The Link Between Oral Health Care and Aspiration Pneumonia
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ABSTRACT

Background: Aspiration pneumonia is an alarming cause of morbidity and mortality in persons age 60 and older, especially in the institutionalized populations. A diseased oral cavity may serve as a source of pathogens of aspiration, bacterial, ventilator-associated and nosocomial pneumonias. This literature review provides the evidence to indicate a positive correlation between oral health improvement and the reduction of the pneumonia rates in the nursing home residents.

Types of Studies Reviewed: The review included original, primary peer reviewed articles obtained through the PubMed article search. The review identified eight longitudinal studies, one pretest-posttest true experimental design study, one nonequivalent control group design study, one microbiological experimental study and one meta-analysis.

Results: The evidence supports the idea that improved oral hygiene may reduce the oral pathogen load, decreasing the rate of pneumonia, febrile days and death from the infection in the nursing home population. In addition, studies have shown that the professional oral health care is beneficial as an intervention measure in the institutionalized patients.

Clinical Implications: Sufficient evidence exists to incorporate more rigorous oral care protocols into routine nursing practices. It is important for the oral health professionals to educate the caregivers regarding the oral-systemic link between oral pathogens and pneumonia.

Key words: pneumonia, aspiration, dental plaque, elderly
INTRODUCTION

Pneumonia is an inflammation of the lungs caused by fungal, viral, parasitic or bacterial infection.\(^1\) Aspiration, bacterial, nosocomial, and ventilator-associated pneumonias are very common in the immunocompromised nursing home patients. Pathogenic microorganisms found in the oral cavity may serve as initiators of the bacterial infection through the process of aspiration. Even though aspiration of small quantities of oral secretions occurs in normal, healthy individuals, patients with altered consciousness (such as nursing home patients) tend to aspirate oral secretions more frequently and in larger amounts.\(^2\) As shown in one study, about 70% of older adults suffering from bacterial pneumonia had silent aspiration into lungs while sleeping due to a weakened swallowing reflex during sleep at night.\(^3,4\) The immune system of elderly persons is much weaker, permitting the bacteria to grow and cause pneumonia.\(^5\)

The oral-systemic link possibility between the oral pathogens and its implication on the pneumonia prevalence in the nursing home population has been discussed extensively in the recent literature. Some studies suggest that poor oral hygiene and periodontal disease may promote the development of respiratory pathogen oropharyngeal colonization in the nursing home patients.\(^6\) Furthermore, patients who reside in a nursing home often have more compromised oral hygiene than the general population.\(^6\) Results from several experimental studies have shown that regular professional oral health care (POHC) played a significant role in reducing the numbers of potential pathogens in the oral cavity (such as *Staphylococcus aureus*, *Candida albicans*, and *Pseudomonas aeruginosa*) and associated pneumonia, fevers, and death from the infection in the nursing home residents.\(^7,8\) The mechanism of protective action that professional oral health care provides is inconclusive amongst researchers. One study attributes it to the fact that POHC may have reduced the amounts of the various Gram-negative bacteria
that possess lipopolysaccharides as endotoxins, as well as protected salivary proteins that masked the cryptic cold virus receptors in the oral mucous membranes.\(^8\) This literature review examines evidence from the longitudinal studies, pretest-posttest true experimental design study, a nonequivalent control group design, microbiological experimental study and a meta-analysis that assessed the relationship between oral hygiene status of nursing patients and its effect on their pneumonia status.

**METHODS**

A PubMed search for the articles relevant to the formed PICO question “Is professional dental care effective in reducing the risk of aspiration pneumonia in the nursing home patient/institutionalized elderly population?” was performed. The inclusion criteria for the literature search were primary peer reviewed original sources, and post-1997 English language literature. This literature review identified the majority of the relevant studies as prospective cohort, but also included a microbiological experimental study, a meta-analysis, a pretest-posttest true experimental design study, and a nonequivalent control group design study. Additional references were identified from the articles’ bibliographies and were included in the literature review. This allowed for a comparison of a pre-professional dental care and post-professional dental care results and its effect on the prevalence of pneumonia amongst nursing home patients.\(^7,8\) Overall, the reviewed studies were indicative of the association between nursing home residents’ oral hygiene status and pneumonia prevalence, as well as the effectiveness of professional oral health care in decreasing oral pathogen load and associated pneumonia. Furthermore, the need for more education and training on oral health in institutionalized settings to improve the oral health and quality of life was emphasized in the reviewed articles.
ARTICLE SYNTHESIS

