NOTE TO USERS

Oral Health of Patients Suffering from Chronic Obstructive Pulmonary Disease and Its Relationship with the Exacerbation Events

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ABSTRACT

Patients suffering from severe COPD encounter frequent episodes of exacerbations. The anatomical continuity between the oral cavity and the lung makes it a potential reservoir for respiratory pathogens that could be aspirated and cause the exacerbations. The objective of this pilot study was to determine the association between the oral health, oral hygiene in particular and the frequency of exacerbations. The study included 55 patients with severe COPD. Data were collected using various questionnaires and examinations. The results showed that poor oral hygiene was correlated significantly with the increase in number of exacerbations. There was a trend towards bad oral health in patients with high frequency of exacerbations however it was not significantly different between the two groups of low and high frequency of exacerbations. The results of bivariate and multiple logistic regression showed no statistical significant association between oral hygiene status and the frequency of exacerbations.

RÉSUMÉ

Les patients qui souffrent de MPCO sévère éprouvent de fréquents épisodes d'aggravation. Le lien anatomique direct entre la cavité buccale et les poumons offre un réservoir éventuel aux agents pathogènes du système respiratoire qui sont aspirés et qui peuvent causer des exacerbations. L'objectif de cette étude pilote était de déceler une association éventuelle entre la santé bucco-dentaire, l'hygiène buccale tout particulièrement et la fréquence des épisodes d'aggravation. L'étude incluait 55 patients démontrant de sévères symptômes de la MPCO. Les données ont été recueillies à l'aide de différents questionnaires et examens. Les résultats démontrent qu'une pauvre hygiène buccale est corrélée de façon significative à la fréquence élevée d'épisodes d'aggravation. On remarque que les patients sujets aux exacerbations fréquentes démontrent une tendance à souffrir de mauvaise santé bucco-dentaire, toutefois, aucune différence significative n'a été démontrée entre le groupe à faible fréquence et celui à fréquence élevée d'épisodes d'aggravation. Le résultat des analyses à deux dimensions et de régression logistique multiple ne démontre aucune association statistiquement significative entre l'hygiène buccale et la fréquence des épisodes d'aggravation.

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) represents the fourth common cause of death among the elderly [1]. The prevalence, incidence, and mortality of COPD increase with age. Smoking is the risk factor responsible for the majority of deaths caused by COPD [2]. Smoking is also an important risk factor for periodontal disease which is one of two main oral diseases of the oral cavity in addition to dental caries [3]. Therefore, smoking is a potential confounder for the association between periodontal disease and COPD. Patients suffering from COPD experience exacerbation events. Exacerbation is a worsening episode of COPD symptoms, and the number of exacerbations the patient encounter is related to the severity of the disease [4-5].

Evidence is increasing that oral health may have are important direct impact on systemic health. The literature supported a plausible association between periodontal disease and conditions such as cardiovascular diseases, stroke, diabetes mellitus, and low birth weight infants [6-9]. Because of aging of the population, the risk of development of systemic diseases increases. Moreover, increasing preservation of teeth among the elderly has increased their risk for serious diseases from oral pathogens. A comprehensive understanding of the influence of oral health on general health requires an assessment of the impact of oral diseases on systemic conditions. The effects of oral diseases are not limited to the oral cavity and its functions. Oral diseases give rise to pathogens, which can be blood borne or aspirated into the lungs, causing severe life-threatening conditions.

Several microbiological and epidemiological studies had suggested an association between dental plaque, periodontal disease, poor oral health, and respiratory diseases such as nosocomial pneumonia and chronic obstructive pulmonary disease (COPD) [56-59] [65-71] [75-81]. Although the association that had been found between periodontal disease and respiratory diseases was weak, the potential impact on public health can be great especially on health care costs. The paucity of published data for the association between oral health and chronic obstructive pulmonary disease makes it difficult to reach a conclusion about the actual relation even though the studies were consistent with one another. Their findings, using multivariate analysis controlling for relevant covariates, indicated that worse periodontal health status was associated with increased risk of COPD, with odd ratios ranging from 1.8 to 4.5(95% confidence level) [77-79]. The magnitude of these results was consistent with those reported for the association between periodontal diseases and various cardiovascular outcomes [7] [9]. Thus, a large prospective study would be needed to confirm this association.

All the studies mentioned earlier, especially those that associated COPD with oral health, were plausible evidences for the presence of a relationship. However, there was no study that investigated COPD exacerbation and its relationship with oral health. We do believe that proving a relationship between the incidence and frequency of exacerbation and oral health, especially oral hygiene, will add to the theory that bacteria has a role in exacerbated COPD. Our study which was a pilot study, exploratory in nature, assessed the role of oral health in the occurrence of exacerbation events in patients with severe COPD. This exploratory and feasibility study was needed to be conducted before considering a large prospective study in the future. The main goal was to investigate the relationship (association) between oral hygiene and the frequency of the exacerbation events.

1. LITERATURE REVIEW

1.1. Chronic Obstructive Pulmonary Disease (COPD)

1.1.1 Definition of COPD

In the recent Canadian Thoracic Society guidelines for Chronic Obstructive Pulmonary Disease, COPD is defined as follows: COPD is a respiratory disorder largely caused by smoking, which is characterized by progressive, partially reversible airway obstruction, systemic manifestations, and increasing frequency and severity of exacerbations [10]. COPD is an umbrella term that includes the entities of chronic bronchitis and emphysema when associated with air flow limitation.

Chronic bronchitis, which is defined in clinical terms, is defined as follows: expectoration of sputum on most days during at least three consecutive months for more than two successive years, with other causes of cough and sputum having been excluded [12]. Emphysema, which is defined in anatomic terms, is defined as follows: destruction of alveolar walls and the permanent enlargement of the airspaces distal to the terminal bronchioles [13].Chronic bronchitis occur in approximately 85% of COPD patients. However, it is essential to recognize that chronic bronchitis commonly occurs without airway obstruction; a minority of patients with chronic bronchitis have evidence of COPD [14].

A diagnosis of COPD in clinical practice requires a thorough history, physical examination and investigatory measures. Pulmonary function testing (spirometry) remains the best objective measurement of pulmonary impairment and it is the most

important tool to establish early diagnosis in individuals at risk for COPD. The forced expiratory volume in 1 second (FEV1) to forced vital capacity (FVC) ratio is the most important measurement for distinguishing an obstructive impairment. A post bronchodilator FEV1 of less than 80% of the predicted value in association with an FEV1/FVC ratio of less than 0.7 defines air flow obstruction, are both necessary to establish a diagnosis of COPD [10].

The patient's history should include a number of pack-years of smoking. The history should also include an assessment of the frequency and severity of exacerbations because this information may guide treatment choices. A careful assessment of symptoms and the resulting disability should be included through probing questions to uncover the actual extent of breathlessness and disability. The physical examination and chest x-rays are not usually diagnostic but are often required to exclude other medical conditions.

1.1.2. Epidemiology of COPD

1.1.2.1. Mortality

COPD is the 4th leading cause of death in Canada and the United States of America after cancer, heart attack, and stroke [1]. Among 28 industrialized countries, the United States ranks 12th in COPD mortality for men and seventh for women [1]. It is the fourth leading cause of death for men and seventh for women, and killed 9,618 Canadians in 1997; in 1980, COPD accounted for 2.6% of all deaths in Canada (3.6% in men and 1.3% in women) [1]. By 1995 the proportion had risen to 4.1% (4.6% in men and 3.3% in women) [15]. The number of deaths from COPD has quadrupled since 1971. While it is projected

that male mortality will begin to stabilize into 2016, female estimates show a triple-fold increase between 1996 and 2016 [16].

In 2001, the World Health Organization estimated that 4.7% of deaths worldwide were due to COPD, making this disease the fifth most common cause of death. By the year 2020, it is estimated that COPD will become the third most common cause of death worldwide [17].

1.1.2.2. Prevalence

The 1998/99 National Population Health Survey indicated that 3.2% of the adult population (500,000 Canadians) over the age of 34 years [2.8% of men (211,900 Canadians) and 3.6% of women (286,600 Canadians)] reported that they had been diagnosed with chronic bronchitis or emphysema by a health professional. The percentages increased with age as 5.4% of people aged 55 to 64 years, and 8.3% of 65 to 74 year-olds had been diagnosed with COPD [16].

In the USA, there were estimated to be 14.021 million men and women with chronic bronchitis and 2,208 million with emphysema in 1994 [1].

1.1.2.3. Health service and cost

In Canada, COPD is the fourth most common cause of hospitalization for men, and sixth for women; in 1995, there were 51,684 hospital separations (discharges) and 12,478 days spent in hospital with the diagnosis of COPD [16]. The economic burden for COPD in Canada is high. It was estimated that around CDN$467 million were spent on hospital care and drugs for COPD. The direct costs (premature mortality, long and short term disability) were estimated at CDN$1.2 billion with total costs estimated at CDN$1.67 billion according to a Health Canada document published in 1998[10].

1.1.3. Risk factors for the development of COPD

Although a number of known independent risk factors for COPD have been identified, the major one is cigarette smoking, which when associated with an accelerated rate of decline in FEV1, results in the development of COPD. It causes more than 80% of COPD cases in the western world [18]. Another host factor of a comparable importance is α_1-antitrypsin deficiency (AAT) but this disorder accounts for <1% of patients who have COPD. This serum glycoprotein is coded by a single gene on chromosome 14. It is produced in the liver, and it inhibits the activity of neutrophil elastase in the lung interstitium protecting the lung parenchyma from the elastolytic breakdown. Deficiency in AAT is inherited as an autosomal co dominant condition. Patients with AAT deficiency develop premature emphysema, often with chronic bronchitis and the onset of the disease is accelerated by smoking. Mucus hypersecretion and airway hyper responsiveness in smokers identified as risk factor for the development of COPD [19].

Other environmental risk factors associated with the development of COPD include: occupational exposure, air pollution and passive smoking. In countries where solid fuels are used for indoor heating with inadequate ventilation and in heavy industrialized urban environments, an increase in the prevalence of COPD has been noted in nonsmokers [20] [21]. People who are exposed to cigarette smoking passively, manifest a higher prevalence of respiratory symptoms and diseases than those who are not [22].

There are other factors that have a probable or possible effect on development of COPD but the true relationship has yet to be established. These include race, socioeconomic factors, nutrition, alcoholic congestion, age and gender.

1.1.3. Disease Manifestation and Progression

The cardinal symptoms experienced by patients with COPD are shortness of breath and exercise intolerance. The symptoms are usually insidious in onset, typically progressive and characterized by frequent exacerbations. COPD is accompanied by systemic manifestations which complicate advance stages of the disease such as skeletal muscle dysfunction, right heart failure, secondary polycythemia, altered nutritional status and depression. Impairment in respiratory function and systemic manifestations together contribute to significant disability and handicap, causing reduced health-related quality of life. The Canadian Thoracic Society (CTS) recommends the use of the Medical Research Council (MRC) dyspnea scale (Fig. 1) [23] which is a functional scale usually used to assess shortness of breath and disability, and can assist in the evaluation of disease severity (Table no.1) in conjunction with the classification based on the spirometry test (Table no.2)[10]. Classification of COPD severity should be undertaken with care in patients with comorbid diseases or other possible contributors to shortness of breath.

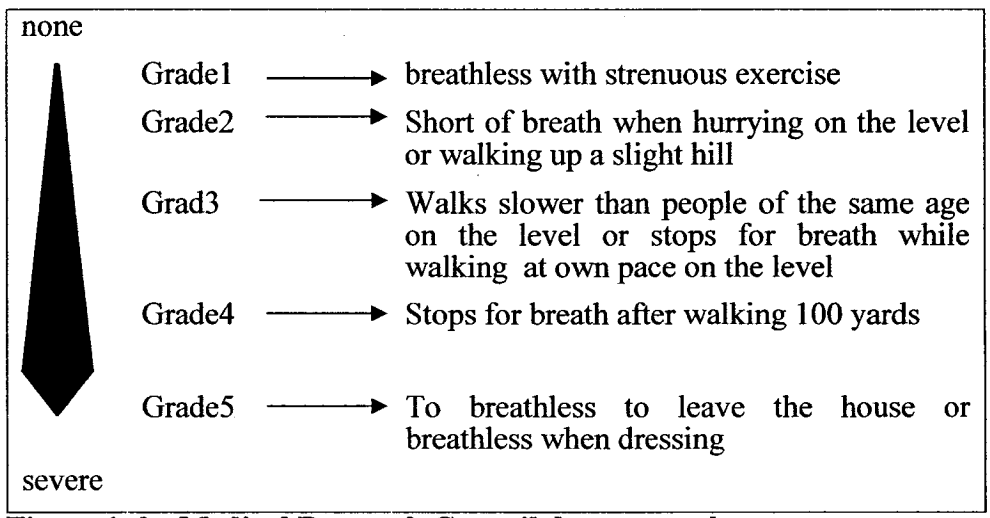


Figure 1 the Medical Research Council dyspnea scale.
Adapted from the Canadian COPD Guideline [10]

Table No.1 Chronic obstructive pulmonary disease (COPD) classification by symptoms/disability. Adapted from the Canadian COPD Guideline [10]

COPD STAGE	*SYMPTOMS*
At risk(does not yet fulfill the diagnosis of COPD)	Asymptomatic smoker, ex-smoker or chronic cough/sputum, but post-bronchodilator FEV1/FVC ≥ 0.7 and/or FEV1≥ 80% predicted
Mild	Shortness of breath from COPD when hurrying on the level or walking up a slight hill (MRC 2)
Moderate	Shortness of breath from COPD causing the patient to stop after walking about 100 m (or after a few minutes) on the level (MRC 3-4)
Severe	Shortness of breath from COPD resulting in the patient becoming too breathless to leave the house, breathlessness after undressing (MRC 5), or the presence of chronic respiratory failure or clinical signs of right heart failure

Table No.2 Chronic obstructive pulmonary disease (COPD) classification by lung function. Adapted from the Canadian COPD Guideline [10]

COPD STAGE	*SPIROMETRY*
At risk	Normal spirometry, chronic symptoms FEV1/FVC ≥0.7 and/or FEV1 ≥80% predicted
Mild	FEV1 60% to 79% predicted, FEV1/FVC <0.7
Moderate	FEV1 40% to 59% predicted, FEV1/FVC <0.7
Severe	FEV1 <40% predicted, FEV1/FVC <0.7

Acute exacerbation is an important feature of COPD. It occurs more frequently with increasing severity of COPD [4-5]. Acute exacerbation is the most frequent cause of medical visits, hospital admissions and death among patients with COPD. It is defined according to the CTS as a sustained worsening of dyspnea, cough or sputum production leading to an increase in the use of maintenance medications and/or supplementation with additional medications [10]. Acute exacerbation can be classified as either purulent or nonpurulent because it is helpful in predicting the need for antibiotic therapy [10].

There are potential causes for acute exacerbation, among them bacterial infections which are believed to be the most important and viral infections, particularly rhinovirus and others that cause the common cold. COPD is more common in winter which is attributed to the increase in the viral load. Environmental factors, such as atmospheric pollutants and a drop in both indoor and out door temperatures, have been also considered as potential causes for COPD exacerbation [25-27].

The role of bacterial infection in the pathogenesis of COPD in general has been reported in the literature for several decades. However, the role of bacterial infection in exacerbations of COPD remains controversial and incompletely understood despite decades of investigation by many researchers [28-31].

In normal subjects the lower airway is sterile, but with patients with stable COPD it can be colonized by bacteria such as *Haemophilus influenzae*, *Streptococcus pneumoniae*, and *Moraxella cataralis* which are the most common bacteria found in the lower airway of COPD patients [32-34], and the positive microbiology samples for these bacteria is higher in patients with exacerbated COPD [35].

1.1.4. Management of COPD

Since COPD is characterized by permanent damages to the lung and is progressive in nature, treatment is largely symptomatic. The goals of COPD management include preventing the disease progression, alleviating symptoms, improving exercise tolerance, preventing and treating exacerbations and reducing mortality. A variety of medications, vaccinations, physical therapy, behavioral modifications, educational programs and surgical therapies have been advised to reduce the symptoms and improve respiratory and overall function.

Tobacco smoking is the most common cause of COPD. Smoking cessation can have a markedly positive impact on the progression of the disease. Studies have showed that smoking cessation reduces the rate of decline in lung function [36] [37]. It is the only known treatment that has been demonstrated to prevent or slow down the disease progression. There are a variety of techniques, programs, medications and devices that have been used in smoking cessation efforts, for example, nicotine-replacement therapy in the form of chewing gum, transdermal patches, and inhaled nasal sprays. Behavioral modification efforts range from counseling in the clinic, to secessions with trained psychologists, to hypnosis.

Medications used for treatment of COPD symptoms are bronchodilators and corticosteroids and they are directed at four potential reversible causes of airflow limitation: bronchial smooth muscle contraction, bronchial mucosal congestion and edema, airway inflammation and increased airway secretions.

Antibiotics are not used routinely for patients with stable symptoms; it is only indicated for the treatment of acute exacerbation of COPD (AECOPD) with increased dyspnea and

increased sputum purulence or volume. Oxygen therapy is provided for patients who have acute or chronic hypoxemia.

Vaccinations are recommended to prevent exacerbation of COPD. Annual influenza vaccinations reduce the mortality and morbidity of the disease and reduce the incidence of hospitalization [38]. A pneumococcal vaccination is recommended at least once in life, since its benefit in COPD patients is less well established.

Exercise, which is part of a pulmonary rehabilitation program, is designed to increase the overall fitness. It has been shown to improve dyspnea, exercise tolerance and health related quality of life [39-40]. Specific exercises are targeted to the upper extremities, lower extremities and the cardiovascular system. In addition, training in breathing techniques is provided to decrease the respiratory rate.

Educational programs consist of didactic lecture sessions which aim at teaching the patients and their families about the physiology of their disease and ways to maximize their function using medicines, physical therapy techniques and lifestyle adjustment.

There are different surgical procedures used to improve symptoms and restore function for patients suffering from emphysema. One such procedure is bullectomy for giant bullae. Bullae are defined as abnormally dilated air spaces within the lung parenchyma that measure > 1 cm in diameter. Another procedure is lung volume reduction surgery for the much more common clinical presentation of diffused emphysema. The last procedure is lung transplantation and it is an option only for selected patients with severe COPD.

1.2. Oral Health and Respiratory Diseases

1.2.1. Bacterial Role in Exacerbated COPD

The association of bacteria with COPD has been appreciated for many years. Bacteria are frequently isolated from the sputum of patients when stable, but studies using sputum and a protected brush to obtain lower airway samples, showed a presence of bacteria during exacerbations in higher percentages or in new forms.

