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COMPARISON OF PNEUMONIA EVENTS AFTER EARLY AND DELAYED TRACHEOSTOMY IN SEVERE BRAIN INJURY PATIENTS SUPPORT WITH VENTILATOR

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Abstract

Pneumonia is an infection of the lung parenchym caused by various microbe ranging from bacteria, viruses, fungi and parasites. Pneumonia is one of the most common complications in patients who are undergoing treatment in the hospital, especially patients in intensive care who are undergoing prolonged bed rest, and in patients who need ventilator. The objective of tracheostomy can be classified into 4 groups, first to ensure a smooth airway, to clear the airway (bronchial toilet), to reduce airway "dead space", and the last to prevent complications in the installation of an extended ventilator. This type of research is an observational analytic study with a retrospective cohort design. The results showed that an early tracheostomy would reduce the risk of developing pneumonia.

Keyword: tracheostomy, pneumonia, severe brain injury

Background

Pneumonia is an infection condition of the lung parenchyma caused by various causes, ranging from bacteria, viruses, fungi and parasites. The incidence of pneumonia generally affects more than 5 million people each year in the United States. This number is increasing in patients in hospital care and patients receiving breathing support machines. The incidence of pneumonia in patients in hospitalization reached 8.1%; and in patients with ventilator the incidence of pneumonia reached 18%. Based on international research and in Indonesia, there were also 18 cases of pneumonia related to ventilator occurring within 1000 days of using the ventilator. (Koulenti, Tsigou and Rello, 2017; Masyithah, 2018; Sattar and Sharma, 2020)

Pneumonia is one of the most common complications in patients who are undergoing treatment in the hospital, especially patients in intensive care who are undergoing prolonged bed rest, and in patients who need ventilator. The mortality rate is up to 20% and specifically in pneumonia associated with ventilator, the mortality rate ranges from 5.8% -10.6%. In addition, pneumonia related to the ventilator also increased

the duration of hospitalization for 7 days and the cost of health care was around 40,000 USD. (Timsit et al., 2017; Leone et al., 2018; Sattar and Sharma, 2020)

Tracheostomy is a procedure for creating a patent airway in the trachea that can be performed by open or percutaneous surgery. Tracheostomy is an attempt to maintain the airway in patients who need a long ventilator.

The aim of the tracheostomy procedure can be classified into 4 groups, namely: to ensure a smooth airway, to clear the airway (bronchial toilet), to reduce the "dead space" of the airways, and to prevent complications in the installation of an extended ventilator.(Wijayahadi et al., 2003)

Moseley dan grillow wrote some of the diseases or conditions associated with tracheostomy, as follows (Wijayahadi et al., 2003):

1. Head trauma with a disturbance of consciousness in which coughing is ineffective
2. Severe inflammation on the face, neck and pharynx.
3. Tracheobronchitis with edema and profuse secretion production
4. Tracheal injury
5. Major surgical procedures on the head and neck
6. Tumour in the airways
7. Thyroid surgery, bleeding complications or recurrent bilateral nerve paralysis
8. Radiotherapy to the neck area
9. Post surgery and ineffective cough
10. Thoracic trauma resulting in ineffective breathing (multiple rib fractures, flail chest)
11. Prolong mechanical breathing support machine> 48 hours
12. Multiple fractures and blast injuries.

Tracheostomy often done in RSUD Dr. Soetomo Surabaya, especially in patients with severe brain injury. (Masloman, 2013)

Research in recent years has begun to consider an approach of early tracheostomy in these patients. The results of this study indicate that the earlier perform tracheostomy to the patient, succeeded in improving the overall outcome of the patient, not only mortality but also length of stay, duration of ventilator and incidence of pneumonia. More over the mortality rate for early tracheostomy was 17.1% vs 36.1% for delayed tracheostomy. The average length of stay for early tracheostomy was 26 days while 47 days for delayed tracheostomy. This opens an insight that tracheostomy indications can be performed in patients who are considered to be in need of a ventilator for a long time. (Mahafza et al., 2012; Shan et al., 2013) Nevertheless there are other studies which show that there is no significant difference in the outcome of

early and delayed tracheostomy in terms of patient outcomes including the incidence of pneumonia. In addition, there are no specific guidelines regarding the day limits of early and delayed tracheostomy (Meng et al., 2016)

