BACTERIAL PNEUMONIA AND ITS ASSOCIATION WITH CHRONIC PERIODONTAL DISEASE AMONG THE PATIENTS ATTENDING AT BARIND MEDICAL COLLEGE HOSPITAL, RAJSHAHI

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Abstract

Pneumonia is an infectious disease of the respiratory tract that causes inflammation of the pulmonary parenchyma. The study aimed to determine the relationship between bacterial pneumonia and chronic periodontitis. This was a cross sectional type of descriptive study which was carried out among the 104 patients attending at Dental Outpatient Department, Barind Medical College Hospital, Rajshahi for the treatment of chronic periodontitis which were selected purposely. Most responders (46.2%) were between the ages of 21 and 30, and the vast majorities (88.5%) were men. Data showed that 92.0% of people came from a nuclear family, 63.5% had completed high school, and 70.2% had a monthly house hold income of less than 10,000 Taka. Great majority (46.2%) lived in standard housing without windows (52.9%) or ventilation (66.0%). With regards to the evaluation of chronic periodontal condition, 87.5% of those with community acquired pneumonia had history of gum bleeding, compared to 95.2% of those with no history of this. Most cases of pneumonia were identified as being caused by *Streptococcus pneumonia* (59.80%) after bacteriological testing. One-way analysis of variance revealed a significant correlation (p<0.001) between oral hygiene index, dental calculus index and dental periodontal index and bacterial pneumonia. Bacterial pneumonia was found to be substantially linked with housing condition, ventilation, sunlight and oral hygiene index (p<0.05). People would not get bacterial pneumonia if we told them to take care of their gums and teeth, patients who had received periodontal therapy and practiced good oral hygiene were found to have a risk of pneumonia that was nearly half that of the general population.

Key words: Bacterial pneumonia, Chronic periodontitis, Health education.

Introduction

Twenty percent to fifty percent of the global population suffer from periodontal disease, an inflammatory condition of the periodontal tissue (Nazir 2017). The loss of the ligaments and alveolar bone that hold teeth in place is due to periapical periodontal pathogen colonization (Abusleme et al. 2013). Tooth loss is an inevitable consequence of chronic periodontitis (CP), an advanced inflammatory form of periodontal disease caused by bacteria (Gendron et al. 2000). Pneumonia is one of the most widespread life-threatening illnesses, impacting both healthy and at-risk populations with high morbidity and fatality rates (Brown 2007). In 2004, pneumonia was the tenth largest cause of death in Korea, but by 2015, it had risen to fourth place, behind cancer, cardiovascular disease, and cerebrovascular illness. 6 Pneumonia (22.9 people, 246.7%), heart disease (17.1 people, 41.5%), and lung cancer (6.5 people, 22.7%) were the leading causes of death, all of which saw sharp increases over the previous decade. Multiple studies have established a link between periodontitis, pneumonia, and other respiratory illnesses (Azarpazhooh and Leake 2006, Scannapieco et al.

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2003, Scannapieco and Shay 2014). Aspiration of oropharyngeal flora into the lower respiratory system, followed by a failure of the host's defense mechanisms to eradicate the invading bacteria, results in bacterial pneumonia in adults.

It is known that anaerobic bacteria can cause community-acquired pneumonia and lung abscesses; therefore, it stands to reason that dental plaque, especially in people with periodontal disease, could be a source of these bacteria. Patients at high risk for pneumonia, such as those in hospitals and nursing homes, may also be less prone to practise good hygiene than their healthier counterparts. Lack of care for one's dental health may be a key factor contributing to this pattern of neglect. Potential respiratory pathogens (PRPs) such Enterobacteriaceae (*Klebsiella pneumoniae*, *Escherichia coli*, *Enterobacter species*, etc. *Pseudomonas aeruginosa* and *Staphylococcus aureus* may colonize the oropharynx when oral hygiene is poor or periodontal disease is present (Scannapieco and Mylotte 1996). It is unclear how the ineffectiveness of both acquired and innate immunity in resolving inflammation contributes to the development and worsening of periodontitis. The significance of tailored early intervention for better periodontal and systemic health cannot be emphasized enough, as individual predisposition contributes to the onset of periodontitis (Van and Sima 2020). Bacteria, mycoplasma, viruses, fungi, and parasites are the typical causative agents of pneumonia, an infectious disease of the lung parenchyma that affects many people.

