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Poor Oral Health as Risk Factor for Community-Acquired Pneumonia

Francesc Rodriguez[1,4], Ignasi Bolíbar[5], Mateu Serra-Prat[1,2,6], Elisabet Palomera[2], M Virginia Ballester[6], Jordi Almirall[1*] on behalf of the Community-Acquired Pneumonia in Catalan Countries (PACAP)

[1]*Critical Care Unit, Hospital of Mataró, Autonomous University of Barcelona, Spain*

[2]*Research Unit, Hospital of Mataró, Autonomous University of Barcelona, Spain*

[3]*Odontology Unit, Hospital of Mataró, Autonomous University of Barcelona, Spain*

[4]*Nurse team, Hospital of Mataró, Autonomous University of Barcelona, CIBERES, Barcelona, Spain*

[5]*Department of Clinical Epidemiology and Public Health, Institute of Biomedical Research (IIB Sant Pau) Barcelona, Autonomous University of Barcelona, Ciber Epidemiology and Public Health (CIBERESP), Spain*

[6]*Ciber of Liver and Digestive Diseases (CIBEREHD), Spain*

[*]**Corresponding author:** Jordi Almirall, Intensive Care Unit, Hospital of Mataró, Road Cherry s / n, E-08304 Badalona, Barcelona, Spain, Tel: +34-93-7417700; E-mail: jalmirall@csdm.cat

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Abstract

Objectives: Considerable evidence exists of the relationship between poor oral hygiene (therefore greater presence of plaque) and risk of pneumonia in special-care populations, including intensive care unit and nursing home settings. However, the effect of poor oral health on the development of community-acquired pneumonia (CAP) remains to be established. We assessed the relationship between CAP and oral health in general adult population.

Study design: Over 1-year period, 1,336 incident cases of CAP and 1,326 controls were enrolled in a population-based case-control study. A questionnaire on CAP risk factors that included oral health-related questions, including visit to dentist in the last month, bleeding gums, gingivitis, dental dysaesthesia, dental prosthesis, gumboil in the last month, teeth move or lost, and periodontal disease was administered to all participants.

Results: The prevalence of dental dysaesthesia and use of dental prosthesis was significantly higher among patients with CAP than in control subjects (23.3% vs. 19.7%, P = 0.043, and 45.6% vs. 40.8%, P = 0.016, respectively), whereas visit to the dentist in the last month was a preventive factor against the development of CAP (odds ratio 0.71, 95% confidence interval 0.55-0.92, P = 0.008). Results of bivariate analysis were confirmed in the adjusted multivariate logistic regression models.

Conclusions: Poor oral health may contribute to a higher risk for CAP in adult patients. Oral hygiene practices are particularly important in subjects with dental dysaesthesia and dental prosthesis. Not only odontologists but also dental hygienists should be aware of the relationship between oral health and potentially severe lung infection.

Keywords: Community-acquired pneumonia; Dental hygiene; Oral health; Risk factors

Introduction

Community-acquired pneumonia (CAP) remains an important cause of morbidity and mortality in developed countries. The annual incidence rate of CAP with radiological confirmation ranges between 1.6 and 13.4 per 1,000 inhabitants, with somewhat higher figures at the extreme ages of life [1,2]. CAP specific mortality varies between 1 and 7 cases per 10,000 inhabitants per year [1,3]. Well known conditions that predispose to CAP in adults include lifestyle and patient characteristics (e.g. smoking, alcohol use, poor functional and nutritional status, weight loss, and use of immunosuppressants), comorbidities (e.g. heart, renal and lung diseases, low body mass index [BMI] and previous respiratory infection) and environmental factors (e.g. second-hand smoke and exposure to gases, fumes and chemicals) [4-8].

Preventive strategies identifying and acting on modifiable risk factors are of paramount importance in reducing the impact of CAP. Considerable evidence exists to support an association between dental plaque, poor oral health, and respiratory diseases such as bacterial pneumonia in frail older people, nursing home residents or nosocomial infections in critically ill patients submitted to mechanical ventilation [9-12]. Teeth or dentures have non-shedding surfaces on which oral biofilms (i.e. dental plaque) form that are susceptible to colonization by respiratory pathogens [13].

