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Investigating Periodontal Care Provided at a Dental Education Institution

By

Amy DeStaffany

A thesis submitted

in partial fulfillment of the requirements for the degree of

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Committee Approval

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of AMY DESTAFFANY find it satisfactory and recommend that it be accepted.

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RE: Study Number IRB-FY2021-124: Investigating Periodontal Care Provided at a Dental Education Institution

Dear Ms. Destaffany:

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Sincerely,

Ralph Baergen, PhD, MPH, CIP
Human Subjects Chair

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Investigating Periodontal Care Provided at a Dental Education Institution

Thesis Abstract—Idaho State University (2021)

The purpose of this study was to evaluate if patients at one dental education institution received appropriate care based on their periodontal diagnosis in a timely manner. This study used a retrospective design to evaluate data from July 2018 to February 2020. A total of 612 charts were generated for review and 157 met the inclusion criteria and were evaluated. Results revealed that more than half (56.7%) of the patient records did not demonstrate a periodontal diagnosis and another 10.8% did not follow current APA Classification Guidelines. Most patients (n=125, 79.6%) had a comprehensive periodontal assessment performed, while 32 (20.4%) had no comprehensive periodontal charting information recorded. Further, of the 157 records reviewed, 96 (61.1%) had no periodontal treatment specified. Documentation of key clinical information, diagnostic conclusions, and treatment rendered requires curriculum review. Further studies are warranted to determine if similar findings exist among other dental school education programs.

Key Words: periodontal diagnosis, dental students, preventive and therapeutic periodontal procedures

Chapter 1: Introduction

Historical Overview

Over 70 years ago, the World Health Organization determined health to be a general sense of well-being considering mental, physical, and social, rather than simply the absence of disease (World Health Organization, 2020a). In addition, the World Health Organization also stated, “oral health is an integral part of general health and wellbeing, and a basic human right” (World Health Organization, 2020b, para. 3). The concept of oral health as a significant contributor to general health and well-being was not completely recognized until the Surgeon General’s report in 2000, where it was addressed as a public health issue (U.S. Department of Health and Human Services, 2000). Oral health is important not just for healthy teeth and gingiva, but because it affects systemic health as well. This chapter will outline the importance of oral health in relation to systemic health, prevention of oral diseases, and current models in dental curricula in moving toward more person-centered care. It will also discuss how students can be productive and focus on prevention in clinical curricula models which are more patient-centered and less procedural based.

Oral health, or lack thereof, has many correlations to several systemic disease conditions. There are links to cardiovascular disease, diabetes, stroke, malnutrition, aspiration pneumonia, and obesity (Buset et al., 2016; Gil-Montoya et al., 2015; Kavar & Alratty, 2011; Kumar, 2019; Manresa et al., 2018; Office of Disease Prevention and Health Promotion, 2020; Sun et al., 2018; Varela-Centelles et al., 2016). In addition, the decline in quality of life suffered by oral diseases should not be discounted, and several studies illustrate how poor oral health can impact a person’s quality of life (Buset et al.,

2016; Gil-Montoya et al., 2015; Manresa et al., 2018; Ramos-Jorge et al., 2014; Sun et al., 2018; Varela-Centelles et al., 2016). Oral health can impact quality of life in a variety of ways including, but not limited to, function, esthetics, psychosocial and physiologic effects (Buset et al., 2016; Manresa et al., 2018). Unfortunately, there are many obstacles to achieving good oral health. These social determinants include level of education and income, geographic location (living in an area without access to oral care), sociodemographic status, and even gender, race and ethnicity (National Institute of Dental and Craniofacial Research, 2019; U.S. Department of Health and Human Services, 2000). In addition, there are external risk factors that affect oral health. They include smoking, the human papilloma virus (HPV), herpes simplex virus (HSV), alcohol intake, and a poor diet, among others (D'Souza & Addepalli, 2018; Glick & Meyer, 2014).

