PUBLIC HEALTH RESEARCH

Risk Factors for Prolonged Mechanical Ventilation Post Cardiac Surgery in Al Thawra Hospital, Sana'a, Yemen

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ABSTRACT

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Introduction Prolonged mechanical ventilation among cardiac surgery patient has been found to be correlated with negative clinical outcome and increased healthcare resources utilization. Prolonged mechanical ventilation (PMV) was defined as the accumulative duration of 24 hours or more of postoperative endotracheal intubation starting from transfer of the patient to cardiac ICU. This study is aimed to identify the risk factors preoperative, intra operative and postoperative for prolonged ventilation among cardiac patients in AL-Thawra Modern General Hospital (TMGH).

Methods Observational study design was conducted during a two-month period (from 1 August 2014 to 30 September 2014). It was among 70 patients who were admitted to cardiac surgery intensive care unit in Al-Thawra Modern General Hospital and selected by convenient sampling. The soci-demographic characteristic and clinical patient data were collected using short questionnaire developed by researcher. All patients had the same anesthetic and postoperative management. Statistical analysis was performed with SPSS version 20 and using bivariate analysis and multivariate logistic regression. The p-value of < 0.05 was found to be statistically significant.

Results Incidence of prolonged mechanical ventilator post cardiac surgery was 37.1% (26/70) through bivariate analysis, multivariate logistic regression. Low Ejection fraction of Left Ventricle was inversely related to mechanical ventilation time (AOR= 0.872) with 95% confidence interval [0.790 - 0.963], hemodynamic instability were associated with prolonged mechanical ventilation time (AOR=16.35) with 95% confidence interval [2.558 - 104.556].

Conclusion Low ejection fraction of Left Ventricle and Hemodynamic Instability post operation were identified risk factors for prolonged mechanical ventilation post cardiac surgery.

Keywords Risk factors - Cardiac surgery - Ventilator.

INTRODUCTION

All patients undergoing open heart surgery have some elements of postoperative pulmonary dysfunction ,thus they will have minimal impairment in oxygenation and ventilation.[1,3] The number of patients undergoing cardiac surgery has estimated that more than 30,000 and 10,000 operation each year in U.K, Greece respectively. In addition, the national center for health statistics estimates that in 2007, In the United States of America, a total of 514,000 open heart operations coronary artery bypass grafting (CABG) and valve replacement surgery were performed.[4]

The prolonged mechanical ventilation (PMV) was defined as the accumulative duration of 24 hours or more of postoperative endotracheal intubation starting from transfer of the patient to cardiac ICU.[2] Prolonged mechanical ventilation after cardiac surgery increases the rate of mortality and morbidity as well as hospitalization cost.[11] Prolonged mechanical ventilation after cardiac surgery is related to post operative complications and patients morbidity.[4] Moreover, prolonged mechanical ventilation leads to increasing ICU stay, higher costs on the patients.[5] If patients breathe without assistance they need less intervention and the cost of both equipment used and nursing care decrease drammaticlly.[11]

Prolonged mechanical ventilation (PMV) is well recognized complication of cardiovascular surgery and incidence has been reported from 3% to 22% [2]. Early tracheal extubation is common goal of post operative recovery after cardiac surgery.[9] nowadays, the need for high quality and cost effective care of surgical patient lead to an increased focus on methods for decreasing length of ICU and total hospital stays.[12]

Aim of our study was to identify the risk preoperative and intraoperative and post operative factors for prolonged mechanical ventilation among cardiac surgery patient. The early identification of high risk patient could contribute to decreasing the rate of mortality and morbidity resulting in prolonged mechanical ventilation post open heart surgery.[1]

METHODS

Sampling

A prospective observational study was followed. This study was conducted at Al Thawra Modern General Hospital (TMGH) in cardiac center. This center is known as the largest cardiac center in Yemen. It started working on operations in 2005. It is reportedly performs approximately 800 to 1000 open heart operations annually.

All patient undergoing cardiac surgery including valve replacement, coronary arteries bypass graft (CABG) and congenital anomalies.

The sample of this study was a convenient sample of a period of two months including both sex male and female patients available during the time of data collections. Sample size was calculated by using Openepi, Sample size for comparing two means from previous study (Shahbazi S. el at. predictive factors for delayed extubation in the intensive care unit after coronary artery bypass grafting).[11] Sample size is 58 through comparing two means according Openepi program out of 120 patients were admitted to the 12-bed cardiac surgery ICU of the hospital. 70 of who met the inclusion criteria of our study. Out of the 120 admitted patients, 6 cases expired and 3 of which met the inclusion criteria during study period. The criteria for inclusion were that patient who had undergone surgery for coronary artery bypass graft (CABG), valve replacement and congenital heart anomalies for adult patient were included under this study. Patient age is $\geq$ 18 years old. All the patients had undergone for the same anaesthesia procedure and cardiopulmonary bypass (CPB). Similarly, all the patients under this study had the same post operative management. On the other hand, the exclusion criteria of this study was that any patient was under Ventilating before surgery, Intraortic balloon pump patient before operation, difficult intubation: (intubation difficult if a normally trained a anaesthesiologist need more than three attempts or more than 10 min for a successful endotracheal intubation) or had an emergency procedure was ruled out from our sample.

