of BIHS on 30 September 2023.
- Presentation was given to Research committee of BIHS on asked date.
- Data was collected from respective departments at Rawalpindi Institute of Cardiology and Farooq Hospital Islamabad.

2.7 Data Analysis
Statistical analysis was performed using the SPSS.
P value less than 0.05 was considered significant
Univariate analysis was performed using independent sample T test to compare measurement data and CHI square test to compare categorical variables.
The relative risk factors obtained through the univariate analysis were the entered into logistic regression analysis and the independent risk factors for post-operative late extubation were identified.

2.8 Sampling Size
Sample size taken was 73 patients according to prevalence formula.

$n=Z^2 \times p\ (1-p) \div E^2$
Z=1.96
Confidence interval=95%
Error=5%
Prevalence (p) =5%

2.9 Sample Selection
Inclusion Criteria :
- All adult patients undergoing cardiac surgery.
- Coronary artery disease patients undergoing CABG.
- Patients undergoing valvular surgeries.
- Patients requiring congenital heart repair surgery (age greater than 18 years)
- Non-emergency cardiopulmonary bypass

Exclusion Criteria:
- All pediatric patients.
- Patients undergoing Re-do operations.
- Patients undergoing emergency cardiopulmonary bypass.
- Patients receiving preoperative mechanical circulatory support (IABP).
- Patients with an implanted pacemaker or implanted cardioverter and defibrillator.
- Patients with preoperative pulmonary function compromised.

RESULTS AND DISCUSSION
Results:
Table 1 Gender ratio of patients

	<24hr n=75	**>24hr n=10**
Female	16	4
	(80.0%)	(20%)
Male	59	6
	(90.85%)	(9.2%)

Table 1: illustrates gender ratio of patients between two groups. In group1 MV <24 hours there were 59 males and 16 females while in group 2 MV >24hrs there were only 4 males and 6 females

Figure 1 Gender ratio of patients

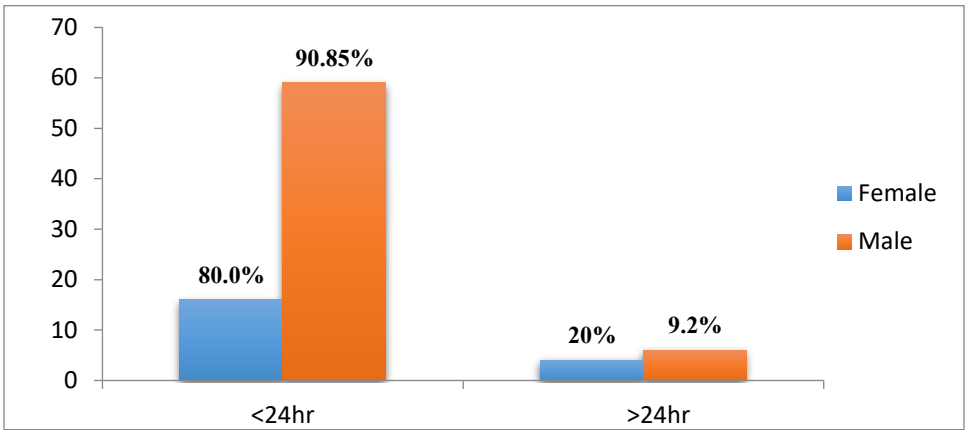

Table 2 Frequency of surgical procedure

	<24hr	>24hr
	n=75	n=10
CABG	48 (92.3%)	4 (7.7%)
Valvular	17 (81.1%)	4 (19.0%)
Congenital	10 (83.3%)	2 (16.7%)

Table 2 illustrates the surgical repair between two groups. In group1 MV <24 there were 48 (92.3%) patients who underwent coronary artery bypass grafting (CABG), 17(81.1%) of valvular repair and 10 (83.3%) patients with congenital heart disease repair. In group 2 there were 4 (7.7%) CABG patients, 4 (19.0%) with valvular repair and 2 (16.75%) with congenital heart surgery