Monson *et al* in 1995 compared the microbiology sampling of bronchial secretions for two groups of outpatients one with stable COPD (40 patients) and the other with exacerbated COPD (29 patients). They found that the prevalence of lower airway bacterial colonization in outpatients with stable COPD is high (25%) and is mainly due to *H. influenzae* and *S. pneumoniae.* Patients with exacerbated COPD had significantly higher prevalence (51.7%) of lower airway bacterial colonization as well as higher bacterial concentration determined in cultures grown after PSB sampling of the lower airway [41].

Eller *et al* in 1998 evaluated clinical data and sputum culture results of one hundred and twelve unselected COPD patients with an acute infective exacerbation of COPD. The patients were categorized into three stages of severity according to the American Thoracic Society (ATS). There was a correlation between deterioration of lung function and the bacteria isolated from patients with infective exacerbation of COPD. They also found in acute infective exacerbations, *Enterobacteriaceae* and *Pseudomonas* spp were the predominant bacteria in patients with an FEV1 <35% of the predicted value [42].

A recent study supported the causative role of bacteria in exacerbations of chronic obstructive pulmonary disease and showed an association between an exacerbation and the isolation of a new strain of a bacterial pathogen. Sethi *et al* in 2002 conducted a prospective study in which clinical information and sputum samples for culture were collected monthly and during exacerbations from 81 outpatients with chronic obstructive pulmonary disease. Molecular typing of sputum isolates of nonencapsulated *Haemophilus influenzae, Moraxella catarrhalis, Streptococcus pneumoniae,* and *Pseudomonas aeruginosa* was performed. On the basis of molecular typing, an exacerbation was diagnosed at 33.0 percent of the clinic visits that involved isolation of a new strain of a bacterial pathogen, as compared with 15.4 percent of visits at which no new strain was isolated ($P<0.001$; relative risk of an exacerbation, 2.15; 95 percent confidence interval, 1.83 to 2.53). Isolation of a new strain of *H. influenzae, M. catarrhalis,* or *S. pneumoniae* was associated with a significantly increased risk of an exacerbation [43].

Studies about antibiotic effect in treating patients with acute exacerbation added support to the role of bacteria in acute exacerbation. The study of Anthonisen *et al* is often cited supporting antibiotic treatment. In this study, 173 patients with COPD were followed for 3.5 yrs during which time they had 362 exacerbations. Antibiotics or placebo were given in a randomized, double-blind, and crossover fashion. There was a significant benefit from antibiotics that was largely accounted for by patients with the most severe exacerbations comprised of worsening dyspnea with increased sputum volume and purulence. The study also showed that, in patients with multiple exacerbations, the duration of antibiotic-treated exacerbations averaged 2.2 days less than those treated with placebo ($p=0.02$) [44].

A meta-analysis of nine placebo-controlled trials concluded that, overall, there was a small but significant benefit from antibiotic treatment of acute exacerbations of COPD in terms of overall recovery and change in peak flow [45].

1.2.2. Oral Bacteria and Respiratory Diseases

The anatomical continuity between the lung and the oral cavity makes the latter a potential reservoir of respiratory pathogens. There are two routes for oral microorganism to reach the lower respiratory tract: hematogenesis spread (which seems rare) and aspiration. Infection of the lungs through aspiration of materials from the oral cavity may occur through three mechanisms as proposed by Mojon [46] [47]: First, periodontal disease or poor oral hygiene might result in a higher concentration of oral pathogens in the saliva, in particular periodontal pathogens, which are also putative pulmonary pathogens. These pathogens would then be aspirated into the lung, overwhelming the immune defences. There are numbers of anaerobes (facultative or obligate) that are implicated in the destruction of periodontal tissues and that have also been isolated from infected lungs. For example, *Actinobacillus actinomycetemcomitans* and *Fusobacterium nucleatum* have been isolated from infected lungs, whereas *Pseudomonas aeruginosa* has been isolated from patients with "refractory" periodontitis. Second, under specific conditions, the dental plaque could harbor colonies of pulmonary pathogens and promote their growth. Thus, dental plaque may function as a reservoir of these pathogens to facilitate the colonization of the oropharynx. Dental plaque is a dynamic and complex community embedded in a matrix of polymers (polysaccharides and glycoproteins)

derived from bacteria and saliva. Dental plaque can accumulate when oral hygiene is poor.

Finally, periodontal pathogens could facilitate the colonization of the upper airways by pulmonary pathogens. Scannapieco listed four possibilities [49]: (1) alteration of receptors on the surface of the mucosal cells to promote adhesion of pulmonary pathogens; (2) degradation of the salivary pellicle coating pulmonary pathogens; (3) degradation of Fibronectin, a protein that coats all oral mucosa; and (4) change by cytokines of adhesion receptors on the mucosal cell surfaces.

Scannapieco in 1999 proposed several mechanisms to explain the potential role of oral bacteria in the pathogenesis of respiratory infection: 1. Aspiration of oral pathogens (such as *Porphyromonas gingivalis, Actinobacillus actinomycetemcomitans*, etc.) into the lung to cause infection; 2. Periodontal disease-associated enzymes in saliva may modify mucosal surfaces to promote adhesion and colonization by respiratory pathogens which are then aspirated into the lung; 3. Periodontal disease-associated enzymes may destroy salivary pellicles on pathogenic bacteria to hinder their clearance from the mucosal surface; and 4. Cytokines originating from periodontal tissues may alter respiratory epithelium to promote infection by respiratory pathogens [48-50].

Colonization of the upper respiratory tract by gram negative bacilli is correlated with adherence of gram negative bacilli to epithelial cells. Increased adherence is associated with the loss of fibronectin from the surface of oral epithelial cells [51]. The fibronectin-degrading ability is a quality of bacteria that is often involved in oral and oropharyngeal infections, whereas many oral species did not display this property [52]. A reduction in epithelial cell fibronectin is associated with elevated salivary protease activity. The

proteolytic enzyme activity of saliva is associated with periodontal disease and the state of an individual's oral hygiene. Therefore, the oral hygiene had been indirectly associated with the level of fibronectin-degrading proteolytic enzymes in the saliva [53]. In addition, a proteolytic enzyme was proposed by Travis *et al* in 1994 follows the same destruction pathway in both periodontal disease and pulmonary emphysema [54]. The initial insult to the individual tissues for the two diseases may be different but the ultimate result in each disease is accumulation and degranulation of neutrophils at inflammatory sites, as a result of phagocytosis and specific activation of phagocytic cells.

The association between oral conditions, oral bacteria and several respiratory conditions had been reported, for example, evidence had suggested a central role for the oral cavity in the process of respiratory infection. Terpenning *et al* in 2001 investigated the importance of medical and dental factors in aspiration pneumonia in 358 old veterans by measuring the demographic and medical data; functional status; dental care utilization; personal oral hygiene; comprehensive dental examination; salivary assay including IgA antibodies; and cultures of saliva, throat, and dental plaque. They found that dental decay, presence of cariogenic bacteria and periodontal pathogens are potentially important risk factors for aspiration pneumonia in an older veteran population. These dental health-related factors were significant in multivariate models after controlling for established medical risk factors [55].

A study by Harkeness *et al* in 1990 presented oropharyngeal secretion (e.g. saliva, foreign particles, bacteria) as a primary risk factor for occurrence of nosocomial pneumonia in the elderly in both the acute- and long-term-care settings. That was an epidemiological case-controlled study that involved 33 cases (who developed radiographically confirmed

pneumonia) from the acute-care setting, and 27 cases from the long-care setting. Two matched controls (who did not have or did not develop respiratory infection) were chosen for each case. Data entered in the analysis were collected from the medical record and verified by medical personal. The data include: current illnesses, nutritional status, general health, activity of daily livings, level of consciousness, orientation, history of respiratory problems, history of smoking, aspiration related events, inhalation therapy, previous infection, immunosuppressive conditions, drug therapy, surgery, pneumococcal and influenza immunizations, and other unusual events[56].

Respiratory pathogens had been shown to colonize the dental plaque of hospitalized intensive care and nursing home patients as reported by Scannapieco *et al* 1992, Fourrier *et al* 1998 and Russell *et al* 1999 [57] [58] [59] respectively.

Scannapieco *et al* in 1992 conducted a prospective, nonrandomized study with age-matched controls. The cases (n=34) were non consecutive, unselected patients admitted to the medical ICU; the controls (n=25) were age-matched patients seen in the preventive dentistry clinic. Oral hygiene status was assessed in both groups using the semi quantitative plaque index described by Silness and Loe and quantitative cultures of dental plaque and buccal mucosa. Oral hygiene of medical ICU patients was poor and their mean plaque score (1.9 ± 0.2) was significantly higher than the same scores seen in outpatients of the preventive dentistry clinic (1.4 ± 0.1). Plaque and/or oral mucosa of 22 (65%) of 34 medical ICU patients were colonized by respiratory pathogens, in contrast to only four (16%) of 25 preventive dentistry clinic patients. The potential respiratory pathogens cultured from medical ICU patients included methicillin resistant *Staphylococcus aureus, Pseudomonas aerginosa,* and ten genera of Gram-negative

bacilli. These findings suggest that bacteria commonly causing nosocomial pneumonia colonize the dental plaque and oral mucosa of medical intensive care patients.

A similar study done by Fourrier *et al* in 1998 looked at the dental status and colonization of dental plaque by aerobic pathogens and their relation with nosocomial pneumonial infection in intensive care unit (ICU) patients. It was a prospective study that involved 57 consecutive patients admitted to the ICU during a 3-month period. The dental status was assessed using the DMFT (Decayed-Missing-Filled Teeth) index. The amount of dental plaque was assessed using the semi quantitative plaque index described by Silness and Loe. Quantitative cultures of dental plaque, nasal secretions, tracheal aspirates, and urine were done at admission (day 0) and every fifth day until death or discharge. The results of this study showed that the amount of dental plaque increased during the ICU stay and the colonization of dental plaque was either present on admission or acquired in 40% of patients. A positive dental plaque culture was significantly associated with the subsequent nosocomial infections in ICU patients.

Russell *et al* in 1999 assessed the prevalence of oral colonization by respiratory pathogens in a group of elderly chronic-care-facility residents (n = 28) and a group of age-, gender, and race-matched outpatients control subjects (n = 30). The amount of plaque in the teeth and dentures was recorded. In addition, plaque and buccal mucosa samples were collected. The plaque scores on teeth and dentures were significantly higher in chronic-care-facility (CCF) subjects than in dental outpatients control (DOC) subjects. While no subjects in the DOC group found to be colonized with respiratory pathogens, 14% of the CCF subjects were found to be colonized. Oral colonization with respiratory

pathogens in CCF subjects was associated with the presence of chronic obstructive pulmonary disease (COPD) and higher plaque scores.

Data from Lindemann *et al* study in 1984 suggested that the oral cavity is a potential reservoir for *Pseudomonas eurogenosa* which may be important in persisting chronic pulmonary infection in cystic fibrosis patients. In this study, microbial samples were collected from the oral cavities of 20 cystic fibrosis patients and 20 age-matched normal control subjects. *Pseudomonas eurogenosa* was isolated from the tongue, buccal mucosa, and saliva of cystic fibrosis patients only [60].

There are a number of studies which indicate that oral surfaces can be colonized by Aerobic Gram-Negative Bacilli (AGNB), such as *Enterobacteriaceae* and *Pseudomonas eurogenosa* especially in patients with periodontal disease [61-62].

At least two studies had associated COPD with AGNB from oropharynx. Mobbs *et al* in 1999 conducted a study by analyzing the oropharyngeal samples from 40 COPD patients via an oral rinse and gargle technique to evaluate the carriage rates of Aerobic Gram-Negative Bacilli (AGNB) according to illness severity. Those COPD patients comprised three disease severity groups: mild, moderate, and severe. The results showed that oropharynx carriage of AGNB in severe COPD patients (FEV1 <50% predicted) presented a potential source of Gram-negative endogenous pneumonia and the overgrowth of AGNB at the oropharynx posed a significant risk of endogenous infection in end stage COPD patients [63].

Sachs *et al* 1993 also studied the oropharyngeal flora in 48 asthma and 147 COPD patients in addition to 157 control subjects, and they found the prevalence of *Enterobacteriaceae* species was significantly high in asthma and COPD patients [64].

1.2.3. Oral Hygiene and Respiratory Diseases

Mojon *et al* in 1997 reported that poor oral hygiene may be a risk factor for respiratory tract infections in institutionized elderly individuals. Frail elders (302) were orally examined for evaluation of hygiene, quality of prosthesis and the prevalence of caries, periodontal disease and mucosal disorders. The incidence of respiratory tract infection over one year was also recorded. The dentate subjects with a history of respiratory tract infection had a significantly higher plaque score [65].

Other studies investigated the effect of improving the oral care on the incidence of respiratory infections: Pugin *et al* in 1991 conducted a double-blind, placebo-controlled trial involving 52 patients requiring mechanical ventilation in the intensive care unit. A combination of topical antibiotics was administered six times daily in the oropharynx. Tracheobronchial colonization by gram-negative bacteria and Staphylococcus aureus, as well as pneumonia, occurred less frequently in the treated than in the placebo group Topical oropharyngeal antibiotic application lowered the rate of ventilator-associated pneumonia, and systemic antibiotics were prescribed less often in the treated group [66].

DeRiso *et al* in 1996 tested the effectiveness of oropharyngeal decontamination on nosocomial infection in a comparatively homogenous population of patients undergoing heart surgery. It was a prospective, randomized, double blind, placebo-controlled clinical trial. A total of 353 patients were randomized to an experimental (n=173) or control (n=180) group. Both groups used 0.12% Chlorhexidine gluconate (CHX) oral rinse twice a day. The overall nosocomial infection rate was reduced in the chlorhexidine treated patients by 65% and there was also a 69% reduction in the incidence of total respiratory tract infections in the chlorhexidine treated patients. The use of nonprophylactic IV

antibiotics was lowered by 43% and a reduction in mortality in the CHX-treated group was also noted [67].

Fourrier *et al* in 2000 conducted a single-blind randomized comparative study to document the effect of dental plaque antiseptic decontamination on the occurrence of plaque colonization by aerobic nosocomial pathogens and nosocomial infection in intensive care unit patients. The patients were consecutively admitted to the ICU with a medical condition suggesting an ICU stay of 5 days and requiring mechanical ventilation. The treated group received dental plaque decontamination with 0.2% chlorhexidine gel three times a day, while the control group received standard oral care. Dental status was assessed using DMFT index; the amount of dental plaque was assessed by Silness and Loe plaque index. Bacterial samplings of dental plaque, nasal and tracheal aspirate, blood, and urine culture were done. The results showed a significant reduction in the rate of nosocomial infection in the treated group and they were inconsistent with a significant preventive effect of the antiseptic decontamination. There was a trend to a reduction of mortality, length of stay, and duration of mechanical ventilation. Therefore, they reached a conclusion: antiseptic decontamination of dental plaque with 0.2% chlorhexidine gel decreases plaque colonization and reduces nosocomial infection in intensive care unit patients [68].

To evaluate the effectiveness of professional oral health care in reducing aspiration pneumonia, Shu Abe *et al* in 2001 examined the prevalence of potential respiratory pathogens in gargled samples from elderly persons. The study included subjects who were 65 years of age (54 requiring daily nursing care and 21 healthy elders) and 22 healthy young subjects under 30 years of age as controls. The numbers of *C. albicans*

cells recovered in samples from elderly subjects were significantly higher than those recovered from the healthy young group. Elderly patients who needed daily care and received professional oral health care had lower prevalences and cell numbers of *C. albicans* than the elderly patients without such oral care. This study showed that professional oral health care in the elderly requiring daily nursing care reduced the cell numbers of potential respiratory pathogens [69].

A recent study by Yoneyama *et al* in 2002 reached a conclusion that oral care may be useful in preventing pneumonia in older patients in nursing homes. Four hundred and seventeen patients in nursing homes were randomly assigned to either an oral care group or no oral care group. For the oral care group, nurses or care givers cleaned the patients' teeth and dentists or dental hygienists provided professional care once a week. During the follow-up of a 2-year period pneumonia, febrile days, and death from pneumonia decreased significantly in patients with oral care. Oral care was beneficial in dentate and edentate patients. Activities of daily living and cognitive functions showed a tendency to improve with oral care [70].

1.2.4. Dental Status and Respiratory Diseases

The risk of respiratory tract infection (RTI) increased significantly in dentate patients as reported by Mojon *et al* 1997 [65] and Terpenning *et al* 1993 [71].

Mojon et al in the study mentioned earlier demonstrated that about 27% of edentulous patients had at least one episode of RTI while the proportion for the dentate subjects was 40%. These results showed a significant increase in the relative risk of RTI of 1.7(95% CI = 1.1-2.8) in dentate subjects.

Terpenning *et al* in 1993 presented preliminary results from an ongoing project that was studying medical and dental conditions in the elderly. There were 134 geriatric patients; 34 inpatients; 53 long-care patients; and 47 outpatients. These preliminary results indicated an association between dentate status and pneumonia. A diagnosis of pneumonia was confirmed for 19% of long care patients with teeth and for 27% of elderly inpatients with teeth. Only two of 38 edentulous patients developed confirmed aspiration pneumonia.

The anaerobic bacteria also existed in edentulous patients with inadequate denture hygiene and bacterial count correlated to denture cleanness as reported by Blair *et al* in 1995 [72]. Specific anaerobic bacteria like the *Prevotella* species which were putative pulmonary pathogens, were found to be present in the mouth of edentulous patients at 1 and 3 months after extraction by Danser *et al* in 1994 and at 1year after extraction by Danser *et a*l in 1995 [73-74].

Microbiological analysis for denture bacterial flora of 50 dependent elderly patients was done by Y. Sumi *et al* in 2002 [75] to assess the existence of oral infectious pathogens in the dentures of these patients, which could potentially cause respiratory disease. The results showed a variety of pathogens with the potential to cause respiratory infections colonized on the dentures. The predominant potential respiratory pathogens detected on the dentures were *Enterobacter cloacae, Klebsiella pneumoniae* and *Staphylococcus aureus.* The conclusion of their study was that denture plaque must be considered a specific reservoir of colonization and subsequent aspiration pneumonia in dependent elderly.

A pilot study by M. Ismand *et al* in 2002 [76] suggested that microorganisms of denture plaque or associated with periodontal disease may give rise to aspiration pneumonia in susceptible individuals. They reached this conclusion after a microbiological assessment of a quantitative aerobic and anaerobic cultures obtained from a bronchoalveolar lavage through an endoscope for twenty patients with clinical diagnosis of bronchopneumonia. A clinical evaluation of oral health status was also carried out.