The 2000 Surgeon General's Report (2000) stated dentistry needs to have a "primary focus on 'producing health' rather than 'restoring health'", and preventive care is a keystone in maintaining health in the oral cavity (Kumar, 2019; U.S. Department of Health and Human Services, 2000; van der Weijden & Slot, 2011; Varela-Centelles et al., 2016). Oral diseases affect an estimated 3.5 billion people world-wide (National Institute of Dental and Craniofacial Research, 2019). Oral health is considered a public health issue, and now almost half of adults who are at least 30 years old have periodontal disease in some form, and that number increases with age (Centers for Disease Control and Prevention, 2013; National Institute of Dental and Craniofacial Research, 2019). Fortunately, oral diseases including periodontal disease can largely be prevented (Centers for Disease Control and Prevention, 2013; Office of Disease Prevention and Health

Promotion, 2020; U.S. Department of Health and Human Services, 2000). The primary etiological factor is due to bacteria and other microorganisms; good oral hygiene can help to prevent periodontal disease (Manresa et al., 2018; van der Weijden & Slot, 2011). Once periodontitis has begun, there is evidence it can often be successfully treated with many non-surgical options (Graziani et al., 2017; G. A. F. Van der Weijden et al., 2019). Periodontal therapy treatments vary and treatment should include offering more personalized care to every patient (Manresa et al., 2018). Afterward, supportive periodontal therapy (SPT) has had success in maintaining the disease process (Axelsson & Lindhe, 1981; Manresa et al., 2018). Supportive periodontal therapy is different from preventive oral therapy in the following ways: it assesses risk for future disease and it implements adjunct therapies as necessary, and includes a professional debridement (Manresa et al., 2018). New periodontitis guidelines were implemented 2018, and risk assessment is now considered an important part of diagnosing periodontitis (American Academy of Periodontology, 2018).

Focusing on periodontal and preventive care in dental curricula provides a way to produce dental health and address the needs of the public. Including an emphasis on prevention and maintenance of periodontal disease will likely involve a change in the clinical curricular models in dental schools today. Afshari et al. (2019) stated: “The goal of both restoring and maintaining dental oral health requires the provider to complete a thorough risk assessment, diagnosis, treatment planning, and completion of planned therapies” (p. 777). The majority of curricula models in dental schools are spent in clinical instruction (Formicola, 2008). As such, dental school clinics are charged with the

difficult task of balancing quality patient care with effective instruction to dental students. One hundred years ago, Alfred Owre, the dean of two of the dental schools in the United States, postulated the faculty would provide most of the dental care, and the students would only do treatment within their capabilities (Formicola et al., 2006). Today, the paradigm in dental schools has shifted to one in which the *students* provide most of the patient services under faculty supervision, and, unfortunately, patient care can become a “secondary by-product of education” (Formicola et al., 2006, p. 1273). In addition, not only do current dental school curricula models show specific treatments might even be selected based on the needs of the student, but also that requirement-based systems neither serve dental student educational purposes, or provide optimal patient care (Formicola et al., 2006; Walji et al., 2017). Further, with the current system, patient care has become inefficient (Formicola, 2008). Many dental schools have recognized this problem and have addressed it by creating curricula based on person-centered care, rather than student-centered care (Park et al., 2011; White et al., 2017).

In the 1990s, dental school clinics started recognizing the need for a more comprehensive care approach, and by the early 2000s, many different clinical curricula models had been tested (Holmes et al., 2000; Johnson, 1999; White et al., 2017). Providing patient care with requirement-based curricula models were based on the theory that repetition creates competence; however, studies have shown that is not necessarily true (Holmes et al., 2000; Wimmers et al., 2006). Instead of focusing on a prescribed amount of procedures to complete, students could actually be more clinically productive in a system which is not procedural-based (Holmes et al., 2000; White et al., 2017).

Statement of the Problem

The most essential factor in quality care of patients with periodontal disease is preventive instruction and consistent supportive maintenance care based on the individual needs of each patient (Lindhe & Nyman, 1984; van der Weijden & Slot, 2011).

Predoctoral dental students often have to manage all the patients assigned to them, or a “patient pool,” during their course of study and many of these patients have periodontitis.

A study published in 2019 demonstrated evidence of periodontitis being greater in a dental school environment than the general population from a 46% in the general population, to 55% at one dental school (Eke et al., 2015). In addition, it is logical to conclude that because periodontitis is greater when there is a lower socioeconomic status (SES), patients with lower SES will seek less expensive dental care which can be found in dental schools (Helmi et al., 2019). Treating and managing periodontal disease among this population can be difficult, and if preventive and periodontal care is omitted, the disease could continue to progress. A variety of factors affect the compliance of patients on a maintenance schedule. These factors could be student, patient, or even institution based. There is a strong need for dental schools to evaluate their curricula models, and determine how to include an emphasis on periodontal preventive care. The first step in that process is tracking how often the students provide appropriate periodontal preventive care in a timely manner.

Purpose of the Study

The purpose of this study was to evaluate if patients at one dental education institution are receiving appropriate care based on their periodontal diagnosis in a timely manner.

