Oral Care Across Ages: A Review

John R. Ashford

SA Swallowing Services, PLLC
Tennessee State University
Nashville, TN

Mouth cleaning is performed to prevent diseases such as dental caries, gingivitis, and periodontitis. Bacteria, present since birth, form complex biofilms that attach to oral surfaces. These florae—controlled with saliva, brushing, and the immune system—may contribute to systemic diseases, including aspiration pneumonia. This review examines oral properties, biofilms, potential disease associated with the oral flora, and oral care practices.

Mouth care begins early with parents teaching their children to clean their teeth daily "to prevent cavities." The World Health Organization (2011) estimates show that dental caries affect 60–90% of school children and the majority of adults in industrialized nations. Periodontal disease affects up to 12% of American adults. With aging, tooth loss affects over a quarter of Americans age 65 and older (Center for Disease Control and Prevention, 2011). Oral disease, in young and old alike, is directly related to the types, population, and control of microorganisms in the oral cavity.

Oral Cavity Environment

Encapsulated by hard and soft surfaces, the oral cavity is covered by a protective mucous membrane, serous fluids, and mixtures of microorganisms, or *flora*, comprised of bacteria, viruses, and fungal species (Avila, Ojcius, & Yilmaz, 2009). Over 600 species of bacteria, either floating free in oral secretions or attached to surfaces as plaque, struggle for survival (Keijser et al., 2008). As the environment changes with maturity, or as a consequence of illness, bacteria composition also changes. Birth moves the infant from the sterile intrauterine environment to an extrauterine environment of continuous exposure to microorganisms (Crielaard et al., 2011). The infant's first feeding introduces bacteria to the oral cavity from its mother. Streptococcus salivarius, present 8 hours after birth, makes up 98% of the infant's oral flora until teeth appear at 6 to 9 months of age (Rotimi & Duerden, 1981; Todar, 2011). Hard, non-shedding tooth surfaces provide permanent locations for new microorganisms, particularly Streptococcus, with concentration levels reaching more than 1,011 microorganisms per cubic millimeter (Li, Kolltveit, Tronstad, & Olson, 2000). Deciduous teeth give way to larger-surfaced permanent teeth, providing more area for colonization (Durso, 2005).

Complex, but slimy, oral flora communities, or *biofilms*, attach and cover the surfaces of the oropharynx and dental restorations. These coatings benefit the oropharynx by stimulating the immune system to protect surfaces against colonization and infection from invading microbes and to stimulate certain nutritional and digestive functions (Todar, 2011). Bacteria within this film chemically communicate among themselves, altering densities, producing virulence factors, and protecting other antibiotic-sensitive bacteria (Drinka, 2010).

Dental plaque, a unique biofilm, contains bacteria and orally secreted glycoproteins that adhere in layers to teeth surfaces. Plaque, if not controlled with good oral care, will evolve into a gram-negative bacterial species that can develop into an oral infection known as *periodontitis* (Guthmiller & Novak, 2002). Findings by Alexander et al. and Saxton et al., as reported by Rowshani, Timmerman, and Van der Velden (2004), show that plaque recolonizes on tooth surfaces within 3 hours of cleaning and to original concentration levels in less than 24 hours in healthy persons. For individuals with periodontal disease, plaque may recolonize within 5 minutes of cleaning.

