Routine Dental Prophylaxis May Reduce Harboring Staphylococcus aureus in Oral Cavity

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Abstract:
Background: Pneumonia shows higher rates of morbidity and mortality in elderly and compromised individuals. Poor oral health has been suggested to be a significant risk factor for the disease, though little is known about acquisition of pathogens that could cause bacterial pneumonia. We investigated the prevalence of respiratory pathogens harbored in the oral cavity of independent elderly.

Materials and Methods: The study cohort consisted of 110 community-dwelling, independent elderly. Dental examinations were conducted by 5 dentists, and information regarding oral health was collected by questionnaire. 12 species of opportunistic pathogens were detected in saliva and identified.

Results: Polymerase chain reaction results revealed opportunistic pathogens in 67.3% of the participants, with Klebsiella pneumoniae, Haemophilus influenzae, Staphylococcus aureus, Serratia marcescens, and Candida spp. isolated from 4, 38, 17, 3, and 38 participants, respectively. Age was significantly lower in participants harboring H. influenzae and higher in participants with Candida albicans. 82 of the participants received routine dental prophylaxis and showed a significantly lower rate of S. aureus colonization while the frequency of dental prophylaxis had no relationship with the colonization of S. aureus.

Conclusion: Our findings suggested that elderly individuals who receive routine dental prophylaxis prevent oral colonization by S. aureus.

Key Words: Dental prophylaxis, elderly, saliva, Staphylococcus aureus

Introduction
Pneumonia, one of the most common infectious diseases in elderly and compromised individuals, is related to higher rates of morbidity and mortality.¹ Poor oral health has been suggested to be a significant risk factor for the disease, as oral bacteria from dental plaque in saliva that is subsequently inhaled into the lower respiratory tract can cause aspiration pneumonia² while a number of clinical studies have demonstrated that oral care might reduce the incidence of bacterial and viral respiratory infectious diseases.³⁻⁶ Sumi et al. reported a high correlation between bacterial species in denture plaque and pharyngeal microflora,⁷ and our previous study revealed that aging and salivary occult blood are significant factors related to the oral colonization by those microorganisms.⁸ Furthermore, dental restorations have been suggested to enhance cariogenic bacteria.⁹ A variety of etiological and epidemiological studies have reported that Streptococcus pneumoniae is one of the most frequently isolated bacteria from patients with pneumonia, followed by Gram-negative bacilli (predominantly Klebsiella pneumoniae and Escherichia coli), Legionella pneumophila, Haemophilus influenzae, and Staphylococcus aureus.¹⁰⁻¹¹ These pathogenic microorganisms are much less commonly found in and seldom fatal for younger patients,¹² whereas their presence is significantly associated with elevated morbidity and mortality rates in patients aged 65 and older, and compromised individuals.¹³

On the other hand, several factors relevant to host condition have been shown to enhance morbidity and mortality related to community-acquired pneumonia (CAP). Fine et al. suggested that patients with coexisting illnesses, such as neoplastic disease, liver disease, and others, should be considered as high risk and hospitalized for treating pneumonia.¹⁴ Immunosuppression, neural diseases, cognitive heart disease, and diabetes mellitus are also suggested to have associations with the higher morbidity and mortality associated with CAP.¹⁵⁻¹⁷

A large number of studies have focused on participants who had already acquired pneumonia, while little is known about acquisition of pathogens that could cause bacterial pneumonia in regard to host condition, including general health status, oral status, and habits such as teeth brushing time and frequency. Herein, we investigated the prevalence of respiratory pathogens harbored in the oral cavities of cognitively healthy independent living elderly Japanese, and analyzed factors associated with the harboring of those microorganisms.

Materials and Methods
Subjects
The present study protocol was approved by the Ethical Committee of Osaka University, Graduate School of Dentistry

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The study cohort consisted of community-dwelling, independent living elderly people who previously participated in the Senior Citizens’ College Program supported by the government of Osaka Prefecture, Japan. The participants were recruited via postal mail. 226 participants were targeted with postcards and replied from 137. The purpose and design of this study were explained to the prospective participants, and they were given an opportunity to ask questions and could refuse to participate in the study. Finally, 110 individuals (52 males, 58 females; mean age 70.9 ± 4.5 years old, range 63-86 years) gave their consent and were enrolled as participants.