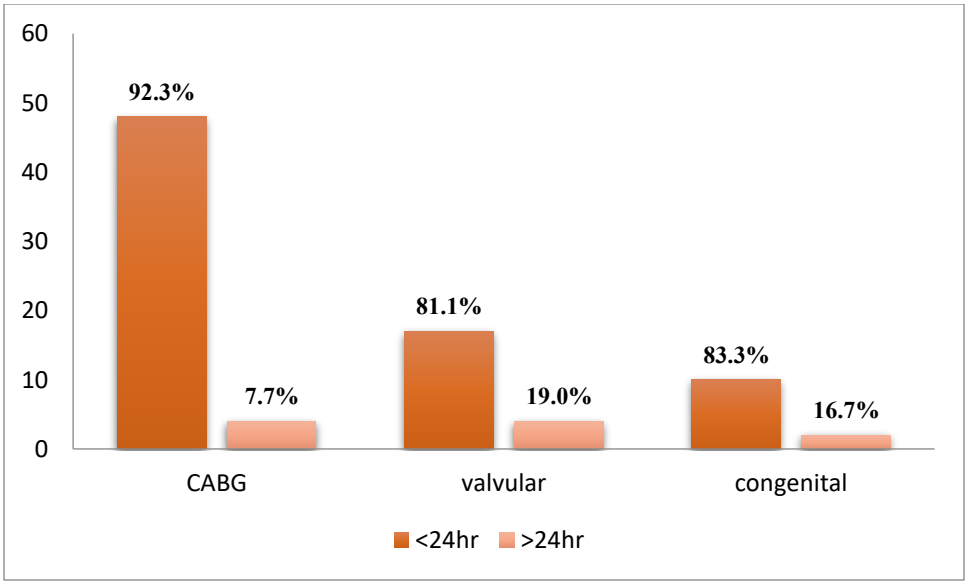

Figure 2 Frequency of surgical procedure

Table 3 Summary statistics: Comparison of categorical variables among normal MV duration and prolonged mechanical ventilation group

Variable		Normal ventilation(n=75)		Prolong Ventilation(n=10)		P value
Name	**Description**	**n**	**%**	**n**	**%**	**%**
Smoking	Yes	25	33.3%	0	0.0%	0.03%
	No	50	66.7%	10	100%	
Diabetes	Yes	24	32.0%	0	0.0%	0.03%
	No	51	68.0%	10	100%	
Hyper-tension	Yes	37	49.5%	4	40.0%	0.57%
	No	38	50.7%	6	60.0%	
Gender	Female	16	21.3%	4	40.0%	0.19%
	Male	59	78.7%	6	60.0%	
Age	<60%	55	73.3%	8	80.0%	0.65%
	>60%	20	26.7%	2	20.0%	
Cross clamp time	<80min	53	70.7%	6	60.0%	0.42%
	>80min	22	29.3%	4	40.0%	
Blood transfusions	Yes	25	33.3%	2	20.0%	0.39%
	No	50	66.7%	8	80.0%	
IABP	Yes	6	8.0%	0	0.0%	0.35%
	No	69	92.0%	10	100%	
Hospital Mortality	YES	5	6.7%	4	40.0%	0.001%
	No	70	93.3%	6	60.0%	
Pneumonia	Yes	1	1.3%	2	20.0%	0.003%
	No	74	98.7%	8	80.0%	
EF	<25%	3	4.0%	0	0.0%	0.76%
	>35%	25	33.3%	4	40.0%	
	>50%	47	62.7%	6	60.0%	
IABP during CPB	Yes	24	32.0%	0	0.0%	0.03%
	No	51	68.0%	10	100%	
Type of procedure	CABG	48	64.0%	4	40.0%	0.33%
	Valvular	17	22.7%	4	40.0%	
	Congenital	10	133.3%	2	20.0%	
Cardioplegia Type	Delnido	75	100.0%	10	100%	
	Crystalloid	75	100.0%	10	100%	
Bypass Time	<120min	53	70.0%	6	60.0%	0.42%
	>120min	23	30.7%	4	40.0%	

Table 3 illustrates the frequency of Pre Intra and post-operative variables age in groups (<60 and >60), gender ratio, smokers & Non- smokers, diabetics, hypertensive, CPB time (<120 or >120 mins), cross clamp time (<80 or >80 mins), frequency of surgical repair, type of cardioplegia Solution , Intraoperative Blood transfusion, EF, post op pneumonia and hospital mortality, The P value of smoker is 0.03%, diabetic 0.035%, hypertensive 0.579, gender ratio 0.194%, age 0.651%, cross clamp time 0.651% blood transfusions 0.395% , IABP 0.354%, surgical procedure 0.395% and bypass time 0.429 %

Table 4 Summary statistics: Comparison of numerical variables among Normal MV and prolonged MV group

