

ORAL HEALTH: IMPACT ON RESPIRATORY DISEASES

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ABSTRACT

Poor oral health has direct link for pathogenesis of many respiratory diseases. Recent data shows that chronic microaspiration is a risk factor for development and aggregation of pneumonia and variety of other chest diseases including COPD and bronchiectasis.

INTRODUCTION

The oral cavity hosts a highly diverse microbiota. Because of its humidity and temperature, the mouth provides an appropriate environment for the development of organized bacterial communities. These occur as biofilms on both hard surfaces (teeth) as well as the soft tissue of the stomatognathic system.¹ It should be emphasized that these communities are complex organizations and include a wide variety of different species of bacteria with varying degrees of virulence.²

In terms of anatomy, the oral cavity is also the gateway for the respiratory tract. In the cases of breathing with the mouth, accidentally inhaling and trachea cannula, saliva in oral microecosystem would enter the respiratory tract, and on the one hand, certain behaviours like cough could make the mucus of the respiratory tract and other substances enter the mouth, thereby achieving the mutual exchange between the oral cavity and the respiratory tract. Extensive evidence from studies of epidemiology, microbiology and molecular biology has established a significant link between oral microbes, dental plaque, oral health, oral diseases and respiratory diseases. Oral microbiota is known as the main source of lung microbiome.³

Microbes indigenous to oral microecosystem are likely to be inhaled into lower respiratory tract and may infect the lung and trachea by pathogenic virulence factors or change respiratory mucosal microenvironment conducive to the colonization of respiratory pathogens.⁴ Besides, the diverse environment inside oral microecosystem could provide latent sites for the lodging of common

respiratory pathogens,⁵ which could further invade the respiratory tract and cause diseases under the condition of low host resistance. Many studies have observed an association between oral health, oral diseases and risk of respiratory diseases like pneumonia, chronic obstructive pulmonary disease (COPD) and lung cancer.⁶ Therefore, it is pretty critical to understand the role of oral microecosystem in pathogenesis of respiratory diseases, which would contribute to the prevention and treatment of respiratory diseases.

PATHOPHYSIOLOGY OF THE SPREAD FROM ORAL CAVITY TO RESPIRATORY SYSTEM -

Oral dysbiosis increases the inoculum of virulent and inflammatory microbes, causing the penetration of microbes in the respiratory tract and lungs. Oral immune system functions as the foremost barrier and defence against pathogens, which depends on efficient function of oral mucosa, salivary glands and saliva, and gingival crevice. Saliva plays a key role in host defence against invading respiratory pathogens via antibody production.

According to World Health Organisation International Statistical Classification of Diseases and Related Health Problems 10th revision 2016, the common causes are bacteria, viruses and fungi, which may colonise the oral cavity and upper airway leading to respiratory diseases. Pulmonary diseases can be broadly divided into lung infections, lung cancer, and those which obstruct airflow (chronic obstructive

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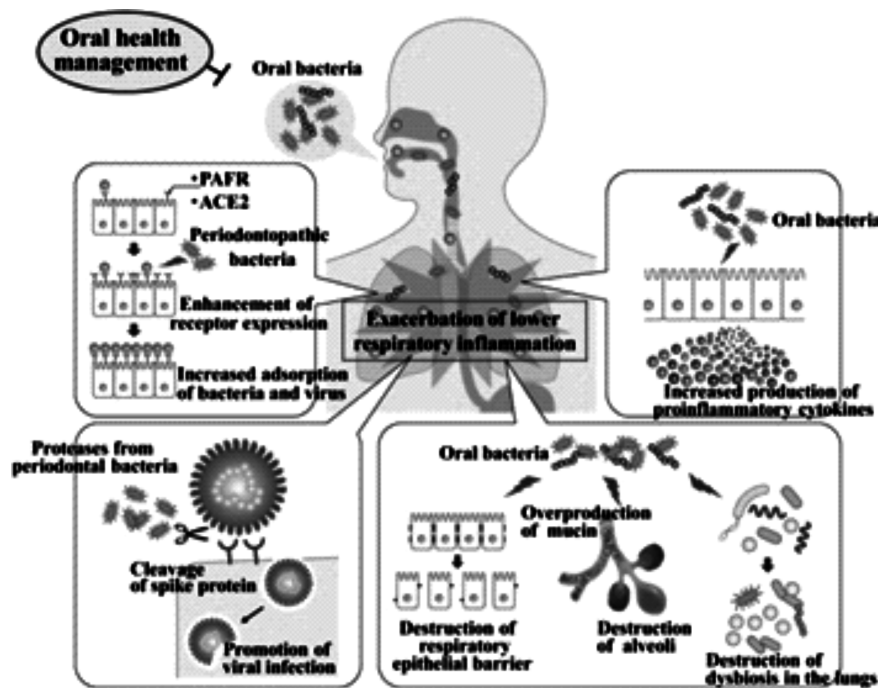
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pulmonary disease (COPD), and lower respiratory tract infections were three of the top six causes of years of life lost in England in 2013.⁷ Pneumonia is a very common infection that inflames the air sacs in one or both lungs. Dental plaques are known to be a reservoir for common respiratory pathogens responsible for pneumonia.⁸ **Biology and mechanism involved in the possible association between oral conditions and respiratory diseases**