In several studies conducted at RSUD Dr. Soetomo in 2009-2014 found that tracheostomy was better than the long-term use of endotracheal tubes, because it can reduce germ colonization. In addition, early tracheostomy also showed an improvement in decreasing pCO2 in patients and acceleration the weaning period of the ventilator. This suggests that early tracheostomy has a better outcome in patient. (Afif, 2009; Masloman, 2013; Pribadi, 2014)

This reason that makes the author want to research and investigate whether early tracheostomy in patients who need a ventilator will have a positive effect on the incidence of pneumonia compared to patients with delayed tracheostomy.

Methods

The type of research is an observational analytic study with a retrospective cohort design. Tracheostomy patients with ventilator who met the inclusion and exclusion criteria of the study, recorded the general data of the subjects such as name, age, gender, diagnosis, time of tracheostomy, incidence of pneumonia and time, length of stay in the intensive room, duration of the ventilator and mortality. The data collection process is carried out by taking secondary data from the patient's medical record. Data were recorded and recapitulated for analysis. Data management was carried out using the SPSS 25.0 program. The data is presented in the form of a frequency distribution table and cross tabulation. The data were analyzed using the Chi square test and the Mantel-Haenszel odds ratio test was performed to measure the hazard ratio of the two groups. Other characteristic data (day of pneumonia incidence, length of stay in intensive care, duration of ventilator, and mortality) were analyzed by independent t-analysis if normally distributed, or Mann Whitney U analysis if the data were not normally distributed..

Results

The results it was found that a total of 178 subjects, consisting of 127 men (71.3%) and 51 women (28.7%). The mean age of the research subjects was 38.8 ± 17.88 years. Obtained the mean time of tracheostomy action was 2.69 ± 3.80 days. From the time of incident to treatment, a mean of 6.72 ± 3.26 hours was obtained.

From the time of tracheostomy procedure, the group found 129 people (72.5%) with early tracheostomy and 49 people (27.5%) with delayed tracheostomy. In terms of gender, women experienced more delayed tracheostomy, 39 patients (76.5%) than men, but there was no statistically significant relationship between sex and type of tracheostomy p value = 0.28 (p> 0.05). In terms of the incidence of pneumonia, it was found that 38 patients (51.4%) who had delayed tracheostomy had pneumonia. And obtained a statistically

significant relationship between the incidence of pneumonia with the type of tracheostomy with p value = 0.001

There were 43 people (24.2%) without other accompanying trauma, 47 people (26.4%) with abdominal trauma, 38 people (21.3%) with thoracic trauma and 50 people (28.1%) with trauma to the extremities. A total of 88 people (49.4%) underwent surgery. Ventilator bundle was performed in 160 people (89.8%) and antibiotics were given to 83 people (46.6%).

The mortality rate was 115 people (64.6%) and 63 people (35.4%) did not die during treatment. The mean treatment time was 13.73 ± 14.35 days.