1.2.5. Oral Health and COPD

The relationship between periodontal disease and chronic pulmonary diseases was studied by Hayes *et al* in 1998. They assessed the alveolar bone loss (ABL) of 1,118 medically healthy dentate men by using a full mouth series of periapical films over a 25-year follow-up period. Of the 1118 subjects, 261 subsequently developed COPD. They showed alveolar bone loss status at baseline was an independent risk factor for COPD, with subjects in the worst population quintile of bone loss (mean ABL >20% per site) found to be at significantly higher risk (OR=1.8 95%CI = 1.3-2.5) [77].

The analysis of data from the National Health and Nutrition Examination Survey I (NHANES I) by Scannapieco *et al* in 1998 was done to assess the potential association between respiratory diseases and oral health. Out of 23,808 individual who were included in this data base, 638 individuals reported with a suspected respiratory condition that was further assessed by a physician. Initial nonparametric analysis noted that individuals with a confirmed chronic respiratory disease (chronic bronchitis or emphysema) (n=41) had significantly greater oral hygiene index (OHI) scores than subjects without chronic respiratory disease (n=193; p=0.044). Logistic regression analysis of these data suggested

that subjects having the median OHI value were 1.3 times more likely to have a chronic respiratory disease relative to those with an OHI of zero. Similarly, subjects with the maximum OHI value were 4.5 times more likely to have a chronic respiratory disease than those with an OHI of zero. There was no evidence to support an association between poor oral health and acute respiratory diseases. Also, there was no association between the periodontal index and any respiratory disease [78].

The analysis of the data adapted from NHANES III by Scannapieco and Ho in 2001 supported the association between periodontal disease and COPD. It was a retrospective analysis of a cross-sectional data derived from the NHANES III data base. The study population consisted of 13,792 subjects $\geq$ 20 years of age with at least 6 natural teeth. They found that subjects with a history of COPD had more periodontal attachment loss than subjects without COPD (1.48 $\pm$ 1.35mm versus 1.17 $\pm$ 1.09mm p=0.0001). Subjects with a mean attachment loss (MAL) $\geq$ 3 mm had a higher risk of COPD than those having MAL < 3 mm (odd ratio= 1.45; 95% CI= 1.02-2.05). They also noted a trend in that lung function appeared to diminish with increasing periodontal attachment loss [79].

Two recent studies investigated the association between periodontal disease and airway obstruction. A study by Wood and Struckfus in 2002 analyzed the NHANES III data for 6371 persons who had periodontal examination, pulmonary function tests, and answered a questionnaire on chronic obstructive pulmonary disease, asthma, and hay fever. The percent of sites per subject with periodontal attachment loss (PAL) of 3 mm or greater was used as a measurement of periodontal severity. The values of pulmonary function tests (FEV1, FVC, FEV/FVC, PEF (peak expiratory flow rate) and FEF (forced expiratory flow)) were the measurement of pulmonary impairment. The severity of

periodontal disease was significantly correlated with pulmonary impairment. Periodontal disease correlated more strongly with obstructive pulmonary impairment than restrictive pulmonary impairment. The risk and severity of periodontitis was significantly increased with increased severity of pulmonary impairment [80].

Katancik *et al* in 2003 also found a significant association between periodontal disease and airway obstruction, particularly in former smokers. Data of 1253 subjects from the Health, Aging and Body Composition study (Health ABC) was analyzed. The periodontal evaluation included plaque index (PI), gingival index (GI), probing pocket depth (PD), and loss of attachment (LOA). The pulmonary evaluation was based on the FEV1/FVC ratio and the percent of predicted FEV1. GI and LOA were significantly better in participants with normal pulmonary function compared to those with airway obstruction after adjusting for age, race, gender, and field center. There was a significant association between periodontal health and airway obstruction in former smokers. Within this group, those with normal pulmonary function had significantly better GI and LOA scores than those with airway obstruction [81].

1.2.6. Summary

The literature review highlighted several recent studies that have demonstrated a connection between oral bacteria, oral diseases and respiratory diseases. Respiratory pathogens have been shown to colonize the dental plaque of hospitalized intensive care and nursing home patients [57-59]. Pathogens with the potential to cause respiratory infections had been found to colonize denture surfaces as well [75-78]. Dental decay, cariogenic bacteria and periodontal pathogens also emerged as potentially important risk factors for aspiration pneumonia after adjustment for established medical risk factors [55]. High prevalence of respiratory infections among dentate elderly was reported in two studies [65] [71]. A number of intervention studies showed that improving oral hygiene might reduce the risk of respiratory infections among elderly patients at risk [66-70].

The best epidemiological evidence for the association between oral health and COPD came from the work of Scannapieco *et al* using the cross-sectional data from NHANS-I and NHANS-III, and the work of Hayes *et al* using longitudinal data from the VA Normative Aging Study [77-79]. Their findings indicated that poor periodontal health, assessed using clinical or radiographic criteria of attachment and bone loss, increases the risk of having or developing chronic obstructive pulmonary disease. Although the findings were statistically significant, the magnitude of the reported risk was small. Despite that, the impact on the public health is great if confirmed by experimental studies. There was no study that looked at the relationship between oral hygiene and COPD exacerbations.

1.3. Hypothesis and Objectives

The **main hypothesis** was: Poor oral hygiene is associated with high frequency of acute exacerbation events in patients with severe COPD.

The **general objective**: to investigate the association between oral hygiene; other oral health measures and the frequency of acute exacerbation events in patients with severe COPD.

The **specific objectives**:

Primary objective: To determine the association between oral hygiene (represented by the accumulations of plaque, gingival, and calculus indices) and the frequency of acute exacerbation events in severe COPD.

Secondary objective: To evaluate dental status, prosthetic status and oral hygiene habits in patients with severe COPD and their relationship with acute exacerbation events.

The **purpose** of this pilot study was to examine the feasibility of conducting a larger scale prospective study in the future: First, to get to know the characteristics of the study population and if they could tolerate the examination procedures and measures. Second, to calculate the amount of time and resources the next study will require. Third, to generate data that will help in sample size and power calculations.

The clinical significances expected from this study are:

1. Inclusion of "Poor oral hygiene" among the list of potential common causes or triggers of acute exacerbations.
2. Considering COPD patients with poor oral hygiene a risk group for having exacerbations.

2. METHODS AND MATERIALS

All patients were recruited from the outpatient COPD clinic of the Montreal Chest Institute, an academic tertiary-care referral centre for respiratory diseases and one of McGill affiliated Hospitals. The study has been approved by the Review Ethical Board of the Montreal Chest Institute.

2.1. Study Design

This was a pilot study, cross sectional & retrospective in nature. The study included one visit for dental exam and clinical evaluation while the study outcome, exacerbation events, were collected retrospectively over the preceding year using the patient's medical chart. The study included a sample size of 55 patients who were stratified according to frequency of exacerbation events.

2.2. Recruitment and Patient Eligibility

2.2.1. Recruitment

The patients were recruited taking into account the number of exacerbation events. The patients were assigned to either one of two groups: group L for patients with low frequency of exacerbation events in the previous year to the examination (≤1acute exacerbation); group H for patients with high frequency of exacerbation events in the previous year to the examination (>1 acute exacerbation). Acute exacerbation was defined as a worsening of dyspnea that exceeds the day to day variations and does not

respond to treatment with regular bronchodilator regimen or to an increase in the dose of inhaled bronchodilators.

The recruitment procedure was done by a research assistant. She was present in the COPD clinic that was held once a week screening all the patients attending the clinic, explaining the study to those who fit the eligibility criteria, and ready with the consent form for those who agreed to participate in the study. The consent form contains a brief description of the study: the purpose of the study, the procedure, discomforts the patient will encounter if any, confirmation of confidentiality and voluntary participation, financial compensation and contact numbers if further information needed. At the end, the patient had to sign the statement of consent and a copy was given to him/her.

2.2.2. Eligibility criteria

All patients had to meet the eligibility criteria as follow:

Inclusion Criteria

1. Age > 40 years.
2. Severe COPD (FEV1/FVC <70% and FEV1 < 50%) and continued presence of cough and sputum production or dyspnea [82].
3. Stable symptoms and medications and no antibiotic or increase in prednisone dosage in the last 4weeks. ATS definition [13].
4. At least 10 pack-year history of cigarette smoking.
5. Patient must be willing and able to participate in the study and sign the written consent.

Exclusion Criteria

Patients were excluded from the study if they were suffering from:

1. Asthma or diffuse bronchiectasis, cystic fibrosis or tuberculosis.
2. Dementia or uncontrolled major psychiatric disorder.
3. Contraindications for dental treatment also included:
    a. Systolic blood pressure higher than 180.
    b. Cerebrovascular accident or any transient ischemic disorder within the last 6 months.
    c. Unstable angina in the last 2 months.
    d. Haemostasis disorder or anticoagulants with INR >3.5.
4. Medical conditions that need pre-medication before periodontal probing:
    a. Joint replacement in the previous 6 months.
    b. Joint replacement combined with immune-compromised state or uncontrolled diabetes.
    c. Heart diseases resulting in high risk of infective endocarditis:
        - Artificial valves.
        - Endocarditis or rheumatic heart disease with the valve involvement
        - Congenital heart disease.
        - Mitral valve prolapses with insufficiency.
        - Idiopathic hypertrophy sub-aortic stenosis.
        - Myocardial infarction within 6 months.

2.3. Data collection

All the data collected were non nominal. Data were collected during one visit in hospital and included the use of various questionnaires and examinations (see flow chart for the steps of data collection in appendix A). Exacerbations were assessed according to the information collected from the patients recalling the number of exacerbations they had in the past year, and from the medical charts which provided information from the outpatient department, emergency department and hospitalizations.

2.3.1. Questionnaires

Socio-demographic and medical information were taking directly from the patients and confirmed by reviewing the patients' medical charts. The Socio-demographic data included the date of birth, marital status; gender of the patient, level of education and race. The medical data included the past and present medical conditions, current respiratory medications and vaccination (influenza in past 12 months, pneumovax in past 10 years), number of exacerbation events that occurred in the one year prior to the oral examination and number of pulmonary infections confirmed with chest x-ray that shows abnormalities compatible with diagnosis pneumonia that took place one year prior to the examination.

The patient was also asked to complete three questionnaires by face to face interview or by telephone interview at the time of the examination or any other time convenient for the patient. The first questionnaire included a modified version of the American Thoracic Society Division of Lung Disease 1978 questionnaire (ATS-DLD-78 questionnaire). It consists of two sections, the respiratory symptoms which included 10 questions and the

smoking habits of the patient, 24 questions. It took about 10 minutes to complete the questionnaire.

The second questionnaire included the St-George Respiratory Questionnaire (SGRQ). This is a disease-specific questionnaire designed to measure impact on overall health, daily life, and perceived well-being. It was developed for use by patients with fixed and reversible airway obstruction. It consists of three sections with 76 questions in total: Symptoms (frequency & severity); Activity (activities that cause or are limited by breathlessness); Impacts (social functioning, psychological disturbances resulting from airways disease). Section I (Symptoms) is a 5-point Likert. Sections II (Activity) and III (Impacts) are Dichotomous (yes/no). Scores for each section and a total score was given; each item was weighted based on empirical data. Scores range from 0 to 100, with higher scores indicating poor health. It took about 10 minutes to complete the questionnaire. The third questionnaire included an oral health questionnaire which consists of 24 questions. It describes patient daily routine in dental care divided in 2 sections for dentate and denture wearer. It took about 5 minutes to complete the questionnaire.

2.3.2 Examinations

Medical and oral examinations were performed to extract the following data:

2.3.2.1. Medical examination

Body weight and height, heart rate and blood pressure and Spirometry test (FEV1, FVC and FEV1/FVC) best within past 6-12 months through a medical examination.

The FVC is the maximum volume of air exhaled after maximum inhalation. The FEV1 is the volume exhaled in the first second of the FCV. Computerized spirometry was used to measure FEV1, FVC and FEV1/FVC

The spirometry procedure consists of the following [83]:

1. Before starting the procedure the examiner (a nurse or a research assistant) prepares the patient for the test. Patient preparation consists of explaining the purpose of the test, determining if there are any contraindications to performing the spirometry, positioning the patient and explaining the actual manoeuvre.
2. Spirometric results are often compared to reference or predicted value. In order to do this correctly the patient sex, height (without shoes) and age (on day of the test) are needed.
3. The examiner shows the patient how to use the mouthpiece and nose-clips and how the mouthpiece fits into the mouth. In the case of a cardboard mouthpiece, the patient should not bite down, as this will obstruct the tubing hole. Lips should be sealed tightly and the tongue should not stick out into the mouthpiece. Dentures that fit poorly may be a nuisance and should be removed if it is thought to interfere. The RA will show the patient the proper chin and neck position, the chin should be slightly elevated and the neck slightly extended. This position should be maintained throughout the forced expiratory procedure.
4. Then the examiner instructs the patient to blow all the air that they can into the tube as hard and as fast as he/she can in one long complete breath. The test is repeated 3 times and is considered acceptable when the 2 largest FVCs and FEV1s agree within 5% or 100 ml.

5. The largest FEV1, FVC values are recorded and FEV1/FVC ratio are called FEV1% by dividing FEV1 by the FVC and multiplying by 100. The percent of predicted value is determined by dividing the observed value by the reference value and the resulting decimal is multiplied by 100. All these values are calculated instantly by the computer.
6. The whole procedure is to be repeated after 45 minutes of using a bronchodilator, and this to determine whether airflow limitation is reversible and excludes the asthma as diagnosis.

2.3.2.2. Oral examination

The oral examination was performed at the Montreal Chest Institute by two trained dentists on Monday afternoon on the day of the COPD clinic or at a subsequent visit. They used a mouth mirror, dental explorer and periodontal probe.

Subjects were seen for most of them by only one dentist. Two subjects were examined by both dentists to evaluate the reliability of the measurements. Pocket depth measurement was used to evaluate agreement between dentists since it is the most difficult measurement fall the parameters recorded clinically to reproduce. In all 90 repeated measurements were recorded. Pocket depth varied between 1 mm and 5 mm with a majority of measurement falling between 1 and 3. Squared weighted kappa statistics was computed to show a good agreement K(w) =0.57 (SE 0.06).

The oral examination consisted of the following:

- Mucosal assessment for the presence of white lesions, sore spots, stomatitis or any other mucosal lesion. Denture stomatitis was recorded according to the Budtz-Jorgensen classifications [84].

- Prosthetic evaluation included vertical dimension of occlusion and maximum mouth opening, type of maxillary and mandibular dentures. Denture quality (status), which consists of retention, stability, presence of faulty occlusion and quality of the base (any part missing or porous resin or temporary reline for complete denture or any fracture or missing clasps, rests, connector or severe corrosion for cast partial denture).The quality of clasps, occlusal rests and denture teeth wear were also evaluated. The denture quality score is a sum of points given for retention, stability and occlusion. If one of them was faulty a score of zero points was given, and if stability and occlusion were good a score of one point was given, and retention was given two points since it is of greater importance. The score can vary from 0 to 4. Bad = 0-1, questionable=2, good = 3, and excellent=4.

  The Resorption degree of the maxillary and mandibular alveolar ridges was recorded according to the classification described by lekholm and Zarb [85].

- The dental examination included:

1. Tooth type: whether the tooth was absent or present whether there was a remaining tooth, overdenture, pontic, crown, or abutment for fixed partial denture or implant.
2. Dental caries (coronal and root caries) according to WHO criteria [86]
3. Fillings status was recorded as adequate, infiltrated if the margins let the probe penetrate and hold it or discoloration of the margins of the esthetic restoration, or inadequate if there was an overhanging that filled the interdental spaces preventing the use of the dental instrument.

- Oral hygiene and Periodontal examination included:

1. Denture plaque accumulation according to Amjborsen *et.al* 1982 [87].

In this index the plaque score of maxillary and/or mandibular dentures was recorded in five different areas of the fitting surface: for the maxillary denture, 1.the incisive papilla; 2. the most posterior areas of both maxillary tuberosities; 3.two areas 1 cm. lateral to the midline of the palate at the bisecting point between the impression of the superior labial frenum and the most posterior point on the midline of the maxillary denture. Each area was limited to a circle with a diameter of 1 cm (Fig.2). The same locations were applied to the mandibular denture. The amount of plaque was recorded according to four scores, which is a modification to the plaque index of Silness and Loe (see table no.3). Before the scoring procedure, the denture was carefully rinsed in water to clean off any soft debris and examined in good light using the dental explorer.

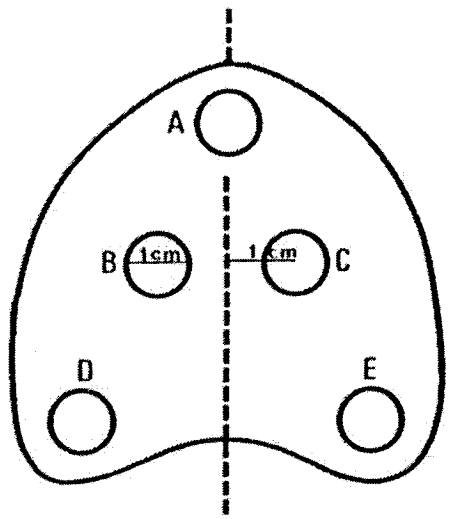


Fig.2 Locations of plaque recording on complete maxillary denture

Table No.3 Denture plaque index according to Amjborsen *et.al* 1982 [87]

Score	*Criteria*	*Descriptions*
0	No plaque	No visible plaque could be seen when scraped with a blunt instrument
1	Plaque visible only by scraping with a blunt instrument	Plaque could be seen on the instrument
2	Moderate accumulation of visible plaque	Areas partly covered with visible plaque
3	Abundance of plaque	Areas completely covered with visible plaque

2. Dental plaque accumulation according to the plaque index of Silness and Loe 1964 [88].

This index examines the plaque in the distofacial, facial, mesiofacial and lingual surfaces, but records the worst surface of the tooth. A dental explorer and mouth mirror were used after drying the tooth with cotton ballets or gauze following the criteria for the dental plaque index by Silness and Loe appears in table no.4 below.

Table No.4 Dental plaque index by Silness and Loe 1964 [88]

Score	*Criteria*
0	No plaque in the gingival area
1	A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be recognized by running a probe across the tooth surface
2	Moderate accumulation of soft deposits within the gingival pocket and on the gingival margin and/or adjacent tooth surface, which can be seen by the naked eye
3	Abundance of soft matter within the gingival pocket and/or on the gingival margin and adjacent tooth surface

3. Gingival index according to Loe and Silness 1963[89].

   The gingival tissue surrounding each tooth was divided into 4 gingival scoring units: the distofacial papilla, the facial margin, the mesiofacial papilla and the lingual gingival margin. The bleeding potential was assessed after completing the recording of the periodontal pocket depth of the teeth using the periodontal probe (Williams probe). The worst scoring among the four units will be recorded according to the criteria in table no.5.

