Comparison of Oropharyngeal Microbial Pattern Based on Nasogastric Tube (NGT) Use in Dr. Mohammad Hoesin Hospital

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A B S T R A C T

Introduction. A Nasogastric Tube (NGT) is a flexible tube inserted into the stomach through the nose (nares) to preserve nutritional support. The use of NGT is claimed to increase the risk of pathogenic bacteria colonization due to stagnation, ultimately worsening the patient's outcome. Proper identification of bacterial patterns is required as colonization grows to avoid further complications. This study aims to compare oropharyngeal microorganism patterns in patients with NGT to those without NGT at Dr. Mohammad Hoesin Palembang. **Methods.** A cross-sectional observational study was used. From September 2022 to October 2022, data were collected using primary data from interviews (research questionnaires) and oropharyngeal swab results (bacterial culture) in 42 patients undergoing treatment at Dr. RSUP. Mohammad Hoesin Palembang's ENT department. **Results.** Positive colonization was found in all patients with NGT (100%) and 90.47% in the group without NGT. P. aeruginosa was the most common pathogen in the NGT group (47.62%). The use of NGT, body weight, height, and body mass index were significant risk factors in the incidence of P. aeruginosa colonization (p=0.012). **Conclusion.** There is a significant difference in P. aeruginosa colonization between NGT and non-NGT users. NGT use is the most important driving factor of colonization development. However, these findings were not found in colonization in general or specific bacteria categories

1. Introduction

Nasogastric Tube (NGT) is a flexible tube with a small opening at one end. It is inserted into the stomach through the nose (nares) in order to sustain enteral nutrition in patients who are unable to achieve their nutritional needs orally. This tool is frequently used in elderly patients (> 65 years) who complain of dysphagia, particularly post-stroke or neurogenic dysphagia, anorexia in conditions related to chronic diseases, advanced dementia, malnutrition, or in groups of patients with life-threatening conditions including decreased consciousness.[1,2]

The use of NGT may provide both advantages and downsides for patients. The primary disadvantages are linked to both local and systemic issues that can lengthen the time spent in intensive care, increase healthcare expenses, and cause nosocomial infections. NGT placement in the oropharynx region might impair chewing, swallowing, and salivation, resulting in mouth pain and mucous membranes dryness. The NGT can also be a potential source of infection because of its abiotic environment and ability to produce changes in the pattern of germs to enable them to become pathogenic gram-negative. In more severe cases, the colonization can develop into a systemic infection and one of them manifests as aspiration pneumonia.[3–7]

The use of the nasogastric tube and its relation to the process of aspiration pneumonia is a contentious topic. The usage of NGT is generally thought to reduce the risk of aspiration. However, aspiration pneumonia has been linked to an increased risk or incidence in other studies, which range from 12% to 87%. Patients with unstable situations, malnutrition, and comorbidities are more likely to experience this process, which lowers the body's immune system's capacity to fight off infections.[8–10]

Based on the description that has been provided, the researchers aim to compare the germ patterns in the oropharynx of patients with and without NGT installations. Furthermore, this study is also expected to explain how the NGT affects the pattern of oropharyngeal bacteria that can increase the risk of

pneumonia from aspirating oropharyngeal material, so that it can be considered when formulating policies to reduce the risk of aspiration pneumonia.

2. Methods

This observational, comparative, cross-sectionalstudy examines the colonization and pattern of bacteria in patients with and without NGT inserted at RSUP Dr. Mohammad Hoesin Palembang between September to October 2022. Inpatients and outpatients using long-term NGT (minimum 14 days) who were treated or referred to the HEENT department, were between the ages of 18 and 64, and were willing to participate in the study were included. Patients with cancer, those undergoing chemotherapy and radiotherapy, and those with infection symptoms in the nasal cavity, sinuses, nasopharynx, and oropharynx were excluded from the study.

The sampling was conducted using a consecutive sampling method. Based on the minimum sample calculation, the minimum number of samples per group was 21 and the minimum number of total participants was 42. Sociodemographic information and confounding variables (smokers, DM) were collected from the study sample. Patients who met the inclusion criteria had an oropharyngeal swab collected (on the buccal mucosa). The type of microbe was then determined when the sample was placed on Stuart transport medium and cultivated on MacConkey agar.