Subsequent aspiration of respiratory pathogens shed from oral biofilms into the lower airway increases the risk of developing a lung infection. Also, correct oral hygiene with tooth-brushing and oral decontamination with antiseptics (chlorhexidine and triclosan rinses on plaque, gingivitis, supragingival calculus and extrinsic staining) [14] has proven to be effective in reducing the incidence of ventilator-associated pneumonia [15-18]. However, the role of poor oral hygiene and oropharyngeal bacterial colonization by potential respiratory pathogens on the development of community-acquired pneumonia (CAP) remains to be elucidated. The present analysis was conducted to investigate whether poor oral health was a risk factor for CAP in adults.

Methods

Design and study population

A population-based, case-control study was conducted in an extensive area of the eastern coast in Spain, with predominantly Mediterranean climatic conditions. Details of the study methodology have been previously published [19]. The target population included 859,033 inhabitants older than 14 years of age assigned to any of the 64 participating primary care centres, selected according to their predisposition to take part in the study. In order to demonstrate association with an odds ratio (OR) of 1.5 for risk factors for CAP with a prevalence of exposure in the control group of 5%, with 80% statistical power and significance level of 0.05, a sample of 1,500 cases and 1,500 controls was required. The study protocol was approved by the Ethics Committee of the Consorci Sanitari del Maresme (Barcelona, Spain) and all participants gave written informed consent before enrollment.

Identification of cases

All subjects with a new diagnosis of CAP from November 1, 1999 to November 30, 2000 were prospectively recruited. Criteria for CAP diagnosis were as follows: a) acute lower respiratory tract infection for which antibiotics were prescribed, b) appearance of new or previously unknown focal signs on physical examination or chest X-ray films and c) a follow-up criteria to reject patients with initial suspicious of CAP in which another respiratory disease was later confirmed by periodically chest roentgenograms until complete recovery.

Patients with active tuberculosis, immunosuppressant treatments or diseases, pneumonia acquired at nursing homes or having been discharged from hospital at least within 7 days before the onset of symptoms, and aspiration pneumonia were excluded from the study. An active surveillance system was established to ensure the identification of all cases in the study population. This system involved all physicians working in public and private health care facilities in the study area and reference hospitals both inside and outside the county region.

Selection of controls

Each case of confirmed CAP was frequency matched to a control subject by age (± 5 years), sex, primary care centre and season. The selection of controls was performed every 3 months by a simple random sampling procedure from the same population-based register than cases, using the list of subjects assigned to each primary care centre. Once a control subject was identified, a maximum of three telephone calls or home visits were made at different schedules, and if after these attempts, the control subject could not be contacted, he/she was replaced following the same selection and matching criteria.

Data collection

A questionnaire on CAP risk factors was administered to all participants at home by specifically trained physicians or nurses. When patients could not directly answer the questions (cognitive impairment, disease, or for CAP cases, death), the questionnaire was administered to the closest family member or caregiver. It included standardized information related to health care habits and lifestyle, chronic respiratory diseases and other clinical conditions, and regular treatments during the last year.

From the current clinical conditions section, the following questions were related to oral health and dental hygiene: "Have you visited a dentist in the last month?", "Do you use dental prosthesis?", "Have you lost all of your teeth?", "Do your gums easily bleed when eating or brushing your teeth?" (as an indicator of periodontitis), "Have you had a gumboil in the last month'", "Are your teeth sensitive to cold and/or sweets?" (as an indicator of dental decay), "Does your teeth move?". Responses to each question were categorized as "yes" or "no". Adding one point for each affirmative answer to the last four questions, the "oral health score" (ranging from 0 to 4) was calculated.

Statistical analysis

A comparison of the oral heath characteristics between cases and controls was performed using the chi-square ($\chi 2$) test or the Fisher's exact test. The bivariate effect of oral health on CAP was estimated as odds ratio (OR) and the 95% confidence interval (CI). A multivariate logistic regression analysis was performed to adjust the effect of those oral health variables with a statistical effect on CAP in the bivariate analysis for possible confounding variables. Confounding variables in the multivariate models were those study variables both related with CAP and with the corresponding oral health characteristic. Statistical significance was set at $P<0.05$.

