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Factors Associated with the Incidence of Infection in Tracheostomy Stoma at Mohammad Hoesin Hospital

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ABSTRACT

Background: Tracheostomy is a surgery to open the trachea to allow air to enter the airway. Tracheostomy cannot be separated from possible complications. Tracheostomy stoma infection is one of the complications of post-tracheostomy that occurs due to the activity of several bacteria. Many factors can cause the incidence of tracheostomy stoma infection. **Objective:** The aim of this study is to determine the factors associated with the incidence of tracheostomy stoma infection. **Methods:** Observational study with cross-sectional design. Data collection was carried out using medical record data on 71 subjects who underwent tracheostomy tube replacement from July 2019 to November 2020. **Results:** From 71 subjects, it was found that the subjects who had tracheostomy stoma infection were 54.9%. The results of bivariate analysis showed that age ($p=0.031$), comorbidities ($p=0.009$), the type of tracheostomy tube ($p=0.015$), the use of antiseptic in tracheostomy dressing ($p=0.020$), tracheostomy tube care ($p=0.013$), and the interval of changing the tracheostomy tube ($p=0.041$) are the significant factors. The results of multivariate analysis showed that tracheostomy tube care and the interval of changing the tracheostomy tube had a significant effect on tracheostomy stoma infection. Tracheostomy tube care has a risk of 9.362 times to experience infection with CI95%(1.535-57.086) and the interval of changing the tracheostomy tube has a risk of 10.669 with CI95% (1.074-105.985). **Conclusion:** There is a significant relationship between age, comorbidities, type of tracheostomy tube, the use of antiseptic in tracheostomy dressing, tracheostomy tube care, and interval of changing the tracheostomy tube with the incidence of tracheostomy stoma infection.

1. Introduction

Tracheostomy is a surgery to open the trachea to allow air to enter the airway. Despite its widespread use, tracheostomy is associated with possible complications. Complications can occur during surgery and postoperatively, both in emergency and elective tracheostomy. Tracheostomy complications vary from mild to severe in scale.^{1,2}

Infection of the tracheostomy stoma is one of the complications of post-tracheostomy. Tracheostomy stoma infection is characterized by thick secretions, foul odor, inflammation, and reddish skin color around the stoma. A tracheostomy cannula is considered a foreign object that can lead to infection. Inflammation due to infection can worsen wound healing and

granulation tissue formation. Research by Kligerman et al. Of the 69.371 visits to the Emergency Department associated with tracheostomy complications had 7.3% complications of tracheostomy infection. The high standard of care of the tracheostomy cannula is key in preventing complications regardless of the surgical technique used.¹⁻⁵

Many factors can cause the incidence of infection in tracheostomy stoma. Factors associated with the incidence of infection in tracheostomy stoma include patient-related factors, factors related to tracheostomy technique, and factors related to post-tracheostomy care.^{3,4,5}

2. Method

This study is an observational study with a cross sectional design. The research was conducted at the RSMH Medical Record Installation. The research sample was the medical record data of tracheostomy patients who had undergone a tracheostomy cannula replacement during the period July 2019 to November 2020 and met the research criteria for analysis. Sampling in this study was carried out by total sampling.

The inclusion criteria in this study were complete medical records from tracheostomy patients who had undergone tracheostomy cannula replacement. The exclusion criteria were medical records of tracheostomy patients who had undergone a tracheostomy cannula replacement whose previous tracheostomy was performed outside RSMH or performed by a doctor other than a ENT specialist.

The variables in this study included the independent variables, namely age, comorbid, tracheostomy timing, type of tracheostomy cannula, use of tracheostomy dressings, use of antiseptics in tracheostomy dressings, tracheostomy cannula care, and intervals of tracheostomy cannula replacement and the dependent variable was infection in the tracheostomy stoma. Processing and data results are assisted by SPSS software for windows version 24.0. Statistical analysis to examine the factors associated with the incidence of infection in tracheostomy stoma was performed with the Chi-Square test or Fisher's exact test.

This study has been considered ethical and approved by the Health Research Ethics Committee of Dr. Mohammad Hoesin Palembang. Ethical license is implemented in accordance with applicable procedures and rules.