A univariate analysis was done on the basic characteristics of the research subjects. Chi-Square test (or Fisher's Exact test if chi-square test criteria were not met) was used to do the bivariate analysis of categorical data, whilst an independent T-test or Mann-Whitney test was conducted for numerical data. The logistic regression analysis using the Backward LR method was done to determine the relationship between the independent and confounding variables (covariates) to the dependent variable. All analyses were conducted using IBM® SPSS® Statistics version 25.0.

3. Results

This study recruited 42 participants and divided them evenly between two groups: NGT users and non-NGT users (n=21). The age ranges of 35–49 years and 50–64 years had the greatest proportion of research participants with 10 samples in each age group (47.62%). The group of patients who had an NGT inserted were predominantly female (16 samples, 76.2%), had a good nutritional status (12 samples, 57.14%), and had taken antibiotics within the last two weeks (15 samples, 71.44%). Patients who did not have an NGT inserted, on the other hand, were predominantly male (11 samples, 52.38%), undernourished and overweight (8 samples each, 38.1%), and had not taken antibiotics in the previous two months (17 samples, 80.95%). Both groups have a tendency to be free of diabetes mellitus, do not smoke, and have normal blood sugar levels (<200 mg/dL). In the analysis of the relationship between confounding variables and NGT use, it was found that antibiotic consumption and NGT use were significantly related (p=0.002). In contrast, none of the other confounding variables were associated with the use of the NGT (p>0.05) (Table 2). In this study, a high percentage of bacterial colonization was found in both patients who had an NGT inserted (100%) and those who did not (90.48%). The Chi-square analysis yielded a value of p=0.488, indicating that there is no correlation between the use of NGT and the incidence of oropharyngeal colonization.

Table 1. Characteristics of Research Participants

Variables	NGT (+) n (%)	NGT (-) n (%)	Data Distribution Value	
			NGT (+)	NGT (-)
Age				
18 – 34 years	1 (4.76%)	6 (28.57%)		
35 – 49 years	10 (47.62%)	4 (19.05%)	51±15[a]	47±17[a]
50 – 64 years	10 (47.62%)	11 (52.38%)		
Sex				
Male	5 (23.8%)	11 (52.38%)	-	-
Female	16 (76.2%)	10 (47.62%)		
Comorbidity (DM)				
Yes	4 (19.05%)	2 (9.52%)	-	-
No	17 (80.95%)	19 (90.48%)		

Nutritional Status				
Undernourished	3 (14.29%)	8 (38.1%)	21.27±2.98[a]	21.10±4.51[a]
Normal	12 (57.14%)	5 (23.8%)		
Overweight	6 (28.57%)	8 (38.1%)		
Antibiotic Use (last two weeks)				
Yes	15 (71.43%)	4 (19.05%)	-	-
No	6 (28.57%)	17 (80.95%)		
Active Smoker Status				
Yes	1 (4.76%)	4 (19.05%)	-	-
No	20 (95.24%)	17 (80.95%)		
Random Blood Glucose				
≥200	1 (4.76%)	2 (9.52%)	110 (87-245)[b]	110 (85-228)[b]
<200	20 (95.24%)	19 (90.48%)		
Weight	-	-	52±9.4[a]	53.8±11.5[a]
Height	-	-	156 (140-163)[b]	160±7[a]
NGT Installation Duration (weeks)	-	-	2.38±0.92[a]	

Notes: [a]Mean±SD, [b]Median (minimum-maximum)