Table 1 – Research Subject Characteristic

		Tracheostomy Group			P Value	OR
		Early	Delayed	Total		
Gender	Men	37	90	127	0.28	1.3
		29.1%	70.9%	100.0%		
	Women	12	39	51		
		23.5%	76.5%	100.0%		
Mortality	Died	28	87	115	0.26	0.64
		24.3%	75.7%	100.0%		
	Life	21	42	63		
		33.3%	66.7%	100.0%		
Concomitant Trauma	No trauma	5	38	43	0.59	1.1
		11.6%	88.4%	100.0%		
	Trauma Thorax	13	25	38		
		34.2%	65.8%	100.0%		
	Trauma abdomen	19	28	47		
		40.4%	59.6%	100.0%		
	Trauma extremity	12	38	50		
		24.0%	76.0%	100.0%		
Age	< 38 y.o	20	64	84	0.29	0.7
		23.8%	76.2%	100.0%		
	> 38 y.o	29	65	94		
		30.9%	69.1%	100.0%		
Operative	Yes	25	63	88	0.62	1.09
		28.4%	71.6%	100.0%		
	No	24	66	90		
		26.7%	73.3%	100.0%		
Antibiotic	Yes	23	60	83	0.57	1.0
		27.7%	72.3%	100.0%		
	No	26	69	95		
		27.4%	72.6%	100.0%		
Ventilator Bundle	Yes	15	69	84	0.006	0.38
		17.9%	82.1%	100.0%		
	No	34	60	94		
		36.2%	63.8%	100.0%		

Table 2 – Characteristics of the Incidence Pneumonia with Other Factors

Category		Pneumonia Group		P value	OR
		No Pneumonia	Pneumonia		
Gender	Men	77 (60.6%)	50 (39.4%)	0.347	1.369
	Women	27 (52.9%)	24 (47.1%)		
Age	< 38 y.o	60 (71.4%)	24 (28.6%)	0.001	2.841
	>38 y.o	44 (46.8%)	50 (53.2%)		
Concomitant Trauma	No trauma	33 (76.7%)	10 (23.3%)	0.040	
	Trauma Thorax	20 (52.6%)	18 (47.4%)		
	Trauma Abdomen	23 (48.9%)	24 (51.1%)		
	Trauma Extremity	28 (56%)	22 (44%)		
Operative	Yrs	52 (59.1%)	36 (40.9%)	0.859	1.056
	No	52 (57.8%)	38 (42.2%)		
Ventilator Bundle	Yes	50 (59.5%)	34 (40.5%)	0.779	1.089
	No	54 (57.4%)	40 (42.6%)		
Antibiotic	Yes	52 (62.7%)	31 (37.3%)	0.285	1.387
	No	52 (54.7%)	43 (45.3%)		
Antibiotic Regimen	No Antibiotics	53 (55.2%)	43 (44.8%)	0.613	
	Ceftriaxone	29 (67.4%)	14 (32.6%)		
	Cefazoline	12 (60%)	8 (40%)		
	Levofloxacin	9 (56.3%)	7 (43.8%)		
	Metronidazole	1 (33.3%)	2 (66.7%)		
Length of Stay	< 13.7 day	68 (61.8%)	42 (38.2%)	0.243	1.439
	>13.7 day	36 (52.9%)	32 (47.1%)		
Length of Stay	< 6.72 hr	56 (64.4%)	31 (35.6%)	0.116	1.618
	>6.72 hr	48 (52.7%)	43 (47.3%)		

In this study, there were 77 men (60.6%) who did not experience pneumonia and 50 people (39.4%) who had pneumonia, while 27 women (52.9%) did not experience pneumonia and 24 people (47.1%) had pneumonia. The statistical test with Chi-square found that there was no relationship between gender and pneumonia with p = 0.347 (p> 0.05) and it was found that men were more likely to experience pneumonia, i.e 1.369x. In the study, it was found that 60 people (71.4%) had no pneumonia and 24 (28.6%) had pneumonia, while 44 people (46.8%) had no pneumonia and 50 (53.2%) who had pneumonia age < 38 years. The statistical test with Chi-square found that there was a significant relationship between age and pneumonia with p = 0.001 (p <0.05) and it was found that people aged > 38 years were more likely to experience pneumonia, i.el[2.841x. In the study, 33 people (76.7%) had no comorbid trauma and 10 (23.3%) had pneumonia. Thorax trauma was found in 20 people (52.6%) who did not have pneumonia and 18 people (47.4%) who had pneumonia. Abdominal trauma 23 people (48.9%) who did not have pneumonia and 24 people (51.1%) who had pneumonia. There were 28 people (56%) who did not have pneumonia and 22 (44%) who suffered from limb trauma. The statistical test with Chi-square found that there was a significant relationship between the presence of comorbid trauma and pneumonia with p = 0.040 (p <0.05). In the study, 52 people (59.1%) who did not have pneumonia and 36 (40.9%) who did not operate had operative action, while 52 people (57.8%) did not have pneumonia and 38 people (42.2%) had pneumonia. Statistical test

