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ASSOCIATION BETWEEN RESPIRATORY DISEASES AND ORAL HEALTH: A SYSTEMATIC REVIEW STUDY

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Abstract

Background: *The purpose of this review was to investigate evidence for a possible etiological association between oral health and pneumonia or other respiratory diseases.*

Methods: *The following data sources were used: Ovid MEDLINE Cumulative Index to Nursing & Allied Health Literature; Evidence Based Medicine of Cochrane Central Register of Controlled Trials; Cochrane Database of Systematic Reviews; Database of Abstracts of Reviews of Effects; EMBASE; Health and Psychosocial Instruments; Health STAR; International Pharmaceutical Abstracts; PubMed; and Google Scholar from the earliest record until July 2018.*

Results*: A total of 728 articles were searched for relevancy, determined by article title, abstract, and full copy, resulting in a yield of 19 studies that met our inclusion criteria.: 1) the potential risk factors for pneumonia were identified as the presence of cariogenic and periodontal pathogens, dental decay, and poor oral hygiene in five studies; 2) there was a weak association identified in four poor to fair studies between periodontal disease and chronic obstructive pulmonary disease (COPD) and 3) 10 studies providing evidence that interventions aiming to improve oral health reduced the progression or occurrence of pneumonia.*

Conclusions: *1) There is fair evidence (II-2, grade B recommendation) of an association of pneumonia with oral health (odds ratio [OR] = 1.2 to 9.6 depending on oral health indicators). 2) There is poor evidence of a weak association (OR <2.0) between COPD and oral health (II-2/3, grade C recommendation). 3) There is good evidence (I, grade a recommendation) that the reduction in progression or occurrence of respiratory diseases among high-risk elderly adults living in nursing homes and especially those in intensive care units could be improved with oral hygiene and frequent professional oral health care.*

Key words: *Dental plaque; oral health; oral hygiene; periodontal diseases; pneumonia; pulmonary disease, chronic obstructive.*

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INTRODUCTION:

Bacterial pneumonia is the result of infection of the lung parenchyma by a variety of pathogenic bacteria. [1] Periodic exacerbation of chronic obstructive pulmonary disease (chronic bronchitis and emphysema) may also be provoked in part by bacterial infection. [2,3] Collectively, acute and chronic respiratory diseases are the most common and costly respiratory diseases, especially in institutionalized and elderly inpatients. [4,5] Respiratory infection results from aspiration of oropharyngeal flora into the lower respiratory tract, failure of host defense mechanisms to eliminate them, multiplication of the microorganisms, and subsequent tissue destruction. [5]

Community acquired pneumonia CAP is a prevalent illness, with an incidence rate of 11.6 per 1,000 adults per year.6 each year, 500,000 pneumonia-related hospitalizations occur in the United States [8]. hospital acquired pneumonia HAP is a serious, life-threatening pneumonia that accounts for 15% of all hospital-acquired infections (diagnosed on the basis of the Centers for Disease Control and Prevention [CDC] surveillance definition of nosocomial pneumonia) and is the second most common type of nosocomial infection after those of the urinary tract. [9] Nosocomial pneumonia incidence has been estimated to be 25 to 44 per 10,000 individuals in people >60 years of age with mortality rates of 21% to 70% in intensive care unit (ICU) patients, 0.009% in low-risk people >65 years of age, and 1% or higher in high-risk populations.[10] HAP generally occurs at least 48 hours after patients have been admitted to medical or surgical general wards. [10,11] Among the ICU patients, those being mechanically ventilated are particularly susceptible to pneumonia.

There are four possible routes of contamination of the lower airways by microorganisms: aspiration of oropharyngeal secretions, food, or gastric contents; inhalation of infectious aerosols; spread of infections from contiguous sites; and hematogenous spread from extra pulmonary sources of infection. [12] However, the primary mechanism of entrance of these bacteria to the lung is the aspiration of colonized secretions from the oropharynx into the upper airway, which can then be aspirated to the lower airway and adhere to the bronchial or alveolar epithelium via specific adhesion-receptor interactions (Fig. 1)

First, dental plaque could be colonized by pulmonary pathogens. Second, periodontal disease-associated enzymes may facilitate the adherence of respiratory pathogens Figure 1. Pathogenesis of nosocomial bacterial pneumonia. Third, hydrolytic enzymes of periodontal disease associated pathogens may destroy protective salivary pellicles such as mucin, resulting in fewer nonspecific host defense mechanisms in high-risk subjects. Fourth, in untreated periodontal disease.

