RISK FACTORS OF VENTILATOR - ASSOCIATED EVENTS AFTER OPEN-HEART SURGERY AT VIETNAM NATIONAL CHILDREN'S HOSPITAL

Pham Thi Thu Hien[1], Tran Minh Dien[2], Le Kien Ngai[2]
1. Nghe An Maternity - Pediatric Hospital,
2. Vietnam National Children's Hospital

ABSTRACT

Objective: *To find out the rick factors of VAE in patients after open-heart surgery.* ***Subjects and methods:*** *A case-control study, 380 patients after open-heart surgery requiring mechanical ventilation ≥ 2 days at Vietnam National Children's Hospital from July 2019 to June 2020.* ***Results:*** *By using both univariate analysis and multiple logistic regression analysis, age < 1 month (OR: 3,8; 95% CI: 1,2-11,8), cardiopulmonary bypass time > 145 minutes (OR: 3,9; 95% CI: 1,3-12,3;), mechanical ventilation time > 7 days (OR: 22; 95% CI: 5,6-89,7) were found to be rick factors for VAEs.* ***Conclusion:*** *Age < 1 months, cardiopulmonary bypass time > 145 minutes, mechanical ventilation time > 7 days were rick factors of VAEs in patients after open-heart surgery.*

Keywords: *Ventilator-associated events (VAE), open-heart surgery, rick factors.*

1. INTRODUCTION

Heart surgery, especially open-heart surgery with external circulation, can cause an inflammatory reaction and lead to lung damage, especially in the postoperative period where the patient has to be ventilated, hemodynamic instability. Ventilator-associated pneumonia (VAP) has been used for monitoring in ventilator-associated patients. However, some limitations of VAP surveillance are the absence of gold standards and clinical criteria for non-sensitive and nonspecific diagnostics. The CDC has proposed a Ventilator-associated event (VAE) monitoring definition to address the limitations of VAP [1].

Ventilator after open-heart surgery is associated with factors before surgery, in real surgery and after surgery. Factors before surgery are age, weight, disease status ... Factors in surgery are the time to run Cardiopulmonary bypass, time to pair the aorta, sternum exposure ... Factors after surgery are ventilator duraten, postoperative bleeding, vasomotor use, acute renal failure, low cardiac output syndrome, endotracheal re-intubation, blood transfusion, fluid overload. All of these factors may be risk factors for VAE. The identification of the risk factors of VAE is essential to providing preventive measures as now the prevention orientation is shifting from only infection prevention (VAP) to the prevention of all complications in ventilator-associated patients in general (VAE).

Received: October 15th, 2020
Accepted: November 25th, 2020
Corresponding author: Pham Thi Thu Hien
Address: Nghe An Maternity - Pediatric Hospital.

However, research on VAE is limited, especially in patients after open-heart surgery. Therefore, this topic is carried out with the goal: *Determining the risk factors of VAE in patients after open heart surgery at the Vietnam National Children's Hospital.*

2. STUDY SUBJECTS AND METHODS

2.1. Study subjects: Patients after open-heart surgery using ventilator for> 2 days at the Vietnam National Children's Hospital from July 2019 to June 2020.

2.2. Study method: Case study. Disease group (VAE group): meets the VAE standard for children of CDC 2019. Control group (non-VAE group): using ventilator for> 2 days does not meet VAE standards of CDC 2019.

Definition of VAE: An event related to ventilator in a child defined when a child ventilated with a deteriorating respiratory condition after a period of stability or improvement. Patient has period of stable or improved ventilation, defined by> 2 stable calendar days or with minimal FiO2 or MAP reduction. The steady-state period is defined as a 2-calendar-day period immediately following the minimum daily increase in MAP or FiO2 [1].

Risk factor variables: age, heart failure classification, time for run Cardiopulmonary bypass, time for pairing aortic, sternum exposure, RACHS-1, time of ventilation, use of vasomotor, use of muscle relaxants, blood transfusion, endotracheal reset, acute kidney Injury (AKI), low cardiac output syndrome.

2.3. Data analysis and processing: Data entry and analysis using SPSS 20.0 software. Calculate the odds rate (OR), 95% confidence interval (95% CI), and test the OR value. Multivariate regression analysis for related variables in univariate analysis has statistical significance (p <0.05).

3. RESULTS

During the study period from July 2019 to June 2020, 380 patients underwent open-heart surgery using ventilator for> 2 days, the male/female rate was 1.5/1. Median age is 3 months, median weight is 4.3 kg. On ventricular septal heart disease accounted for the highest rate of 23.2%, followed by arterial stem displacement (15.3%), the right ventricle of the two ways out (12.4%) were the most common congenital heart diseases in this study. There were 32 patients with VAE and 348 patients without VAE.