Tooth destruction and disease are directly related with poor oral cavity health. Tooth decay, a risk factor for children and adolescents, is a softening and degrading of the tooth enamel. Bacterial-laden plaque attaches to these surfaces, and, if not removed, produces acids that demineralize the enamel, leaving pits and fissures (Durso, 2005). Destructive bacteria, such as Streptococcus mutans, use a sticky sucrose-derived substance to attach to these pits and fissures, increasing tooth decay susceptibility (Shay, 2002). Gingivitis, a form of periodontal disease, is characterized by swollen, inflamed, and bleeding gums, and is a consequence of dental plaque irritating the gingival and adjacent mucosa. Other promoting factors may include mouth-breathing, orthodontic appliances, and misaligned teeth. Periodontitis, another form of periodontal disease, chronically inflames and destroys the periodontal ligament and alveolar bone that hold teeth in place (Chi, Neville, Krayer, & Gonsalves, 2010). Localized juvenile periodontitis is particularly destructive in adolescents and is associated with impaired immune response to oral bacteria in the plaque biofilm (Durso, 2005). For elderly persons wearing dentures, bacterial biofilms present unique difficulties. Coulthwaite and Verran (2007) report that acrylic and silicone materials used in denture and denture-lining construction provide ample surfaces for bacteria attachment. Many elderly people are unable to adequately clean their dentures, increasing the prevalence of *stomatitis*, or mouth inflammation. Denture biofilm is broadly similar to dental biofilm but has fewer types of gram-negative bacteria. Dentures that fit closely to mouth surfaces reduce salivary cleaning and encourage development of Candida abicans, a yeast-laden biofilm affecting 10% to 75% of denture wearers.

Oropharyngeal colonization of bacteria has been implicated directly with systemic diseases. *Bacteremia*, or bacteria circulating in the bloodstream, can result from dental work or simple tooth brushing, but usually does not affect healthy children or adults. For some, particularly those with periodontitis, the risk for developing or complicating systemic illnesses is significantly increased (Li et al., 2000). Diseases such as arthritis, osteomyelitis, and meningitis may result from serious infections associated with bacteremia originating from oral sources (Kuppermann, 1999). Other systemic diseases include atherosclerosis, myocardial infarction, endocarditis (Li et al., 2000), chronic obstructive pulmonary disease (Scannapieco, Bush, & Paju, 2003), pregnancy complications, and diabetes (Scannapieco, Dasanayake, & Chhun, 2010; Shay, 2002). Risk of developing pneumonia from aspiration in children or adults with dysphagia is of the utmost concern to the medical team. The causal relationships of oral microorganisms and dysphagia with pneumonia have not been well understood until recently. Studies have identified respiratory pathogens in oral secretions in persons with aspiration pneumonia (Scannapieco, 1999). Poor oral hygiene, profuse plaque development, and a compromised host immune system provide favorable conditions for pneumonia development when orally incubated pulmonary pathogens are aspirated (Li et al., 2000; Scannapieco et al., 2003; Scannapieco et al., 2010; Shay, 2002).

Oral Care

Maintaining ecological balance of the oral cavity is contingent upon constant and adequate rinsing of oral surfaces with saliva, thorough manual cleaning of the oral surfaces, and maintaining good overall systemic health. Saliva is the predominant lubricant and oral cavity defender. Because this serous fluid is rich in antimicrobial substances, such as

immunoglobulin A and enzymes, oral pathogens are prevented from attaching to and colonizing the oropharyngeal surfaces, thus preventing oral infections (Gibson & Barrett, 1992). Reduced salivary flow may result in surface dryness, or *xerostomia*, increasing the probability of bacteria colonization and stomatitis. Prescription medications are the most common cause of xerostomia, followed by Sjögren's syndrome and head and neck radiation therapy (Cassolato & Turnbull, 2003; Vissink, Spijkervet, & Amerongen, 1996). Primary Sjögren's syndrome is an autoimmune disease that destroys salivary glands cells and affects salivary flow rate and composition. As a secondary disease, it may accompany connective tissue diseases including rheumatoid arthritis, systemic lupus erythematosus, and scleroderma. Though predominately affecting middle-aged and elderly Caucasian women, it may occur in persons of all ages and ethnic backgrounds (Cassolato & Turnbull, 2003). Radiation to salivary tissues results in severe inflammation and significantly affects salivary flow (Cassolato & Turnbull, 2003). Xerostomia treatment may include reducing medications and using artificial saliva, such as MouthKote spray or Salivart aerosol, or dentrifices, such as Biotene Dry Mouth toothpaste, mouthwash, or gum (Daniels & Wu, 2000; Rayman, Dincer, & Almas, 2010). Fehder (2008) suggests sipping water between and during meals, eating fibrous foods (apples and carrots) to stimulate saliva, chewing sugarless gum, using saliva substitutes, and using medications such as Evoxac and Salagen.