The mortality and morbidity caused by bacterial pneumonia are widespread in human communities (Jiang et al. 2020). There are microorganisms, some beneficial, some harmful, and symbiotic, in every area of our bodies. Disease onset and development may be affected by changes to the microbiome, the population of microbes that live in and on our bodies. The oral cavity is home to a microbial population that is both diverse and the second biggest in the body (Kouanda et al. 2021). More than 700 different kinds of prokaryotes, such as Firmicutes, Fusobacteria, Proteobacteria, Actinobacteria, Bacteroidetes, Chlamydiae, Chloroflexi, Spirochaetes, Synergistetes, Saccharibacteria, and Gracilibacteria, have been discovered in the mouth. On the tongue, for example, you'll find a plethora of papillae but very few anaerobic sites, meaning that the flora there is primarily anaerobic (Eke et al. 2020).

Periodontal disease is a common cause of pneumonia, although there is no concrete evidence to support the theory that chronic periodontal disease causes pneumonia or worsens clinical infections in those who have it. Periodontal therapy in patients is associated with a decreased likelihood of developing pneumonia. Dentists and medical doctors should increase their understanding of the correlation between periodontal diseases and pneumonia. These findings provide evidence to policy-makers that addressing periodontal disease could be a modifiable factor in preventing pneumonia.

Methodology

This cross-sectional descriptive study was done for the treatment of chronic periodontitis. The researcher personally conducted face-to-face interviews with all of the patients who were diagnosed with chronic periodontitis at the Barind Medical College Hospital, Rajshahi in order to collect data using a questionnaire that was only partially organized. The study population was informed about the purpose of the study in detail and consent from every individual was taken with assurance of maintenance of secrecy. For each participant, a code number was used both in questionnaire and in the specimen label. Information on periodontitis and other types of pneumonia, in addition to some selected socio-demographic and biological variables of the respondents, was gathered as well as baseline information. We made every effort to collect accurate data. Respondents were given the opportunity to openly express their opinions in open-ended questions in a neutral and friendly tone. The data were analyzed utilizing IBM SPSS (version-23) in keeping with the objectives of the study.

Results

Regarding age distribution of the respondents it was found that out of 104 respondent's majority (46.2%) were in the age group of 21-30 years, 38.8% were in the age group of up to 20 years and a few (10.6%) constituted the age group of (31-40) years. 3.2% in this age group and (41-50) years and a few 1.2% were found in the age group of 51+ year. Majority of the respondents (63.5%) had class 6-12 level of education, 14.4% had primary level of education, 11.5% were graduates and 10.6% were illiterate. It was revealed that majorities (52.9%) of the respondents were in service, 33.7% were business men, 11.5% were house wife and 1.9% was in others profession. Majority (70.2%) of the respondents had up to 10000 taka as monthly family income, 24.0% had 10001-20000 Taka and 5.8% had more than 20000 taka as monthly family income. It was found that 46.2% had crowded housing condition, 37.5% had normal housing and 16.3% had healthy housing system. Most (52.9%) of the respondents did not have proper ventilation system and 47.1% had proper ventilation system. It was found that 66.0% of the respondents did not have proper sunlight in their house and 34.0% had proper sunlight. It was found that out of 104 respondents, most of them (59.6%) had history of gum bleeding, 28.8% did not have that type of history and 11.5% did not know about this. Regarding most types of bacterial pneumonia, most of the respondents (87.5%) had CAP (Community Acquired Pneumonia), 9.6% had HAP (Hospital Acquired Pneumonia), 1.9% had HCAP (Healthcare Associated Pneumonia) and 1.0% had VAP (Ventilator Associated Pneumonia). Regarding previous history of pneumonia, most of the respondents (95.2%) did not have it and 4.8% had pneumonia. Out of the 104 respondents the majority of 59.8% had *Streptococcus pheumonia* (21.6%) were affected by *Haemophilus influenzea* (9.4%) had infection by *Staphylococcus aureus.* The rest of (6.2%) respondents affected by Group A- *Streptococci* and the only 3% respondent by others (Table 1).