3. Results

The number of research subjects was 71 subjects. Based on the age category, the most research subjects were the age group 19-60 years (57.7%). In this study, more men (62%) than women (38%). Subjects who had comorbid number were 47 subjects (66.2%) with the most comorbid was a history of chemotherapy as many

as 33 subjects (46.5%). Based on the tracheostomy timing, the most elective tracheostomy was 59 subjects (83.1%). The most commonly used tracheostomy cannula was fenestrated cannula which was found in 54 subjects (76.1%). Most of the subjects used tracheostomy dressings as many as 58 subjects (81.7%), as well as the use of antiseptics in tracheostomy dressings in 50 subjects (70.4%). Meanwhile, the most common tracheostomy cannula treatment performed by subjects was once a day in 42 subjects (59.2%) and the dominant tracheostomy cannula replacement interval was > 30 days which was found in 64 subjects (90.1%).

Table 2 shows the distribution of tracheostomy stoma infection criteria. Based on the criteria for the presence of swelling, only 6 subjects were found with swelling (8.5%) and most of the subjects had no swelling (91.5%). There were 33 subjects who experienced redness around the stoma (46.5%), almost as many subjects who did not experience redness around the stoma (53.5%).

Subjects with thick secretions on tracheostomy stoma were 27 subjects (38%). The discoloration of secretions to yellow was found in 11 subjects (15.5%). Meanwhile, smelly subject tracheostomy stoma was found in 29 subjects (40.8%). Granulation tissue on tracheostomy stoma was present in 27 people (38%).

Data from the analysis showed that there was a relationship between age ($p = 0.031$), comorbids ($p = 0.009$), type of tracheostomy cannula ($p = 0.015$), use of antiseptics in tracheostomy dressings ($p = 0.020$), tracheostomy cannula treatment ($p = 0.013$) and the interval between replacement of tracheostomy cannula ($p = 0.041$) and the incidence of infection in tracheostomy stoma.

The chance (OR) of subjects with comorbid infections in tracheostomy stoma was 3.9 times with 95% CI (1.4-10.9), while the chance (OR) of patients who used fenestrated cannulae to experience infection in tracheostomy stoma was 4, 1 time with 95% CI (1.3-13.2), the chance (OR) of patients who do not use antiseptics in tracheostomy dressings to experience infection in tracheostomy stoma is 3.8 times with 95% CI (1.2-11.8), the chance (OR) of patients who had

tracheostomy cannula replacement with an interval of > 30 days to experience infection in the tracheostomy stoma was 8.8 times with a 95% CI (0.9-77.2).

In the multivariate analysis, the dependent variable was the incidence of infection in the tracheostomy stoma and the independent variables were age, comorbid, type of tracheostomy cannula, use of tracheostomy dressings, use of antiseptics in tracheostomy dressings, tracheostomy cannula treatment, and time interval for tracheostomy cannula replacement. and intervals of tracheostomy cannula

replacement which significantly influence the incidence of infection in tracheostomy stoma. Tracheostomy cannula treatment had a significant effect on the incidence of infection in tracheostomy stoma ($p = 0.015$) with a risk of 9.362 times to experience infection and 95% CI (1.535-57.086). The time interval for tracheostomy cannula replacement had a significant effect ($p = 0.043$) on the incidence of infection in tracheostomy stoma, with the risk of experiencing infection up to 10.669 times and 95% CI (1.074-105.985).

Table 1. Characteristics of research subjects (N = 71)

Variable	N	%
Age		
0 – 18 years old	5	7.0
19 – 60 years old	41	57.7
> 60 years old	25	35.2
Gender		
Male	44	62.0
Female	27	38.0
Comorbid		
yes	47	66.2
No	24	33.8
Comorbid		
Diabetes mellitus	3	4.2
Hypertension	13	18.3
Chemotherapy history	33	46.5
History of radiotherapy	17	23.9
Tracheostomy timing		
Emergency	12	16.9
Elective	59	83.1
Types of Tracheostomy Cannula		
Fenestrated	54	76.1
Nonfenestrated	17	23.9
Use of tracheostomy dressings		
Yes	58	81.7
No	13	18.3
Use of antiseptics in tracheostomy dressings		
Yes	50	70.4
No	21	29.6
Tracheostomy cannula care		

1 time per day	42	59.2
2 times per day	21	29.6
≥ 3 times per day	8	11.3
Interval of tracheostomy cannula replacement		
> 30 days	64	90.1
≤ 30 days	7	9.9
Total	71	100.0