The first six articles reviewed were based on the subject of the pathogen etiology and microbiology associated with aspiration pneumonia. A nonequivalent control group design study was conducted by Abe, Ishihara, and Okuda\textsuperscript{7} to evaluate the effectiveness of POHC in reducing the risk of aspiration pneumonia. The researchers examined the prevalence of potential respiratory pathogens in gargled samples from 54 elderly nursing patients aged 65 and over, 21 healthy elderly subjects aged 65 and over, and from 22 healthy young subjects under 30 as controls. The group of 54 was further divided (not assigned at random) into an experimental group of 34 who received POHC and a control group of 20 independent elderly without POHC. The prevalence of the Staphylococcus species, MRSA, \textit{P. aeruginosa}, and \textit{C. albicans} using culture and the polymerase chain reaction was determined and compared between the case and control groups. Major limitations of the study included a small sample size (only 34 participants in the experimental group) and a non-random sample assignment. The presentation of operationally defined variables in this article is very strong (for example, the definition of the oral hygiene index (OHI) criteria). The comparison revealed that professional oral health care was effective in reducing \textit{C. albicans} in the nursing home patients who received POHC.

Another study of interest is a pretest-posttest true experimental design study conducted by Adachi and colleagues\textsuperscript{8} as a follow-up to the study by Abe and colleagues.\textsuperscript{7} This study was aimed to evaluate the effectiveness of POHC on the reduction of fevers and fatal aspiration pneumonia in the nursing home residents over 24 months. The subjects of the study were 141 elderly adults residing in two nursing homes, further randomly divided into an experimental group of 77 subjects receiving POHC, and a control group of 64 subjects who did not receive any treatment. This is a convenience sample. This nonprobability method is often used by the
researchers, because it is easy to select the subjects and it is the most cost-efficient sampling. However, a convenience sample could potentially produce outcomes that cannot be applied to the general population. In this study, the numbers of *Staphylococcus* species and *Candida albicans* were compared between the POHC and the non-POHC groups. Comparison of exhaled methylmercaptan amounts was performed between the two groups. The two groups were examined for the incidence of fevers and the prevalence of the fetal aspiration pneumonia. The prevalence of fevers, the ratio of fatal aspiration pneumonia and the numbers of *C. albicans* were all significantly lower in the POHC group, compared to the non-POHC group (*P*<.05, *P*<.05, and *P*<.01, respectively). The researchers did not state in the paper if the pilot study was conducted at any point. Since the researchers didn’t conduct a pilot study prior to carrying out the proposed experiment, the potential deficiencies in its design could have been overlooked. Authors also found that for the first 6 months of observation, no significant difference was seen between the two groups due to the one of the limitations of the study: limited communication and cooperation between the staff and subjects. They added that the limitation was corrected as the study proceeded and allowed to carry out the POHC more effectively. The conclusion drawn from this pretest posttest true experimental study is that POHC administered to a group of nursing home patients was associated with a reduction in prevalence of fevers and fatal pneumonia. Even though the samples were selected from a homogenous nursing home population of Japanese descent in both of the discussed pretest posttest experimental studies, this is not necessarily considered a study bias; however, it could affect the study outcomes applicability to the populations of a different descent.