1. Oral pathogens directly aspirated into the lungs. There is evidence in the literature indicating that periodontal organisms such as *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans* are involved in aspiration pneumonia.

Furthermore, it is important to understand that the dental biofilm can be colonized by pulmonary pathogens, thus strengthening the idea that the oral cavity may constitute a reservoir for pathogens that are responsible for aspiration pneumonia in high-risk patients.^{9,10}

2. Salivary enzymes associated with periodontal disease modify respiratory tract mucosal surfaces. In this hypothesis salivary enzymes associated with periodontal disease modify respiratory tract mucosal surfaces and promote adhesion and colonization by respiratory pathogens, with consequent aspiration into the lungs thereby causing infection. Enzymes secreted by oral bacteria can spread influenza infection¹¹



3. Hydrolytic enzymes from periodontopathic bacteria may destroy the salivary film that protects against pathogenic bacteria. This may reduce the ability of mucins to adhere to pathogens such as *Haemophilus influenzae*, thus leaving them free to adhere to mucosal receptors in the respiratory tract. In turn, this results in fewer non-specific host defence mechanisms in high-risk individuals.

4. The presence of a large variety of cytokines and other biologically active molecules continually released from periodontal tissues and peripheral mononuclear cells. In cases of untreated periodontal disease in high-risk individuals, the presence of a large variety of

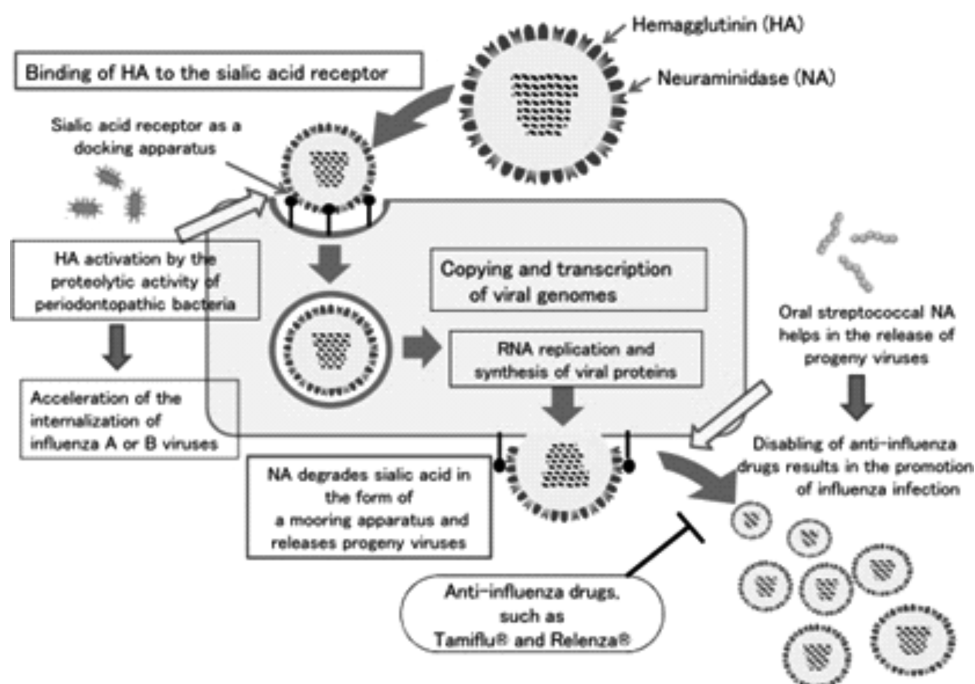
cytokines and other biologically active molecules continually released from periodontal tissues and peripheral mononuclear cells may alter the respiratory epithelium and promote colonization by respiratory pathogens via the upregulation of adhesion receptor expression on the mucosal surfaces, thereby resulting in infection.