Table 1: Distribution of the respondents by their different characteristics.

Variable and group	N (%)	Variable and group	N (%)
Age in group		**Educational status**	
Up to 20 years	41 (38.8)	Illiterate	11 (10.6)
21 - 30 years	49 (46.2)	Class 1-5	15 (14.4)
31 - 40 years	9 (10.6)	Class 6-12	66 (63.5)
41-50 years	4 (3.2)	Graduate+	12 (11.5)
>51 years	1 (1.2)	**Occupation**	
Mean ± SD	23.61 ± 5.36 years	Service	55 (52.9)
Monthly family income group		Housewife	12 (11.5)

Up to BDT 10000	73 (70.2)	Business	35(33.7)
BDT 10001 - 20000	25 (24.0)	Others	2(1.9)
>20000 BDT	6 (5.8)	**Proper ventilation**	
Mean ± SD	13557.28 ± 9.258 BDT	Yes	49 (47.1)
Housing condition		No	55 (52.9)
Normal	39 (37.5)	**Proper sunlight**	
Crowded	48 (46.2)	Yes	35 (34.0)
Healthy	17 (16.3)	No	69 (66.0)
History of gum bleeding		**Previous history of pneumonia**	
Yes	62 (59.6)	Yes	5 (4.8)
No	30 (28.8)	No	99 (95.2)
Don't know	12 (11.5)	**Responsible bacteria**	
Types of bacterial pneumonia		*Streptococcus pheumonia*	61 (59.8)
CAP (Community acquired pneumonia)	91 (87.5)	*Haemophilus influenzea*	24 (21.6)
HAP (Hospital acquired pneumonia)	10 (9.6)	*Staphylococcus aureus*	10 (9.4)
VAP (Ventilator associated pneumonia)	1 (1.0)	Group A: *Streptococci*	7 (6.2)
HCAP (Healthcare associated pneumonia)	2 (1.9)	Others	2 (3.0)

Table 2 showed the significant relationship with types of bacterial pneumonia and oral hygiene status, dental calculus index and dental periodontal index. It indicated that the respondents who did not have good oral health and condition had more chance to develop bacterial pneumonia.

Table 2: ANOVA test between types of bacterial pneumonia and oral hygiene status, dental calculus index, dental periodontal index.

	Sum of squares	df	Mean square	F	Sig.
Between items	98.313	1	98.313	258.404	p<0.001
Residual	39.187	103	0.380		
Total	137.500	104	1.322		

	Sum of squares	df	Mean square	F	Sig.
Between items	65.813	1	65.813	117.507	p<0.001
Residual	57.687	103	0.560		
Total	123.500	104	1.188		

	Sum of squares	df	Mean square	F	Sig.
Between items	6.582	1	6.582	14.449	p<0.001
Residual	46.918	103	0.456		
Total	53.500	104	0.514		

Table 3 showed the significant relationship with types of bacterial pneumonia and housing condition, proper ventilation and proper sunlight.

Table 3: ANOVA test between types of bacterial pneumonia and housing condition, proper ventilation, proper sunlight.