Table No.5 Gingival index by Loe and Silness 1963 [89]

Score	*Criteria*
0	Normal gingival
1	Mild inflammation, slight change in color, slight edema; no bleeding on probing
2	Moderate inflammation, redness, edema, and glazing; bleeding on probing
3	Severe inflammation, marked redness and edema, ulceration, tendency to spontaneous bleeding

4. Calculus index according to Ramjord 1959[70].

   The calculus accumulation was assessed using a mouth mirror and dental explorer on the buccal and lingual surfaces of each tooth and the worse score was recorded according to the criteria mentioned in table no.6 below.

Table No.6 Calculus index by Ramfjord 1959[70]

Score	*Criteria*
0	Absence of calculus
1	Supragingival calculus extending only slightly below the gingival margin
2	Moderate amount of supragingival and subgingival calculus or subgingival calculus alone
3	An abundance of supragingival and subgingival calculus

5. The periodontal pocket depth was measured in 6 areas of the tooth: the mesiofacial, facial, distofacial, mesiolingual, lingual and distolingual. The probe should be inserted parallel to the vertical axis of the tooth and "walked" circumferentially around each surface of the tooth to measure the distance between the gingival margin and the base of the pocket (the deepest penetration).
6. Gingival recession was measured buccaly and palataly (lingualy) with the periodontal probe. The largest recession between the cemento-enamel junction (CEJ) and the crest of the gingival was recorded in millimeters. When the CEJ was not visible, the recession was recorded as 0.
7. Tooth mobility was evaluated as the following: the tooth was held firmly between the handle of the metallic instrument and one finger, and an effort was made to move the tooth in the buccolingual direction. Mobility was recorded as follows: 0 for no mobility (only physiological mobility=1mm); 1 for mobility more than 1 mm; 2 for buccolingual and mesiodistal combined with vertical mobility.

- Measurement of salivary flow:

  Stimulated salivary flow was measured by asking the patient to chew a small piece of paraffin wax for 3 minutes and to produce the saliva in a cup [92].

2.4. Statistical Analysis

2.4.1. The Variables

The dependent variable:

The outcome variable was the frequency of exacerbations that occurred in the year prior to the oral examination. It was obtained from the medical chart or from the patient if he/she was not followed for at least one year at the hospital.

The variable coded: Group L = 0 for patients with low frequency of exacerbations (0-1)

Group H = 1 for patients with high frequency of exacerbations (≥2)

Another coding system was considered in the bivariate analysis for comparison purposes:

0 for patients with no exacerbations

1 for patients with one exacerbation

2 for patients with two or more exacerbations

The independent variables

Variables of the primary objective:

The main exposure *variable* was the oral hygiene status of the patient. This variable was created from a combination of indices measuring the oral hygiene through oral examination. Originally, for patients with teeth, indices like the dental plaque index, the calculus index and the gingival index (ordinal indices coded from 0-3) were recorded for each tooth in the mouth. For denture wearing patients, the denture plaque index (ordinal index coded from 0-3) was recorded for specific sites on the denture surface. The mean was then calculated after checking the distribution. Three values were calculated for each dentate patient: the mean of the dental plaque index, the mean of the calculus index and

the mean of the gingival index and one value for denture wearing patients: the mean of the denture plaque index. Those values were then rounded off to the nearest number on the scale from 0-3 (0=0-0.49, 1=0.5-1.49, 2=1.5-2.49, 3= 2.5-3) the new scale accepted after the distribution checked positive for normality. The average value of the different indices was the oral hygiene value.

Oral hygiene was coded: 0= good oral hygiene

1= fair oral hygiene

2= bad oral hygiene

3= poor oral hygiene

Another coding system was considered in all the analysis: 0= good oral hygiene and 1= bad oral hygiene (this includes patients with categories1, 2&3 from the original coding).

The averages of: the dental plaque index, the denture plaque index, the calculus index and the gingival index were tested separately in addition to the main exposure variable (oral hygiene index).

Variables of the secondary objective:

1. Dental variables: dental status, restoration status, number of teeth, number of active caries, maximum mouth opening, mucosal lesion, and salivary flow rate
2. Prosthetic variables: vertical dimension of occlusion, denture stomatitis, alveolar ridge resorption, and denture quality
3. Oral hygiene habits variables: time of brushing, frequency of brushing, denture cleaning habits, teeth cleaning habits, effect of the disease on brushing, dental

profession patient visited, time of last visit to the dentist/dentrulogist, and oral health perception

Other independent variables:

1. Socio-demographic variables: age, educational level, gender, race, and marital status.
2. Respiratory and medical variables: FEV1, FEV1/FVC, smoking status, average number of cigarettes per day, number of years of smoking, comorbidity, medications, Saint George Respiratory Questionnaire (SGRQ)scores, and Body Mass Index (BMI),

SGRQ scores were calculated by giving scores for each of the three sections of the questionnaire (symptoms, activity and impact) and one total score was calculated.

Each questionnaire response has a unique derived 'weight' which is documented in the literature. The lowest possible weight is zero and the highest is 100. Each section of the questionnaire was scored separately in two steps:

i. The weights for all items with a positive response were summed.

ii. The score was calculated by dividing the summed weights by the maximum possible weight for that section and expressing the result as percentage:

$$\text{Score} = 100 \times \frac{\text{Summed weight from positive items in that section}}{\text{Sum of weights for all items in that section}}$$

The total score was calculated in similar way:

$$\text{Score} = 100 \times \frac{\text{Summed weight from positive items in the questionnaire}}{\text{Sum of weights for all items in the questionnaire}}$$

This calculation was done using SAS package V8

BMI calculated using SPSS according to this equation: $\text{BMI} = \frac{\text{Weight}}{\text{Height}^2}$

Patients with BMI value < 21 kg/m^2 were considered malnourished.

For variables type and coding see Table No. 7 appendix A

2.4.2. Statistical Methods

The Statistical Package for the Social Sciences (SPSS) (SPSS Inc., Chicago Ill.) was used to analyse the data. The data was cleaned and formatted in Microsoft access XP. The variables of interest were then transformed into Excel XP format to be easily imported in SPSS.

A Descriptive statistic was used to describe the population characteristics. The results were presented as means and standard deviations (sds) for normally distributed continuous variables, as median for those not normally distributed and as percentages for the categorical variables. The criteria used for normality were: the median, the normal p-p plots of regression standardized residual and p-value of the kolmogorov goodness of fit.

The bivariate analysis was used to test for significant relationships between the variables. Paired 2-tailed *t*-tests were used to test for significance between mean values for normally distributed continuous variables and the Mann-Whitney test for not normally distributed continuous variables. Chi-square tests were used to test for significance between categories and if the case number in one group was below 5, Fisher's exact test was used. Pearson and Spearman correlation coefficients, odd ratios and 95% confidence intervals were also recorded.

Multiple logistic regression was used to test the association between the main exposure and the outcome when adjusted for other variables. Due to the small number of patients, only variables that apply to all of them were considered. Variables that showed 10% increase or decrease in the risk of increasing the frequency of exacerbations accompanied with p-value < 0.3 in the bivariate analysis were included. Smoking was included due to

its well documented confounding effect. The assessment for the presence of effect modifiers was based on a prior knowledge of any interaction between the variables. To assess for the potential confounding effect on the association between oral hygiene status and the frequency of exacerbation events, the variables were removed one at a time and if there was a change in the odd ratio of oral hygiene status of $\geq$ 10%, the variable was considered as confounder. The Hosmer-Lemeshow goodness of fit test was carried out for the models to assess goodness of fit. A large chi-square and small p-value indicate poor fit. A probability of 5% was defined as significant for all statistical tests in this study.

3. RESULTS

3.1. Descriptive Analysis

All of the patients were treated as outpatients. Most of them were able to walk without assistance. Only a few of them who were using oxygen therapy came to the examination room in a wheel chair. The information about the type of residency was not obtained and the percentage of patients who were living in their own houses or in a seniors housing was not available. However, they were autonomous and mobile enough to come to their follow-up visits and participate in the study. Around half of the patients (25) were examined on the same day of their follow-up visit at the COPD clinic and the rest at a subsequent visit.

The percentages of patients who were approached and those who refused were not recorded but it was roughly estimated that around 70% (55 patients) accepted to participate in the study. The percentage of patients with high frequency of exacerbation was 45.4% (25 patients) and 55.6% for the patients with low frequency of exacerbation (30 patients).

- ***Socio-demographic characteristics***

All of the patients were Caucasians except for one Hispanic. The study population consisted of a higher percentage of males, whose mean age was 68.4 years (sd 8.5); compared to the females, whose mean age was 65.9 years (sd 11). Most of the patients were married; the non married group consisted of: 4 singles, 5 were living with a spouse, one separated, 9 widowers and 9 divorced. Table no.8 shows the distribution of the variables for the whole population and between the two groups of exacerbations.

Table No.8 Socio-demographic information of the study population according to disease severity.

Variables	*Group L n= 30*	*Group H n= 25*	*All patients n=55*
Age (mean±sd)	69.07±7.93	66.24±10.39	67.78±9.15
Gender *Male* *Female*	 23(76.6%) 7(23.3%)	 18(72%) 7(28%)	 41(74.5%) 14(25.5%)
Educational level (mean±sd)	10.40±4.14	11.84±3.92	11.05±4.07
Marital status *Married* *Not married*	 15(50%) 15(50%)	 12(49.1%) 13(50.8%)	 27(49.1%) 28(50.9%)

Group L= low frequency of exacerbation, Group H= high frequency of exacerbation.

- ***Respiratory and medical characteristics***

Table no.9 gives the description for the respiratory parameters. All patients had been cigarette smokers, nine (16.4%) of the patients had been also pipe smokers and 5 (9.1%) cigar smokers. All of them stopped smoking.

Medical records revealed that 33 patients had been diagnosed with at least one medical condition in addition to COPD. Table 10 shows the different medical conditions present in this group of patients. The median number of medical conditions per subject was 2 (range 1-9). All patients were taking at least one type of COPD medications: bronchodilators or inhaled corticosteroid or a combination of the two. There were 22 (41.5%) patients who were taking medications (for one or more medical condition) in addition to COPD medications: 12 patients were taking medications for cardiac problems, 7 were taking iron, minerals or vitamins, 13 were taking drugs for psychiatric conditions, 4 patients were using NSAID, 5 were taking anti ulcer drugs, 3 patients were taking oral anti diabetic pills. Other medications mentioned by the patients included: thyroid drugs,

topical steroids, anti coagulants, laxatives, anti diarrheal and anti-inflammatory drugs. The median number of medication per subject was 2 (range 1-10)

Table No.9 Clinical findings of the study population according to disease severity.

Variable	*Group L n= 30*	*Group H n= 25*	*All patients n=55*
Fev1(mean±sd)*	1.08±0.43	0.77±0.25	0.94±.039
Fev1/Fvc%(mean±sd)	41.78±13.72	37.60±37.6	39.8±12.84
SGRQ(mean±sd)	40.57±12.78	47.68±16.81	43.8±15.04
BMI(mean±sd)	25.84± 5.09	24.72± 4.59	25.3 ±4.86
Years of smoking (mean±sd)	42.43± 10.9	40.44±12.56	41.53±11.3
No. of cigarettes /day (median)	25	25	25
Cigarette Smoking			
Current smoker	9(30%)	9(36%)	18(32.7%)
Previous smoker	21(70%)	16(64%)	37(67.3%)
Comorbidity			
Absent	10(33.3%)	12(48%)	22(40%)
Present	20(66.7%)	13(52%)	33(60%)
Medications			
Respiratory only	18(62.1%)	13(54.2%)	31(58.5%)
Respiratory and other medications	11(37.9%)	11(45.8%)	22(41.5%)

***significant at 0.003 level.**

Table No. 10 Number of past and present comorbid conditions of the study population.

Medical condition	*Past medical condition*	*Present medical condition*
ENT	8	3
Eye	6	7
Respiratory	30	55
Cardiovascular	10	11
Gastrointestinal	7	5
Hepatobiliary	2	0
Urology	7	5
Neurology	4	6
Blood & lymphatic	4	4
Endocrine & metabolic	3	5
Musculoskeletal	12	7
Skin	3	3
Psychiatric	5	5
Non-specific	11	9

- ***Dental status***

A total of twenty patients (36.4%) were dentate. The total number of teeth was 298. We found 35 (11.7%) carious teeth: 19(6.4%) were active caries and 16(5.3%) were inactive carious lesions. In all, thirteen patients (65%) had at least one carious tooth and 9(45%) patients had at least one tooth with active caries. There were 103 restored teeth. The mean number of restored teeth per patient was 5.15 (SD 5.5). There were 88 restorations with adequate status and 15 with inadequate status. The results for salivary flow rate, mucosal lesion, and maximum mouth opening variables are presented in table no.11. A total of 16 (80%) out of 20 dentate patients had at least one tooth with a periodontal pocket depth $\geq$ 5 mm. Eleven (55%) patients had at least two teeth with a periodontal pocket depth $\geq$ 5 mm, 9 (45%) patients had at least three teeth with a periodontal pocket

depth ≥ 5 mm and two (10%) patients had at least 20 teeth with a periodontal pocket depth ≥ 5 mm.

Table No.11 Oral findings of the study population according to disease severity.

Variable	*Group L n = 12*	*Group H n = 8*	*All patients n = 20*
No. of teeth mean±sd	16.3 ± 8.30	12.7± 8.27	14.9±8.27
No. of active caries mean±sd median	1.08 ±1.37 .50	0.75± 1.38 0	1 ±1.37 0
*Restorations **			
Absent	2	1	3
Adequate	9	1	10
Inadequate	1	1	2
Both (Ad& Inad)	0	5	5
Variable	*Group L n = 30*	*Group H n = 25*	*All patients n = 55*
Salivary flow rate mean±sd	1.89±1.38	1.530± 0.97	1.73±1.24
Mucosal lesions			
No lesion	17(56.7%)	10(40%)	27(49%)
At least one	13(43.3%)	15(60%)	28(51%)
MMO			
Normal	29(96.7%)	21(84%)	50(90.9%)
limited	1(3.3%)	4(16%)	5(9.1%)

***Significant at 0.01 level, *MMO*=maximum mouth opening**

- ***Prosthetic status***

The percentages of patients with teeth, or with teeth and dentures, or those who were completely edentulous are listed in table no.12, in addition to denture stomatitis and vertical dimension of occlusion variables. The upper alveolar ridge had no sign of resorption in 9.6% of the cases. It was slightly resorped in 80% and moderately resorped

in 11.5% of patients with edentulous upper ridge (Fig.3). The lower alveolar ridge had no sign of resorption in 5.8% of the cases.

It was slightly resorped in 41%, moderately resorped in 31.4%, severely resorped in 17.2% and flat in 5.8% of patients with edentulous lower ridge Fig.4. The quality of the upper dentures (complete/partial) was excellent in 44.4%, good in 28.9%, questionable in 15.6% and bad in 11% of all patients who wore complete or partial upper dentures (Fig.5). The quality of the lower dentures (complete/partial) was excellent in 45.9%, good in 13.5%, questionable in 18.9% and bad in 21.6% of all patients who wore complete or partial lower dentures (Fig.6).

Table No.12 Prosthetic findings of the study population according to disease severity.

Variable	*Group L n = 30*	*Group H n = 25*	*All patients n = 55*
Dental status			
Only teeth	7(23.3%)	3(12%)	10(18.2%)
Teeth & denture	5 (16.7%)	5(20%)	10(18.2%)
Complete dentures	18(60%)	17(68%)	35(63.6%)
Variable	*Group L n = 18*	*Group H n = 17*	*All patients n = 35*
Denture stomatitis			
Absent	8(44.4%)	8(47.1%)	16(45.7%)
Mild	5(27.8%)	3(17.6%)	8(22.9%)
Moderate	5(27.8%)	6(35.3%)	11(31.4%)
VDO			
Normal	11(61.1%)	14(82.4%)	25(71.4%)
decreased	7 (38.9%)	3(17.6%)	10(28.6%)