Table 1. Factors before surgery

Factor		With VAE	Without VAE	P
		(n=32)	(n= 348)	OR (95%CI)
Age	<1 month	20	118	0.001
	>1 month	12	230	3.2 (1.5-6.8)
Heart failure rating	3-4	11	53	0.006
(Ross)	1-2	21	295	2.9(1.3-6.4)

Comment: There was a statistically significant association between age <1 month, moderate severe heart failure (Ross 3-4) and VAE.

Table 2. Factors in surgery

Factor		With VAE	Without VAE	p; OR (95%CI)
Time for run Cardiopulmonary bypass	>145	18	74	<0.001
	<145	14	274	4.8 (2.3-10)
Time for pairing aortic	>100	11	86	0.21
	<100	20	257	1.6 (0.8-3.6)
Sternum exposure	Yes	10	14	<0.001
	No	22	334	10.8 (4.3-27.2)
RACHS-1	>3	17	65	<0.001
	<3	15	283	4.9 (2.3-10.4)

** Only counted in patients with aortic pairing.*

Comment: There was a statistically significant correlation between the time of Cardiopulmonary bypass> 145, sternum exposure, RACHS-1> 3 with VAE.

Table 3. Treatment factors after surgery

Factor		With VAE	Without VAE	p; OR (95%CI)
Time of ventilator	>7	28	45	<0.001
	2-7	4	303	47 (16-140)
Use of vasomotor *	>2 types	6	10	<0.001
	<2 types	26	333	7.7 (2.6-22.8)
	VIS48 hours >7.5	22	69	<0.001
	VIS48 hours <7.5	10	274	8.7 (4-19)
Use of muscle relaxants	Yes	26	122	<0.001
	No	6	226	8 (3-20)
Blood transfusion	Yes	29	212	0.001
	No	3	136	6.2(1.8-20.7)
Endotracheal re-intubation	Yes	10	41	0.002
	No	22	307	3.4(1.5-7.7)

** Calculated only in patients using vasomotor*

Comment: There was a statistically significant correlation between ventilator time> 7 days, use> 2 types of vasomotor, VIS48 hours> 7.5; using muscle relaxants, blood transfusions and endotracheal re-intubation with VAE.

Table 4. Complications factors after surgery

Factor		With VAE	Without VAE	p; OR (95%CI)
Acute kidney injury	Yes	11	45	0.001 3.5 (1.6-7.8)
	No	21	303	
Low cardiac output syndrome	Yes	9	39	0.006 3.1 (1.3-7.2)
	No	23	309	

Comment: There is a relationship between acute kidney injury, low cardiac output syndrome and VAE.

Table 5. Multi-variable regression analysis of risk factors for VAE

Factor (Independent variables)	Regression coefficient	P	OR	95%CI
Age <1 month	1.345	0.019	3.8	1.2-11.8
Severe moderate heart failure	0.562	0.341	1.8	0.6-5.6
Time for run of Cardiopulmonary bypass > 145 minutes	1.369	0.019	3.9	1.3-12.3
Sternum exposure	0.225	0.755	1.3	0.3-5.1
RACHS1 >3	-0.51	0.933	0.9	0.3-3.1
Time for ventilator > 7 days	3.107	0.000	22	5.6-89.7
Use of vasomotor> 2 types	0.647	0.386	1.9	0.4-8.2
Index VIS48 hours > 7.5	0.471	0.418	1.6	0.5-5.0
muscle relaxants	0.904	0.138	2.5	0.7-8.2
Blood transfusion	-0.028	0.972	1	0.2-4.7
Endotracheal re-intubation	0.343	0.563	1.4	0.4-4.5
Acute kidney injury	-0.128	0.836	0.9	0.3-3
Low cardiac output syndrome	-0.662	0.276	0.5	0.2-1.7

Comment: Age <1 month, time for run of time for ventilator > 7 days are risk factors through multivariate regression analysis.

4. DISCUSSION

In our study, children <1 month old were the factors related to the occurrence of VAE (OR: 3.2; 95% CI: 15-6.8; p = 0.001). Mean severe heart failure in the VAE group was higher than in the non-VAE group, the difference was statistically significant (OR: 2.9; 95% CI: 1.3-6.4; p = 0.006). Author Siyi He noted that in adults after heart surgery, heart failure NYHA 4 was higher in the VAE group compared with the non-VAE group, the difference was statistically significant (p <0.01) [2].

Cardiopulmonary bypass can affect many organs in the body including the circulatory system, causing myocardial edema, heart failure after surgery. In this study, patients with time for run of Cardiopulmonary bypass > 145 minutes

were associated with VAE (OR = 4.8; 95% CI: 2.3-10; p <0.001). When we divided the aortic pair time group> 100 and the aortic pair time group <100 according to 75 percent of the aortic pair time, the aortic pair time> 100 minutes were not statistically relevant with VAE.