	Sum of squares	df	Mean square	F	Sig.
Between items	19.692	1	19.692	57.447	p<0.05
Residual	35.308	103	0.343		
Total	55.000	104	0.529		

	Sum of squares	df	Mean square	F	Sig.
Between items	6.582	1	6.582	27.206	p<0.05
Residual	24.918	103	0.242		
Total	31.500	104	0.303		

	Sum of squares	df	Mean square	F	Sig.
Between items	5.558	1	5.558	21.649	p<0.05
Residual	26.442	103	0.257		
Total	32.000	104	0.308		

Table 4 showed the significant relationship with oral hygiene index and housing condition, proper ventilation and proper sunlight. This relationship was also related with types of bacterial pneumonia. So we concluded that types of pneumonia is associated with oral hygiene status as well as related with housing condition, proper ventilation and proper sunlight.

Table 4: ANOVA test between oral hygiene index and housing condition, proper ventilation, proper sunlight.

	Sum of squares	df	Mean square	F	Sig.
Between items	30.005	1	30.005	62.440	p<0.01
Residual	49.495	103	0.481		
Total	79.500	104	0.764		
	Sum of squares	df	Mean square	F	Sig.
Between items	54.019	1	54.019	132.536	p<0.01
Residual	41.981	103	0.408		
Total	96.000	104	0.923		
	Sum of squares	df	Mean square	F	Sig.
Between items	57.120	1	57.120	153.294	p<0.01
Residual	38.380	103	0.373		
Total	95.500	104	0.918		

Bacteria such as *Streptococcus pneumoniae* are present all over the world. While they typically do not cause illness, they can occasionally lead to pneumonia and other respiratory infections. Meningitis, sepsis, otitis media, bacteraemia, peritonitis, sinusitis, and community-acquired pneumoniae are all caused by these harmful microorganisms in people. They often invade the airways. From one individual to another, they disseminated via aerosol droplets. Those with weakened immune systems, children, and the elderly are the most common victims. The Gram-positive, lanceolate-shaped diplococci known as *S. pneumoniae* are a major cause of pneumonia, meningitis, and other infections in humans. Due to the high levels of hydrogen peroxide (H_2O_2) that this organism produces, it thrives in environments with 5% carbon dioxide (CO_2) and media containing blood (blood agar, chocolate gar). Because MacConkey agar (MA) does not include blood and also has a high quantity of bile, which inhibits the growth of *S. pneumoniae*, it will not support its growth. Nonetheless, this is the first and most uncommon instance of *S. pneumoniae* development on MA that we are aware of.
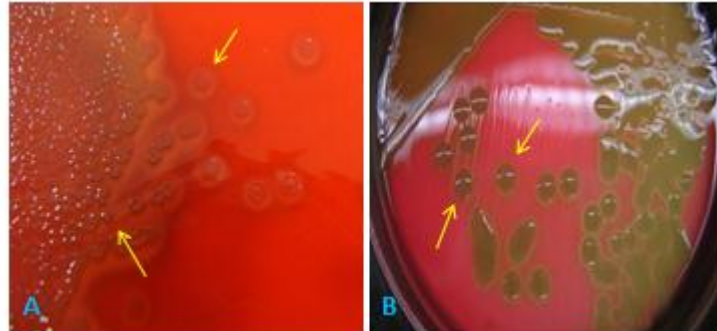
Fig. 1 (A-B): *Streptococcus pneumoniae* on blood agar media.