***VDO*=Vertical dimension of occlusion.**

Fig.3 Upper Alveolar Ridge Resorption

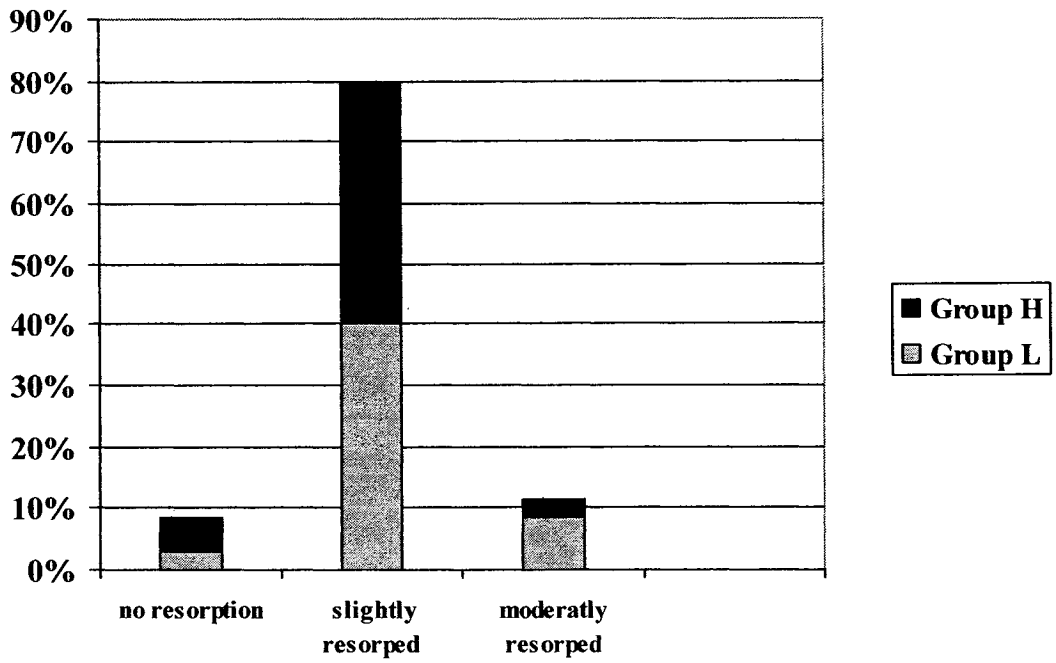


Fig.4 Lower Alveolar Ridge Resorption

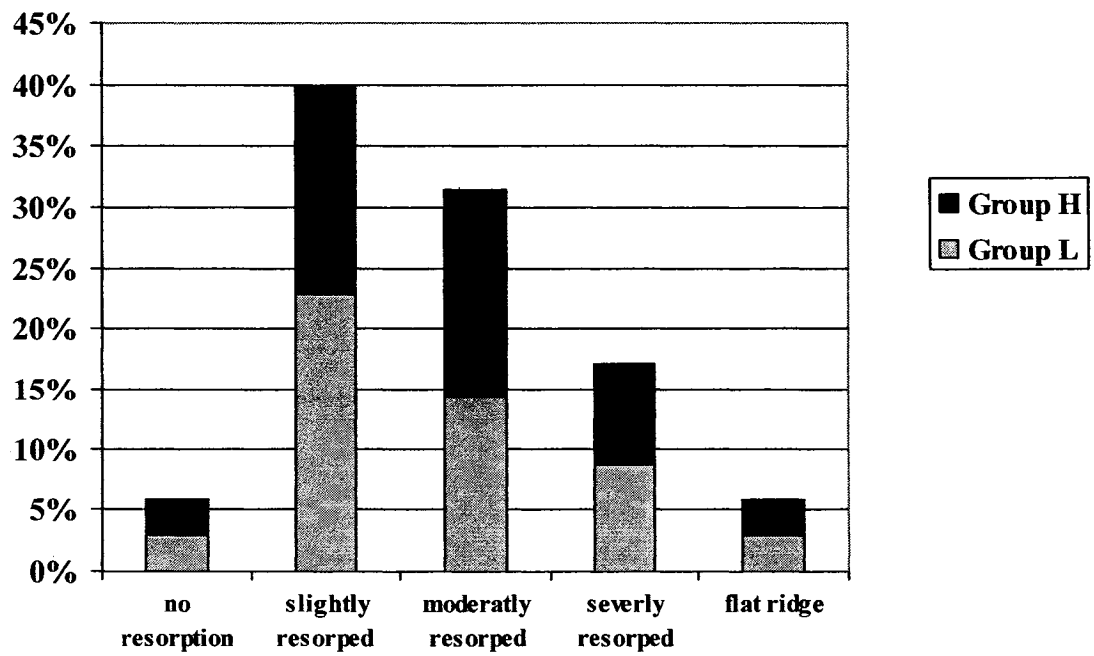


Fig.5 Upper Denture Quality

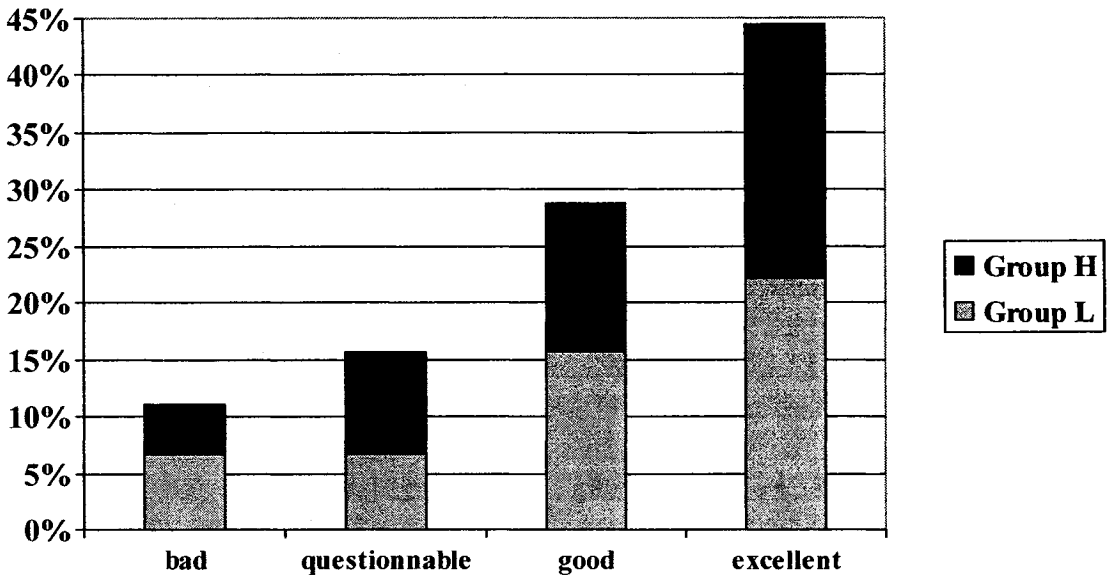
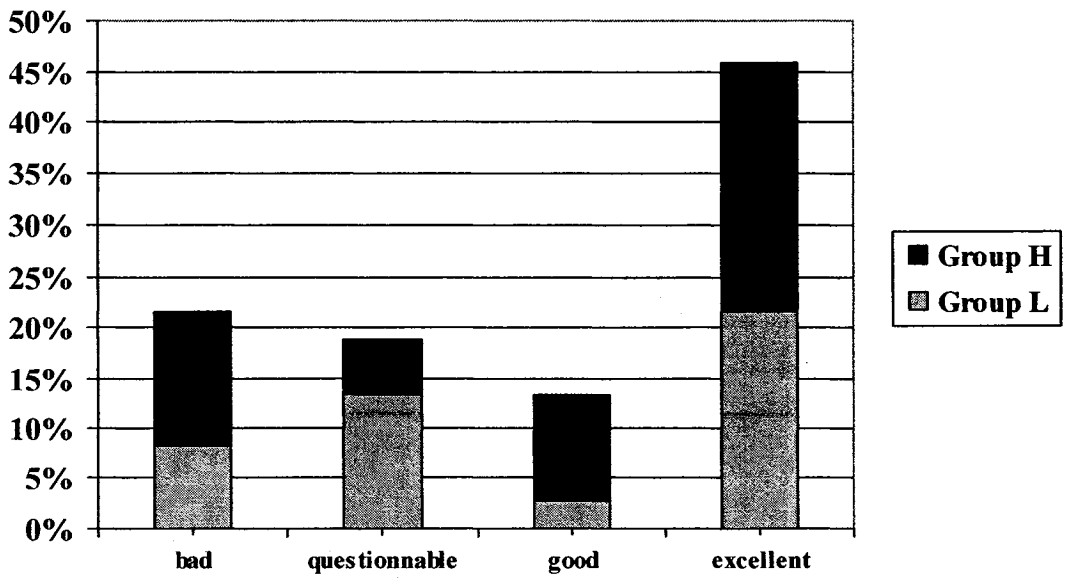


Fig.6 Lower Denture Quality



- ***Oral hygiene status***

When patients were asked about their daily oral hygiene practices, 17 (30.9%) brushed their teeth/dentures twice a day, 17 (30.9%) three time or more a day, 9 (16.4%) only once a day and 12 (21.8%) did not brush their teeth/dentures. Most of the patients (28 or 51.9%) spent 2 minutes in brushing their teeth/dentures, 23 (42.6%) spent 2-5 minutes and only 3 (5.6%) spent more than 5 minutes in brushing their teeth/dentures.

Most denture wearing patients (26 or 57.8%) used a brush and cleaning tablets for cleaning their dentures, 16 (35.6%) only brushed their dentures, 2 (4.4%) used only cleaning tablets and one patient rinsed his denture to clean it. Most dentate patients (12 or 60%) used a tooth brush with other aids like dental floss or tooth pick or interproximal brush and 8 (40%) patients used only a tooth brush.

The time lapse since their last visit to the dentist was 6 months for 50% of the dentate patients. The time lapse since their last visit to the dentist or dentrulogist was 5-10 years for 50% of the edentulous patients and 1-2 years for 50% of patients wearing partial dentures. In response to the question asking why the patient stayed without consultation for 2 years (dentate) or 5 years (edentate); 24 (80%) said there was no need to go to the dentist/dentrulogist, 2 (6.7%) gave financial reasons and 4 (13.3%) gave other reasons.

Answering a question about the effect of the disease in their brushing ability, 16 (84.2%) of dentate patients said it does not affect them at all, 2 (10.5%) said it affects them a little and one (5.3%) said it affects him quite a lot. Thirteen patients (24.1%) thought that they had very good oral health, 24 (44.4%) good oral health, 11(20.4%) quite good, and 6 (11.1%) poor oral health irrespective of their dental status.

The mean denture plaque index, the mean dental plaque index, the mean gingival index, and the median of the calculus index per patient on a scale from 0-3 are present in table no.13. On the oral hygiene index, the difference between the two groups was tested for two types of classifications of the oral hygiene index: as a categorical with 4 categories and as dichotomous. The results are present in table no.14.

Table No.13 Oral hygiene status of the study population according to disease severity

Variable	*Group L n = 12*	*Group H n = 8*	*All patients n = 20*
Dental plaque index(mean±sd)	1.259±0.82	1.63± 0.53	1.407 ± 0.73
Gingival plaque index(mean±sd)	0.85±0.81	1.34±0.45	1.047 ±0.71
Calculus index(median)	0.07	0.14	0.14
Variable	*Group L n = 23*	*Group H n = 21*	*All patients n = 44*
Denture plaque index(mean±sd)	0.79±0.58	0.08±0.78	0.79 ±0.68

Table No.14 Oral hygiene index of the study population according to disease severity

Oral hygiene index	*Group L n = 30*	*Group H n = 25*	*All patients n = 55*
Categorical			
Good	12 (40%)	6 (24%)	18 (32.7%)
Fair	13 (43.3%)	15 (60%)	28 (50.9%)
Bad	5 (16.7%)	2 (8%)	7 (12.7%)
Poor	0	2 (8%)	2 (3.6%)
Dichotomous			
Good	12(40%)	6(24%)	18(32.7%)
Bad	18(60%)	19(76%)	37(67.3%)

3.2. Bivariate Analysis

3.2.1. Bivariate analysis using Chi-square and T-test

Testing the hypothesis

The mean of the dental plaque index and the mean of the gingival plaque index were higher in patients with high a frequency of exacerbations. However, the differences between the two groups of low and high frequencies for the dental and denture plaque, gingival and calculus indices were not statistically significant. The oral hygiene index (categorical and dichotomous) was not significantly different between the two groups (p-value > 0.05).

Assessing the other variables

- ***Socio-demographic variables:***

The two-tailed t-test revealed no statistically significant difference between the two groups for age and educational levels (p-values >0.05). The chi-square test also showed no significant difference for gender and marital status.

- ***Respiratory and medical variables:***

Patients with a high frequency of exacerbations (group H) were significantly associated with low Fev1 values (t-test p-value= 0.003), while all other respiratory and medical variables (Fev1/Fvc, SGRQ total score, BMI, comorbidities, medications, smoking status, no. of cigarette/day, and years of smoking) were similar in the two groups. There was no

statistically significant association between the frequency of exacerbations, the presence of comorbidity, and the use of medications.

• ***Dental and Prosthetic variables:***

There were no statistically significant differences in the number of teeth or number of active caries between patients with low frequency of exacerbations and high frequency of exacerbations There was a statistically significant difference in the restoration status for patients with a high frequency of exacerbations compared to patients with a low frequency of exacerbations (chi-square test p-value = 0.01), as most of the patient in group L have restorations with adequate status whereas patients of group H had restorations with adequate and inadequate status. There was no statistically significant association between the mucosal lesions, maximum mouth opening, salivary flow rate and the frequency of exacerbation events.

None of the prosthetic variables were significantly associated with the frequency of exacerbations. The variables derived from the oral hygiene questionnaire describing the oral hygiene habits also did not shows any statistically significant difference between the two groups.

3.2.2. Bivariate analysis using logistic regression

The odd ratios and 95% confidence intervals for the variables that show risk in increasing the frequency of the exacerbation events as a result of the bivariate using logistic regression analysis are presented in table no.15.

Table No.15 Odd Ratio and 95% CI from the bivariate analysis using Logistic regression analysis

Variable	*p-value*	*Odd Ratio*	*95% CI*
Categorical	0.46		
Oral hygiene 1	0.76	0.00	(0-4.4 E+18)
Oral hygiene 2	0.78	0.001	(0-1 E+19)
Oral hygiene 3	0.75	0.00	(0-3.5 E+18)
Dichotomous Oral hygiene	0.90	1.09	(0.27-4.40)
Fev1	0.006	0.05	(0.006-0.42)
Gender	0.69	0.78	(0.23-2.64)
Smoking status	0.46	0.65	(0.20-2.04)
Comorbidity	0.27	1.85	(0.62-5.50)
Medications	0.56	0.72	(0.24-2.16)
	0.51		
Dental status 1	0.26	0.36	(0.06-2.16)
Dental status 2	0.66	0.74	(0.19-2.89)
Salivary flow rate	0.27	0.76	(0.47-1.24)
Mucosal lesions	0.22	0.5	(0.17-1.49)
	0.75		
Denture stomatitis1	0.82	0.83	(0.17-3.88)
Denture stomatitis2	0.46	0.50	(0.07-3.21)
	0.64		
Time of brushing 1	0.51	0.43	(0.035-5.34)
Time of brushing 2	0.38	0.32	(0.025-4.08)
	0.27		
Frequency of brushing 1	0.06	0.10	(0.009-1.17)
Frequency of brushing 2	0.28	0.25	(0.02-3.10)
Frequency of brushing 3	0.15	0.18	(0.02-1.86)
Frequency of brushing 4	0.04	0.07	(0.006-0.94)

3.2.3. Bivariate analysis using Correlations

- ***The outcome***

The frequency of exacerbation (dichotomous) was negatively correlated with Fev1 r^2= -0.42 ($p<0.01$), positively correlated with SGRQ scores r^2= 0.29 ($p<0.05$) and with denture cleaning habits r^2 = 0.33 ($p<0.05$) (Fig.7a). Patients with a high frequency of exacerbations had reduced Fev1 and bad quality of life according to the SGRQ scores. Denture wearers with a high frequency of exacerbations used more than one type of cleaning method to clean their dentures.

The frequency of exacerbation (categorical) was positively correlated with oral hygiene status (dichotomous) r^2= 0.266 ($p<0.05$) meaning that an increase in the number of exacerbations was associated with poor oral hygiene. The frequency of exacerbation (categorical) was also positively correlated with denture cleaning habits r^2= 0.32 ($p<0.05$) (i.e. patients with higher frequency of exacerbations used more than one type of cleaning method to clean their dentures), with SGRQ scores r^2= 0.38 ($p<0.01$) and with the type of dental professional visited r^2= 0.28($p<0.05$). In other words, patients who were going to both the dentist and the denturologist presented with a higher frequency of exacerbations. There was a negative correlation between the frequency of exacerbation (categorical) and Fev1 r^2= -0.35 ($p<0.01$) (Fig.7b).

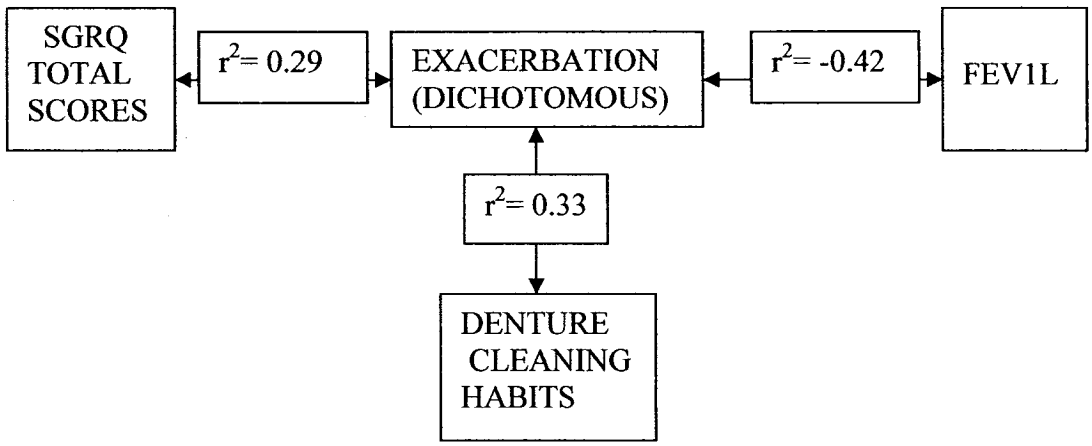


Fig.7a Correlations of exacerbation in dichotomous form.

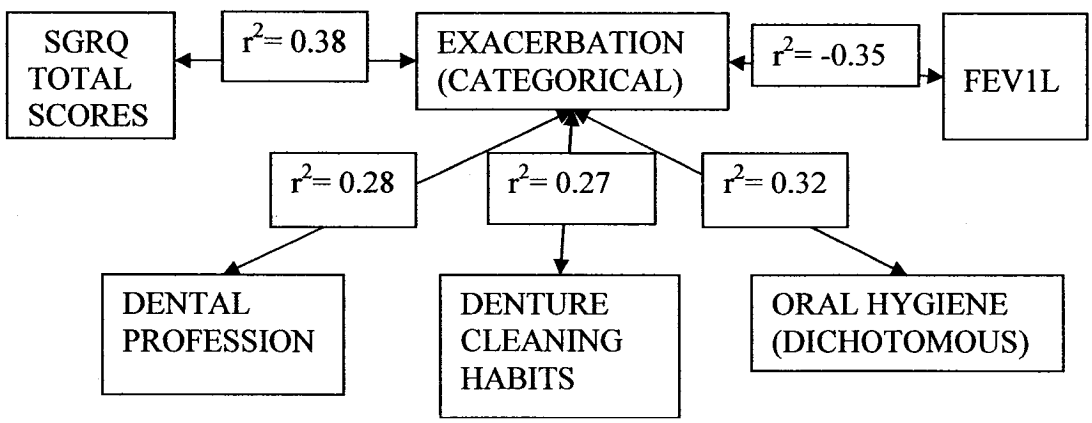


Fig. 7b Correlations of exacerbation in categorical form.

- ***Respiratory variables***

SGRQ total scores was negatively correlated with Fev1 r^2= -0.343 ($p<0.01$) and with Fev1/Fvc r^2= -0.27 ($p<0.05$), Fev1 was positively correlated with Fev1/Fvc r^2=0.55 ($p<0.01$). Fev1/Fvc was correlated with denture stomatitis r^2=-0.38 ($p<0.05$) i.e. patients with a higher degree of denture stomatitis were associated with reduced Fev1/Fvc ratio.

SGRQ total scores were also significantly correlated with the effect of respiratory disease on maintaining dental care r^2= 0.52 ($p<0.01$), the length of time since the last visit to the dentist/denturologist r^2= 0.32 ($p<0.05$) and the time spent for cleaning r^2= -0.44 ($p<0.01$) i.e. patients who spend less time in cleaning their teeth/dentures, those who have long lapses between visits their dentist/denturologist and those who feel that their respiratory disease prevents them from taking good dental care, are associated with a bad quality of life (high score of SGRQ)

There was a positive correlation between years of smoking and age r^2= 0.41 ($p<0.01$) and a negative correlation between BMI and smoking status r^2 = -0.29 ($p<0.05$).