Significance

The mission of the American Dental Education Association (ADEA) is to contribute to the promotion of health care through preparing professionals in oral health care (American Dental Education Association, 2019b). Research is also an important component of ADEA. In “ADEA Snapshot of Dental Education 2019-2020”, the American Dental Education Association addresses the importance of “research into contemporary and emerging issues that impact decisions in the dental education and policy-making communities” and this study supports that goal by evaluating dental clinical curricular outcomes (American Dental Education Association, 2019b, para. 3). This study could help catalyze future improvements in dental school education when necessary.

In addition, this study is related to the American Dental Association (ADA) Dental Quality Alliance (DQA), a newly formed organization designed to implement performance measurement guidelines in dentistry (American Dental Association, 2020). The performance measures used to assess quality of care is supported by evidence-based guidelines of the ADA (American Dental Association, 2020). Specifically, objective two of the DQA is relevant to this study, which is to “advance the effectiveness and scientific basis of clinical performance measurement and improvement.” (American Dental Association, 2020, para. 3).

Research Questions:

The following questions guided the conduct of this study.

1. What prohibits dental students from providing preventive periodontal care or therapeutic periodontal care in a timely manner?

2. Do patients seeking care at a dental school clinic receive a periodontal diagnosis?
3. If there is a periodontal diagnosis, was it based on a comprehensive assessment?
4. If there is a periodontal diagnosis, were the new American Academy of Periodontology (AAP) Classification Guidelines used for the diagnosis?
5. If there is a periodontal diagnosis, was appropriate prophylactic treatment rendered based on the periodontal diagnosis?
6. If there is a periodontal diagnosis, was appropriate therapeutic periodontal treatment rendered based on the periodontal diagnosis?
7. If there is a periodontal diagnosis, was appropriate preventive prophylactic treatment rendered in a timely manner?
8. If there is a periodontal diagnosis, was appropriate therapeutic periodontal treatment rendered in a timely manner?
9. Does the type and year of dental student predict a periodontal diagnosis, comprehensive assessment, use of new AAP Classification Guidelines, appropriate prophylactic treatment, appropriate therapeutic periodontal treatment, and treatment rendered in a timely manner?

Hypothesis

There is no significant relationship between the type and year of dental student predicting periodontal diagnosis, comprehensive assessment, the use of new AAP Classification Guidelines, appropriate prophylactic treatment, appropriate therapeutic periodontal treatment, and treatment rendered in a timely manner.

Definitions

Comprehensive periodontal assessment. A comprehensive periodontal assessment is the evaluation of the complete dentition, state of the gingiva and bacterial deposits (biofilm), and risk factors in periodontal disease progression (American Academy of Periodontology, 2019). For the purposes of this study, an appropriate periodontal assessment is charting gingival depth, bleeding on probing, clinical attachment level, furcation involvement and mobility, as well as an assessment of the radiographs.

Periodontal diagnosis. A periodontal diagnosis is determined by a patient's risk factors for the disease, the extent and distribution of the disease, and a clinical evaluation including periodontal charting, radiographs, and a review of the patient's history (American Academy of Periodontology, 2018). For the purposes of this study, an appropriate periodontal diagnosis includes detailing the extent, distribution, severity, and risk assessment.

Correct periodontal diagnosis. A correct periodontal diagnosis operationally defined based on the most recent AAP Classification Guidelines which includes extent, distribution, severity and risk factors (American Academy of Periodontology, 2018).

Appropriate preventive prophylactic treatment. Patients who do not have periodontitis, and received a prophylaxis (Current Dental Terminology [CDT] codes D1110 and D4346).

Appropriate therapeutic periodontal treatment. Patients who have periodontitis and are treated under the CDT codes D4341 and D4342.

Appropriate periodontal treatment based on diagnosis. Appropriate periodontal treatment is based on the Dental Procedures and Nomenclature (CDT) codes, and is operationally defined as treatment to those without bone loss (D1110, and D4346), and those with bone loss will be determined by the codes (D4342, D4341, D4910).

Timely preventive and therapeutic periodontal treatment. For the purposes of this study, timely preventive and therapeutic periodontal treatment is operationally defined as preventive care and treatment of periodontal disease being provided within 90 days of a comprehensive oral evaluation.

Dental education institution. A dental education “refers to all aspects of academic dental, allied dental, and advanced dental institutions” and the term “institution refers to the academic unit in which the educational program is housed” (American Dental Education Association, 2019a). For the purposes of this study, dental education institution refers to the dental school at the University of Colorado School of Dental Medicine in Aurora, Colorado.