Relationship between the composition of oral commensal flora and infectivity of influenza viruses in the host

Seasonal influenza caused by influenza A and B viruses often causes severe illness and consequently leads to death in those with underlying diseases and in the elderly. Hemagglutinin

(HA) and [neuraminidase](#) (NA) are expressed as spikes on the surface of influenza A and B viruses, and they play important roles in adsorption and release during viral proliferation. During adsorption, HA on the surface of the virus binds to [sialic acid](#) on the [viral receptor](#) expressed on the host's upper [respiratory mucosa](#), allowing the virus to adsorb to the target cell and then be taken up into the target cell for entry. Viral [nucleic acids](#) and [viral proteins](#) are synthesized in the target cell, and

these components are aggregated to form progeny viral particles, which exit the target cell by budding and are moored by sialic acids on the target cell surface. It should be noted that release of the progeny virus does not occur in this state. When the NA on the virus itself degrades sialic acid, which holds the progeny virus in place, the progeny virus then are released from the infected cell and spread to other target cells in the vicinity.¹¹



RELATIONSHIP BETWEEN ORAL MICROBIOTA AND THE DEVELOPMENT OF COPD-

COPD is a general term for diseases that were previously known as chronic bronchitis and emphysema. The number of patients with COPD continues to increase, with the disease having become the third leading cause of death worldwide in 2020, and global countermeasures are required. COPD is mainly caused by prolonged inhalation of tobacco smoke and presents as airflow obstruction. As inflammation progresses, the disease destroys lung tissue and the ability to inhale oxygen and expel carbon dioxide; thus, external respiratory function is reduced, which interferes with daily life. Nowadays, COPD is regarded as chronic, systemic inflammation rather than local inflammation confined to the lungs, and it is associated with a high incidence of comorbidities such as diabetes, ischemic heart disease, and osteoporosis. In recent years, there have been many reports on the association between COPD and chronic periodontitis as well as the association with

pneumonia. Among smokers, those with severe chronic periodontitis had higher odds (ratio of 3.71) of developing COPD than those without chronic periodontitis.⁴

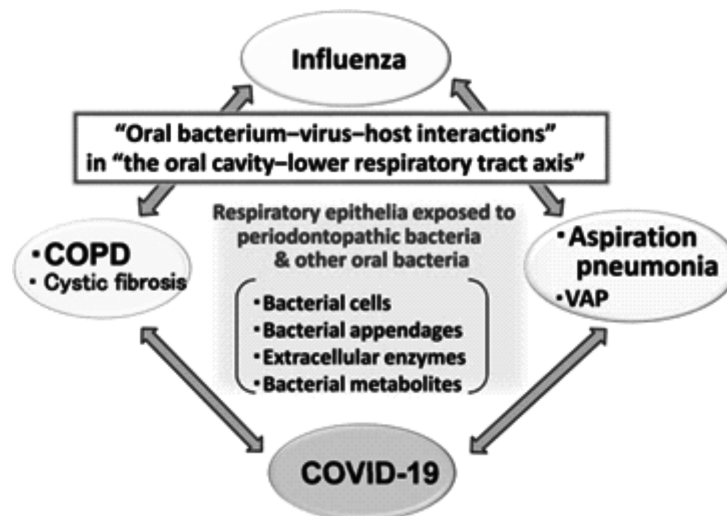
In the absence of effective oral care, initial plaque formation will occur within forty-eight hours; the composition of the oropharyngeal flora becomes more heavily colonised by virulent gram-negative pathogens that, as well as leading to oral disease, may be transported to the lungs where they have the potential to cause respiratory infections.⁵ There is moderate evidence of an association between oral health and two pulmonary conditions: chronic obstructive pulmonary disease (COPD) and pneumonia. There is also a strong evidence that frail populations (such as ventilated, or community-living and hospital-based patients) would have a lower incidence of pneumonia after regular oral hygiene interventions which include use of chlorhexidine or povidone iodine, with stronger evidence supporting chlorhexidine in

mouthwash, gel, or other forms. Although evidence suggests that chlorhexidine reduces the incidence of ventilator-associated pneumonia, other outcomes such as mortality are not affected.