Table 2. Association between Research Participants' Characteristics and NGT Use

Variables	NGT (+), n (%)	NGT (-), n (%)	*P-value*
Age			0.052
18 – 34 years	1 (4.76%)	6 (28.57%)	
35 – 49 years	10 (47.62%)	4 (19.05%)	
50 – 64 years	10 (47.62%)	11 (52.38%)	
Sex			0.111
Male	5 (23.8%)	11 (52.38%)	
Female	16 (76.2%)	10 (47.62%)	
Comorbidity (DM)			0.663
Yes	4 (19.05%)	2 (9.52%)	
No	17 (80.95%)	19 (90.48%)	
Nutritional Status			0.080
Undernourished	3 (14.29%)	8 (38.1%)	
Normal	12 (57.14%)	5 (23.8%)	
Overweight	6 (28.57%)	8 (38.1%)	
Antibiotic Use (last two weeks)			0.002
Yes	15 (71.43%)	4 (19.05%)	
No	6 (28.57%)	17 (80.95%)	
Active Smoker Status			0.343
Yes	1 (4.76%)	4 (19.05%)	
No	20 (95.24%)	17 (80.95%)	
Random Blood Glucose			1.000
≥200	1 (4.76%)	2 (9.52%)	
<200	20 (95.24%)	19 (90.48%)	

The percentage of bacterial colonization in NGT users after a minimum of two weeks of installation was higher than that of non-NGT users (100% vs 90.48%). Based on the colonization pattern of NGT users and non-NGT users, there was a significant association with *P. aeruginosa*-colonized samples (p=0.015; OR=8.636 (1.593–46.807)). On the other hand, there was no significant association between NGT use and colonization by *K. pneumoniae*, *A. baumanii*, *E. cloacae complex*, *S. aureus*, *Stenotrophomonas maltophilia*, as well as by mixed, gram-negative, and other categories of colonization (p>0.05) (Table 3). No correlation was found between age group, sex, comorbidities, nutritional status, antibiotics use, active smoker status, and blood sugar categories to the colonization of *P. aeruginosa* (p>0.05). Table 4 provides information regarding this correlation.

Binary logistic regression calculation was performed by entering data on colonization by *P. aeruginosa* bacteria as the dependent variable, along with patient-related independent variables and confounding variables as covariates. According to the multivariate analysis, the model could account for 24.8% of the predictor factors for colonization episodes. The research findings indicated that the use of NGT had the greatest impact on the incidence of *P. aeruginosa* colonization (p = 0.012).

Table3. Association Between NGT use and oropharyngeal colonization

NGT use	Oropharyngeal Colonization		value	OR (CI 95%)
	Yes	No		
Yes	21 (100%)	0	0.488	*Undefined*
No	19 (90.48%)	2 (9.52%)		
P. aeruginosa Colonization				
Yes	10 (47.62%)	11 (52.38%)	**0.015**	**8.636**
No	2 (9.52%)	19 (90.48%)		**(1.593-46.807)**
K. pneumoniae Colonization				
Yes	7 (33.3%)	14 (66.7%)	0.277	3.000
No	3 (14.29%)	18 (85.71%)		(0.655-13.747)
A. baumanii Colonization				
Yes	8 (38.1%)	13 (61.9%)	1.000	1.231
No	7 (33.3%)	14 (66.7%)		(0.348-4.358)
E. cloacae Colonization				
Yes	6 (28.57%)	15 (71.43%)	1.000	1.280
No	5 (23.8%)	16 (76.2%)		(0.322-5.088)
S. aureus Colonization				
Yes	2 (9.52%)	19 (90.48%)	0.488	*Undefined*
No	0	21 (100%)		
S. maltophilia Colonization				
Yes	2 (9.52%)	19 (90.48%)	1.000	1.000
No	0	21 (100%)		(0.040-5.679)
Mixed Colonization				
Yes	10 (47.62%)	11 (52.38%)	0.197	2.909
No	5 (23.8%)	16 (76.2%)		(0.777-10.887)
Gram Negative Bacteria Colonization				
Yes	19 (90.48%)	2 (9.52%)	1.000	1.000
No	19 (90.48%)	2 (9.52%)		(0.127-7.850)
Other Colonization				
Yes	5 (23.8%)	16 (76.2%)	1.000	1.000
No	5 (23.8%)	16 (76.2%)		(0.242-4.138)

Note: [a]Chi-square or Fisher Exact test. Other colonization includes: *Pantoea spp.* (n=1), *Rhizobium radiobacter* (n=1), *Serratia marcescens* (n=1), *Staphylococcus haemolyticus* (n=1), *Chryseobacterium indologenes* (n=1), *Pseudomonas luteola* (n=1), *Candida tropicalis* (n=1), *Citrobacter freundii* (n=1)