Results

During the study period, 1,336 incident cases of CAP were identified (with a 40.0% hospitalization rate), 52.9% of which were males with a mean ± SD age of 58.6 ± 19.8 years and 47.3% were females with a mean age of 54.6 ± 20.7 years. A total of 1,326 matched control subjects were recruited. In the control group, 52.6% were males aged 58.9 ± 19.6 yrs and 47.4% were females aged 54.6 ± 20.6 yrs. Characteristics of both study groups have been previously published [19]. Main differences between cases and controls included smoking habit, alcohol intake (in men), BMI, educational level, and prevalence of diabetes, heart failure, chronic bronchitis, asthma or epilepsy.

Comparison of main oral health characteristics between cases and controls are shown in Table 1. Dental dysaesthesia, use of dental prosthesis and a oral health score >2 were risk factors for CAP while visit to dentist in the last month showed a protective effect. Bleeding gums, moving teeth, edentulous condition or recent history of a gumboil were not associated with CAP either in analysis of the overall population or stratified by age groups.

	Controls (n = 1,326) No. (%)	Cases (n = 1,336) No. (%)	Odds ratio (95% CI)	P value
Gums easily bleed	242 (18.4)	217 (16.4)	0.87 (0.71-1.06)	0.173

Gumboil in the last month	49 (3.7)	51 (3.8)	1.03 (0.69-1.54)	0.875
Edentule without prosthesis	43 (3.2)	29 (2.2)	0.66 (0.41-1.07)	0.088
Dental dysaesthesia	210 (19.7)	245 (23.3)	1.24 (1.01-1.53)	0.043
Use of dental prosthesis	512 (40.8)	567 (45.6)	1.22 (1.04-1.42)	0.016
Visit to dentist in the last month	156 (11.8)	116 (8.7)	0.71 (0.55-0.92)	0.008
Teeth move	88 (8.3)	97(9.2)	1.13 (0.84-1.53)	0.427
Oral health score > 2	20 (1.5)	37 (2.8)	1.86 (1.07-3.22)	0.025

Table 1: Relationship between oral health-related variables and CAP (univariate analysis)

CI: confidence interval

Table 2 shows the results of the multivariate analysis in which the effect of dental dysaesthesia, dental prosthesis and visit to dentist in the last month was adjusted for possible confounding variables. These analyses confirmed an independent effect of dental dysaesthesia (OR = 1.36, P = 0.049), wearing dental prosthesis (OR = 1.39, P = 0.004) and visit to dentist (OR = 0.69, P = 0.01). No significant interactions between visit to the dentist in the last month and dental dysaesthesia or use of prosthesis were found, that is, the effect of dental dysaesthesia and prosthesis is not modified by a visit to the dentist in the last month.

Regression models	Odds ratio (95% CI)	P value
Model with dental dysaesthesia		
Dental dysaesthesia	1.36 (1.00-1.58)	0.049
Smoking status		
Never smoker	1	
Ex-smoker	1.12 (0.89-1.42)	0.327
Current smoker	1.29 (1.02-1.63)	0.035
Usual contact with children < 15 years at home or work	1.76 (1.43-2.17)	< 0.001
Diabetes mellitus	1.37 (0.90-2.11)	0.147
Inhaled anticholinergics	8.29 (3.48-19.8)	< 0.001
Home oxygen therapy	2.47 (1.12-5.43)	0.016
Dental prosthesis	1.30 (1.05-1.61)	0.018
Visit to dentist in the last month	0.55 (0.41-0.75)	< 0.001
Model with dental prosthesis		
Dental prosthesis	1.39 (1.11-1.75)	0.004
Body mass index (BMI, underweight)	2.25 (1.50-3.39)	< 0.001
Never smoker	0.93 (0.76-1.14)	0.500
Sudden work temperature changes last 3 months	2.92 (1.84-4.63)	< 0.001
Usual contact with children < 15 years at home or work	1.73 (1.39-2.16)	< 0.001
Contact with pets	1.22 (1.00-1.50)	0.047
Educational level		
Low	1	0.285
Middle	0.83 (0.64-1.07)	0.143