Abe and associates\(^9\) performed a longitudinal prospective cohort study over a period of one year to see if pneumonia could be predicted using bacteria in saliva and patients’ oral
hygiene status. This correlation was used to set a standard for visualization of oral hygiene. The purpose of the study did not state that the subjects were nursing home patients. The researchers failed to state any specific inclusion or exclusions, but identified that informed consent was given by each participant. Over a period of one year, 145 Japanese residents over the age of 65 in nursing homes were evaluated. A Dental Plaque Index (DPI) and Tongue Plaque Index (TPI) were used to categorize patients into a good oral hygiene group (DPI 0, DPI 1 and TPI 0) and a poor oral hygiene group (DPI 2 and TPI 1). Saliva sampling and bacterial analysis were also used for data collection to confirm a correlation. The conclusion of this investigation showed the poor oral health group had a significant increase in febrile days and new signs of pneumonia. Patients classified with a DPI 2, operationally defined as plaque presence on more than half the tooth, were considered a high risk group for developing aspiration pneumonia. The purpose of the study was confirmed; the risk of aspiration pneumonia can be predicted by bacteria in the saliva and using the visual index for oral hygiene. It is suggested that further studies are needed to identify major microorganisms to verify if there is a correlation in plaque levels and types of bacteria.

Sumi and associates performed a microbiological study to verify a correlation between plaque found on dentures and aspiration pneumonia in nursing home patients. This study was performed using 50 dependent patients by the Department of Dental Surgery of National Chubu Hospital. The sample presented is biased; this could have been avoided by using a random sample of subjects from different institutions. All 50 patients wore a complete maxillary denture. A culture method was used to determine if respiratory pathogens were sub cultured from the original samples. *Staphylococcus aureus, Streptococcus pneumonia, Pseudomonas aeruginosa, Haemophilus influenzae, Haemophilus parainfluenzae, Enterobacter cloacae,*
Klebsiella pneumonia, Serratia marcescens, Proteus mirabilis or Escherichia coli were colonized from the denture plaque sample and isolated. The major species found was Streptococcus species at 98%. The subcultures presented Enterobacter cloacae (18%), Klebsiella pneumonia (16%), Staphylococcus (10%), Escherichia coli (8%), Haemophilus parainfluenzae (4%) and Pseudomonas aeruginosa (2%). The report concludes this study is one of the first in this area. Previous studies on denture plaque showed the prevalence of Candida species causing yeast infections in patients with dentures. This study concludes that the improvement in oral health care in the nursing homes may prevent aspiration pneumonia. The authors gave a specific operational definition of sample collection methods, but could have been more descriptive on the inclusions and exclusions for the study. They also failed to disclose if human rights were protected. Sumi and associates successfully showed a need for further research and the importance of improvements in the oral health of the dependent elderly.

In a study published in the American Journal of Respiratory Critical Care Medicine, authored by El-Solh and colleagues,11 the microbial etiology and prognostic indicators of elders with aspiration pneumonia were investigated. This was a prospective longitudinal study from January 2000 through October 2002, involving 95 institutionalized participants. The data collection included demographic information, activities of daily living, plaque index and type of antimicrobial treatment provided. Strict inclusion criteria included radiographic evidence of pneumonia, signs or symptoms of lower respiratory tract infection and risk factors for aspiration such as difficulty swallowing. The strict inclusions of this study increased the validity and could easily be replicated in other study. The authors sought to recognize the relationship between three different groups of bacteria and aspiration pneumonia. The three groups were divided by
the presence of aerobic microorganisms (n=43), anaerobic microorganisms (n = 11) and those with no verifiable microbial pathogens (n = 41). The patients initially were treated with either monotherapy or dual combination antimicrobial therapy. The treatment was ineffective for 35 of the participants which lead to death. This included fourteen in the aerobic group, four in the anaerobic group and seventeen of those with unverified pneumonia. The authors stated the limitations of this study were the relatively small sample size, the definition of aspiration pneumonia was not clearly defined and a comparator group of elderly residents was needed to fully understand the results. While this study focused on the etiology, it also suggested that due to the deterioration of this population’s daily living activities, insufficient poor oral hygiene can lead to colonization of dental plaque by these microorganisms.