with Chi-square found that there was no relationship between operative action and pneumonia with p = 0.859 (p <0.05) and it was found that those who are not operative are more at risk of developing pneumonia, that is of 1.506x. In the study, 50 people (59.5%) who did not had pneumonia and 34 (40.5%) had pneumonia, while 54 people (57.4%) who did not use the ventilator bundle were not pneumonia. The Chi-square statistical test showed that there was no relationship between the ventilator bundle and pneumonia with p = 0.779 (p <0.05) and it was found that people who did not use the ventilator bundle had a higher risk of developing pneumonia, which was 1.089x. In the study, 52 people (62.7%) did not use antibiotics and 31 people (37.3%) had pneumonia, while 52 people (54.7%) did not use pneumonia and 43 people (45.3%) had pneumina. Statistical test with Chi-square found that there was no relationship between operative and mortality rates with p = 0.285 (p <0.05)

In this study, the group whom receive antibiotics consists of 52 people (62.7%) had no pneumonia and 31 people (37.3%) had pneumonia, while group whom did not receive antibiotics consists of 52 people (54.7%) had no pneumonia and 43 people (45.3%) had pneumonia. The statistical test with Chi-square found that there was no relationship between operative and mortality rates with p = 0.285 (p <0.05) and it was found that people who did not use antibiotics were more at risk of developing pneumonia, which was 1.387x. Obtained the cut off value of the action time is 2.69 days. In the study, there were 79 people (69.3%) who did not have pneumonia and 35 people (30.7%) who had pneumonia, while the time of action > 2.69 days were 25 people (39.1%) who did not have pneumonia and 39 people (60.9%).) who have pneumonia. The statistical test with Chi-square found that there was a significant relationship between action time and pneumonia p = 0.000 (p <0.05) and it was found that people with action time < 2.69 days were more at risk of having a high mortality, which was 1,950x. The cut off value for treatment duration was 13.7 days. In the study, 68 people (61.8%) who did not have pneumonia and 42 (38.2%) had length of stay <13.7 days, while 36 people (52.9%) did not have pneumonia and 32 people (47.1%)) who have pneumonia. The statistical test with Chi-square found that there was no relationship between length of stay and pneumonia with p = 0.243 (p <0.05) and it was found that people with length of treatment <13.7 days were more at risk of experiencing pneumonia, namely 1.439x. From the study, it was found that those who did not use antibiotics were 53 people (55.2%) who did not have pneumonia and 43 people (44.8%) who had pneumonia. It was obtained using Ceftriaxone as many as 29 people (67.4%) who did not have pneumonia and 14 people (32.6%) who had pneumonia. It was obtained using Cefazoline as many as 12 people (60%) who did not have pneumonia and 8 people (40%) who had pneumonia. Obtained using Levofloxacin as many as 9 people (56.3%) and 7 people (43.8%) who had pneumonia. Obtained using Metronidazole as many as 1 person (33.3%) who did not have pneumonia and 2 people (66.7%) who had pneumonia. The statistical test using Chi-square found that there was no relationship between the type of antibiotics and pneumonia with p = 0.613 (p <0.05).