Dental examinations
Dental examinations were conducted by five registered dentists using dental mirrors and penlights who were trained but whose methods were not calibrated. The numbers of natural teeth, including those with restorations, and decayed lesions were determined without any cleaning performed before the examination. Usage of removable denture prostheses was also noted.

Customary information in regard to oral health
Information regarding the frequency of routine dental prophylaxis (every 3, 6, 12 months or more) was collected from self-administered questionnaires. Here, dental prophylaxis was defined as scaling and/or polishing of teeth by dental practitioners performed at dental clinics, and the frequency of dental prophylaxis within 12 months was defined as routine.

Sample collection for isolation of salivary respiratory pathogens
Stimulated salivary samples were collected from each participant and immediately inoculated into seven kinds of culture medium agar after the collection, as previously described with minor modifications.6 The media selection before colony pick-up polymerase chain reaction (PCR) was designed to avoid unexpected cross-reactions. Briefly, each salivary sample was inoculated into seven different types of culture medium agar (Group A selective strep agar with 5% sheep blood, Drigalski agar, chocolate II agar with bacitracin, Mannitol salt agar, opacity proteins II staphylococcus agar, PASA medium, CHROMagar Candida; Becton, Dickinson and Company, Franklin Lakes, NJ, US). Following incubation for 24-48 h in a 5% CO2 atmosphere, nine species of respiratory bacteria (methicillin-resistant S. aureus [MRSA], methicillin-susceptible S. aureus, Staphylococcus aureus, Streptococcus pyogenes, S. pneumoniae, H. influenzae, K. pneumoniae, Serratia marcescens, and Moraxella catarrhalis) were identified using a colony pick-up PCR method after media selection. Maximum of eight colonies were picked from each strain and tested. The primer pairs used in this study were selected based on previous studies.18,24

Statistical analyses
A Mann–Whitney U-test was used to evaluate the differences in age and stimulated salivary flow rates according to detection of the pathogens. A Chi-squared test was used to evaluate the associations of gender, regular routine dental prophylaxis or not, and removable denture use according to detection of the pathogens. Furthermore, data were analyzed with a multivariate model using logistic regression analyses. The contribution of each variable to the model was evaluated to assess the influence of variables such as age, gender, and removable denture usage. Risk ratios were calculated with 95% confidence intervals. Statistical significance was considered for P < 0.05.

Results
PCR analyses revealed salivary opportunistic pathogens harbored by 74 of the 110 participants (67.3%; 39 females, 35 males), with K. pneumoniae, H. influenzae, S. aureus, S. marcescens, and Candida spp. isolated from 4, 38, 17, 3, and 38, respectively (Table 1). 28 of those 74 participants harbored 2 or more respiratory microorganisms, while S. pneumoniae, MRSA, S. pyogenes, P. aeruginosa, and M. catarrhalis were not detected in any. Age was significantly higher in participants harboring H. influenzae and Candida albicans (P = 0.047 and 0.043, respectively), as shown in Table 2. Gender was not a contributing factor for harboring any of the microbial pathogens (Table 3).

Around 82 (74.5%) of the participants had received routine dental prophylaxis, and this group showed a significantly lower rate of harboring S. aureus (P = 0.026), as shown in Table 3. The frequency of dental prophylaxis had no relationship with the presence of S. aureus (P = 0.247), and undergoing routine dental prophylaxis did not affect the harboring of H. influenzae and C. albicans. In addition, stimulated salivary flow rate had no significant association with the presence of the tested respiratory pathogens (Table 2).

At total of 49 participants wore removable denture prostheses, and they showed significantly higher rates of harboring C. albicans and Candida spp. as compared to those who did not wear removable dentures (Table 3). These results corresponded to a study presented by Budtz-Jorgensen et al., which found that denture use was a contributing factor for harboring respiratory bacteria.25

A multivariate logistic regression analysis was employed to determine the association between harboring S. aureus and demographic characteristics. A significant lower risk of harboring S. aureus was observed in the participants who received regular dental prophylaxis (Table 4).