High	0.82 (0.61-1.09)	0.169
Hospital admission in the last 5 years	1.42 (1.14-1.76)	0.002
Upper respiratory tract infection (more > 1 during last year)	1.32 (1.07-1.63)	0.009
Diabetes mellitus	1.33 (0.85-2.06)	0.210
Heart failure	0.92 (0.54-1.57)	0.766
Heart valve disease	1.68 (0.93-3.05)	0.084
Chronic bronchitis	2.65 (1.75-4.01)	< 0.001
Nonactive pulmonary tuberculosis	1.59 (0.85-2.99)	0.148
Stroke	0.80 (0.36-1.75)	0.571
Cancer	1.28 (0.81-2.01)	0.295
Dental dysaesthesia	1.18 (0.93-1.50)	0.186
Model with visit to dentist		
Visit to dentist in the last month	0.69 (0.52-0.91)	0.010
Usual contact with children < 15 years at home or work	1.74 (1.43-2.12)	< 0.001
Contact with pets	1.31 (1.01-1.57)	0.004
Educational level		
Low	1	0.004
Middle	0.74 (0.59-0.93)	0.001
High	0.66 (0.51-0.85)	< 0.001
Body mass index (BMI, underweight)	2.29 (1.57-3.34)	< 0.001
Dental dysaesthesia	1.18 (0.95-1.48)	0.143

Table 2: Effects of dental dysaesthesia and dental prosthesis use on the risk of CAP adjusting for confounding factors

CI: confidence interval

Discussion

The present study relates the development of CAP with some oral health characteristics. Dental dysaesthesia triggered by hot or cold substances (indicator of dental caries or periodontal disease) and wearing dental prosthesis were independent risk factors for CAP, whereas visit to dentist was a preventive factor.

Several articles have assessed lifestyle factors and comorbid conditions as risk factors for CAP, but few of them have analyzed oral health symptoms or indicators [20]. Some authors have shown that poor oral hygiene may cause an increase of respiratory infections [21,22]. El-Solh et al. [23] have proven that respiratory pathogens colonizing dental plaques are implicated in lower respiratory tract infections of hospitalized elderly subjects. Of the 13 isolates recovered from protected BAL fluid, nine respiratory pathogens matched genetically those recovered from the corresponding dental plaques of eight patients. Colonization of dental plaque has been shown to be a relevant risk factor of nosocomial pneumonia in critically ill patients admitted to the ICU [24], the effect of which decreases with prophylactic treatment with antiseptics [25] and topical antibiotics [26]. This suggests that dental plaque colonization by aerobic microorganisms may constitute a reservoir of respiratory pathogens [27]. Moreover, dental prosthesis also favours colonization of oral mucosa and dentures by Candida spp. [28]. However, other clinical conditions, such as easy bleeding gums suggestive of gingivitis, moving teeth indicating periodontal disease, edentulous mouth or recent history of a gumboil were unrelated to CAP. In relation to edentulous condition, our results are consistent with other studies, in which no difference in incidence of aspiration pneumonia between dentate patients and edentulous patients was reported [29]. On the other hand, a recent visit to dentist seems to exert a preventive effect against CAP. This preventive effect, which was independent of the education level, may be explained by a better oral care and dental hygiene, dental plaque control and reduction of microorganisms, with a lower colonization by potentially pathogenic bacteria.

In summary, although the limitation of case–control studies and those of the self-reported questionnaires, the results of this population-based study suggest that poor oral health can contribute to an increased risk of CAP in the adult population. Therefore, reinforcement of bucco-dental health and hygiene habits are essential to prevent the accumulation of plaque and bacterial colonization, particularly in subjects with dental prostheses, dental caries and periodontal disease. Odontologists and dental hygienists should be

aware of the relationship between oral health and potentially severe lung infection.

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Author Contributions

Conceived and design the study: JA, IB, MSP. Performed the experiments: JA, FR, MVB. Analyzed the data: EP, MSP. Wrote the manuscript: JA, MSP, FR. All authors have seen and approved the final draft.

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