Type of student. The type of student is operationally defined as either a traditional or international student.

Traditional dental students. Traditional dental students can be defined as individuals who “...should have four-academic-year curricula or the equivalent of four-year curricula provided in a flexible format...in order to achieve defined goals and objectives that reflect contemporary methods of oral health care delivery” (American Dental Education Association, 2019a). For the purpose of this study, the students who are attending the University of Colorado School of Dental Medicine are considered traditional dental students who are in their third or fourth year of curriculum.

International dental students. An international dental student is an individual who has graduated from a dentistry program in a foreign country, and would like to expedite their dental education in the United States (American Dental Education Association, 2019d). For the purposes of this study, international dental students are those students who are enrolled in a two-year program at the University of Colorado School of Dental Medicine.

Year of dental student. “During the first two years of dental school, students spend most of their time studying basic biological sciences and learning the structure and function of the body and the diseases that can affect it” and the “last two years of dental school mostly involve clinical study (direct patient care) and some practice management instruction” (American Dental Education Association, 2019c). For the purposes of this study, 3rd and 4th year traditional dental students at the University of Colorado School of Dental Medicine will be the year of dental student studied. For international students, 1st and 2nd year international students will be the year the student studied.

Periodontal disease. Periodontal disease is characterized as a dysbiotic condition caused by bacteria and exacerbated by environmental and the host response which involves all of the supporting periodontal structures in the mouth: gingiva, bone, periodontal ligament, and cementum (Kumar, 2019; Manresa et al., 2018). For the purposes of this study, periodontal disease is effectively managed by “an individualized risk assessment and treatment plan that include appropriate risk factor mitigation, such as control of diabetes, smoking cessation, among others” (Kumar, 2019, p. 1).

Appropriate periodontal care. Appropriate periodontal care involves an understanding of the etiological process of disease, assessing risk and creating a

treatment plan, oral hygiene self-care and education, non-surgical periodontal therapy, and surgical periodontal interventions if necessary (Kumar, 2019). For the purposes of this study, appropriate periodontal care is based on a correct periodontal diagnosis and appropriate preventive and therapeutic treatment.

Active periodontal therapy. Active periodontal therapy is treatment rendered performing non-surgical and surgical periodontal therapy to remove supra and subgingival deposits in order to lower the quantity of the bacterial load, and to reduce the particular pathogens which cause disease. Active periodontal therapy is deemed successful when periodontal pockets are $\leq 5\text{mm}$ (Van der Weijden et al., 2019).

Supportive periodontal therapy Supportive periodontal therapy include procedures performed at select intervals to “reduce the probability of re-infection and progression of disease: to maintain teeth without pain, excessive mobility or persistent infection in the long term, and to prevent related oral diseases” (Manresa et al., 2018, p. 2) For the purposes of this study, supportive periodontal therapy is ongoing and individualized based on the patient’s needs.

Components of supportive periodontal therapy appointment: Supportive periodontal therapy “should include all components of a typical dental recall examination, and importantly should also include periodontal re-evaluation and risk assessment, supragingival and subgingival removal of bacterial plaque and calculus, and re-treatment of any sites showing recurrent or persistent disease” (Manresa et al., 2018, p. 2). For the purposes of this study, supportive periodontal therapy should follow anyone with extant periodontal disease.

Summary of Chapter 1

Oral health is integral to overall health for many reasons. Preventive care is a keystone in oral health, and should be strongly emphasized in dental curricula. To determine if the curricular emphasis is strong enough, the behaviors of dental students in different years of the curriculum need to be evaluated for consistency of preventive and periodontal care.

Chapter 2 Literature Review

The year 2000 marked a milestone for dental professionals. That was the first year oral health was addressed in the context of overall health in any United States Surgeon General's report (U.S. Department of Health and Human Services, 2000). This report was significant because it recognized the “interdependence” of oral health and general health (U.S. Department of Health and Human Services, 2000). In fact, it illuminated how the health of the oral cavity is so vital that overall health cannot be achieved without oral health (U.S. Department of Health and Human Services, 2000). Unfortunately, the prevalence of oral diseases is still significant. Untreated dental caries in permanent teeth is the number one common disease globally, and periodontitis is the 11th (National Institute of Dental and Craniofacial Research, 2019). Fortunately, oral diseases are largely preventable, therefore, prevention should be emphasized in dental schools (Centers for Disease Control and Prevention, 2011; U.S. Department of Health and Human Services, 2000). A way to achieve an emphasis on prevention would start with tracking dental students' oral preventive procedures. In healthcare, certain procedures need to be performed in a specific order for the best results and treatment outcomes. In some instances, advancing to a procedure without patient education and performing preventive services could be unethical. If preventive work is not completed before restorative treatment, the presence of an oral disease such as periodontal disease can further contribute to oral health decline contributing to loss of the restored teeth. Due to curriculum requirements, periodontal preventive procedures can be overlooked (White et al., 2017).