- ***The oral hygiene variables***

The mean of the dental plaque index was negatively correlated with the number of teeth (r^2 = -0.59 ($p<0.01$)) Thus patients with few teeth had a higher plaque index. It was also negatively correlated with their teeth cleaning habits (r^2 = -0.44 ($p=0.05$)) Thus patients who used only a tooth brush to clean their teeth had higher a plaque index than those who used a tooth brush and dental floss, or a tooth pick or an interproximal brush. The mean of the dental plaque index was positively correlated with the mean of the gingival index

(r^2 = 0.72 (p=0) and BMI r^2 = 0.46 (p<0.05)). Patients with a high plaque accumulation had a higher degree of gingival inflammation and were overweight.

The mean of the denture plaque index was correlated with denture stomatitis r^2 = 0.45 (p<0.01) and with mucosal lesion r^2 = 0.36 (p=0.01). More accumulation of denture plaque was associated with increased severity of denture stomatitis and the presence of at least one mucosal lesion.

The mean gingival index was positively correlated with SGRQ total scores r^2 =0.48 (p<0.05) which means that patients with a high gingival index had a worse quality of life. It also correlated with the time lapse since their last visit to the dentist r^2 = 0.50 (p<0.05) and negatively correlated with the time spent for cleaning r^2= -0.54 (p=0.01).

Gender was correlated with the oral hygiene index categorical and dichotomous r^2 = -0.41 and r^2 =-0.39 respectively (p<0.01) i.e. males were associated with poor oral hygiene. The oral hygiene index (categorical) correlated with the number of years of smoking r^2 =0.27 (p<0.05) i.e. the increase in the years of smoking was associated with poorer oral hygiene. The time spent for cleaning correlated with the oral hygiene index categorical and dichotomous r^2= -0.39 and r^2=-0.38 respectively (p<0.01), patients who spent less time in cleaning their teeth/dentures had poorer oral hygiene.

The vertical dimension of occlusion was correlated with the oral hygiene index categorical and dichotomous r^2 = 0.28 and r^2 = 0.27 respectively (p< 0.05). Patients with decreased vertical dimension of occlusion had poor oral hygiene.

The correlations of other oral findings are present in table no.16.

Table No.16 Correlations of oral findings

Correlated Variables	R^2	*p-value*
SFR* Mucosal lesion	-0.36	0.007
SFR*Time of last visit	-0.44	0.001
Denture stomatitis *age	-0.39	0.005
Denture stomatitis *Mucosal lesion	0.28	0.04
MMO* Mucosal lesion	0.31	0.02
Oral health perception* Mucosal lesion	0.31	0.02
Oral health perception* no of active caries	0.56	0.01
VDO*frequency of brushing	-0.27	0.04
VDO*time of brushing	-0.34	0.01
Frequency of brushing* time of brushing	0.34	0.01
Frequency of brushing*gender	0.26	0.05
Marital status*effect of respiratory disease	-0.45	0.02
Dental status*effect of respiratory disease	-0.40	0.05
Dental status*denture cleansing habits	0.30	0.04
No of teeth* dental cleansing habits	0.5	0.02
No of teeth*educational level	0.57	0.009
Educational level * dental cleansing habits	0.46	0.04

3.3. Multiple Logistic Regressions

Based on the bivariate analysis results, almost none of the variables was found to be significantly related to the outcome except for Fev1. Although the result of the multiple logistic regression is not of statistical significance, the decision to proceed with this step was for academic and exploratory purposes.

According to the criteria mentioned earlier in the statistical analysis section, two models were compared: the first model with oral hygiene in a categorical state and the second model with oral hygiene in a dichotomous state

First model:

Logit (p) = oralhygiene1+oralhyiene2 +oralhyiene3 +fev1 + comorbidity+ mucosal lesion+ smoking+ SFR+ FOB1+ FOB2+ FOB3+ FOB4

p = the probability of observing high frequency exacerbation events
SFR=salivary flow rate
FOB=frequency of brushing

Second model:

Logit (p) = oral hygiene+fev1+comorbidity+mucosal lesion+ smoking+ SFR+FOB1 + FOB2 + FOB3+FOB4

No effect of modifier or confounder was observed. The results of the multiple logistic regression for the two models are presented in table no.17 and 18.

The Hosmer-Lemeshow goodness of fit test for both models yielded non significant p-value indicating that both models fit the data well. The second final model (p=0.54) was considered to better fit the data than the first final model (p=0.41), given its higher (less significance) p-value. Therefore, the second model is considered the final model.

So the result of the multiple logistic regression showed that oral hygiene was not significantly associated with the frequency of exacerbation after controlling other variables in the model (forced expiratory volume in one second, comorbidity, mucosal lesions, smoking status, salivary flow rate and frequency of brushing).

Table No.17 Summary of logistic regression analysis for model No1

Variables	*Wald Chi-square*	*df*	*p-value*	*Odd Ratio*	*95% C.I.*	
					Lower	Upper
Oral hygiene	2.27	3	0.52			
Oral hygiene1	0.04	1	0.84	0.0003	4.64E-38	2.32E+30
Oral hygiene2	0.03	1	0.86	0.001	1.78E-37	8.62E+30
Oral hygiene3	0.05	1	0.82	0.0001	1.66E-38	1E+30
Fev1	8.58	1	0.003	0.008	0.0003	0.20
Comorbidity	3.38	1	0.06	5.63	0.89	35.46
Mucosal lesions	3.16	1	0.07	0.20	0.04	1.17
Smoking	0.0008	1	0.98	0.97	0.10	8.92
SFR	0.89	1	0.34	0.69	0.33	1.47
FOB	6.11	4	0.19			
FOB1	4.44	1	0.03	0.02	0.0004	0.75
FOB2	1.94	1	0.16	0.07	0.001	3.01
FOB3	1.35	1	0.24	0.11	0.003	4.53
FOB4	3.97	1	0.05	0.02	0.0005	0.94
Overall statistics	24.97	12	0.02			

SFR=salivary flow rate, FOB=frequency of brushing

Table No.18 Summary of logistic regression analysis for model No2

Variables	*Wald Chi-square*	*df*	*p-value*	*Odd Ratio*	*95% C.I.*	
					Lower	Upper
Oral hygiene	1.37	1	0.24	0.33	0.05	2.12
Fev1	9.24	1	0.002	0.007	0.0003	0.17
Comorbidity	2.87	1	0.08	4.69	0.78	28.02
Mucosal lesions	3.49	1	0.06	0.19	0.03	1.08
smoking	0.14	1	0.70	0.67	0.09	5.08
SFR	1.37	1	0.24	0.63	0.29	1.36
FOB	6.49	4	0.16			
FOB1	4.35	1	0.03	0.02	0.0006	0.79
FOB2	1.57	1	0.20	0.10	0.003	3.58
FOB3	1.07	1	0.29	0.15	0.004	5.41
FOB4	3.97	1	0.05	0.03	0.0008	0.94
Overall statistics	24.12	10	0.007			

4. DISCUSSION

The main aim of this study was to evaluate the oral hygiene of patients with severe COPD and to investigate its relationship with exacerbation events, in addition to the evaluation of other oral health measures that might be of importance. The results of the study showed that the study population was primarily elderly, predominantly male, with a history of current or previous smoking. Most of them were completely edentulous and they were taking good oral care measures. There was no association between the values of indices measuring oral hygiene status and frequency of exacerbation without taking into consideration the other variables. Moreover, there was no statistically significant association between oral hygiene status and frequency of exacerbation when adjusted for other variables in the model.

Our study was the first to look at the relationship between oral health and exacerbations in COPD, while other studies compared the oral health of individuals with and without COPD disease. Despite this, studies that investigated the oral health of the elderly and those suffering from COPD in general, will be included in the discussion as the patients of our study belong to both categories.

Most of the patients were willing to participate in our study. Clinical observations showed that patient responsiveness is an essential indicator to their attitude towards dental care and their dental status. The socio-demographic information indicated a relative homogeneity of the patients. Most of them were of similar age, around 68 years on average, and had an equivalent level of education which was on average lower than 12 grades. The males' percentage was higher than the females due to the predominance of male smokers, until recent years. Half of the patients were married and almost all of them

were Caucasians, which raise the question as to whether this sample of patients was representative of the COPD population in Montreal since it is a multicultural community. Most of the patients were suffering from other medical conditions besides COPD which is normal for this age group. Accordingly, most of them used other medications in addition to those of COPD. None of these medical conditions presented with oral manifestations. Around 22% of the patients were under weight with a BMI < 21 kg/m^2. By opposition to other studies, which associated poor oral health with nutritional deficiency in old people [94-96], our study showed no association between BMI and any oral measures except for an inverse correlation with the mean plaque index (plaque accumulation correlated with overweight).

4.1. Oral hygiene status

The oral hygiene for most of the patients (83.6%) in our study was fairly good, on a scale ranging from 0-3. In addition, the values of dental plaque, denture plaque, gingival, and calculus indices for the patients were low, indicating a good oral hygiene.

The study by Scannapieco *et al* in 1998 [79] showed that the oral hygiene index (OHI) was significantly higher in patients who suffered from chronic bronchitis or emphysema than those without chronic respiratory diseases. This means that the population of COPD in that study had poor oral hygiene in contrast to our study. The definition of OHI index in Scannapieco *et al* study was different than ours. In the Scannapieco *et al* study, the OHI was the sum of the calculus index and plaque index recorded for specific teeth, while our index was the arithmetic average of all indices that measured the gingival and hygiene status (dental plaque, denture plaque, gingival, and calculus indices) for all teeth

present or for specific sites of the denture. The OHI index used in our study was more sensitive as it took into consideration all the teeth in the mouth. The comparison between the two studies may be inaccurate because the severity of COPD in the Scannapieco *et al* study was not specified. It was most probably a mix of all levels of severity. In our study, however, it was confined to those with severe COPD.

Degree of education is usually associated with quality of oral hygiene. In other words, well educated individuals usually have good oral hygiene. In our study, 50% of the patients had $\geq$ 11 years of education, which was correlated with their dental cleaning habits and number of teeth. Patients with higher education had more teeth and used other dental aids in addition to a tooth brush. This may partly explain the fact that this group of patients had relatively good oral hygiene. The other explanation for observing good oral hygiene in this group of patients is that only patients with good oral hygiene accepted to participate in the study. It was roughly estimated that around 30% of the patients we approached refused to participate. There were no obvious reasons for the refusal. The only probable explanation is that the patients who refused had bad oral hygiene and could have been embarrassed and did not want to show it.

If the oral hygiene in the scale of 0-1 were considered, most of the patients (67.3%) in this case had bad oral hygiene. We also observed a significant correlation between the oral hygiene and the frequency of exacerbations. Patients with a high frequency of exacerbation had poor oral hygiene. The logistic regression confirmed this relation when adjusted for the other variables in the model but it was not significant.

The mean of the gingival index per patient was significantly correlated with the SGRQ scores, indicating an association between an increase in gingival inflammation and bad

quality of life due to an increase in COPD symptoms. In the Katancik *et al* study [81], they found a significant association between the gingival index and the pulmonary function (based on FEV1/FVC and FEV1): those with normal pulmonary function had significantly better GI. This was not observed in our study because the FEV1/FVC and FEV1 were all reduced since they were measured for severe cases only and were not compared to non COPD patients with normal pulmonary function.

Most of the patients spent enough time cleaning their teeth or dentures using tooth brushes and other aids like cleaning tablets for denture wearers and dental floss for dentate patients. This was consistent with their oral hygiene status which indicated a good personal and professional oral hygiene care especially for the dentate patients, half of whom were 6 months away from their last visit to the dentist. A recent report from the Directorate of Public Health of Montréal mentioned that approximately one third of Quebecers aged 65 and over consulted a dentist during the last year (2002) [97]. This is similar to the percentage in our study where 33% of all patients visited a dentist or denturologist in the past year. Reasons why dental care was not sought more frequently involve many factors: the difference between perceived and real need; lack of mobility and accessibility to care; or a fear of dentistry and its high cost. In this study, a lack of perceived need was the main reason (80%) why dental care was not sought more frequently.

There were two epidemiological studies [77] [78] that associated periodontal disease with COPD. However, this association was not investigated in our study. Periodontal disease association is beyond the scope of this study due to the small number of patients with

pathological periodontal pockets, and the limited number of posterior teeth to measure the alveolar bone loss.

4.2. Dental status

The average number of teeth per patient was 5.5 (SD 8.7), for dentate patients only, the average number was 14.9 (SD 2.3). The mean number of teeth per dentate patients is comparable to other studies for the elderly in long term care: 16.4 (Chris C.L.), 11.6 (Frenkel *et al*) 16.6, 14 (Lee), (Guivante-Nabet *et al*), 15.5 (Galan *et al*), and 11.9 (Hawkins *et al*) [98-103] respectively. The results showed a higher percentage of completely edentulous patients (65%) as compared to the general population in Montréal over 65 years of age (58%). The number of completely toothless elders has dropped from 76% in 1980 to 72% reported in 1985 to 58% in 1993 [104-106].

The reported prevalence of completely edentulous subjects in other provinces of Canada varied from 24 to 55 % [107-110]. Percentages from outside Canada were also lower than ours: in Switzerland, 51% in Mojon *et al* [65] and 49.4% in Mojon *et al* [95], except for Frenkel *et al* which was 71.4% for the elderly in England. We observed that this high percentage of edentulous elderly in our study was probably due to a poor oral hygiene which causes COPD patients to lose their teeth.

The mean number of carious teeth (1) in our study was lower than any other studies that reported the dental caries status of the elderly, such as Chris C.L. (3.8) [111] and Hawkins *et al* (2.6) [103]. The percentage of patients with caries was 45% compared to 78.6% in Chris C.L. [98] and 76% in Galan *et al* [102].

Patients with more teeth in this study had lower plaque accumulation, were of a higher educational level, and used dental aids in cleaning their teeth in addition to a tooth brush. This explains the low plaque accumulation as mentioned earlier.

The restoration status was significantly worse in patients with a high frequency of exacerbations, more patients having had adequate and inadequate restorations. The average number of restorations per patient was 5.1 which was low compared to other studies [98] [101] and this, because of the few number of teeth present.

The examiners observed the presence of denture stomatitis in quite a number of patients during the clinical examination, however there was no statistical association between the degree of inflammation and the frequency of exacerbations or to a specific type of medication. The use of inhaled corticosteroid associated with oral candidiasis [112]. *Candida Albicans* is the main bacteria culture that is usually taken from the dentures of individuals suffering from denture stomatitis [113-116]. Individuals wearing upper complete dentures who use inhaled oral corticosteroid usually presented with some degree of Candida associated denture stomatitis. The severity of the inflammation is related to the level of the oral hygiene the individual has [117]. An individual with poor oral hygiene most probably will have a severe form of denture stomatitis. Other factors also have a role in the occurrence and severity of denture stomatitis such as the quality of the denture, the cleaning habits, and how long the individual has been wearing the denture.

The percentage of patients with denture stomatitis with mild and moderate severity (54.3%) is comparable to the one reported by Gornitsky *et al* (52%) for geriatric patients

in Montréal residing in long term care institutions [118], but higher than those reported in Frenkel *et al* (33%) [99] and Mojon *et al* (45%) [95].

Nineteen (34.5%) patients in our study used inhaled corticosteroid but there was no association between it and denture stomatitis. There was a significant correlation between the accumulation of denture plaque and severity of denture stomatitis similar to the findings in Frenkel *et al* study.

Half of the patients presented with at least one type of mucosal lesions (white lesion, sore spots, hyperplasia or others). Patients with at least one mucosal lesion were correlated with an increase in severity of denture stomatitis.

Salivary flow rate is an important determinant of oral health. Aging or multiple medication usage or smoking in this group of patients may cause dry mouth. However those factors were not correlated with salivary flow rate in this study. Salivary flow rate was within normal range for most of the patients. Only 9 patients had a flow rate below the normal < 0.7ml/min. Reduced salivary flow rate was correlated significantly with the presence of mucosal lesions.

Most of the patients who wear upper and/or lower dentures maintained their dentures in excellent condition. The percentage of patients with bad quality lower dentures (21.6%) was higher than those with bad quality upper dentures (11%). These percentages are lower than those reported by other Canadian studies that have demonstrated 31-80% of edentulous subjects have inadequate denture prosthesis [106] [108-110] [119] whether prostheses age or manufacturing quality of prostheses influenced this difference is unknown. The Majority of patients with an edentulous upper ridge showed a slight alveolar ridge resorption. Most of the patients with an edentulous lower ridge showed a

slight alveolar ridge resorption. Whereas a considerable number of patients with an edentulous lower ridge showed severe alveolar ridge resorption, few showed a totally flat ridge.

6.3. Strengths and Limitations of the study

This study has a number of strengths. First, the diagnosis of COPD was likely to be valid since this information was based on a professional clinical evaluation supported by the use of spirometry in a specialized hospital for respiratory diseases. Second, the validity of the results: Two trained dentists, following the same protocol to decrease bias among groups, performed the examinations in the same clinical setting provided for that purpose. Third, the sensitivity of the indices used to measure the oral hygiene status (plaque, gingival, and calculus indices). The criteria which define the components of the indices were clear, and understood. They can be applied to all teeth, even those with gingival restorations or crowns. Their validity and reliability had been tested in many studies [87] [91] [120] [121].

A number of potential limitations need to be highlighted in the present study. First, the small sample size: The statistical power of our study was limited and could have ignored showing an association when such an association was present. This was evident when we spotted high values of dental plaque and gingival indices in the group with higher frequencies of exacerbations, nevertheless they were lacking statistical significance due the small number of dentate patients.

Second, the study design: Our data was limited by the cross-sectional and retrospective nature of the data collection. Cross-sectional studies allow for association to be identified

but do not support causal associations. Since exacerbations were collected the year preceding the oral exam, we cannot establish if poor oral hygiene was a cause for higher frequency of exacerbation or if it was a consequence as a result of the debilitated health of COPD patients, limiting their ability to maintain good oral hygiene.

Third, presence of potential biases: 1. Patient selection was not random since all patients who accepted to participate were included in the study. This was unavoidable due to the small number of patients who were fitting the eligibility criteria. This selection bias raises the question as to whether this group of patients is representative of the total population of COPD patients in Montréal. 2. The presence of classification bias for the outcome and the main exposure. The number of exacerbations may have been underestimated because the number reported from the medical files may have missed those exacerbations treated elsewhere. In addition, in the case of new patients, the information taken directly from the patient may have been inaccurate as the patients may have forgotten or be may have been confused with other medical causes of debilitation. The fact that more than half of the patients examined in a subsequent visit (not on the same day of their follow-up visit), means they had been aware of the dental examination and extra oral care may have been taken. This, perhaps, may have caused false negative cases (i.e. more patients with good oral hygiene).