El-Sohl et al.\textsuperscript{12} published a prospective cohort study with 49 participants residing in an intensive care unit at a long term care facility. The researchers evaluated the ability of dental plaque to harbor bacteria and its association with aspiration pneumonia. The study criteria included patients that needed mechanical ventilation. The independent variables for this study were information gathered from the complete oral examination. These variables included plaque index and enumeration of the number of remaining teeth. The respiratory pathogens were cultured and 33 microorganisms were identified. Once the dental plaque was cultured it was considered colonized if the respiratory pathogens present were greater than one percent. The results showed nine of the respiratory pathogens were matched to eight of the persons that acquired aspiration pneumonia. The outcome of this study verified the referred hypothesis that state colonization of dental plaque increases the risk of respiratory tract infections in the elderly institutionalized population. This suggests that dental plaque may be a reservoir for pathogens that are responsible for nosocomial acquired pneumonia. A limitation of this study may be
concluded that the size of 49 participants is a small sample size. Another mentioned limitation is that this study used participants with low functional status and high comorbidities. The combination of the small sample size and the use of low functioning subjects may question the validity of this study. This is the first study of its kind to test for microorganisms using molecular genotyping. The authors noted, due to the colonization of the dental and respiratory bacteria, increased attention should be placed on the routine oral health needs of residents in long-term care facilities.

The next three studies, including a meta-analysis, involved evaluation of the risk factor assessment and the intervention measures. A study conducted by Quagliarello and colleagues\textsuperscript{13} was a prospective cohort study from February 2001 through March 2003. This convenience sample included 613 elderly residents from five New Haven, Connecticut area nursing homes. The researchers collected baseline information on demographics, coexisting health conditions and the activities of daily living. The authors also identified nine modifiable risk factors that may have affected the incidence of aspiration pneumonia. Inadequate oral health care and difficulty swallowing were the two modifiable risk factors that caused patients to be more susceptible to nursing home acquired pneumonia. The major strengths of this study are the large sample size from multiple nursing homes and the strict guidelines for determining the modifiable risk factors. The authors noted the limitations of this study as inadequate oral care as determined by the lack of a dental examination within the last year. This questions the internal validity of the study. Taking into consideration oral hygiene, dental caries, or periodontal condition may have affected the outcome of the modifiable risk factors. This study supported the previous data that indicated inadequate oral health care is a modifiable risk factor in patients that have nosocomial pneumonia.
Scannapieco and colleagues\textsuperscript{1} conducted a meta-analysis of the five intervention studies to determine the relationship between oral hygiene intervention and the rate of pneumonia in institutionalized patients. The inclusion criteria were very strong and incorporated the following study designs: randomized controlled clinical trials, longitudinal, cohort, and case-control studies. The included intervention trials were post-1996 English language articles. General findings from the selected intervention trials suggested that the incidence of nosocomial pneumonia in institutionalized subjects, including nursing home patients, may be reduced by improving oral hygiene through mechanical and/or chemical approaches. Scannapieco and colleagues found a moderate level of evidence for the relationship between nosocomial pneumonia and the improvement of oral health care in nursing home patients. The rationale for the assignment of the “moderate” level of evidence was based on the fact that the selected intervention trials showed consistent positive effects of improved oral health care on the incidence of nosocomial pneumonia. Out of the five evaluated intervention trials, two were specifically related to the trials that involved nursing home patients.\textsuperscript{14,15} However, in one of the intervention trials with 60 ICU patients requiring mechanical ventilation, the correlation between oral intervention and the incidence of nosocomial pneumonia was not clearly stated.\textsuperscript{16} The outcomes of this study could have been affected by the small sample size (only 30 patients in the experimental group were included). In addition, authors made recommendations for further randomized controlled trials to determine the beneficial effect of oral health care therapy on the rate of morbidity and mortality associated with pneumonia.

Since a moderate level of evidence has been assigned in this meta-analysis to the association between the incidence of nosocomial pneumonia and the improved oral hygiene care in institutionalized patients, Scannapieco and colleagues concluded that routine nursing practice
needs to include more rigorous oral health care protocols. Furthermore, as new evidence is evolving, the role of the dental hygienist in preventing nosocomial pneumonia in nursing home settings becomes very important in terms of care provision for the residents, as well as patients’ and caregivers’ education.