Variable (n=75)		Normal ventilation			prolong ventilation (n=10)			
Name	**Unit**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**	**P valve**
BMI		24.565	24.300	4.2421	21.66	20.200	4.7063	0.048
Age	yr	49.65	50.0	13.820	37.0	37.0	188233	0.011
Weight	Kg	66.90	68.00	12.760	59.00	53.00	18.243	0.085
BSA		2.802	1800	7.6036	1.636	1.550	0.305	0.613
Creatinine	mg/dl	0.983	0.900	2.882	0.780	0.800	0.2044	0.334
HB	mg/dl	13.456	13700	1.826	12.26	14.100	2.6048	0.073
CPG Volume		10.154	1026.0	173.96	8.850	795.0	275.136	0.042
MV		5.09	5.00	2.406	102.0	31.00	97.980	0.00
Bypasstime	min	105.18	98.0	4.754	143.8	95.0	89.108	0.031
CXL Time	min	69.57	68.0	37.080	81.0	72.00	43.899	0.373
ICU Stay		4.51	4.00	2.538	9.40	11.0	5.758	0.000

Table 4: illustrates the comparison of pre, intra and post-operative variables mechanical ventilation. In Non PMV p value for significant variables is BMI (p-value 0.048), Age (p-value 0.011), weight (p-value 0.085) Hb (p-value 0.073), Cardioplegia volume (p-value 0.042), MV (p-value 0.00 and ICU stay (p-value 0.000)**Table 5** Multivariate regression results for independent risk factors

Variables	ODDs ratios	95%confidence interval	p value
Age	0.942	0.898-0.989	0.015
Smoking	323094	000-0.00	0.998
Diabetes	31675	0.00-0.00	0.998
Gender	0.407	0.102-1.618	0.202
EF	1.044	0.317-3.433	0.944
IABP	3167597	000-0.00	0.998
CPB Time	1.001	1.00-1.021	0.042
Cross Clamp Time	1.007	0.991-1.023	0.372
Pneumonia	0.054	0.004-0.664	0.023
Hospital Stay	0.107	0.023-0.508	0.005
Cardioplegia Volume	0.997	0.993-1.000	0.0048

Table 5 Illustrates the Multivariate analysis for prediction of risk factors for prolong MV. Significant variable illustrated by comparison of pre, Intra and post-op variable using independent sample T test and CHI square test were analyzed using regression analysis. P value < 0.05 was considered significant. Odds ratio, confidence interval and P value for identified risk factors are age odd ratios (0.942), 95% CI (0.898-0.980), p-value (0.015%), CPB time odds ratio (1.001), CI (1.00-1.022), p-value (0.042), pneumonia odds ratio (0.054), CI (0.004-0.664), p-value (0.024) , hospital stay odds ratio (0.107), CI (0.0230-0.508), p-value (0.005), Cardioplegia volume odds ratio(0.997), CI (0.993-1.000),P value(0.0048).

Table 6 post-operative pneumonia

	<24hr	>24hr
	n=75	n=10
Yes	1 (33.3%)	2 (66.7%)
No	74 (90.2%)	8 (9.8%)

Table 6: illustrates the post-operative pneumonia complication with total 3 patients showing pneumonia. Among them 2 patients were kept on ventilator for >24 hour while one patient with pneumonia was extubated within 24 hours