6.5. Future Directions

Teeth presence is a valuable source of information especially if the relationship of periodontal disease with COPD exacerbations is to be investigated in the future. This pilot study showed a low percentage of dentate patients. Therefore, the researchers should

consider recruiting more dentate patients for future studies. Although microbiological analysis of dental and/or denture plaque is important because of its well documented relationship with respiratory diseases in the literature, it was not part of this study. So it is recommended to include a thorough microbiological assessment in any type of study that will be done.

The association between oral hygiene and the frequency of exacerbation cannot be ruled out due to the potential limitation mentioned previously. Further studies should follow to investigate this relationship. The next step, therefore, would be to conduct a large longitudinal prospective study starting with patients with a spectrum of oral hygiene status, and observing the number of exacerbations during the following year to see if there is a causal association between the two. If an association existed, an intervention study could be done. A randomized clinical trial will be an appropriate design to investigate the effect of improving the oral health of severe COPD patients on the incidence and frequency of COPD exacerbations.

5. CONCLUSION

Our main hypothesis was that poor oral hygiene was associated with high frequency of exacerbation events in patients with severe COPD. In this pilot study we could not find a significant association between oral hygiene status and frequency of exacerbations. Moreover, none of the other oral measures has been associated significantly with the exacerbation events. We were not able to show that the oral health of this population of patients affects the initiation or occurrences of exacerbation events in severe COPD. Increasing the sample size and correcting the methodological flaws might change this negative association. Including a thorough microbiology assessment of dental and denture plaque in future studies will add valuable support to our hypothesis. This study is an important source of information for planning studies in the future. Sample size and power calculations can be produced from the data of this study. This group of severe COPD patients tolerates the examination procedure and measures well considering their breathing status, which requires more pauses during examination than for the healthy patients.

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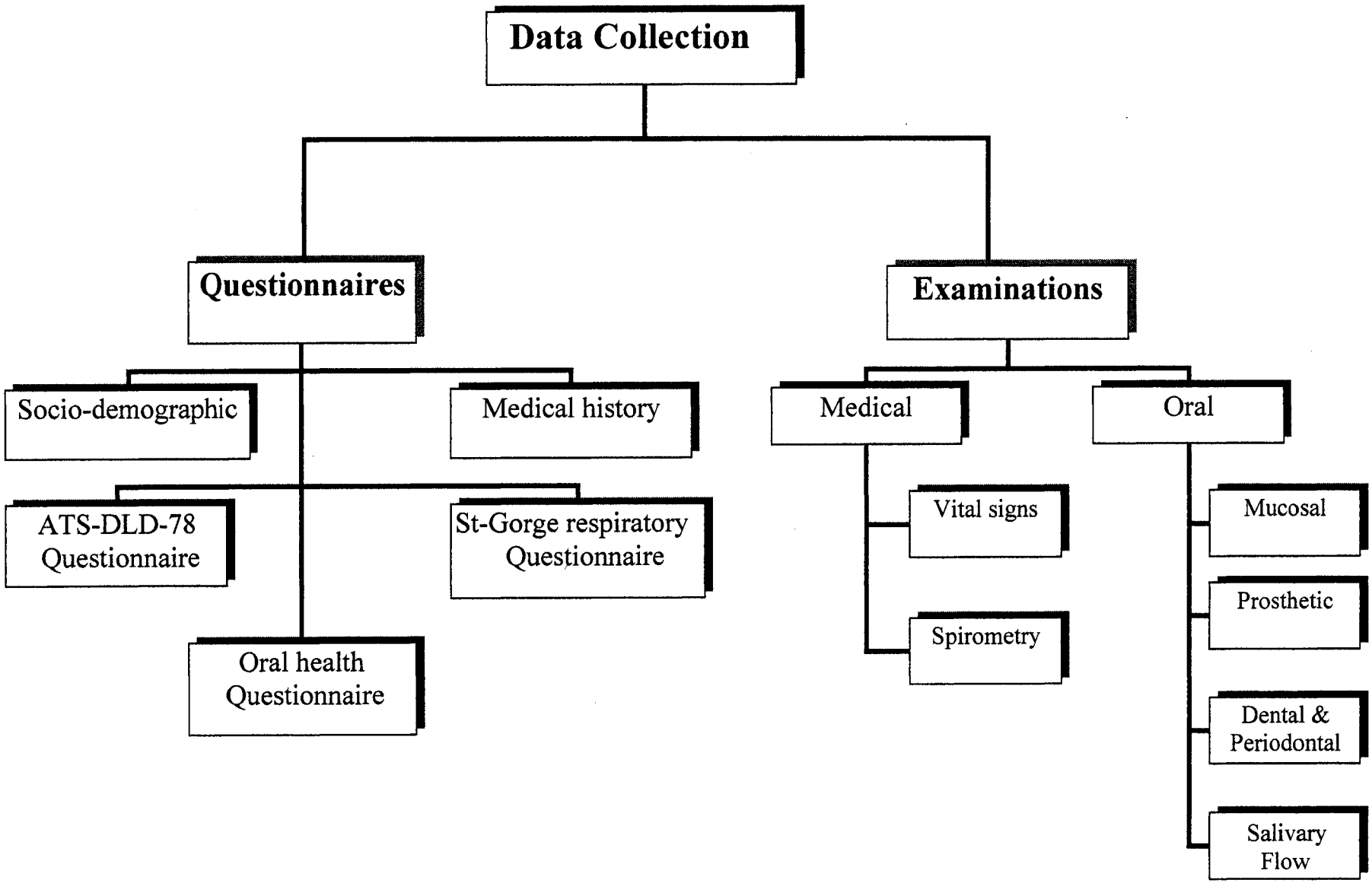
APPENDIX A
Other Tables and Figures

Table No.7 list of the variables

variables	*Type of the variable*	*Coding*
Age	Continuous	Year
Educational level	Continuous	Year
Fev1	Continuous	Litter
Fev1/Fvc	Continuous	Percentage
Salivary flow rate	Continuous	Millilitre per minute
BMI	Continuous	kg/m^2
Plaque index	Continuous	Mean
Gingival index	Continuous	Mean
Calculus index	Continuous	Mean
Gender	Dichotomous	0=male 1=female
Marital status	Dichotomous	0=married 1=not married
Comorbidity	Dichotomous	0=absent 1=present
Medication	Dichotomous	0=respiratory only 1=respiratory & other
Mucosal lesions	Dichotomous	0=absent 1=present
Smoking status	Dichotomous	0=pervious 1=current
Dental status	Categorical	0=dentate 1=denture 2=dentate with denture
Restorations	Categorical	0=no restorations 1=adequate 2=inadequate 3=both (adequate & inadequate)
Denture stomatitis	Categorical	0=absent 1=mild 2=moderate 3=severe
Alveolar ridge resorption	Categorical	0=normal 1=slightly resorped 2=moderately resorped 3=severely resorped 4=flat

Cont. Table No.7

Variables	*Type of the variable*	*Coding*
Denture quality	Categorical	0=bad 1=questionable 2=good 3=excellent
Vertical dimension of occlusion	Dichotomous	0=normal 1=decreased
Maximum mouth opening	Dichotomous	0=normal 1=limited
Time of brushing	Categorical	0=<2 minutes 1=2-5 minutes 2=>5 minutes
Frequency of brushing	Categorical	0=< 1/day 1=1/day 2=2/day 3=3/day 4=>3/day
Oral health perception	Categorical	0=very good 1= good 2= quite good 3=poor 4=very poor
Time of last visit to Dentist/dentrulogist	Categorical	0=6 months 1=6-1year 2=1-2 years 3=2-5 years 4=5-10 years 5=>10 years
Dental Profession	Categorical	0=dentist 1=dentrulogist 3=dentist & dentrulogist
Denture cleaning habits	Categorical	0=rinsing 1=cleaning tablets 2=brushing 3=combined
Teeth cleaning habits	Categorical	0=tooth brush 1=tooth brush & aids
Effect of the disease on brushing	Categorical	0=not at all 1= a little 2= quite 3=very much 4=not possible


Data Collection
Questionnaires
Examinations
Socio-demographic
Medical history
ATS-DLD-78 Questionnaire
St-Gorge respiratory Questionnaire
Oral health Questionnaire
Medical
Oral
Vital signs
Spirometry
Mucosal
Prosthetic
Dental & Periodontal
Salivary Flow

APPENDIX B

Ethic Certificate + Consent form

THE ORAL HEALTH OF PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND ITS RELATIONSHIP WITH EXACERBATION EVENTS. PART 1: ORAL HEALTH EXAMINATION

PRINCIPAL INVESTIGATOR: Dr. Philippe Mojon, Faculty of Dentistry, McGill University

COINVESTIGATOR: Dr. Jean Bourbeau, Montreal Chest Institute and Epidemiology and Biostatistics, McGill University

INTRODUCTION

You are invited to take part in a research study that will involve about 60 subjects with Chronic Obstructive Pulmonary Disease (COPD). Before you decide whether or not you wish to take part, it is important for you to understand why the study is being done and what it will involve if you agree to take part. Please read the following information carefully and also listen to the explanation given by the study doctor and/or one of the study staff. Discuss it with your friends and relatives if you wish. Feel free to ask about anything that is not clear or if you would like more information. You will be given as much time as you want to make a decision.

Thank you for reading this

PURPOSE OF THE STUDY

The purpose of the study is to evaluate your oral health and daily oral hygiene measures and to relate them to your COPD history, in particular the exacerbation events.

PROCEDURES

The study will proceed in the following manner. If you decide to participate in the study, on the study day a dentist will examine your teeth and gums as in any regular dental check up. We will look for caries, gums diseases and check your dentures if any. The information will be recorded in a standardised manner. We will then evaluate your salivary flow by asking you to chew a small piece of paraffin (wax) for one minute without swallowing and to spit all your saliva and the paraffin in a plastic cup. We may also collect a dental plaque sample from your teeth and your denture. The dental plaque is the soft material on the surface of the teeth near the gum. We will use a plastic instrument to collect a small amount of this soft material from one of your teeth. For the denture, we will put them in a sealed plastic bag and sonicate them like for a thorough cleaning of the denture.

If dental disease is discovered, you will be informed and be offered the possibility of referral for treatment.

We will also ask you to complete a questionnaire on your oral hygiene and visits to your dentists.

If you have retained at least 6 posterior teeth and are not pregnant, we will ask you to go to the dental clinic of the Montreal General Hospital to have 2 dental radiographs taken (one for each side). These 2 intra-oral radiographs are the same as the usual radiograph taken during a regular recall dental visit to detect caries and gum diseases that cannot be diagnosed clinically. We will provide you with a taxi ticket to cover the cost of transportation both ways.

RISKS AND DISCOMFORTS

In healthy subjects, an oral examination is performed without any significant problems. In patients with stable COPD, the examination will allow for short interruptions to enable the patient to resume a regular breathing pattern. This procedure may lengthen the examination slightly.

You should understand that you, Dr. Mojon or the research assistant may request that the oral examination be stopped at anytime if you are found to be too uncomfortable or short of breath, without prejudice to treatment of yourself or your family.

There is no known risk associated with the dental plaque and denture plaque sampling.

Dental radiograph is usually performed without discomfort. The irradiation is minimal. However, if you have had a dental radiograph within the last year or two you may forward this to the study investigator instead.

CONFIDENTIALITY

The oral examination is being carried out exclusively for research purposes. You should understand that all the records relating to your involvement in this study will be held strictly confidential. However, results from these studies may appear in publications. You will not be identified by name in any presentation or publication.

POTENTIAL BENEFITS

You will not benefit directly from this study except for a report on your oral health state. We hope that the results obtained will clarify the role of oral diseases and bacteria in the development of exacerbation events in COPD patients and might help in designing new preventive measures in the future.

VOLUNTARY PARTICIPATION

Your participation is voluntary. Refusal to participate will not affect the future care you or your family receives at this institution.

FINANCIAL COMPENSATION

You will be given a compensation of $25.00 to cover expenditures such as travel, meals and time away from work. The compensation allotted is not a salary for your participation in the study. Your consent to participate in the study should be totally voluntary and should not be based on the compensation.

CONTACT PERSON

For more information on this study, please contact Dr. Philippe Mojon at (514) 398-7203 ext. 0129 or one of the research assistants, Palmina Mancino or

Chantal Savard at 849-5201 ext. 2185 or ext. 2116. For emergencies, please contact Dr. Jean Bourbeau at (514) 406 1946 (pager). For questions relating to your participation in a study in general, please contact the hospital patient representative at (514) 842-1231 ext. 5655.

Thank you for taking part in this study! You will be given a copy of the information sheet and a signed consent form to keep

Statement of consent

THE ORAL HEALTH OF PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND ITS RELATIONSHIP WITH EXACERBATION EVENTS. PART 1: ORAL HEALTH EXAMINATION

Subject informed consent form:

I have been satisfactorily informed of the above-described procedure with its possible risks and benefits. I understand that my participation in this study is voluntary. I give permission for my participation in this study. I understand that I am free to withdraw this consent and discontinue participation in this project at any time, even after signing this form, without penalty or loss of benefits.
I authorize the release of my medical records to Dr. Philippe Mojon, Faculty of Dentistry, McGill University, strictly for the purposes of this study. This authorization is valid for a period of 2 years.
Having read all the pages of this consent form and understood the requirements of the study, my signature below indicates that I voluntarily consent to participate in the study.

_____
Participant's Name (please print)

_____ _____
Participant's Signature Date

I have fully explained to _____ (participant) the nature and purpose of the above-described procedure and the risks involved in its performance. I have answered and will answer all questions to the best of my ability. The participant has been informed that I shall be available to answer all queries prior to, during and following the procedure and that I can be contacted at (514) 398 7203 ext. 0129.

_____
Investigator's Signature

APPENDIX C

Oral Health Questionnaire

Patient Id number	Patient initials	Date of visit	Visit number
Oral1 [ ][ ][ ][ ]	Oral2 [ ][ ][ ]	Oral3 [ ][ ] dd [ ][ ][ ] mmm [ ][ ] yy	Oral 4 [ ]

LA SANTE BUCCODENTAIRE DES PATIENTS ATTEINTS DE MPOC
THE ORAL HEALTH OF PATIENTS WITH COPD

Questionnaire buccodentaire
Oral questionnaire

Oral51. Avez-vous des prothèses dentaires? *Do you have dentures?*	non O_0	oui O_1

Oral6 2. Combien de fois par jour nettoyez-vous vos prothèses? *How often do you clean your dentures?*	<1x par jour/ <1x per day	O_1
	1x	O_2
	2x	O_3
	3x	O_4
	>3x	O_5
	pas applicable /not applicable	O_8

Oral7 *3. Comment nettoyez-vous vos prothèses?* *How do you clean your dentures?*	Rinçage */Rinsing*	O_1
	Pastille nettoyante/ *Cleaning tablet*	O_2
	Brossage */brush*	O_3
	Autre (précisez)/other	O_4
	pas applicable/ not applicable	O_8
Oral8 4. Précision/Specify.....	.....	

Oral9 5. Avez-vous de la difficulte a brosser vos prothèses? *Do you have difficulty brushing your teeth?*	pas du tout *Not at all*	O_0
	un peu *slightly*	O_1
	beaucoup *Very much*	O_2
	pas applicable	O_8

Oral10 6. Combien de temps prenez-vous pour nettoyer vos prothèses? *How much time does it take to clean your dentures?*	<2 minutes	O_1
	2-5 minutes	O_2
	>5 minutes	O_3
	pas applicable /not applicable	O_8

Patient Id number	Patient initials	Date of visit	Visit number
Oral1 ☐☐☐☐	Oral2 ☐☐☐	Oral3 ☐☐ dd ☐☐☐ mmm ☐☐ yy	Oral 4 ☐

Oral11 7. Portez-vous vos prothèse ...
Do you wear your dentures ...

Jour et nuit/day and night	O1
Pas la nuit/not at night	O2
Pour manger ou pour / *To eat or* sortir seulement / *to go out only*	O3
pas applicable /not applicable	O8

Oral12 8. Si vous portez vos prothèses que de temps en temps, pourquoi?
If you wear your dentures only occasionally, then why?

douleurs/tiennent pas/ *Too painful/loose*	O1
m'empêchent (plus difficile) de (à) respirer / *difficulty in breathing*	O2
Autre/other	O3
pas applicable/not applicable	O8

Oral13 9. Combien de dents naturelles avez-vous? ....
How many natural teeth do you have?

Oral14 _____ (entrebetween 0 et/and 32)

Oral14 10. Combien de fois par jour vous brossez-vous les dents?
How often do you brush your teeth?

<1x par jour/per day	O1
1x	O2
2x	O3
3x	O4
>3x	O5
pas applicable	O8

Oral1511. Utilisez vous des accessoires interdentaires?
Do you use any oral hygiene instruments other than a toothbrush?

non O0 oui O1

Oral1612. Lesquels?
Which ones?

fil dentaire *Dental floss*	O1
Cure-dents *Toothpick*	O2
Brossette interdentaire *Interproximal brush*	O3
autre (précisez)/other specify	O4
pas applicable/not applicable	O8

Oral17 13. Précision/Specify .....

Oral18 14 Combien de temps prenez-vous pour vous brosser les dents?
How much time does it take for you to brush your teeth?

<2 minutes	O1
2-5 minutes	O2
>5 minutes	O3
pas applicable not applicable	O8

Patient Id number	Patient initials	Date of visit	Visit number
Oral1	Oral2	Oral3 dd / mmm / yy	Oral 4

Oral19 15. Pensez-vous que votre maladie respiratoire vous empêche de vous brosser les dents efficacement?

Do you think that your respiratory disease prevents you from brushing your teeth effectively?

- pas du tout /*Not at all* O0
- un peu /*A little* O1
- assez /*quite* O2
- beaucoup /*Very much* O3
- brossage impossible / *Brushing not possible* O4
- pas applicable /not applicable O8

Oral2016. Quand avez-vous été chez le dentiste ou le denturologiste pour la dernière fois?

When was the last time you visited your dentist or denturologist?