Table 4. Correlation between confounding factors with *P. aeruginosa* colonization in the oropharyngeal region

Variables	Colonization (+)	Colonization (-)	*P-value*
Age			
18 – 34 years	1 (2.38%)	6 (14.28%)	
35 – 49 years	6 (14.28%)	8 (19.05%)	0.421
50 – 64 years	5 (11.9%)	16 (38.1%)	
Sex			
Male	5 (11.9%)	11 (52.38%)	0.316
Female	16 (76.2%)	10 (47.62%)	
Comorbidity (DM)			
Yes	2 (4.76%)	4 (9.52%)	1.000
No	17 (40.47%)	19 (45.24%)	
Nutritional Status			
Undernourished	3 (14.29%)	8 (38.1%)	
Normal	12 (57.14%)	5 (23.8%)	0.767
Overweight	6 (28.57%)	8 (38.1%)	
Antibiotic use (last two weeks)			
Yes	15 (71.43%)	4 (19.05%)	0,098
No	6 (28.57%)	17 (80.95%)	
Active Smoker Status			
Yes	1 (4.76%)	4 (19.05%)	0.298
No	20 (95.24%)	17 (80.95%)	
Random Blood Glucose			
≥200	1 (4.76%)	2 (9.52%)	1.000
<200	20 (95.24%)	19 (90.48%)	

Based on this study's multivariate analysis, a mathematical formula was developed for calculating the incidence of *P. aeruginosa* colonization as follows:

$$y = \alpha + \beta_1 X_1 \rightarrow \quad p = \frac{1}{1+e^{-y}}$$

description:
p : probability
α : constant
β_1 : $\beta_{NGT\ use}$ (2.156)
X_1 : NGT use (1= yes; 2 = no)
e : exponential

P. aeruginosa colonization =0.095 + (2.156* NGT use)
P. aeruginosa colonization = 0.095 + (2.156*1)
P. aeruginosa colonization = 2.251

$$p = \frac{1}{1+e^{-y}} = \frac{1}{1+e^{-2.251}} = \frac{1}{1+0.105} = \mathbf{0.905}$$

Therefore, a patient with an inserted NGT has a 90.5% chance of developing oropharyngeal colonization by *P. aeruginosa*.

4. Discussion

This study investigated the association between oropharyngeal colonization and NGT use. The average age of NGT users in this study was 51 years, compared to 43.51 to 44.64 years in a prior study. This is associated with an increase in dysphagia cases in line with increasing age and underlying comorbidities.[11,12] In addition, it is crucial to investigate the high prevalence of comorbidities in this study, particularly diabetes mellitus (DM) since it produces an ideal hyperglycemic environment for the growth of microbes and impairs the immune system. In this study, 19.05% of NGT-using patients had diabetes. This finding is in line with the findings of Darwish et al. (20% of prevalence) and Leibovitz et al. (17% of prevalence).[5,13,14]

Irrational use of antibiotics can increase resistance.[15] A prior study demonstrated that initial broad-spectrum antibiotic treatment is an independent risk factor for gram-negative bacterial colonization. This occurs more frequently in hospitalized patients who have an NGT inserted than in hospitalized individuals who do not. This was shown in a prior study conducted in England, which demonstrated significant differences in the usage of antibiotics among individuals who use NGT (p=0.04). Antibiotics were administered to 55% of patients who had an NGT inserted, compared to 49% of patients

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who did not have an NGT inserted.[16,17]

Both NGT (100%) and non-NGT (100%) groups had high oropharyngeal colonization. This is consistent with the research by Leibovitz et al., which stated that oropharynx colonization reached 100% after NGT use for >24 hours, whereas the minimum duration for NGT use in the present study was 14 days. However, the incidence of colonization varies according to Darwish et al. (2012), from 43.3% to 81% based on the study by Leibovitz et al. (2003).[14,18,19]