Table 2. Characteristics of infection in tracheostomy stoma

Variable	N	%
Incidence of infection in tracheostomy stoma		
Yes	39	54.9
No	32	45.1
Tracheostomy stoma infection *		
Swelling	6	8.5
Redness around the stoma	33	46.5
Thick secretions	27	38.0
Color yellowish secretions	11	15.5
Bad odor	29	40.8
Granulation tissue	27	38.0

* There can be more than one sign

Table 3. Relationship of various factors with incidence of infection in tracheostomy stoma

Factor	Tracheostomy stoma infection				Total		P value	OR (CI95%)
	Yes		No		n	%		
	n	%	n	%				
Age								
0 – 18 years old	0	0.0	5	100.0	5	100.0	0.031	N/A
19 – 60 years old	23	56.1	18	43.9	41	100.0		
> 60 years old	16	64.0	9	36.0	25	100.0		
Comorbid								
Yes	31	66.0	16	34.0	47	100.0	0.009	3.9 (1.4-10.9)
No	8	33.3	16	66.7	24	100.0		
Tracheostomy timing								
Emergency	5	41.7	7	58.3	12	100.0	0.311	0.5 (0.1-1.8)
Elective	34	57.6	25	42.4	59	100.0		
Types of tracheostomy cannula								
Fenestrated	34	63.0	20	37.0	54	100.0	0.015	4.1 (1.3-13.2)
Nonfenestrated	5	29.4	12	70.6	17	100.0		
Use of tracheostomy dressing								

No	10	76.9	3	23.1	13	100.0	0.078	3.3 (0.8-13.3)
Yes	29	50.0	29	50.0	58	100.0		
Use of antiseptics in tracheostomy dressings								
No	16	76.2	5	23.8	21	100.0	0.020	3.8 (1.2-11.8)
Yes	23	46.0	27	54.0	50	100.0		
Tracheostomy cannula care								
1 time per day	29	69.0	13	31.0	42	100.0	0.013	N/A
2 times per day	8	38.1	13	61.9	21	100.0		
≥ 3 times per day	2	25.0	6	75.0	8	100.0		
Tracheostomy cannula replacement time interval								
> 30 days	38	59.4	26	40.6	64	100.0	0.041	8.8 (0.9-77.2)
≤ 30 days	1	14.3	6	85.7	7	100.0		

Table 4. Multivariate analysis of various factors associated with the incidence of infection in tracheostomy stoma

Factor	Coefficient (B)	P value	OR	CI95%
Tracheostomy cannula care	2.237	0.015	9.362	1.535-57.086
Interval of tracheostomy cannula replacement	2.367	0.043	10.669	1.074-105.985
Constant	-3.625	0.023	-	-

4. Discussion

In this study, there were as many as 71 study subjects, with 39 of them having infections in the tracheostomy stoma. This means that 54.9% of the total sample experienced infection in the tracheostomy stoma. This is different from the research of Ahmadinegad et al. In 2014, it was found that the incidence of infection in tracheostomy stoma was 13.75% as well as the study by Klotz et al. in 2018, the incidence of infection in tracheostomy stoma was 7.6%. Kligerman et al. 2020 had the same thing, where the incidence of infection in tracheostomy stoma was 7.3%.^{3,5,6}

The most common features of infection in subjects were redness around the tracheostomy stoma (46.5%), odor (40.8%), thick secretions (38%), and granulation tissue (38%). In the research of Ahmadinegad et al. In 2014, a tracheostomy stoma was assessed for swelling, redness, and purulent discharge at the time of changing the tracheostomy dressing, but the frequency distribution of these clinical symptoms was not explained. According to Morris et al. (2014) stoma

infection is one of the tracheostomy complications that can arise due to the activity of several bacteria and to prevent this, a constant assessment of the stoma must be carried out including secretions, odor, swelling and redness around the stoma. After a tracheostomy, the airway's filtration and humidification function is weakened, and with the addition of bacterial infection, the skin around the tracheostomy can become inflamed and secretion production can increase, besides the tracheostomy cannula can accumulate with debris and can act as a source of infection. The use of the same tracheostomy cannula for a long time, where the cannula is a foreign object, causes an inflammatory tissue response that can cause granulation tissue, increase secretion production, and bacterial colonization.^{3,4,7}