Manually cleaning the teeth and other oral structures is a common activity for most people. To maintain adequate oral health, the American Dental Association (ADA) recommends brushing twice daily (ADA, 2011). Oral cleaning should begin very soon after birth. The infant's gums should be cleaned with wet gauze or a washcloth. After teeth begin to appear, using a small toothbrush with water is recommended (ADA, 2008). Tooth brushing is strongly supported over use of foam swabs with hospitalized and nursing care patients. Many published clinical studies confirm the ineffectiveness of swabs to clean teeth. Pearson and Hutton (2002) examined dental plaque removal with 34 volunteers and reported that toothbrushes were substantially better at removing plaque than foam swabs. Reports suggest oscillating/rotating/pulsating electric toothbrushes are significantly more effective than manual toothbrushes for removing plaque (Pizzo, Licata, Pizzo, & D'Angelo, 2010). However, a study by Pobo et al. (2009) reported that use of electric toothbrushes with ventilator patients was not effective in preventing ventilator-associated pneumonia. In a systematic review, Ames (2011) could not establish the effectiveness of toothbrush use with critically ill children and adults based on current clinical studies. Other studies report oral cleaning should occur every 2 to 4 hours (Day, 1993; Trenter & Creason, 1986). Some recommend every 8 hours (Fields, 2008) or every 12 hours for intubated patients, with oral moistening every 2 hours (Barnason et al., 1998). Suction toothbrushes are widely utilized with intensive care patients and nursing home residents, but no reports are available evaluating their effectiveness.

Oral care should include use of dentifrices and/or mouth rinses. *Dentifrice* is a powder or paste used as a cleaning agent. Toothpastes containing fluoride are recommended over non-fluoride dentifrices, particularly for children and adolescents. Marinho et al., as reported by Davies (2004), found a 24% reduction in caries when using fluoride toothpastes. However, frequency of use, fluoride concentration, and rinsing behavior are significant to the effectiveness of this agent. Triclosan, a broad-spectrum antibacterial agent used in some dentifrices, has been shown to effectively reduce plaque and gingivitis and is now included in many toothpaste products. Mouth rinses containing fluoride have been found to help reduce caries in children and adolescents by 26% (Davies, 2004). Also found in toothpastes and mouth rinses is chlorhexidine, a widely used broad spectrum, antimicrobial agent. A report from the Center for Disease Control and Prevention (2003) declined to recommend chlorhexidine oral rinse with surgical or other high-risk patients due to lack of strong supporting evidence. However, Houston et al. (2002) reported that oral rinses mixed with a 0.12% solution of chlorhexidine reduced the rate of pneumonia in heart surgery patients by 52%. Beraldo and de Andrade (2008) identified eight meta-analyses and randomized clinical trials examining

chlorhexidine effectiveness. Seven (87.5%) reported chlorhexidine diminished oropharynx pathogen colonization and reduced ventilator-associated pneumonia.

Oral care practices across the lifespan differ little among most healthy individuals, regardless of age. With serious illnesses, typically requiring intensive care including ventilator support, oral care is recognized as a crucial part of a larger treatment regimen. However, standard protocols for oral care have not been widely or uniformly developed. Although tooth brushing and mouth rinsing are generally accepted as pathogen deterrents, more research is needed to incorporate these tools into a standard and cohesive care package.

References

American Dental Association. (2008). *Cavity prevention tips from the American Dental Association.* Retrieved November 3, 2011, from www.ada.org/sections/NewsAndEvents/pdfs/cavity_prevention_tips.pdf

American Dental Association. (2011). *Oral health topics: Cleaning your teeth & gums*. Retrieved November 3, 2011, from www.ada.org/3072.aspx?currentTab=1

Ames, N. J. (2011). Evidence to support tooth brushing in critically ill patients [Electronic version]. *American Journal of Critical Care, 20*, 242–250.