- <6 mois/6 months O1
- 6 mois-1 an/6 months to a year O2
- 1-2 ans /years O3
- 2-5 ans /years O4
- 5-10 ans/years O5
- >10 ans/years O6
- pas applicable/not applicable O8

Oral21 17. Quel professionnel? *Which professional?* Dentiste O1 *Dentist* denturologiste O2 *Denturologist* les deux O3 *Both*

Oral22 18. Si plus de 2 ans (pour les dentes. 5 ans pour les édentés) sans consultation, pourquoi ne pas avoir consulté? *If more than 2 (5) years. without consultation. then why no consultation?*

- Pas besoin *No need* O1
- Je ne sais pas où aller *I don't know where to go* O2
- Pour des raisons financières (ça coûte cher / je n'ai pas assez d'argent) *For financial reasons (too expensive / I don't have enough money)* O3
- ma maladie rend difficile/impossible les visites chez le dentiste *My disease makes it difficult/impossible to visit my dentist* O4
- Son bureau est difficile d'acces pour moi trop loin /escaliers /personne pour m'accompagner *Access to the office is difficult: too far/too many stairs /nobody to accompany me* O5
- Autre/ raison O6
- Pas applicable/not applicable O8

Oral2319. Précision : .....

Oral24 20. Comment décririez-vous votre santé dentaire actuelle?

How would you describe your present state of oral health?

- Très bonne /*Very Good* O1
- Bonne/ *Good* O2
- Assez bonne /*Quite good* O3
- Mauvaise /*Poor* O4
- Très mauvaise/ *Very poor* O5

APPENDIX D
ATS-DLD questionnaire

Patient Id number	Patient initials	Date of visit	Visit number
Oral1 ☐☐☐☐	Oral2 ☐☐☐	Oral3 ☐☐ (dd) ☐☐☐ (mmm) ☐☐ (yy)	Oral 4 ☐

ATS-DLD-78 questionnaire (modified)

Ats5 **Start time administering questionnaire** ☐☐ (hh) : ☐☐ (mm)

These questions pertain mainly to your chest. Please answer yes or no if possible. If you are in doubt about whether your answer is yes or no, please reply no.

EPISODES OF COUGH AND PHLEGM

Ats6 3A Have you had periods or episodes of (increased *) cough and phlegm 0 ◯ No 1 ◯ Yes lasting 3 weeks or more each year?

* (For persons who usually have cough and/or phlegm)

If *"no"* to question 3A, skip to 4A.

Ats7 3B For how long have you had at least one such episode per year? ☐☐ number of years

Patient Id number	Patient initials	Date of visit	Visit number
Oral1	Oral2	Oral3 dd mmm yy	Oral 4

BREATHLESSNESS

Ats8 | 6 | If disabled from walking by any condition other than heart or lung disease, please describe. 8 ○ n/a

Ats9 _____

If *"n/a"* to question 6, skip to question 6A.

Ats10 | 6A | Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill? 0 ○ No 1 ○ Yes

If *"no"* to question 6A, skip to question 7A.

Oral1 Patient Id number | Oral2 Patient initials | Oral3 Date of visit (dd / mmm / yy) | Oral 4 Visit number

Ats11 6B Do you have to walk slower than people of your age on the level because of breathelessness? 0 ○ No 1 ○ Yes 8 ○ n/a

Ats12 6C Do you ever have to stop for breath when walking at your own pace on the level? 0 ○ No 1 ○ Yes 8 ○ n/a

Ats13 6D Do you ever have to stop for breath after walking about 100 yards (or after a few minutes) on the level? 0 ○ No 1 ○ Yes 8 ○ n/a

Ats14 6E Are you too breathless to leave the house or breathless on dressing or undressing? 0 ○ No 1 ○ Yes 8 ○ n/a

Ats15 6F For how many years have you been this breathless? ☐☐ number of years

CIGARETTE SMOKING

Ats16 8A Have you ever smoked cigarettes? 0 ○ No 1 ○ Yes
(NO means less than 20 packs of cigarettes or 400 grams. of tobacco in a lifetime or less than 1 cigarette a day for 1 year.)

If *"yes"* to question 8A, go to 8B. If *"no"*, go to question 9A.

Ats17 8B Do you now smoke cigarettes (as of 1 month ago)? 0 ○ No 1 ○ Yes 8 ○ n/a

Ats18 8C How old were you when you first started regular cigarette smoking? ☐☐ age

Ats19 8D If you have stopped smoking cigarettes completely, how old were you when you stopped? ☐☐ age

Ats20 8E How many cigarettes do you smoke per day? ☐☐☐ # of cig/day

Ats21 8F On the average of the entire time you smoked, how many cigarettes did you smoke per day? ☐☐☐ of cig/day

Patient Id number	Patient initials	Date of visit	Visit number
Oral1	Oral2	Oral3 dd mmm yy	Oral 4

Ats22 | 8G | Do or did you inhale the cigarette smoke? ☐

1. Not at all 2. Slightly 3. Moderately 4. Deeply 8. n/a

Ats23 | 8H | During all the time you have smoked cigarettes, would you say you smoked tips filter: ☐

0. Never 1. Less than half the time 2. About half the time 3. More than half the time 4. Always 8. n/a

Ats24 | 8I | During all the time you have smoked cigarettes, what sort of cigarettes did you usually smoke? ☐

1. Regular 2. King size 3. Hand rolled 8. n/a

Patient Id number	Patient initials	Date of visit	Visit number
Oral1 ☐☐☐☐	Oral2 ☐☐☐	Oral3 ☐☐ dd ☐☐☐ mmm ☐☐ yy	Oral 4 ☐

PIPE SMOKING

Ats25 | 9A | Have you ever smoked a pipe regularly? (YES means more than 12 oz of tobacco in a lifetime.) — 0 ◯ No 1 ◯ Yes

If *"yes"* to question 9A, go to 9B. If *"no"*, go to question 10A.

Ats26 | 9B | Do you now smoke a pipe (as of 1 month ago)? — 0 ◯ No 1 ◯ Yes 8 ◯ n/a

Ats27 | 9C | How old were you when you first started to smoke a pipe regularly? ☐☐ age

Ats28 | 9D | If you have stopped smoking a pipe completely, how old were you when you stopped? ☐☐ age

Ats29 | 9E | How much pipe tobacco are you smoking now? (a standard pouch of tobacco contains 50 grams) ☐☐☐ # of pouch(es)/week

Ats30 | 9F | On the average of the entire time you smoked a pipe, how much pipe tobacco did you smoke per week? (a standard pouch of tobacco contains 50 grams). ☐☐☐ # of pouch(es)/week

Ats31 | 9G | Do or did you inhale the pipe smoke? ☐
1. Not at all 2. Slightly 3. Moderately 4. Deeply 8. n/a

Oral1 Patient Id number | Oral2 Patient initials | Oral3 Date of visit (dd / mmm / yy) | Oral 4 Visit number

CIGAR/CIGARILLO SMOKING

Ats32 10A Have you ever smoked cigars or cigarillos regularly? 0 ○ No 1 ○ Yes
(YES means more than 1 cigar or cigarillo a week for a year.)

If *"yes"* to question 10A, go to 10B. If *"no"*, end questionnaire.

Ats33 10B Do you now smoke cigars or cigarillos (as of 1 month ago)? 0 ○ No 1 ○ Yes 8 ○ n/a

Ats34 10C How old were you when you started to smoke cigars regularly? ☐☐ age

Ats35 10D If you have stopped smoking cigars completely, how old were you when you stopped? ☐☐ age

Ats36 10E How many cigars are you smoking per week now? ☐☐☐ # of cigars/week

Ats37 10F On the average of the entire time you smoked cigars, how many cigars did you smoke per week? ☐☐☐ # of cigars/week

Ats38 10G Do or did you inhale the cigar smoke? ☐
1. Not at all 2. Slightly 3. Moderately 4. Deeply 8. n/a

Ats39 10H During the whole time you have smoked cigars, what sort of cigar did you usually smoke? ☐
1. Mini (cigarette sized) 2. Small (cigarillos) 3. Large (real cigars) 8. n/a

Ats40 **End time administering questionnaire** ☐☐ : ☐☐ Hh mm

APPENDIX E

St. George Respiratory Questionnaire (SGRQ)

Patient Id number	Patient initials	Date of visit	Visit number
Oral1 [ ][ ][ ][ ]	Oral2 [ ][ ][ ]	Oral3 [ ][ ] dd [ ][ ][ ] mmm [ ][ ] yy	Oral 4 [ ]

ST GEORGE'S RESPIRATORY QUESTIONNAIRE (SGRQ)

Sgr5 Start time administering questionnaire [ ][ ] : [ ][ ]
hh mm

This questionnaire is designed to help us learn much more about how your breathing is troubling you and how it affects your life. We are using it to find out which aspects of your illness cause you most problem, rather than what the doctors or nurses think of your problem.
I will read you the questions and the instruction carefully and ask if you do not understand any thing. Do not spend too long deciding about your answers.

PART 1

QUESTIONS ABOUT HOW MUCH CHEST TROUBLE YOU HAVE HAD OVER THE LAST YEAR. PLEASE ANSWER THE QUESTIONS WITH THE FOLLOWING CHOICES:

Sgr6 [1] OVER THE LAST YEAR, I HAVE COUGHED: [ ]

1. Most days a week
2. Several days a week
3. A few days a week
4. Only with chest infections
5. Not at all

Sgr7 [2] OVER THE LAST YEAR, I HAVE BROUGHT UP PHLEGM (SPUTUM): [ ]

1. Most days a week
2. Several days a week
3. A few days a week
4. Only with chest infections
5. Not at all

Sgr8 [3] OVER THE LAST YEAR, I HAVE HAD SHORTNESS OF BREATH: [ ]

1. Most days a week
2. Several days a week
3. A few days a week
4. Only with chest infections
5. Not at all

Sgr9 [4] OVER THE LAST YEAR, I HAVE HAD ATTACKS OF WHEEZING: [ ]

1. Most days a week
2. Several days a week
3. A few days a week
4. Only with chest infections
5. Not at all

Patient Id number	Patient initials	Date of visit	Visit number
Oral1 ☐☐☐☐	Oral2 ☐☐☐	Oral3 ☐☐ (dd) ☐☐☐ (mmm) ☐☐ (yy)	Oral 4 ☐

Sgr10 [5] DURING THE LAST YEAR, HOW OR MANY SEVERE VERY UNPLEASANT ATTACKS OF CHEST TROUBLE HAVE YOU HAD: ☐

1. More than 3 attacks
2. 3 attacks
3. 2 attacks
4. 1 attack
5. No attacks

(IF PATIENT HAS ANSWERED "NO ATTACKS", GO TO QUESTION 7)

Sgr11 [6] HOW LONG DID THE WORST ATTACK OF CHEST TROUBLE LAST: ☐

1. A week or more
2. 3 or more days
3. 1 or 2 days
4. Less than a day

Sgr12 [7] OVER THE LAST YEAR, IN AN AVERAGE WEEK, HOW MANY GOOD DAYS (WITH LITTLE CHEST TROUBLE) HAVE YOU HAD: ☐

1. No good days
2. 1 or 2 good days
3. 3 or 4 good days
4. Nearly every days is good
5. Every day is good

Sgr13 [8] IF YOU HAVE A WHEEZE, IS IT WORSE IN THE MORNING: ☐

1. No
2. Yes

Patient Id number	Patient initials	Date of visit	Visit number
Oral1 ☐☐☐☐	Oral2 ☐☐☐	Oral3 ☐☐ (dd) ☐☐☐ (mmm) ☐☐ (yy)	Oral 4 ☐

PART 2

SECTION 1

Sgr14 HOW WOULD YOU DESCRIBE YOUR CHEST CONDITION? ☐

1. The most important problem I have
2. Causes me quite a lot of problems
3. Causes me quite a few problems
4. Causes no problem

Sgr15 IF YOU HAVE EVER HAD PAID EMPLOYMENT, PLEASE CHOOSE ONE OF THESE ANSWERS: ☐

1. My chest trouble made me stop work
2. My chest trouble interferes with my work or made me change my work
3. My chest trouble does not affect my work

SECTION 2 : QUESTIONS ABOUT WHAT ACTIVITIES USUALLY MAKE YOU FEEL BREATHLESS THESE DAYS. FOR EACH ITEM, PLEASE ANSWER EITHER TRUE OR FALSE AS IT APPLIES TO YOU.

		True	False
Sgr16	Sitting or lying still	0 ○	1 ○
Sgr17	Getting washed or dressed	0 ○	1 ○
Sgr18	Walking around the house	0 ○	1 ○
Sgr19	Walking outside on level ground	0 ○	1 ○
Sgr20	Walking up a flight of stairs	0 ○	1 ○
Sgr21	Walking hills	0 ○	1 ○
Sgr22	Playing sports or games	0 ○	1 ○

SECTION 3 : SOME MORE QUESTIONS ABOUT YOUR COUGH AND BREATHLESSNESS THESE DAYS.

FOR EACH ITEM, PLEASE ANSWER EITHER TRUE OR FALSE AS IT APPLIES TO YOU.

		True	False
Sgr23	My cough hurts	0 ○	1 ○
Sgr24	My cough makes me tired	0 ○	1 ○
Sgr25	I am breathless when I talk	0 ○	1 ○
Sgr26	I am breathless when I bend over	0 ○	1 ○
Sgr27	My cough or breathing disturbs my sleep	0 ○	1 ○
Sgr28	I get exhausted easily	0 ○	1 ○

Patient Id number	Patient initials	Date of visit	Visit number
Oral1 ☐☐☐☐	Oral2 ☐☐☐	Oral3 ☐☐ dd ☐☐☐ mmm ☐☐ yy	Oral 4 ☐

SECTION 4 : QUESTIONS ABOUT OTHER EFFECTS THAT YOUR CHEST TROUBLE MAY HAVE ON YOU THESE DAYS. FOR EACH ITEM, PLEASE ANSWER EITHER TRUE OR FALSE AS IT APPLIES TO YOU.

		True	False
Sgr29	My cough or breathing is embarrassing in public	0 ○	1 ○
Sgr30	My chest trouble is a nuisance to my family, friends or neighbours	0 ○	1 ○
Sgr31	I get afraid or panic when I cannot get my breath	0 ○	1 ○
Sgr32	I feel that I am not in control of my chest problems	0 ○	1 ○
Sgr33	I do not expect my chest to get any better	0 ○	1 ○
Sgr34	I have become frail or an invalid because of my chest	0 ○	1 ○
Sgr35	Exercise is not safe for me	0 ○	1 ○
Sgr36	Everything seems too much of an effort	0 ○	1 ○

SECTION 5 : QUESTIONS ABOUT YOUR MEDICATION. IF YOU ARE RECEIVING NO MEDICATION TO STRAIGHT TO. FOR EACH ITEM. PLEASE ANSWER EITHER TRUE OR FALSE AS IT APPLIES TO YOU.

		True	False
Sgr37	My medication does not help me very much	0 ○	1 ○
Sgr38	I get embarrassed using my medication in public	0 ○	1 ○
Sgr39	I have unpleasant side effects from my medication	0 ○	1 ○
Sgr40	My medication interferes with my life a lot	0 ○	1 ○

SECTION 6 : THESE ARE QUESTIONS ABOUT HOW YOUR ACTIVITIES MIGHT BE AFFECTED **BY YOUR BREATHING.** FOR EACH QUESTION. PLEASE ANSWER TRUE IF ONE OR MORE PARTS APPLIES TO YOU BECAUSE OF YOUR BREATHING. OTHERWISE, ANSWER FALSE.

		True	False
Sgr41	I take a long time to get washed or dressed	0 ○	1 ○
Sgr42	I cannot take a bath or shower. or I take long time	0 ○	1 ○
Sgr43	I walk slower than other people, or else I stop for rests	0 ○	1 ○
Sgr44	Jobs such as housework take a long time, or I have to stop for rests	0 ○	1 ○
Sgr45	If I walk up one flight of stairs, I have to go slowly or stop	0 ○	1 ○
Sgr46	If I hurry or walk fast, I have to stop or slow down	0 ○	1 ○
Sgr47	My breathing makes it difficult to do things such as walk up hills, carrying things up stairs. light gardening such as weeding, dance, play bowling or play golf	0 ○	1 ○
Sgr48	My breathing makes it difficult to do things such as carry heavy loads, dig the garden or shovel snow. jog or walk at 5 miles (8 km) per hour, play tennis or swim	0 ○	1 ○
Sgr49	My breathing makes it difficult to do things such as carry heavy manual work, run, cycle swim fast or play competitive sports	0 ○	1 ○

Patient Id number	Patient initials	Date of visit	Visit number
Oral1 [ ][ ][ ][ ]	Oral2 [ ][ ][ ]	Oral3 [ ][ ] dd [ ][ ][ ] mmm [ ][ ] yy	Oral 4 [ ]

SECTION 7 : WE WOULD LIKE TO KNOW HOW YOUR CHEST TROUBLE USUALLY AFFECTS YOUR DAILY LIFE. PLEASE ANSWER EITHER TRUE OR FALSE AS IT APPLIES TO YOU BECAUSE OF YOUR CHEST TROUBLE (REMEMBER THAT TRUE ONLY APPLIES TO YOU IF YOU CANNOT DO SOMETHING **BECAUSE OF YOUR BREATHING**)

		True	False
Sgr50	I cannot play sports or games	0 ○	1 ○
Sgr51	I cannot go out for entertainment or recreation	0 ○	1 ○
Sgr52	I cannot go out of the house to do the shopping	0 ○	1 ○
Sgr53	I cannot do the housework	0 ○	1 ○
Sgr54	I cannot move far from my bed or chair	0 ○	1 ○

HERE IS A LIST OF OTHER ACTIVITIES THAT YOUR CHEST TROUBLE MAY PREVENT YOU DOING. (YOU DO NOT HAVE TO CHOOSE; THEY ARE JUST TO REMIND YOU OF WAYS IN WHICH YOUR BREATHLESSNESS MAY AFFECT YOU):

GOING FOR WALKS OR WALKING THE DOG
DOING THINGS AT HOME OR IN THE GARDEN
SEXUAL INTERCOURSE
GOING OUT TO CHURCH. OR PLACE OF ENTERTAINMENT
GOING OUT IN BAD WEATHER OR INTO SMOKY ROOMS
VISITING FAMILY OR FRIENDS OR PLAYING WITH GRANDCHILDREN

PLEASE MENTION ANY OTHER IMPORTANT ACTIVITIES THAT YOUR CHEST TROUBLE MAY STOP YOU DOING:

Sgr55 _____
Sgr56 _____
Sgr57 _____
Sgr58 _____

Sgr59 NOW, WOULD YOU CHOOSE (ONE ONLY) WHICH YOU THINK BEST DESCRIBES HOW YOUR CHEST AFFECTS YOUR: [ ]

1. It does not stop me doing anything I would like to do
2. It stops me doing one or two things I would like to do
3. It stops me doing most of the things I would like to do
4. It stops me doing everything I would like to do

Sgr60 **End time administering questionnaire** [ ][ ] : [ ][ ]
Hh