A study was performed by Yoneyama and colleagues\textsuperscript{14} in 1996 to determine the correlation between professional oral health care and the incidence of pneumonia. The results indicated that the POHC once a day reduced the number of febrile days in 46 elderly nursing home patients. The POHC was operationally defined as a supervised toothbrushing and oral topical 1\% povidone iodine use. However, the number of patients in this trial was very limited. A two-year follow-up study of 366 nursing home patients was conducted in 2002 by the same group of researchers. Yoneyama and associates\textsuperscript{15} used a longitudinal study over two years to investigate pneumonia in older patients in 11 nursing homes in Japan. Four hundred seventeen residents were randomly assigned to an oral care group and to no oral care group. Measurements over two years were taken on pneumonia, febrile days, and death from pneumonia, activities of daily living (ADLs) and cognitive functions. At the end of the two year period, there were 366 residents left in the study due to the exclusions. The measurements between the two groups were compared. Cognitive functions and ADLs showed an improvement in the group with oral care. More importantly, there was a significant decrease in pneumonia, febrile days, death from pneumonia in the oral care group. Yoneyama and associates concluded their investigation and showed that oral care in nursing home residents may prevent pneumonia.

The next two studies involved a retrospective data analysis of oral health care in nursing homes and the aspiration pneumonia incidence. In a longitudinal retrospective study completed
by Mojon and colleagues, the incidence of respiratory tract infection (RTI) was recorded in 302 elderly residents living in a long term medical care facility over a one year period. The researchers obtained information from the patient’s medical files from routine medical examinations over the study period from March 1993 to March 1995. This information included height, weight, and serum albumin concentration (ALB). They performed a thorough initial oral examination including evaluation of oral hygiene habits. Subjects with the combination of low ALB and poor oral health, showed most likely to incur a RTI. During the study, one third of the subjects had at least one RTI. The dentate residents showed a greater incidence of experiencing an RTI than edentate residents. The testing of the serum albumin level was an operationally defined variable that could be easily replicated in a future study. The authors also noted that experiencing a dental emergency also placed the participants at an increased risk for aspiration pneumonia. The sample size was large enough to draw solid conclusions. The limitation of this study is that the diagnosis of RTI was based on the clinical signs and judgments of only two physicians. There were no strict guidelines for supporting their diagnosis of pneumonia. Corroboration of their findings was not possible because chest radiographs and microbiological samples were not taken and autopsies were not performed. Due to the sample size, the authors inferred that health care providers should strongly consider all risk factors for RTI as a major consideration among the institutionalized elderly population is appropriate.

Terpenning and colleagues conducted a longitudinal study of nine years (June 1990-December of 1998) with prospective enrollment of subjects and retrospective analysis of the data. The objective of the study was to investigate the importance of dental factors in aspiration pneumonia in older veteran population, using the data from the comprehensive dental examination, salivary assays including IgA antibodies, and cultures of saliva, throat, and dental
plaques. Three hundred fifty-eight veterans age 55 and older; 50 subjects with aspiration pneumonia participated in this study. There were two data groupings for these subjects: a subgroup of 218-dentate, and an inclusive group of 58-dentate and edentulous. In the dentate subject with aspiration pneumonia, the presence of *P. gingivalis* in plaque (OR=2.7; 95% CI =1.3-5.3) and *S. aureus* (OR=4.3; 95% CI= 2.0-9.3) and *S. sobrinus* (OR=2.3; 95% CI=0.9-5.9) in the saliva, as well as the presence of decayed teeth (*P*. .06) was significantly higher. In the dentate and edentulous group, the presence of *S.aureus* and *S. sobrinus* was more likely in the subjects with aspiration pneumonia. Due to the presence of *P. gingivalis* in the dentate subject model, periodontal disease was considered a potential risk factor for aspiration pneumonia. The authors also mentioned xerostomia as a possible risk factor for aspiration pneumonia, as it contributes to the concentration of the number of bacteria per milliliter of saliva. This study concluded that oral health care programs are crucial for a community-living and institutionalized older people, as they may assist in the reduction of aspiration pneumonia incidence. One of the limitations of this study could be the set-up of the model that included edentulous patients. This model could not test the effects of factors associated with having teeth. However, authors further stated that the addition of a dentate model is complementary, since it identified modifiable dental risk factors that the edentulous model could not account for. Some of the results of this study needed further determination, such as the interpretation of the finding that functional units (a pair of teeth that can contact each other in chewing) are a significant risk factor in developing aspiration pneumonia. This study called for further investigations to test for a beneficial effect of oral health care programs in nursing homes.