A part of the typical human skin flora and the nasal passageways, *Staphylococcus aureus* is a Gram-positive, facultative anaerobic bacterium. A variety of infectious illnesses, including skin infections, bacteremia, endocarditis, pneumonia, and food poisoning, can be caused by *Staphylococcus aureus*, a Gram-positive bacterium. After making a name for itself as a nosocomial infection, the organism eventually spread to community settings in the form of epidemiologically separate clones. To aid in attachment, invasion, and evasion of the host immune response, *S. aureus* expresses a variety of virulence factors that aid in infection establishment. The fact that *S. aureus* can develop resistance to more than one class of antibiotics makes it a very difficult disease to eradicate. High rates of morbidity, death, and treatment expenditures were caused by the emergence and spread of methicillin-resistant *Staphylococcus aureus* (MRSA). In appearance, *S. aureus* cells are spherical and Gram-positive. After Gram staining, they tend to cluster together in what looks like bunches of grapes under a light microscope. On nutrient-rich agar media, *S. aureus* forms rather big colonies and is both aerobic and facultative anaerobic. Carotenoids, which are produced by the organism, give the colonies their characteristic yellow color.
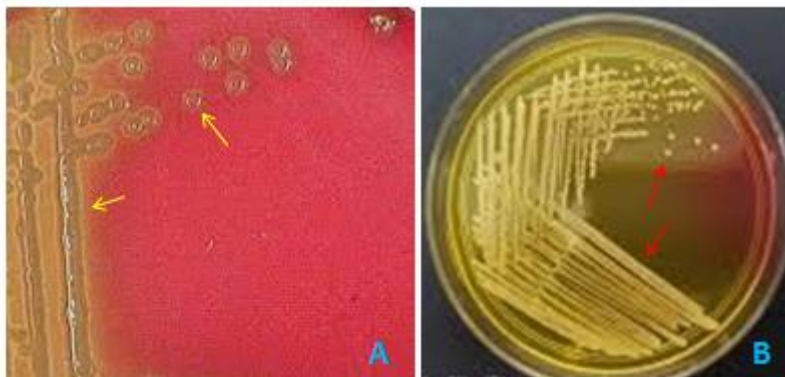
Fig. 2 (A-B): A) Beta-haemolytic colonies after 2 days incubation at 37°C,
B) *Staphylococcus aureus* on nutrient agar media.

Discussion

This was a cross sectional type of descriptive study which was carried out among the patients of chronic periodontitis and who had bacterial pneumonia as well. Regarding age distribution of the respondents it was found that majority (46.2%) were in the age group of 21-30 years. Yang et al. (2020) in their study reported that the age-specific adjusted HR of pneumonia increased with age from 2.28 (age 40-64 years) to 7.98 (age ≥65 years) as compared with the age 20-39 group. Majority (70.2%) of the respondents in our study had up to 10000 Tk. as monthly family income, 24.0% had 10001-20000 Tk. and 5.8% had more than 20000 Tk. as monthly family income. The above finding of ours is in good agreement of the findings of Yang et al. (2020) who showed that the higher monthly income group had a lower risk for pneumonia (adjusted HR: 0.65; 95% CI: 0.58-0.73).

It was found by us that out of 104 respondents, most of them (59.6%) had history of gum bleeding, 28.8% did not have that type of history and 11.5% did not know about this. Aspiration pneumonia is most commonly brought on by neglecting dental hygiene, suctioning sputum, taking antipsychotic medications, losing muscle tone in the throat, becoming dehydrated, or suffering from dementia (Manabe et al. 2015). Out of the 104 respondents the majority of 59.8% had *Streptococcus pheumonia* (21.6%) were affected by *Haemophilus influenzea* (9.4%) had infection by *Staphylococcus aureus.* The rest of (6.2%) respondents affected by Group-A streptococci and the only 3% respondent by others.

We found a significant relationship between bacterial pneumonia and different oral hygiene status, dental calculus index and dental periodontal index. However, while controlling for other major health factors, another study revealed no significant association between CP and CAP. Brown's study, which found no connection between CAP and dental biofilms, was supported by our findings (Brown 2007). The main causative agents of CAP are *Streptococcus pneumoniae* and *Haemophilus influenzae*. CAP is also caused by the spread of viral bacterial pathogens such as *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*, and *Legionella pneumophila*. *Porphyromonas gingivalis* and *Treponema denticola*, which are the bacteria involved in CP, and are not typically CAP-related bacteria (Tan et al. 2014). Recently, intensive periodontal treatment was associated with a 29% reduction in the risk of hospitalization for pneumonia in hemodialysis patients (Huang et al. 2015). The oral cavity is an important source of bacteria that cause infections of the respiratory system. The connection of periodontal diseases and pneumonia might result from the colonization of pathogenic bacteria present in dental biofilm (Paju and Scannapieco 2007), followed by aspiration of the colonized pathogens, which is considered a significant risk factor for pneumonia (Azarpazhooh and Leake 2006).