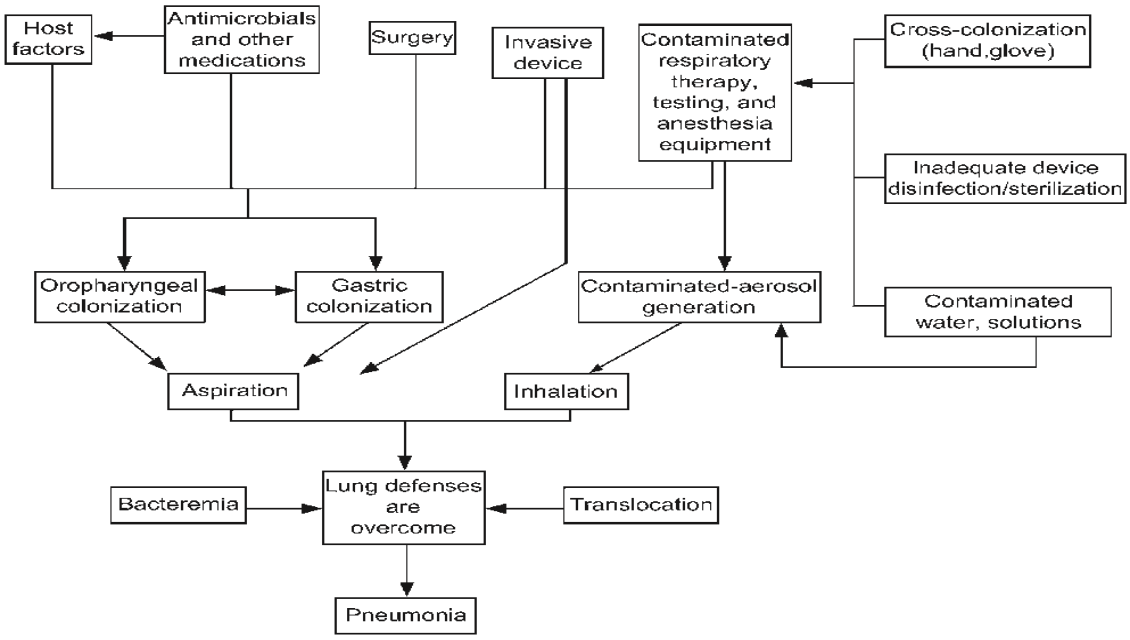

Figure 1. Pathogenesis of nosocomial bacterial pneumonia

MATERIAL AND METHOD:

The literature search for relevant articles was performed using Ovid MEDLINE In-Process &Other Non-Indexed Citations, Ovid MEDLINE Daily, Ovid MEDLINE, and Ovid OLDMEDLINE (dating from 1950 to 2018), Cumulative Index to Nursing & Allied Health Literature (CINAHL)), Evidence Based Medicine of Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Database of Abstracts of reviews of Effects, EMBASE, and PubMed. In addition to the above, searches of the World Wide Web were conducted using Google Scholar. Table 1 shows the key words and combinations of the key words used. At first, limiting the searches to holdings at the University of Toronto, articles in English, and human subject's retrieved 1,019 articles. After removing duplicates, 728 articles were searched for relevancy, determined by article title, resulting in a yield of 68 articles. The abstraction sheets for annotated references, i.e., with citation; author/date; population and representative population; age; gender; location; intervention, or test treatment (number studied); control treatment (number studied); outcome; critical appraisal comments; conclusion; strength of evidence and classification, were printed, read, reviewed independently to determine relevance, and scored to obtain the evidence for this review. Reference lists were checked to identify any other articles relevant to the research question that may have provided additional information.

Table 1: search strategy

Category	Key Words	N Articles Found in Database Group A	N Articles Found in Database Group B	N Articles Found In Database Group C
Key words related to nursing special patient category	Intensive care unit or ICU or home or hospitalized patient or institutionalized elder or long-term care facility or susceptible individual or normal individual	219,093	85,316	
Key words related to chronic respiratory diseases	Chronic lung disease or obstructive pulmonary disease or lower RTI or bacterial pneumonia or nosocomial pneumonia or aspiration pneumonia or hospital-acquired pneumonia or HAP or community-acquired pneumonia or CAP	46,555	24,317	
Key words related to oral health	Oral health or oral hygiene or periodontal disease or gum disease or dental plaque or plaque index or oral pathogen or oral bacteria or bacterial species or fungal species or bacterial cultivation or respiratory pathogen or S. aureus or Pseudomonas aeruginosa or Acinetobacter baumannii or Enterobacter cloacae	283,837	134,665	
Combination (limited to English language, local holding, and human subject)		728	272	19
Total		1,019		
Removing the duplicates		728		
Relevant articles at the title stage		68		
Relevant articles at the abstract stage		38		
Hand searching the references for new relevant articles		6		
Scored and included articles		19		