Data Collection

The data collection during a two-month period (from 1 August 2014 to 30 September 2014) was carried out through using a questionnaire to obtain socio-demographic (age, sex, body mass index, residence, smoking, chewing Qut and educational level) and clinical characteristic (diabetes mellitus, hyperlipidemia, ejection fraction, COPD, renal failure, type of procedure, duration of cardiopulmonary bypass, duration of surgery, hemodynamic instability, excessive bleeding and mechanical ventilator duration). This questionnaire was prepared by the researcher to identify the relative risk factors and independent risk factors for prolonged ventilation post open heart surgery and also depended on the EuroScore and (STS) score during proper questionnaire. Ethical approval permission to conduct this study was obtained from the ethical committee at the University of Science and Technology MECA NO: (2014/10).

Definition of Variable

Dependent variable:

Mechanical ventilation duration

- Prolonged mechanical ventilation: accumulative duration of 24h or more of post operative endotracheal intubation

starting from transfer of patient to cardiac ICU.

- Non prolonged ventilation: accumulative duration of less than 24h of post operative endotracheal intubation.

Independent variables:

Age was defined as documented age of any patient admitted in our study and met inclusion criteria more than 18 years.

History of chronic obstructive pulmonary disease (COPD) was defined as slowly progressive obstruction of airflow into and out of the lungs or history of emphysema or chronic bronchitis necessitating the use of bronchodilator inhaler or steroids or previous spirometery report revealing COPD.[2]

Ejection fraction was defined as those patients with an ejection fraction, whereas those with an ejection fraction of less than 50% were classified as having heart failure with reduced ejection fraction .[13]

Body- mass index (the weight in kilograms divided by the square of the height in meters) of 30 or more.[12]

Hemodynamic instability Systolic blood pressure increase by more than 20% or to over 160mmHg, heart rate changes by more than 20% in either direction or to over 140, acute need for vasoactive medications, arrhythmias develop or become more frequent, respiratory rate increase more than 10 breaths/min.[3]

Type of surgery was defined surgical operations were divided into two groups as simple and complex procedures the simple open heart procedures included isolated CABG, isolated single valve surgery, repair of atrial septal defect and repair of simple ventricular septal defects, combined CABG and valve operations.[10]

Preoperative renal failure was defined as preoperative serum creatinine level of 150(μmol/L) or more.[2]

Statistical Analysis

Statistical analysis was performed with SPSS version 20 using the following statistical tests:

- The data was summarized as median and inerquartile range for continues variables and frequencies and percentages for categorical variables.
- Bivariate analysis and multivariate logistic regression were used to identify the significant of association between the risk factors and the outcomes. The p value< 0.05 was considered as statistically significant.
- The Bivariate analysis performed using the Chi-sqaure test, Fisher exact test to compare categorical variables. Mann-whitney U test was also used to compare continuous variables with the outcome.
- Multivariate logistic regression. All Significant variables obtain from bivarite analysis entered into logistic regression analysis to observe the independent risk factor for PMV.

RESULTS

A total 70 patients undergoing cardiac surgery how met inclusion criteria in our study, 26 (37.1%) patients had prolonged mechanical ventilation for more than 24 hours and 44 (62.9%) patients had non prolonged mechanical ventilators extubation within 24 hours post cardiac surgery. 42 (60%) underwent valve replacement, 21 (30%) underwent CABG, 5 (7.1%) had congenital heart surgery, and 2 (2.9%) combined surgery.