In the bivariate analysis of the relationship between various factors and the incidence of infection in the tracheostomy stoma, the results of the analysis show that there is a relationship between age, comorbid, type of tracheostomy cannula, use of antiseptics in tracheostomy dressings, tracheostomy cannula treatment, and intervals of tracheostomy cannula

replacement with the incidence of infection in tracheostomy stomas. . In this study, the 19-60 year age group experienced more infections in tracheostomy stoma (57.7%), but in the > 60 years age group the percentage of subjects experiencing infection in tracheostomy stoma increased. This is consistent with research by Kligerman et al. in 2020 where the most infections were in the 18-64 year age group at 42.5%. In contrast to research by Ahmadinegad et al. 2014 and Chuang et al. in 2013 it was found that there was no significant difference in terms of age. Some argue that age is related to something that cannot be avoided in terms of physiology and the ability to tolerate physical stress. Some physiological changes related to age do not directly influence surgical complications, but indirectly, physiological changes can result in a higher risk of surgical morbidity. From the histological findings, it shows that the ability of fibroblasts to produce extracellular matrix is reduced so that the wound healing process is slow or imperfect.^{3,4,5,8,9}

Research by Kumarasinghe et al. in 2020, subjects with diabetes (64.6%) were at risk for bacterial colonization of the tracheostomy cannula and infection. Acute and chronic illnesses cause changes such as anemia, hypotension and hypoxemia. Diseases such as diabetes mellitus and hypertension can affect peripheral vascularization. The buildup of the end product glucose in the tissues is responsible for the delay in wound healing. Diabetes has also been shown to cause reduced initial inflammatory response and delayed epithelialization. In addition, diabetes mellitus causes a decrease in the body's immune system so that the risk of infection increases.^{4,9,10}

Chemotherapy is a fundamental treatment in cancer patients. Chemotherapy modalities target cell proliferation by disrupting certain components of the cell cycle. Although chemotherapy agents target specifically fast growing cells, other tissues can be affected by this effect, such as macrophages and fibroblasts involved in the wound healing process are also susceptible to this effect. The effect of agents such as cyclophosphamide, mechlorethamine, and cisplatin may decrease wound tensile strength and inhibit wound healing during the initial proliferation period.

Radiation can have an immediate or slow effect on the tissue and thus have an effect on wound healing. Radiation causes acute degenerative changes in the membrane floor and increases vascular permeability. The long-term effects of radiation include skin and subcutaneous tissue atrophy, with decreased wound vascularization and increased hypoxia, this results in impaired normal healing and increases the likelihood of bacterial infection and fistula formation.^{1,2}

In this study, the tracheostomy timing did not affect the incidence of infection in tracheostomy stoma probably because the subjects in this study predominantly underwent elective tracheostomy. The type of tracheostomy cannula affects infection in the tracheostomy stoma. Fenestrated cannula has more potential for granulation tissue formation, especially in children. In a study conducted by Pandian et al. in 2019 out of 2000 tracheostomy patients, 15 patients used fenestrated prongs and 60% of patients had granulation tissue formation. The fenestration hole is the maximum contact point for the tracheostomy cannula and the stoma and is a common site for crusting and biofilm formation. The development of granulation tissue is associated with the tracheal mucosa being subjected to fenestration during tracheal suctioning or the fenestration position at the wrong location because it relates to the anatomy of the patient's airway, malposition can cause irritation of the tracheal mucosa, leading to granulation tissue formation. In addition, the use of the same tracheostomy cannula for a long time, where the cannula is a foreign object, causes an inflammatory tissue response that can cause granulation tissue, increase secretion production, and colonization of bacteria, thereby increasing the risk of infection. The selection of the type of cannula in the subject is based on the patient's communication needs and since March 2020 the tracheostomy cannula used when the tracheostomy cannula was replaced in the subject is a nonfenestrated cannula due to the Covid-19 pandemic condition.^{11,12}