Avila, M., Ojcius, D. M., & Yilmaz, O. (2009). The oral microbiota: Living with a permanent guest [Electronic version]. *DNA and Cell Biology, 28*, 405–411.

Barnason, S., Graham, J., Wild, M. C., Jensen, L. B., Rasmussen, D., Schulz, P., . . . Carder. B. (1998). Comparison of two endotracheal tube securement techniques on unplanned extubation, oral mucosa, and facial skin integrity. *Heart & Lung, 27*, 409–417.

Beraldo, C. C., & de Andrade, D. (2008). Oral hygiene with chlorhexidine in preventing pneumonia associated with mechanical ventilation [Electronic version]. *Jornal Brasileiro de Pneumologia, 34*, 707–714.

Cassolato, S. F., & Turnbull, R. S. (2003). Xerostomia: Clinical aspects and treatment. [Electronic version]. *Gerodontology, 20*, 64–77.

Center for Disease Control and Prevention. (2003). *Guidelines for preventing health-care–associated pneumonia, 2003*. Retrieved November 6, 2011, from www.cdc.gov/mmwr/preview/mmwrhtml/rr5303a1.htm

Center for Disease Control and Prevention. (2011). *Oral health: Preventing cavities, gum disease, tooth loss, and oral cancers*. Retrieved October 30, 2011, from www.cdc.gov/chronicdisease/resources/publications/AAG/doh.htm

Chi, A. C., Neville, B. W., Krayer, J. W., & Gonsalves, W. C. (2010). Oral manifestations of systemic disease [Electronic version]. *American Family Physician, 82*, 1381–1388.

Coulthwaite, L., & Verran, J. (2007). Potential pathogenic aspects of denture plaque [Electronic version]. *British Journal of Biomedical Science, 64*, 180–189.

Crielaard, W., Zaura, E., Schuller, A. A., Huse, S. M., Montijn, R. C., & Keijser, B. J. F. (2011). Exploring the oral microbiota of children at various developmental stages of their dentition in the relation to their oral health [Electronic version]. *BMC Medical Genomics, 4*, 22–34.

Daniels, T. E., & Wu, A. J. (2000). Xerostomia—clinical evaluation and treatment in general practice [Electronic version]. *Journal of the California Dental Association, 28*, 933–941.

Davies, R. M. (2004). The rational use of oral care products in the elderly [Electronic version]. *Clinical Oral Investigations, 8*, 2–5.

Day, R. (1993). Mouth care in an intensive care unit: A review. *Intensive Critical Care Nursing, 9*, 246–252.

Drinka, P. (2010). Preventing aspiration in the nursing home: The role of biofilm and data from the ICU [Electronic version]. *Journal of the American Medical Directors Association, 11*, 70–77.

Durso, S. C. (2005). Oral manifestations of disease. In D. L. Kasper, A. S. Fauci, D. L. Longo, E. Brauwald, S. L. Hauser, & J. L. Jameson (Eds.), *Harrison's principles of internal medicine* (16th ed., pp. 194–201). New York, NY: McGraw-Hill. Retrieved October 13, 2011, from www.ebscohost.com

Fehder, W. P. (2008). Nursing care and management of pathological oral conditions among women and children [Electronic version]. *American Journal of Maternal/ Child Nursing, 33*, 38–44.

Fields, L. B. (2008). Oral care intervention to reduce incidence of ventilator-associated pneumonia in the neurology intensive care unit [Electronic version]. *Journal of Neuroscience Nursing, 40*, 291–298.

Gibson, G., & Barrett, E. (1992). The role of salivary function on oropharyngeal colonization [Electronic version]. *Special Care in Dentistry, 12*, 153–156.