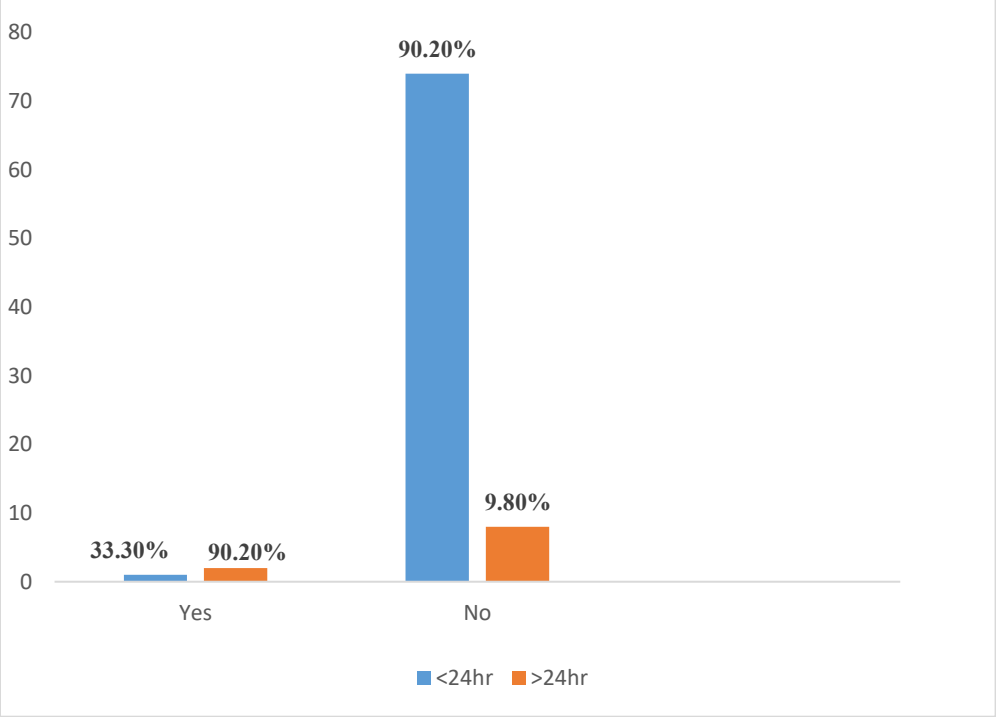

Figure 3 Bar chart representing post-operative pneumonia

Table 7 Post-operative In hospital mortality

	<24hr	>24hr
	n=75	n=10
Yes	5 (55.6%)	4 (44.4%)
No	70 (92.1%)	6 (7.9%)

Table 7 illustrates the post-operative hospital mortality in patients between two Groups. Total of 10 patients with in hospital mortality showed 5 patients exhibited post-operative in hospital mortality in group 1 while 4 patients in Group 2 MV >24hr exhibited post-operative hospital mortality

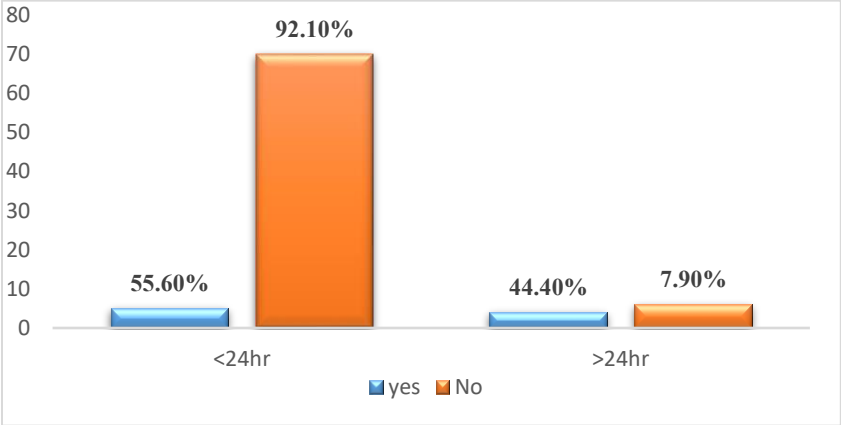

Figure 4 bar chart representing post-operative hospital mortality

Discussion

In this study, we found that 10 patients out 85 included in the study undergoing complex cardiac surgery who survived to hospital discharge received mechanical ventilation of >24 hours. The main aim of our study was to identify the risk factors associated with PMV in adult patients undergoing cardiac surgery. We divided duration of MV in two groups Non PMV <24 hrs and PMV >24hrs. In our study the risk factors for PMV identified are age, CPB time, cardioplegia volume, pneumonia and ICU stay. Mostly patients wean off from ventilation within 12-24 hours however in some patients prolonged mechanical ventilation is required with ventilation time exceeding more than 24 hours or those with one or more failed attempt to extubated leading to cumulative endotracheal use of at least 24 hours intubation [11]. There have been many attempts to identify high risk patients, as well as to identify intraoperative variables that may contribute to poor outcomes [15]. Previous studies are carried our mostly in pediatric patients however our study intended to identify these risk factors in adult population.

The results of our study revealed significant association between age and mechanical ventilation support with a P value < 0.01. This finding aligns with existing literature. Feng Y et al (2009) conducted a study focusing on age and duration of mechanical ventilation. The results of this study revealed that age and duration of MV are strongly associated with mortality and post hospital disposition[34]. Our results were also supported by Branca P et al (2001) who studied factors associated with prolonged mechanical ventilation following coronary artery bypass surgery. He concluded in his study that the risk of prolonged postoperative ventilation increases with increasing age [35]. similar findings were also observed by Rahimi S (2023). Ji Q et al (2010) in his study revealed that age (>65 years) was one of the major risk factors contributing to late extubation[12, 36].