The high incidence of colonization in both groups makes the difference between them insignificant, and it can be attributed to the characteristics of patients from developing nations, who, in addition to nutritional factors, tend to have a lower middle standard of living and inadequate hygiene conditions. A study in Gambia revealed that colonization of the oropharynx is found in up to 82.1% of the population.[5,7,19–21]

The NGT use and its adverse effects contribute to the increased colonization in NGT-using patients. This can include a decrease in the quality of oral hygiene, malnutrition, decreased production, composition, and flow of saliva, as well as mechanical disturbances in the form of deficits in mastication and food passage, all of which increase the colonization of gram-negative bacteria in the oropharyngeal region of patients who have an NGT inserted.[7,14,22–24]

Thirteen microbial species were discovered to have colonized the oropharyngeal area of the research participants. *P. aeruginosa* (47.62%) and *A. baumanii* (38.1%) were the species with the highest colonization rate among patients who had an NGT inserted. On the other hand, *A. baumanii* (33.3% of non-NGT patients) and *E. cloacae* (23.8% of non-NGT patients) predominated among non-NGT patients. The findings that *P. aeruginosa* is the predominant bacterium in the oropharyngeal region of NGT-inserted patients are consistent with earlier research that achieved results ranging from 18% to 43.3%.[7,14,19,25]

This research showed that the prevalence of *P. aeruginosa* colonization varied significantly between the two study groups. These findings demonstrate that *P. aeruginosa* is the predominant bacterial species in patients with NGT. This finding is similar with prior study in Israel (colonization in 34% of patients) and Egypt (43.3%). This colonization is associated with a lack of food clearance mechanisms related to chewing and swallowing, resulting in stagnation and growth of gram-negative bacteria, as well as the abiotic environment, particularly if the NGT is made of polyvinyl chloride, which causes adhesions and the formation of biofilms, thereby increasing the risk of aspiration pneumonia and systemic infection. Patients with NGT tend to get long-term care with a high prevalence of antibiotic usage, producing a favorable environment for the development of bacteria and antibiotic resistance; *P. aeruginosa* can even cause nosocomial infections, particularly in the critical care unit.[5,7,14,19]

This finding of *P. aeruginosa* must be emphasized since, as an opportunistic infection with a high level of resistance, it can negatively affect patient outcomes. The primary finding was associated with the prevalence of aspiration pneumonia caused by *P. aeruginosa*. *P. aeruginosa* and antibiotic-resistant *P. aeruginosa* caused 4.2% and 2.0% of community-acquired pneumonia (CAP) in 54 countries, respectively. A Chinese cohort study found a 28-day mortality rate of 28.4% among study participants. The carbapenem-resistant *P. aeruginosa* was one of the leading causes of death in the study (OR=4.485, P=0.038). Meanwhile, *P. aeruginosa* has been linked to aspiration pneumonia in hospitalized patients, particularly in the elderly and dependent populations. This condition is caused by the transmission and colonization of pathogenic bacteria from the oropharyngeal fluid to the lower respiratory tract and lungs. This requires a stricter clinical approach in patients with bacteremia, ventilator-associated pneumonia, urinary tract infections, upper respiratory tract infections, or soft tissue infections, including adequate antibiotic therapy with anti-*Pseudomonas* agents and evaluation of the frequency of NGT replacement, which may provide a favorable environment for the growth of these bacteria.[5,26–29]

The limitations of this study lie in the relatively small sample size and the inclusion of HEENT patients in the control group, which should have been composed of healthy individuals. On the other hand, this study has the advantage of collecting primary data directly from patients, which allows for a more comprehensive examination.

5. Conclusion

The use of a nasogastric tube was significantly related to the growth pattern of *Pseudomonas aeruginosa* in the oropharyngeal region (p=0.015) but not to other confounding factors such as age, nutritional status, comorbidities, transient blood sugar, sex, smoker status, or antibiotic use. Patients with an NG tube had a higher rate of antibiotic use than those who did not have an NG tube (p = 0.002). *P. aeruginosa* colonization modeling revealed that the NGT (p=0.012) was the most influential factor in driving the process, with a 90.5% colonization probability.

6. Acknowledgements

7. References

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