Frenkel19 performed a longitudinal open-ended questionnaire to gather qualitative data from nursing home staff. The study was looking for the attitudes, practices and critical
comments concerning oral healthcare in dependent patients. The quality of oral health care provided to nursing home patients usually falls below the standard of care. In 1997, a random sample of 22 nursing homes was taken from the 96 registered with Avon Health Authority. Two hundred twenty seven questionnaires of the 396 that returned were completely or partially answered. Frenkel did not inform the reader if the responses were used from only the completed questionnaires. In total, 95% were returned, but only 57% replied with all or partial questions answered. The questions were designed to be open-ended regarding the caregivers’ views on providing oral health care, their own personal dental experiences and imagining themselves as the dependent patient. The validity of the questions was debatable, since the author did reveal how they came about. The responses returned a number of strong opinions such as: oral health care could be improved if more training was in place; policy and procedures were in need of improvements and better management decisions could be made. Many caregivers also noted that if they were to put themselves into the patients’ place, they would want their teeth to be cared for on a daily basis. Frenkel concluded that if caregivers’ attitudes improved and management addressed the need for the oral health care, improvement in nursing home patients’ oral health and in quality of life should become evident.

CONCLUSION

The reviewed literature shows a substantial support of improving oral health care in nursing home patients and lowering the risk of aspiration pneumonia. The rate of morbidity and mortality in persons age 60 and older, with aspiration pneumonia is very high, especially in institutionalized populations. Oral health care programs are vital to patients’ overall health. The studies showed improvement in patients ADLs and cognitive functions when POHC or daily oral care was provided by caregivers. Dental plaque is a possible reservoir for
pathogens found in dentate and edentate patients. Due to the deterioration of this population’s daily living activities, insufficient poor oral health can lead to the colonization of dental plaque containing pathogens. Poor oral hygiene patients with plaque found on more than half of the tooth are considered high risk and were found to have more febrile days then patients with good oral hygiene. Oral health care on a daily basis reduces the plaque and therefore decreases the oral pathogen load.

Noticeable gaps in the studies include the need of a broader demographic sampling with increased randomized controlled studies. They are considered the gold standard of testing and provide the greatest validity. A challenging aspect of conducting studies with the nursing home population is the barriers in communication and cooperation between caregivers and patients. Additional training of nursing home personnel on oral hygiene is strongly recommended and oral health care protocols should be implemented in every nursing home.