The median (IQR) time between received patient to ICU post cardiac surgery and extubation in the prolonged mechanical ventilation group was 42 (32-51) hours more than non prolonged mechanical ventilation group with median (IQR) time 13.5 (10.25-16) hours. Table 1 Shows the socio demographic characteristic, forty sixe male (65.7%) and twenty four female (34.3%). The median (IQR) patient age was 55.5 (34-62.5) years old and most patients had primary education and less than 37 (52.9%), 39 patients (52.9%) came from rural areas whereas 31 (47.1%) came from urban area. Table 2 shows the clinical characteristic, most patient not diabetic 49 (70%) also most patient not COPD patient 66 (94.3%) and the median (IQR) patient ejection fraction was 55.5 (45-69.25), and 27 (38.6%) was hemodynamic instability, 43 (61.4%) was hemodynamic stable. Table 3 shows Comparison of risk factors between Prolonged and Non prolonged mechanical ventilator groups. The result of the bivariate analyses are: age, gender, preoperative ejection fraction, postoperative bleeding, intraoperative cardiopulmonary bypass time, intraoperative operation time, postoperative hemodynamic instability, type of surgery was significant p.value was < 0.05. All the above mentioned variables were relative risk factors for prolonged mechanical ventilator. The relative risks factors obtained from bivariate analyses were then entered into multivariate logistic regression to observe independent risk factors. Table 4 reveals independent risk factors for prolonged mechanical ventilator including hemodynamic instability (adjusted odds ratio [AOR] = 16.35 with 95% confidence interval [2.558 - 104.556]) probabiliy of occurence prolonged mechanical ventilation with hemodynamic instable 16 time more than patient with hemodynamic stable. Preoperative ejection fraction (adjusted odd ratio [AOR] = 0.872 with 95% confidence interval [0.790 - 0.963]) probability of occurrence prolonged mechanical

ventilation with low ejection fraction patients near one time (0.8) more than another group with normal ejection fraction.

Table 1 Socio demographic characteristic of the patients (n=70)

	Median (IQR)	Freq (%)
Age	41(31-57)	
BMI(kg/m²)	22(17.5-24)	
Gender		
Male		46(65.7)
Female		24(34.3)
Resident		
Urban area		31(44.3)
Rural area		39(55.7)
Education		
Primary school		37(52.9)
Secondary		16(22.9)
University		17(24.3)
Smoking		
Yes		33(47.1)
No		37(52.9)

Table 2 Clinical characteristic of the patients (n=70)

	Median (IQR)	Freq (%)
DM		
Yes		21(30)
No		49(70)
COPD		
Yes		4(5.7)
No		66(94.4)
E.F (%)	55.5(45-69.25)	
Creatinin level (μmol/L)	114.5(90-135.25)	
Duration of surgery (min)	200(180-262.5)	
Duration of M.V (hour)	16.5(12-34.75)	
Duration of CPB (min)	111.5(92-150)	
Type of surgery		
CABG		21(30)
Valve		42(60)
Combined		2(2.9)
Congenital		5(7.1)
Bleeding	326.5(2590-455)	
HDI		
Yes		27(38.6)
No		43(61.4)

Note: *COPD: Chronic Obstructive Pulmonary Disease, CPB: Cardio Pulmonary Bypass (min), M.V: Mechanical Ventilation duration(hour), Duration of surgery (min), E.F: Ejection Fraction of Left Ventricle, D.M: Diabetes Mellitus, CABG: Coronary Artery Bypass Graft, HDI: Hemodynamic Instability*

Table 3 Bivariate analysis comparison of risk factors between prolonged and non prolonged mechanical ventilator groups

	PMV n=26	Non PMV n=44	RR	p-value
Gender			2.87	0.010**
Male	22(47.8%)	24(52.2)%		
Female	4(16.7%)	20(83.3%)		

Education			N.A	0.532**
Primary School	16(43.2%)	21(58.8%)		
Secondary	5(13.2%)	11(68.8%)		
University	5(29.4%)	12(70.6%)		
Age (years)	55.5(34-62.5)	35.5(29-51.5)	N.A	0.030*
BMI (kg/m²)	22(17.37-24.5)	22(17.95-24)	NA	0.75*
COPD			0.660	1.00***
Yes	1(25.6%)	3(75%)		
No	25(37.1%)	41(62.1%)		
E.F (%)	46.5(42.75-54)	62(52.5-71.5)	N.A	0.001*
D.M			1.458	0.235**
Yes	10(47.6%)	11(52.4%)		
No	16(32.7%)	33(67.3)		
Smoking			1.308	0.388**
Yes	14(42.4%)	19(57.6%)		
No	12(32.4%)	25(67.6%)		
Resident			0.666	0.211**
Urban area	9(29%)	22(71%)		
Rural area	17(43.6%)	22(56.4%)		
Preserum criatnen (μmol/L)	118(101-145.5)	110(88.5-131.5)	N.A	0.132*
Duration of CPB (min)	122(109.7-180)	105(90-130)	N.A	0.003*
Duration of surgery (min)	250(207-300)	190(180-227)	N.A	0.001*
HDI			4.323	0.001**
Yes	19(70.4%)	8(16.3%)		
No	7(16.3)	36(83.7%)		
Bleeding(ml/h)	430(250-792.5)	320(250-420)	N.A	0.039*
Type of surgery			N.A	0.017***
CABG	12(57.1%)	9(42.9%)		
Valve	11.(26.2%)	31(73.8%)		
Combined	2(100%)	0(0.0%)		
Congenital	1(26%)	4.(80%)		