Discussion
Pneumonia is frequently diagnosed in elderly and compromised individuals and a common cause of death in those populations. According to a study by Spika et al., pneumococcal pneumonia occur in 2 of 1000 elderly (65 years or older) individuals each year in the United States.26 In addition, it was reported that Japanese mortality rate of pneumonia was 97.8/100,000
population in 2013 (http://www.mhlw.go.jp/english/database/db-hw/populate/). Most cases of bacterial pneumonia are considered to be initiated following aspiration of pathogenic bacteria from the oral cavity.2 Furthermore, several previous studies have suggested that oral hygienic intervention by dental practitioner reduces the number of oral microorganisms and leads to reductions in the frequencies of systemic diseases, such as aspiration pneumonia and influenza viral infection, in elderly individuals requiring nursing care.3,6 In the present study, opportunistic pathogens were detected in fewer participants as compared to previous reports. However, the study populations in those were older than our participants, and living in nursing homes or under medical treatment.

In addition, it could be assumed that the study cohort used in this study have rather higher socioeconomic status and motivation because they had previously participated in the Senior Citizens’ College Program and could have afforded to pay tuition and fees for additional education, and to make efforts for self-fulfillment.
Poor oral health status has been demonstrated to be a risk factor for pneumonia. In the present study, we found that routine dental prophylaxis significantly reduced the possession of *S. aureus* in saliva, suggesting that to be a predicting factor for pneumonia. Based on our findings, we could presume that frequent dental prophylaxis diminishes the chance of *S. aureus* biofilm formation, prevent oral colonization, and/or detachment to saliva. The role and contribution of professionals complementary to dentistry (dental hygienists and dental therapists) in maintaining periodontal health have been participants of focus in recent years. Scaling and polishing of teeth by a dentist or a dental hygienist are non-surgical intervention methods intended to supplement, but not substitute for, plaque control at home by the patient, and are commonly provided as a part of general dental practice. In the United Kingdom, approximately 50% of all adult courses of treatment provided under the National Health Service (general dental services) regulations consist of a patient having nothing more than an examination, scaling, and polishing.

To date, there is a lack of consistency regarding the impact on outcomes in studies that have compared different frequencies of routine dental prophylaxis. Davenport et al. concluded that there is no existing high-quality evidence to support or refute the practice of encouraging half-yearly or another specific frequency for routine dental prophylaxis in adults and children. Our findings also suggested that the frequency of dental prophylaxis has no statistical association with the presence of salivary respiratory microbes.

There was a statistically significant difference between younger and older participants regarding the prevalence of *H. influenzae*, whereas the younger participants showed the higher level of possession. On the contrary, older participants showed significantly higher level in *C. albicans*, as shown in Table 2. We are not able to explain the mechanism only by our results. However, one possible reason is a removable denture usage, since the participants with removable dentures showed higher rates of harboring *C. albicans*, as corresponded to previous studies. It might be said that removable denture usage promotes harboring *Candida* spp. and have barrier capability against colonization of *H. influenzae* coinstantaneously. The frequency of *H. influenzae* and *C. albicans* was lower than a previous report among dependent elderly.

At the same time, we recognize the limitations of our investigation, including small sample size, the microbial detection methods employed, and the homogenic samples (community-dwelling Japanese elders). According to the power analysis proposed by Machin et al., at least 220 participants were necessary to conduct accurate analyses (α = 0.05, power = 0.8, ψ = 82/28). Bacterial strains were isolated from salivary specimens in our study because of ease of collection and the non-invasiveness of the method employed. However, Garcia-Vidal et al. suggested that the results of microbiological investigations are often negative, as invasive procedures are necessary to obtain a reliable diagnosis but not usually performed because of the time-consuming procedures required when investigating a large number of samples. In addition, we recognize the lack of information in regard to the state of oral hygiene and denture plaque control of the participants which might be potential confounders for bacterial possession. This point should be solved in the future works. Nevertheless, our findings provide additional information and support the notion that elderly individuals should receive routine dental care not only for oral health but also as prevention from mortal infectious diseases.

**Conclusion**

Our findings suggested that elderly individuals who receive routine dental prophylaxis prevent oral colonization by *S. aureus*.

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