Implementation of standardized oral health care procedures needs to be given priority including proper training in oral health for all health care providers that specialize in the elderly population. All of the articles reviewed agreed that oral health care plays a significant role in reducing the oral pathogens associated with aspiration pneumonia and improves the quality of life in nursing home patients.
<table>
<thead>
<tr>
<th>*AUTHOR/DATE</th>
<th>STUDY DESIGN</th>
<th>SIZE OF SAMPLE</th>
<th>METHODS</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abe et al., 2001</td>
<td>Nonequivalent control group design</td>
<td>54 subjects</td>
<td>-Comparisons of respiratory pathogens</td>
<td>-Professional POHC** plays a significant role in reducing pathogens associated with AP±.</td>
</tr>
<tr>
<td>Adachi et al., 2002</td>
<td>Pretest-posttest true experimental design</td>
<td>141 subjects</td>
<td>-Compared numbers of Staphylococcus and C. Albicans between two groups</td>
<td>-Subjects receiving OH was associated with a reduction in fatal AP±.</td>
</tr>
<tr>
<td>Abe et al., 2006</td>
<td>Double Blind – Prospective – Cohort</td>
<td>145 subjects</td>
<td>-Analyze the relationship between OH and bacteria in the development of AP±</td>
<td>-Positive correlation between bacteria and increased AP±.</td>
</tr>
<tr>
<td>Sumi et al., 2002</td>
<td>Experimental</td>
<td>50 subjects</td>
<td>-Specimens from dentures searching for respiratory pathogens</td>
<td>-18 types of microorganisms were discovered</td>
</tr>
<tr>
<td>El-Solh et al., 2003</td>
<td>Longitudinal – Prospective - Cohort</td>
<td>95 – subjects-Convenience</td>
<td>-Compared aerobic, anaerobic and non verifiable microorganisms</td>
<td>-Lack of POHC**results in promotion of bacterial colonization</td>
</tr>
<tr>
<td>El-Solh et al., 2004</td>
<td>Longitudinal – Prospective- Cohort</td>
<td>49 subjects</td>
<td>-PI *, check for colonization of bacteria</td>
<td>-Respiratory pathogens were identified</td>
</tr>
<tr>
<td>Quagliarello et al., 2005</td>
<td>Longitudinal , Prospective- Cohort</td>
<td>613 -subjects Convenience</td>
<td>-Compared 9 modifiable risk factors</td>
<td>-Inadequate oral health and difficulty swallowing are major risk factors</td>
</tr>
<tr>
<td>Scannapieco, et al., 2003</td>
<td>Meta-analysis</td>
<td>-5 intervention trials</td>
<td>-Compared a number of studies testing Oral Intervention</td>
<td>-Improved POHC**may prevent AP± in institutionalized patients</td>
</tr>
<tr>
<td>Yoneyama et al., 2002</td>
<td>Longitudinal- RCT</td>
<td>417 subjects</td>
<td>-Subjects received POHC**</td>
<td>-Patients with POHC** care showed decrease in AP±.</td>
</tr>
<tr>
<td>Mojon et al., 1997</td>
<td>Longitudinal – Retrospective</td>
<td>303subjects</td>
<td>-Incidence of RTI^ over 1 year period</td>
<td>-33% of subjects experienced 1 RTI^</td>
</tr>
<tr>
<td>Terpenning et al., 2001</td>
<td>Longitudinal</td>
<td>358 subjects</td>
<td>-Investigate the importance of dental factors in AP±</td>
<td>-Oral cavity could be a source of bacterial species causing AP±.</td>
</tr>
<tr>
<td>Frenkel, 1999</td>
<td>Longitudinal- RCT-survey</td>
<td>416 subjects from 22 nursing homes</td>
<td>-Questionnaires regarding POHC** histories of care givers</td>
<td>-Increased training on OH is needed for health care givers</td>
</tr>
</tbody>
</table>

*PI – Plaque Index, ^RTI- Respiratory Tract Infections, **POHC- Professional Oral Health Care, ±Aspiration Pneumonia
REFERENCES


Research Plan Worksheet-Module 6

1. Identify your
   a. **Research question** Does professional oral hygiene training of nurses and nursing aids affect the incidence of aspiration pneumonia?
   b. **Purpose of your study** The purpose of the study is to determine if providing oral hygiene care instructions to nurses and nursing aids will affect the incidence of aspiration pneumonia on elderly nursing home patients with predisposing conditions
   c. **Hypothesis** Professional oral hygiene training of nurses and nursing aids makes no difference in the incidence of aspiration pneumonia in elderly nursing home patients.

2. Identify your
   a. **Independent variable(s)** Professional oral hygiene training for nurses and nursing aids
   b. **Dependent variable(s)** Incidence of aspiration pneumonia

3. **What type of research design would you use?** The research design would be a randomized controlled study. The study would include six area nursing homes. Three nursing homes would be random selected to provide oral hygiene training to the nurses and nursing aids. The training would include instructions on proper toothbrushing and flossing techniques, and use of mouthrinse (either swabbing or actual rinsing). The nurses and nursing aids would be instructed to provide this care two times daily on all patients participating in the experimental group of this study. The actual performance of the oral hygiene care provided by the nurses and nursing aids will not be directly supervised. This could be a potential limitation of the randomized control study.

4. **Identify your sampling plan.** Select patients that are at highest risk for aspiration pneumonia. This would include patients with compromised care including: greater than 70 years of age and difficulty performing daily life activities. Exclusions include previous history of pneumonia within the past 12 months, vaccination for pneumonia and a history of dysphagia, as diagnosed by attending physician.

5. **What would be your data collection method?** Collect demographic information via questionnaire from the study subjects. The questionnaire would include the following information: age, gender, race, degree of mobility and the level of dependence for activities of daily living, social economic status, medical records for pneumonia vaccinations, and predisposing health conditions. Incidence of pneumonia would be identified by a chest radiograph and/or by culture method.