* Mann-Whitney Test, ** Chi-Square, *** Fisher Exact Test, NA: not available, **RR**: Relative Risk

Table 4 Multivariate regression results

	AOR value	95% CI	P value
E.F (%)	0.872	0.790-0.963	0.007
HDI	16.35	2.558-104.556	0.003
Bleeding	1.003	0.999-1.006	0.144
Age	0.982	0.917-1.051	0.596
Duration of CPB (min)	0.983	0.958-1.008	0.176
Gnder	1.067	0.157-7.236	0.947
Duration of surgery (min)	1.003	0.974-1.034	0.824

DISCUSSION

Incidence of prolonged mechanical ventilator post cardiac surgery in our study was (37.1%).This is on the upper side of the range reported in the published. The main risk factor of our study was one preoperative risk factor (ejection fraction) and one post operative risk factor (hemodynamic instability) for prolonged mechanical ventilator. Prolonged mechanical ventilation defined as cumulative ventilation time of more than 24 hours believing that 24 hours is a sufficiently long time for hemodynamic stabilization and to off-set the deleterious effects of surgery and cardiopulmonary bypass if used.[1]

Independent risk factor for PMV including low ejection fraction preoperative (adjusted odd ratio [AOR] = 0.872 with 95% confidence interval [0.790 - 0.963]) and postoperative hemodynamic instability associated with PMV (Adjusted odds ratio [AOR] = 16.35 with 95% confidence interval [2.558 - 104.556]). The relationship between ejection fraction and the duration of the mechanical ventilation is an inverse relationship. When low the E.F 46.5 (42.75 - 54) in PMV group, the increase

the mechanical ventilation time. Also when elevated the E.F 62 (52.5 - 71.5) in non PMV group, the decrease mechanical ventilation time, ejection fraction major risk factor are for prolonged mechanical ventilation.

The hemodynamic instability postoperative also was found as a major risk factor for prolonged mechanical ventilation in our study. The first hemodynamic instability noted in the patient who is not tolerating weaning very well, tachypnea is the first clinical sign of ineffective weaning and there is another sign agitation, diaphoresis, systolic blood pressure increasing by more than 160mmHg. heart rate changes to over 140, acute need for vasoactive medications, arrhythmias develop or become more frequent, increases respiratory rate increases more than 10 breath/min, Pao_2 falls to less than 60 torr wit FIO_2 90%, PCO_2 rises above 50 torr with respiratory acidosis (PH <7.30).[2] Many of risk factors like BMI and education level, resident, D.M, COPD, smoking, creatinine level did not have significant p value in our study.

We need in our center to develop a system for identifying high risk patients so that preoperative planning could be done to modify the risk factors and use (Euro score and STS score) Euro Score for stratification of the risk of mortality. These scores only predict the risk of mortality and provide no information about the risk of prolonged ventilation. The Society of Thoracic Surgeons has developed a risk model for predicting prolonged ventilation Post cardiac surgery the STS scoring systems is much more comprehensive. Also early identification of high risk patient contribute to more effective allocation of limited healthcare resources and development preemptive strategies and good planning of operative list, should use high quality and cost effective care methods for open heart patients to decrease length of ICU and hospital stays, there are more problems if patient PMV post open heart increase mortality and morbidity, ICU Loss, hospital Loss, ICU infection, loss cardiac teams times to treat complication and increase negative outcome.

Recommendations

Good diagnosis and good assessment are needed to identify heart contractility (% E.F) because there is inverse relationship between ejection fraction and the duration of the mechanical ventilation. Any patient with low E.F needs good medical management before operation to prevent PMV post surgery.However patient with E.F lees than 30% need medical management only. When patient transferred to ICU post surgery, he needs close observation to decrease hemodynamic instability.

The ICU team needed to be trained (doctor and nurse and respiratory therapist) to do good intervention to prevent HDI. Keeping patient with normal hemodynamic by use all medication helps to make early extubation possible.

Further research is recommended with high sample size and to illustrate other factors that could be risk factors of prolonged mechanical ventilation post cardiac surgery.

CONCLUSION

Prolonged mechanical ventilator in our study was 37.1%. Low ejection fraction of Left Ventricle and Hemodynamic Instability post operation were identified risk factors for prolonged mechanical ventilation post cardiac surgery. Good assessment and diagnosis are important in preventing prolonged mechanical ventilation.

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