Conclusion

There is an increased risk of pneumonia in patients with chronic periodontitis. The connection between periodontal disease and pneumonia should be better known by dentists and medical experts. Policymakers may use these results as proof that periodontal care is a modifiable factor in the primary prevention of pneumonia.

Conflict of interest: The authors declare that there is no conflict of interest.

References

Abusleme L, Dupuy AK, Dutzan N, Silva N, Burleson JA, Strausbaugh LD, Gamonal J and Diaz PI (2013). The subgingival microbiome in health and periodontitis and its relationship with community biomass and inflammation. The ISME Journal 7(5): 1016-1025.

Azarpazhooh A and Leake JL (2006). Systematic review of the association between respiratory diseases and oral health. Journal of Periodontology 77(9): 1465-82.

Brown JS (2007). Oral biofilms, periodontitis and pulmonary infections. Oral Diseases 13(6): 513-514.

Eke PI, Borgnakke WS and Genco RJ (2020). Recent epidemiologic trends in periodontitis in the USA. Periodontol 82(1): 257-267.

Gendron R, Grenier D and Maheu-Robert LF (2000). The oral cavity as a reservoir of bacterial pathogens for focal infections. Microbes and Infection 2(8): 897-906.

Huang ST, Lin CL, Yu TM, Wu MJ and Kao CH (2015). Intensive periodontal treatment reduces risk of infection-related hospitalization in hemodialysis population: A nationwide population-based cohort study. Medicine 94(34).

Jiang Y, Zhou X, Cheng L and Li M (2020). The impact of smoking on subgingival microflora: From Periodontal Health to Disease. Front Microbiology 29: 11-66.

Kouanda B, Sattar Z and Geraghty P (2021). Periodontal diseases: major exacerbators of pulmonary diseases? Pulm Medicine 4712406.

Nazir MA (2017). Prevalence of periodontal disease, its association with systemic diseases and prevention. International Journal of Health Sciences 11(2): 72-80.

Paju S and Scannapieco FA (2007) Oral biofilms, periodontitis, and pulmonary infections. Oral Diseases 13(6): 508-12.

Scannapieco FA and Mylotte JM (1996) Relationships between periodontal disease and bacterial pneumonia. Journal of Periodontol 67(10 Suppl): 1114-1122.

Scannapieco FA and Shay K (2014). Oral health disparities in older adults: oral bacteria, inflammation, and aspiration pneumonia. Dental Clinics 58(4): 771-782.

Scannapieco FA, Bush RB and Paju S (2003). Associations between periodontal disease and risk for nosocomial bacterial pneumonia and chronic obstructive pulmonary disease. A systematic review. Annals of Periodontology 8(1): 54-69.

Tan KH, Seers CA, Dashper SG, Mitchell HL, Pyke JS, Meuric V, Slakeski N, Cleal SM, Chambers JL, McConville MJ and Reynolds EC (2014). *Porphyromonas gingivalis* and *Treponema denticola* exhibit metabolic symbioses. PLoS Pathogens 10(3): e1003955.

Van TE and Sima C (2020). Understanding resolution of inflammation in periodontal diseases: Is chronic inflammatory periodontitis a failure to resolve? Periodontol 82(1): 205-213.

Yang LC, Suen YJ, Wang YH, Lin TC, Yu HC and Chang YC (2020). The association of periodontal treatment and decreased pneumonia: A nationwide population-based cohort study. International of Journal Environ Research Public Health 17(1): 356.