In this study, our findings supports that increasing cardiopulmonary bypass duration positively correlates with mechanical ventilation duration. Our results revealed intraoperative variable cardiopulmonary bypass time to be statistically significant (p value 0.04) and was identified as a risk factor for prolonging mechanical ventilation support in post bypass patients. Similar findings are observed in previous studies that strongly supports our result. Siddiqui et al. studied Risk factors of prolonged mechanical ventilation following open heart surgery. The findings of his study concludes that prolonged CPB time (≥120 minutes), was one of the main risk factor that correlates with PMV duration[16]. studies by Alrddadi et al. (2005) who studied risk factors for prolonged MV in congenital patients [28]and Szekely et al (2002) who also studied intra and post-operative risk factors in pediatrics Both of the studies found strong association between cardiopulmonary bypass time and delayed extubation[6].

The findings in the post-operative analysis reveal a statistically significant association between pneumonia and duration of mechanical ventilation (p value 0.023). This observation aligns with research carried out by Shi S et al (2008) who studied Perioperative Risk Factors for Prolonged Mechanical Ventilation Following Cardiac Surgery in Neonates, concluded in his study that pneumonia was a significant and independent risk factor for prolonged mechanical ventilation [19] another study carried out by Polito A et al(2011) who studied Perioperative factors associated with prolonged mechanical ventilation after complex congenital heart surgery, also supported our result, concluded that pulmonary complication was significantly associated with the greater odds of needing at least 7 days of mechanical ventilation [32]. Wong D T et al (1999) studied Risk Factors of Delayed Extubation, Prolonged Length of Stay in the Intensive Care Unit, and Mortality in Patients Undergoing Coronary Artery Bypass Graft with Fast-track Cardiac Anesthesia also reported pneumonia as a risk factor for prolonged MV[37].

The intraoperative administration of Cardioplegia volume has emerged as a significant risk factor influencing the Mechanical ventilation duration (p value 0.048). Our result was highly supported by Carrel T et al (2000) who studied Low Systemic Vascular Resistance After Cardiopulmonary Bypass concluded in his study that total cardioplegia volume infused was a predictive factor for early postoperative vasoplegia (persistent low systemic vascular resistance) low SVR did not affect the hospital mortality but was the cause for delayed extubation and prolonged stay in ICU [19]. Our study aligns with carrel T et al in context of clinical significance of cardioplegia volume with mechanical ventilation duration.

Our research study has identified significant association between ICU stay and post-operative mechanical ventilation duration. This analysis was supported by kaier et al.(2019) Who studied Impact of mechanical ventilation on the daily costs of ICU care concluded that mechanical ventilation is associated with a substantial increase in the daily costs of ICU care [38] .Our findings were also reinforced by azarfarin et al.(2014)who studied Factors influencing prolonged ICU stay after open heart surgery came to the conclusion that Duration of intubation, units of transfused blood in ICU can be considered as independent predictors of prolonged ICU stay [39].Our rulings were also strengthen with another artifact by shi et al.(2008) studied Perioperative risk factors for prolonged mechanical ventilation reveled that Prolonged mechanical ventilation after cardiac surgery in children is associated with a high postoperative morbidity and mortality, as well as increased ICU and hospital resource utilization[19].

DEDICATION

We humbly dedicate this piece of work to our beloved parents and honorable teacher .Their unwavering love, encouragement, support and guidance help us to achieve our goal. Without their care, support and prayers this project would not have been made possible.

DECLARATION

I hereby declare that the work presented in this report is my own effort "study of risk factors during cardiopulmonary bypass on post-operative mechanical ventilation duration in adult cardiac surgery" for the partial fulfillment of bachelor degree in Cardiac perfusion Technology, The Bashir Institute of Health Sciences is an authentic record of my own work during the period from October 2023 to December 2023, under the direct supervision Miss Abeera Khalid of Bashir Institute Of Health Sciences. I have not submitted the matter embodied in this thesis for the award of any degree or diploma.

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Conclusions:

The present study strongly suggests that advanced Age, prolonged cardiopulmonary bypass time, cardioplegia volume, Post-operative pneumonia and ICU stay are risk factors for PMV in adults undergoing surgical heart repair using cardiopulmonary bypass technique.

Recommendations:

This study is based on a two different centers private and government, local practice patterns, and extreme small size of cases, which might impede the application of present results to other institutions. Also in previous studies number of studies are carried are in pediatric patients with limited studies on adult population and only focusing on CABG patients. It is recommended to conduct more studies in adult population with a large sample size to better evaluate risk factors.

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