Patients with sternum exposure are a group of young patients with complex heart damage such as arterial trunks, arterial stem transfer... meaning that the patient has to use sedation, deep muscle relaxation and prolonged ventilator time. Results of our study, sternum exposure were associated with VAE (OR: 10.8; 95% CI: 4.3-27.2; p <0.001). RACHS-1 allows us to see the difference in the mortality rates of patients with different congenital heart surgeries. According to the analysis results in Table 2, RACHS-1> 3 has a statistically significant relationship with VAE (OR: 4.9; 95% CI: 2.3-10.4; p <0.001).

When dividing group of ventilator for> 7 days and group of ventilator for 2-7 days, we found that group of ventilator> 7 days increased the risk of VAE by 47 times (95% CI: 16-140; p <0.001) in univariate analysis. Endotracheal re-intubation during ventilator gives the bacteria a chance to enter the lower airways, causing pneumonia. In our study, endotracheal re-intubation was associated with VAE (OR: 3.4; 95% CI: 1.5-7.7, p = 0.002).

In this study, patients using> 2 types of vasomotor, VIS index 48 hours> 7.5 increased the risk of VAE by 7.7 times (95% CI: 2.6-22.8; p < 0.001) and 8.7 times (95% CI: 4-19; p <0.001). Patients using muscle relaxants will slow down the ventilator withdrawal and prolong the time for mechanical ventilation. We found that in patients using the risk relaxer had an 8-fold risk of developing VAE (95% CI: 3-20; p <0.001). Raeley Guess also found that the use of muscle relaxants increased the risk of VAE in univariate regression analysis [3]. By univariate analysis, we recorded an increase in the risk of VAE by 6.2 times in patients after surgery with blood transfusion (95% CI: 1.8-20.7; p = 0.001).

Results in this study, patient AKI are associated with VAE (OR: 3.5; 95% CI: 1.6-7.8; p = 0.001). Among 32 VAE patients, 9 patients with low cardiac output syndrome, accounting for 28% higher than the non-VAE group, were statistically significant (OR = 3.1; 95% CI: 1, 3-7.2; p = 0.006).

Multivariate regression model is applied to analyze and identify risk factors of VAE in pediatric patients after open-heart surgery. Factors that were significantly related to VAE from univariate analysis were gathered for inclusion in the regression model. The results showed that only the factors of age <1, time for run of Cardiopulmonary bypass> 145 minutes and time for ventilator> 7 days were independent risk factors for VAE. There have been many authors studying the risk factors of VAE, study results vary by author, method of study, study population and study period. Study by Siyi He et al 2018, chronic obstructive pulmonary disease, LVEF <30%, time for run of Cardiopulmonary bypass, aortic pair time, blood transfusion, acute kidney injury, endotracheal reintubation, time for ventilator were the independent risk factors for VAE [2]. Sarah C. Lewis et al. 2014 in case-control studies have recorded AC ventilation, positive daily fluid balance as a risk factor for VAE [4]. Noelle M. Cocoros in 2017 announced that muscle relaxation, positive fluid balance, blood transfusion are independent risk factors capable of predicting VAE [5]. Raeley Guess et al. 2018 again found that acute kidney injury, PIM 2, mean peak pressure was an independent risk factor in a case study in children [3]. Study by Ji Liu et al. 2018, through multivariate analysis, has shown that the risk factors for VAE are daily fluid balance> 50 ml, use of sedation, and gastric fluid> 200 ml on the fourth day of ventilator [6]. Jae Kyeom Sim et al. 2016 noted that using ventilator due to trauma and pulmonary edema were risk factors for VAE through multivariate analysis [7].

5. CONCLUSION

Risk factors for VAE in pediatric patients after open-heart surgery through univariate analysis and multivariate regression are age <1 month, time for run of Cardiopulmonary bypass> 145 minutes and time for ventilator> 7 days.

REFERENCES

1. CDC-NHSN. Patient Safety Component Manual (2019), Pediatric Ventilator-Associated Event.1101-1119.

2. He S., Wu F., Wu X., et al. (2018). Ventilator-associated events after cardiac surgery: evidence from 1,709 patients. Journal of Thoracic Disease, 10(2), 776-783.

3. Guess R., Vaewpanich J., Coss-Bu J.A., et al. (2018). Risk Factors for Ventilator-Associated Events in a PICU. Pediatric Critical Care Medicine, 19(1), 7-13.

4. Lewis S.C., Li L., Murphy M.V., et al. (2014). Risk Factors for Ventilator-Associated Events: A Case-Control Multivariable Analysis. Critical Care Medicine, 42(8), 1839-1848.

5. Cocoros N.M., Priebe G., Gray J.E., et al. (2017). Factors Associated with Pediatric Ventilator-Associated Conditions in Six U.S. Hospitals: A Nested Case-Control Study. Pediatric Critical Care Medicine, 18(11), 536-545.

6. Liu J., Zhang S., Chen J., et al. (2018). Risk factors for ventilator-associated events: A prospective cohort study. American Journal of Infection Control, 1-6.

7. Sim J.K., Oh J.Y., Min K.H., et al. (2016). Clinical significance of ventilator-associated event. Journal of Critical Care, 35, 19-23.