The increased use of inhaled drugs and the fact that a large ratio of the inhaled substances remains in the oro-pharyngeal region has raised attention to the oral consequences of this type of medication: xerostomia, mucosal changes,

ulcerations, dental cavities, halitosis, taste disturbances, oropharyngeal candidiasis, gingivitis, periodontitis, and signs of gastro-esophageal reflux.

It was suggested that gingipains from *P. gingivalis* may reduce respiratory function by inducing excessive mucin production in the lungs and bronchi, resulting in bronchial lumen narrowing.



RELATIONSHIP BETWEEN THE COMPOSITION OF ORAL COMMENSAL FLORA AND INFECTIVITY OF INFLUENZA VIRUSES IN THE HOST

Seasonal influenza caused by influenza A and B viruses often causes severe illness and consequently leads to death in those with underlying diseases and in the elderly. Hemagglutinin (HA) and neuraminidase (NA) are expressed as spikes on the surface of influenza A and B viruses, and they play important roles in adsorption and release during viral proliferation. Poor oral hygiene is likely to lead to the inflammation of the lower airway caused by the aspiration of oral bacteria through the mechanisms described previously.

It has also been reported that coronavirus disease 2019 (COVID-19) becomes more severe and results in higher mortality rates in SARS-CoV-2-infected individuals with underlying diseases such as diabetes, heart disease, and COPD⁵ which are known to be closely related to “chronic periodontitis and oral bacteria”.⁷ Mechanisms of oral bacterial pathogenicity for the development and progression of pneumonia as well as the development and exacerbation of COPD. Aspiration of oral bacteria may promote infection with pneumonia-causing bacteria

DISCUSSION ATTENTIONS IN DENTAL TREATMENT

Patients with COPD have large amounts of mucous secretions (chronic bronchitis) with repeated coughing or dyspnoea (emphysema) caused by airway destruction. If possible, it is recommended that during dental treatment, severely affected COPD patients be treated by sitting upright in dental chairs because they may experience difficulties in breathing while lying flat. At the same time, taking into account the important role of dental care and oral health knowledge in the prevention and treatment of COPD, attention should be paid to their oral hygiene guidance.¹²

Since an asthma attack could be triggered or exacerbated by a lot of risk factors, asthma patients should receive greater attention in dental treatment. It is suggested to assess the risk level of an asthma patient by a dental professional to decide whether the patient's health is stable enough to proceed with treatment and make sure that the patient has his or her own rescue inhaler on hand and on the bracket table.¹³ All dental operations as well as dental instruments and materials used during dental treatment should not trigger an asthma attack and prolonged supine positioning should be avoided.¹⁴

Although the number of reported cases of infection or respiratory symptoms caused by dental waterway pollution is limited, the American Dental Association requires that the routine dental treatment output water used in dental unit waterlines should meet the quality standard for drinking water (i.e., ≤ 500 CFU/ml of heterotrophic water bacteria) and it is recommended to use sterile saline or sterile water as a coolant or irrigant when performing surgical procedures.¹⁵

DISCUSSION

Although the association is not fully established and the biological mechanisms not yet fully understood, it is important to realize that oral diseases are preventable and protocols should be developed to prevent even the possibility of such an association. The history of health sciences presents episodes such as the classic example of puerperal fever, in which the problem was not fully understood nor a biological basis established, but where control or even preventive measures were adopted on a population-wide basis.^{18,19,20}

The importance of oral hygiene maintenance apart from normal hygiene is also utmost need for prevention of respiratory diseases and complications exiting pulmonary diseases. The common among them is Providing oral health care, including tooth, tongues and dentures, is helpful to reduce the number of microorganisms inhalable in the lower respiratory tract and control subsequent respiratory infections.¹⁶

SUMMARY

Aspiration from oral cavity is a well-known inciting factor for pulmonary diseases. Epidemiological studies have shown that oral health has direct axisto lung health. Microorganism from the oral cavity may be aspirated to the lower respiratory tract setting in infections in alveoli leading to pneumonia. Aspiration with infected particulate matter is an important cause of aspiration pneumonia and/or lung abscess.

Brushing twice, regular uses of mouth washes and early immediate treatment of the dental diseases should be advised to the patients. A regular visit to dentist for oral hygiene check-up should be anideal protocol for patients with respiratory diseases.

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11. November 2021, Pages 224-230 Relationship between the oral cavity and respiratory diseases: Aspiration of oral bacteria possibly contributes to the progression of lower airway inflammation. panel Kenichi Imai ^a, Toshimitsu Iinuma ^b, Shuichi Sato ^c
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