Note: Database groups A) Ovid MEDLINE In-Process & Other Non-Indexed Citations, Ovid MEDLINE Daily, Ovid MEDLINE and Ovid OLDMEDLINE), CINAHL - Cumulative Index to Nursing & Allied Health Literature , Evidence Based Medicine (EBM) of Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, EMBASE), Health and Psychosocial Instruments, HealthSTAR/Ovid Healthstar (dating from 1975 to June 2005), and International Pharmaceutical Abstracts. B) PubMed. C) Google Scholar and World Wide Web.

Table 2: Canadian Task Force on Preventive Health Care: Quality of Evidence and Grades of Recommendations

Quality of Published Evidence	
I	Evidence from at least one proper RCT.
II-1	Evidence from well-designed controlled trials without randomization.
II-2	Evidence from well-designed cohort or case-control analytic studies, preferably from more than one center or research group.
II-3	Evidence from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments could also be included here.
III	Opinions of respected authorities based on clinical experience; descriptive studies or reports of expert committees.
Grades of Recommendations	
A	Good evidence to support the recommendation that the condition be specifically considered in a PHE.
B	Fair evidence to support the recommendation that the condition be specifically considered in a PHE.
C	Poor evidence regarding inclusion or exclusion of a condition in a PHE, but recommendations may be made on other grounds.
D	Fair evidence to support the recommendation that the condition be specifically excluded from consideration in a PHE.
E	Good evidence to support the recommendation that the condition be specifically excluded from consideration in a PHE.

RESULTS:

We identified nine case-control (of which two are epidemiological studies) and cohort studies that examined the association of pneumonia or COPD with oral health indicators. Also, we found nine clinical trials that examined the efficacy of improvement of oral health indicators in reducing the incidence and occurrence of pneumonia. Of these, four were dated later than Scannapieco. The best available evidence was summarized in evidence tables listing the studies in decreasing order of strength, according to the level of evidence classification system developed by the Canadian Task Force on Preventive Health Care[13] (Table 2) and checklists for appraising evidence in health care. ASSOCIATION BETWEEN PNEUMONIA AND ORAL HEALTH (TABLE 3) Oral health was associated with pneumonia in four prospective cohort studies and one case-control study therefore, the evidence is of level II-2. However, in two of these studies, no bivariate analyses were reported, and in another no model fit statistics were reported, thus limiting their validity. Also, the results could not be verified from the published data in one study.

The first study in the table investigated the importance of medical and dental factors in relation to pneumonia among 358 older veterans who were followed for 9 years. Dental decay, presence of cariogenic bacteria, and periodontal pathogens were shown to be significant risk factors for aspiration pneumonia. The next study followed 189 elderly subjects for a period of 4 years. The investigators confirmed the risk associated with decayed teeth. They also found that dependence on caregivers for oral care was associated with pneumonia. However, no fit statistics related to the logistic regression model were provided in the article. Overall, potential risk factors for pneumonia were identified as the presence of cariogenic and periodontal pathogens in saliva and dental plaque (odds ratio [OR] = 4 to 9.6) and dental decay (OR; 1.2 per decayed tooth). Higher plaque scores were also shown to be associated with a previous history of respiratory tract infection (RTI).

Table 3. Evidence for Assessing Causation: Pneumonia

Author, Date	Population	Cases	Non-Cases
Terpenning et al., 2001[17]	Department of Veterans Affairs outpatient clinic, inpatient ward, and nursing home. Yearly follow-up visits for dental examinations and prospective medical follow-up for development of pneumonia. Nine-year prospective study. Age: ‡55 years. All males.	N = 50 subjects with aspiration pneumonia.	N = 308 subjects who did not develop any type of pneumonia as determined by a review of medical records and chest radiographs.
Langmore et al., 1998[35]	189 subjects from the outpatient clinics, inpatient acute care medical wards, and the nursing home care center at the VA Medical Center, Ann Arbor, Michigan, followed for 4 years. Age: ‡60 years. All males.	N = 41 subjects with pneumonia.	N = 148 subjects without pneumonia.
El-Solh et al., 2004[32]	49 critically ill residents of long-term care facilities in the critical care unit, in a hospital affiliated with the University of Buffalo, State University of New York at Buffalo, Buffalo, New York. F/M gender ratio: 27/22.	N = 35 HAP patients. Mean age: 80.0 – 6.1 years.	N = 14 non-HAP patients. Mean age: 78.4 – 5.8 years.
Mojon et al., 1997[36]	302 frail elders living in a medical care facility from 1993 to 1995. Mean age: 85 years. F/M gender ratio: 215/87.	N = 100 residents identified from medical records as having had RTI in the year prior to the study.	N = 202
Fourrier et al., 1998[19]	57 patients admitted to the ICU during the 3-month interval between June and September 1995. Mean age: 49 – 18 years. F/M gender ratio: 27/30.	N = 21 subjects with nosocomial infection.	N = 36 subjects without nosocomial infection.