Table 3 – Relationship between Time to Tracheostomy and the Incidence of Pneumonia

Category		Pneumonia Group		P value	RR (95% CI)
		No Pneumonia	Pneumonia		
Tracheostomy	Early	91 (70.5%)	38 (29.5%)	0.000	0.40 (95% CI 0.29 – 0.54)
	Late	13 (26.5%)	36 (73.5%)		
Total		104 (58.4%)	74 (41.6%)		

In this study, it was found that 13 people (26.5%) had delayed tracheostomy and 36 (73.5%) had pneumonia, while 91 people (70.5%) had no pneumonia and 38 (29.5%) had pneumonia. Early tracheostomy action significantly (p value = 0.000) protects pneumonia compared with delayed tracheostomy of 0.40 (95% CI 0.29-0.54)

Discussion

Tracheostomy is a procedure for creating a patent airway in the trachea that can be performed by open or percutaneous surgery. Common indications for tracheostomy procedures include patients with acute respiratory failure who are expected to need a prolonged ventilator, failure to wean from a ventilator, upper airway obstruction, difficult airway, and excessive sputum secretion. The most common indications for tracheostomy are acute respiratory failure and the need for a prolonged ventilator (representing two-thirds of all cases) and traumatic or catastrophic neurological disorders requiring a long-term patent airway or both. The most common reason for tracheostomy in the ICU is to provide access for a prolonged ventilator. One group of patients who often require tracheostomy are patients with central nervous system disorders such as stroke and in patients with severe brain injury. (Cheung and Napolitano, 2014)

From the analysis of the patient's demographic status such as age and sex, there was no significant difference in the incidence of pneumonia in patients. In addition, this study found various other comorbidities that influence the incidence of mortality, such as accompanying trauma and treatment time since the incident occurred. In addition, factors that influence the incidence of pneumonia such as ventilator bundle action and antibiotic administration were also recorded. However, analysis of these other factors did not prove to be significant in the incidence of pneumonia.

In this study, it was found that early tracheostomy (less than 3.5 days) significantly reduced the incidence of pneumonia and the length of stay in the hospital. This suggests that the initial tracheostomy will have a positive effect on the patient. Although in this study tracheostomy and pneumonia did not have a direct correlation with mortality. This mortality rate can be due to the underlying disease. A systematic review and meta-analysis revealed that early tracheostomy, in patients with severe brain injury, was associated with shorter duration of mechanical ventilation and intensive care unit (ICU) and hospital stay. Similarly, a reduced risk of pneumonia was found. Other literature comparing early and delayed tracheostomy populations shows longer ICU length of stay, lower length of stay, lower rates of pneumonia and lower costs.. (Araujo de França *et al.*, 2020)

The ideal tracheostomy timing until nowadays remain elusive, there is no clear guidelines for the best time to perform a tracheostomy. A published meta-analysis of the advantages of early tracheostomy, such as decreased duration of breathing support machines, length of ICU stay, and hospital stay, is consistent with the conclusions of other meta analyzes. The study explained that tracheostomy time correlated significantly with the duration of the ventilator, the ICU stay, and the hospital stay. Therefore, the gains from resources and time savings should be interpreted as consensus. Whereas early tracheostomy can shorten the ventilator by about 10 days, which greatly reduces the need for medical care and expenses. The average cost of an ICU patient requiring a ventilator is $ 3,968 per day, according to research conducted by Dasta et al. Therefore, the overall cost savings from early tracheostomy, compared to delayed tracheostomy, could be as high as $ 40,000, based on the findings of Dasta et al. Found a reduction in machine breathing time by 10 days. A reduction in the length of ICU stays and hospital stays also means savings in ICU costs and medical resources. With regard to VAP, several studies have found no association with the occurrence of VAP. However, there has been an observed trend towards a decreased VAP when tracheotomy is performed between days 3 and 7. Whether earlier tracheotomy (before day 3) would have any additional benefit is unclear. (Shan et al., 2013) In patients with a ventilator, tracheostomy has several advantages. Tracheostomy is thought to provide several advantages over translaryngeal intubation in patients using long-term ventilator, such as improved oral and bronchial toilet hygiene, increased patient comfort, decreased airway resistance, accelerated weaning from mechanical ventilation, ability to transfer patients who are reliance on the ventilator from the ICU to the facility is lower and the risk of developing ventilator-related pneumonia (VAP) is reduced.(Lin *et al.*, 2015)

Conclusion

Early tracheostomy reduces the risk of developing pneumonia in patients with severe brain injury with a ventilator

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