Guthmiller, J. M., & Novak, K. F. (2002). Periodontal disease: Overview of dental plaque development. In K. A. Brogden & J. M. Guthmiller (Eds.), *Polymicrobial diseases*. Retrieved November 1, 2011, from www.ncbi.nlm.nih.gov/books/NBK2496/

Houston, S., Houghland, P., Anderson, J. J., LaRocco, M., Kennedy, V., & Gentry, L. O. (2002). Effectiveness of 0.12% chlorhexidine gluconate oral rinse in reducing prevalence of nosocomial pneumonia in patients undergoing heart surgery [Electronic version]. *American Journal of Critical Care, 11*, 567–570.

Keijser, B. J. F., Zaura, E., Huse, S. M., van der Vossen, J. M. B. M., Schuren, F. H. J., Montijn, R. C., . . . Crielaard, W. (2008). Pyrosequencing analysis of the oral microflora of healthy adults [Electronic version]. *Journal of Dental Research, 87*, 1016–1020.

Kuppermann, N. (1999). Occult bacteremia in young febrile children [Electronic version]. *Pediatric Clinics of North America, 46*, 1073–1109.

Li, X., Kolltveit, K. M., Tronstad, L., & Olson, I. (2000). Systemic diseases caused by oral infection [Electronic version]. *Clinical Microbiology Reviews, 13*, 547–558.

Pearson, L. S., & Hutton, J. L. (2002). A controlled trial to compare the ability of foam swabs and toothbrushes to remove dental plaque [Electronic version]. *Journal of Advanced Nursing, 39*, 480–489.

Pizzo, G., Licata, M. E., Pizzo, I., & D'Angelo, M. (2010). Plaque removal efficacy of power and manual toothbrushes: A comparative study [Electronic version]. *Clinical Oral Investigations, 14*, 375–381.

Pobo, A., Lisboa, T., Rodriguez, A., Sole, R., Magret, M., Trefler, S., . . . RASPALL study investigators. (2009). A randomized trial of dental brushing for preventing ventilator-associated pneumonia [Electronic version]. *Chest, 136*, 433–439.

Rayman, S., Dincer, E., & Almas, K. (2010). Xerostomia: Diagnosis and management in dental practice [Electronic version]. *The New York State Dental Journal, 76*, 22–27.

Rotimi, V. O., & Duerden, B. I. (1981). The development of the bacteria flora in normal neonates [Electronic version]. *Journal of Medical Microbiology, 14*, 51–62.

Rowshani, B., Timmerman, M. F., & Van der Velden, U. (2004). Plaque development in relation to the periodontal condition and bacterial load of the saliva [Electronic version]. *Journal of Clinical Periodontology, 31*, 214–218.

Scannapieco, F. A. (1999). Role of oral bacteria in respiratory infection [Electronic version]. *Journal of Periodontology, 70*, 793–802.

Scannapieco, F. A., Bush, R. B., & Paju, S. (2003). Associations between periodontal disease and risk of nosocomial bacterial pneumonia and chronic obstructive pulmonary disease: A systematic review [Electronic version]. *Annals of Periodontology, 8*, 54–69.

Scannapieco, F. A., Dasanayake, A. P., & Chhun, N. (2010). Does periodontal therapy reduce the risk of systemic diseases? [Electronic version]. *Dental Clinics of North American, 54*, 163–181.

Shay, K. (2002). Infectious complications of dental and periodontal disease in the elderly population [Electronic version]. *Clinical Infectious Diseases, 34*, 1215–1223.

Todar, K. (2011). *The normal bacteria flora of humans*. Todar's online textbook of bacteriology. Retrieved October 31, 2011, from http://textbookofbacteriology.net/normalflora.html

Trenter, P., & Creason, N. S. (1986). Nurse administered oral hygiene: Is there a scientific basis? *Journal of Advanced Nursing, 11*, 323–331. doi:10.1111/j.1365-2648.1986.tb01255.x

Vissink, A., Spijkervet, F. K. L., & Amerongen, A. V. (1996). Aging and saliva: A review of the literature [Electronic version]. *Special Care in Dentistry, 16*, 95–103.

World Health Organization. (2011). *What is the burden of oral disease? Oral disease burdens and common risk factors*. Retrieved October 30, 2011, from www.who.int/oral_health/disease_burden/global/en/index.html