In this study, the use of tracheostomy dressings did not affect the incidence of infection in tracheostomy stomas. This may be because the subjects in this study

predominantly used tracheostomy dressings and all study subjects used gauze tracheostomy dressings. There are no studies linking the use of antiseptics in tracheostomy dressings with the incidence of infection in tracheostomy stomas. However, there is ample evidence to suggest that antiseptics can be used in local skin infections. The use of antiseptics is important for wounds that are sensitive and difficult to treat. Antiseptics must have various specifications. The main purpose of using an antiseptic is to prevent infection, reinfection and potential interference with wound healing. The secondary purpose of using antiseptics is to support wound healing by having a positive effect on cell proliferation and regeneration. Other antiseptic effects include cleaning the wound, which can promote debridement. Research by Bigliardi et al. In 2017 povidone iodine has many characteristics that position it very well for wound healing, including having a wide spectrum of antimicrobials, lack of resistance, effectiveness of biofilms, good tolerability, and a wide range of effects on inflammation. Due to its fast, strong, broad spectrum antimicrobial properties, and its beneficial properties, it is hoped that povidone iodine can aid in the effective healing of acute and chronic wounds. In this study all subjects used an antiseptic type povidone iodine.^{13,14,15}

The results of the bivariate analysis showed that there was a relationship between tracheostomy cannula treatment and the incidence of infection in the tracheostomy stoma. The results of multivariate analysis showed that tracheostomy cannula treatment had a significant effect on the incidence of infection in tracheostomy stoma with a risk of 9.362 times to experience infection. No studies have been conducted to determine the optimal frequency of deep cannula cleansing, including other tracheostomy cannula treatments. Post-tracheostomy care includes suctioning, deep cannula cleaning, tracheostomy dressing and cord replacement, humidification, and tracheostomy stoma cleaning. One of the most important aspects of post-tracheostomy care is the mobilization of secretions, cleaning of the secretions in the tracheostomy cannula can be done by suctioning, and it is recommended that deep cannula maintenance

be carried out routinely to prevent the secretions from drying out and clogging the lumen. The tracheostomy strap is replaced as needed, if it is dirty or wet from secretions. Tracheostomy stoma cleaning should be carried out, gauze can be used in semicircular movements from the inside out. The clinical consensus statement on tracheostomy care emphasizes that effective wound care in tracheostomy patients has a positive effect in reducing infection rates, shortening tracheal cannula use time and improving patient quality of life.^{16,17}

In this study, through bivariate analysis, it was found that there was a relationship between the time interval between tracheostomy cannula replacement and the incidence of infection in the tracheostomy stoma. The results of the multivariate analysis showed that the intervals of tracheostomy cannula replacement had a significant effect on the incidence of infection in the tracheostomy stoma with the risk of experiencing infection up to 10.669 times and if there were conditions where the subject performed cannula treatment 1 time per day and the intervals of tracheostomy cannula replacement > 30 days then the probability or the chance of developing tracheostomy stoma infection was 72.7%. Tracheostomy cannula replacement is within 1 month. Subjects who had a tracheostomy cannula replacement after 1 month had a higher percentage of granulation tissue. White et al. 2010 suggested tracheostomy cannula replacement includes the need for a different cannula size, a damaged cannula, the need for a different type of tracheostomy cannula, and routine replacement of cannula in long-term tracheostomy to prevent infection. They suggested that the tracheostomy cannula should be replaced within 7-14 days of initial insertion, but there is no evidence to support this recommendation. Tracheostomy wounds are colonized within 24-48 hours by many organisms, such as *Pseudomonas* and gram-positive bacteria. Tracheostomy cannula is also colonized by bacteria such as *Staphylococcus epidermidis*, besides that, tracheostomy cannula can accumulate with debris and can act as a source of infection. Preventing colonization is not possible, besides the use of the same

tracheostomy cannula for a long time, where the cannula is a foreign object, causes an inflammatory tissue response that can cause granulation tissue, increase secretion production, and colonization of bacteria. In accordance with the results of the study, the interval between cannula replacement of less than 30 days can prevent infection in the tracheostomy stoma.^{12,16,18}

5. Conclusion

Infection in tracheostomy stoma occurred in 54.9% of tracheostomy patients who had tracheostomy cannula replacement at Dr. Mohammad Hoesin Palembang. Factors associated with the incidence of infection in tracheostomy stoma are age, comorbidities, type of tracheostomy cannula, use of antiseptics in tracheostomy dressings, tracheostomy cannula treatment, and intervals of tracheostomy cannula replacement. Tracheostomy cannula treatment once a day had a 9.362 chance of experiencing infection in the tracheostomy stoma. The tracheostomy cannula replacement interval > 30 days has a 10.669 chance of experiencing infection in the tracheostomy stoma, so the ideal time to perform a tracheostomy cannula replacement is within 30 days.

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