Association between Pneumonia and Oral Health (Table 3):

Oral health was associated with pneumonia in four prospective cohort studies and one case-control study therefore, the evidence is of level II-2. However, in two of these studies, no bivariate analyses were reported, and in another,no model fit statistics were reported, thus limiting their validity. Also, the results could not be verified from the published data in one study. The first study in the table investigated the importance of medical and dental factors in relation to pneumonia among 358 older veterans who were followed for 9 years. Dental decay, presence of cariogenic bacteria, and periodontal pathogens were shown to be significant risk factors for aspiration pneumonia. The next study35 followed 189 elderly subjects for a period of 4 years. The investigators confirmed the risk associated with decayed teeth.

They also found that dependence on caregivers for oral care was associated with pneumonia Overall, potential risk factors for pneumonia were identified as the presence of cariogenic and periodontal pathogens in saliva and dental plaque (odds ratio [OR] = 4 to 9.6) and dental decay (OR; 1.2 per decayed tooth).Higher plaque scores were also shown to be associated with a previous history of respiratory tract infection (RTI).

Association between Periodontal Disease and COPD

Oral health indicators were associated with COPD in two case-control and two cross-sectional studies. Ordinarily, for case-control and cross-sectional studies, the evidence is of level II-2 and II-3, respectively. However, the quality measure was lowered to II-3 in one case-control study as a result of small sample size and poor control selection. All four studies in this set showed a potential association between periodontal disease and COPD. The first study in this series analyzed the data from a Veterans Affairs (VA) Dental Longitudinal Study, a prospective 25-year cohort study of aging and health in male veterans who were medically healthy at the baseline. Periodontal status, as assessed by radiographic measures of alveolar bone loss (ABL), was found to be associated with an increased risk for COPD. However, ABL was only measured at the baseline, which would not likely be a good marker of the exposure to active periodontal diseases over every one of the 25 years. These three studies found a weak association (OR/relative risk [RR]. (Table 4)

Table 4: Evidence for Assessing Causation: COPD

Author, Date	Population	Cases	Non-Cases
Hayes et al., 1998[37]	1,118 men from VA Dental Longitudinal Study, a long-term study of aging and health in veterans who were medically healthy at baseline. All males.	N = 261 men with COPD. Mean age: 45.06 – 9.7 years.	N = 857 men without COPD. Mean age: 42.18 – 9.1 years.
Scannapieco et al., 2001[38]	13,792 subjects ‡20 years of age with at least six natural teeth selected from the cross-sectional, retrospective study of NHANES III of Americans randomly selected from 1988 to 1994.	N = 810 with COPD. Mean age: 51.2 –17.9 years. F/M gender ratio: 506/304.	N = 12,982 without COPD. Mean age: 43.9 – 17.7 years. F/M gender ratio: 6 ,821/ 6,161.
Scannapieco et al., 1998[39]	Data from NHANES I were analyzed. Age was evenly distributed from 25 to 74 years. >50% female.	N = 41 subjects with a confirmed chronic respiratory disease.	N = 193 subjects without a respiratory disease.
Russell et al., 1999[20]	Goldwater facility nursing (chronic care) wards of Coler-Goldwater Memorial Hospital, a 1,000-bed public hospital in New York, New York.	N = 28 elderly CCF residents. Mean age: 75.9 years. F/M gender ratio: 14/14.	N = 30 age-, gender-, and race-matched outpatient control subjects from undergraduate clinics of the New York University College of Dentistry, New York, New York. F/M gender ratio: 18/12.

CONCLUSION:

In conclusion there is fair evidence of an association of pneumonia with oral health (II-2, grade B recommendation). The strength of the association varied from 1.2 to 9.6 depending on the oral health indicators examined. 2) There is poor evidence supporting a weak association (OR <2.0) between COPD and oral health (II-2/3, grade C recommendation). 3) There is good evidence (I, grade A recommendation) that oropharyngeal decontamination with different antimicrobial interventions reduces the progression or occurrence of respiratory diseases (NNT = 2 to 16; RRR = 34% to 83%).

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