This literature review begins by defining periodontal disease, the importance of preventive measures to prevent or maintain the disease process, and how it is taught in dental schools. Finally, this chapter will discuss how often students are advancing to procedures without proper preventive care, the influence of dental school curricula on the decision-making process in a healthcare setting, and how curricular changes could lead to better patient care. This literature search was conducted using PubMed and Google Scholar databases with the search terms “preventive care in dentistry”, “preventive care AND dental student curriculum,” “clinical dental curriculum,” “person-centered care in dental schools”, “patient-centered care in dental school curriculum, “person-centered care in dental school curriculum”, “comprehensive care in dental school”, “periodontics”, and “teaching periodontics in the dental school curriculum” The literature review was organized into three categories: periodontal disease and treatment, appropriate periodontal prevention and treatment, and periodontal preventive care within different curricular models in dental schools.

Periodontal Disease

The 2000 Surgeon General’s Report illustrated oral health as being imperative to overall health; this idea was a turning point for dental professionals and other healthcare professionals alike (U.S. Department of Health and Human Services, 2000). This report highlighted strong systemic links formed between the oral cavity and cardiovascular disease, and diabetes (Office of Disease Prevention and Health Promotion, 2020). Periodontal disease will be defined by its prevalence, etiology, presentation, and diagnosis.

The American Dental Association (2015) defines oral health in resolution 97H2014: “Oral health is a functional, structural, aesthetic, physiologic and psychosocial state of well-being and is essential to an individual's general health and quality of life” (Buset et al., 2016, pp. 333; Glick & Meyer, 2014). Oral health does not just encompass health in the oral cavity. Oral health is essentially the health of all the structures that support the oral cavity: the muscles, nerve enervation, bone and structures of the head and neck region (U.S. Department of Health and Human Services, 2000). Therefore, any disorder in the head and neck region could affect overall health. For example, a disorder in the jaw could affect a person’s ability to chew and their overall nutrition.

Periodontitis is an inflammatory condition in the oral cavity which can cause alveolar bone destruction through a complex relationship involving the microbes in the oral cavity, the host’s immune system, and other environmental (i.e. smoking) and genetic factors (Kumar, 2019). Periodontitis remains the 11th most prevalent disease worldwide, the number one cause of tooth loss in the United States, and the second most common cause of tooth loss globally (Helmi et al., 2019; National Institute of Dental and Craniofacial Research, 2019; U.S. Department of Health and Human Services, 2000; Varela-Centelles et al., 2016).

Defining Periodontal Disease

According to Highfield (2009), in order to diagnose periodontal disease, a thorough knowledge of periodontal health must be ascertained. In periodontal health, there is a small space between the gingiva and the tooth, called the gingival sulcus, which ranges between 1-3mm, and is measured with a periodontal probe. Periodontal disease will create a deeper probing depth, ranging from 4mm, which is likely gingivitis, to

greater than 4mm, which indicates attachment loss or periodontitis. Loss of attachment is determined both by probing and measuring where the gingival margin is in relation to a fixed point: the cemento-enamel junction (Highfield, 2009). Once the loss of attachment has occurred, only marginal gains can be made in gaining it back; in short, the difference between gingivitis and periodontitis is that gingivitis is reversible, and periodontitis is not. The American Academy of Periodontology (AAP) classifies the existence of periodontitis by many different parameters including both clinical signs and risk factors. The clinical signs include bleeding on probing, deeper probing depth and/or gingival recession (Highfield, 2009). Radiographic bone loss is also a clinical sign; however, radiographic bone loss is not apparent until 6-8 months after it has occurred (Goodson et al., 1984). In addition, there are two different types of periodontal disease. One is characterized by a rapid loss of attachment, primarily in the first molars and incisors and the other is a more gradual loss generalized throughout the mouth (Highfield, 2009).

The etiology of periodontitis is multifactorial and complex, and while oral biofilm is the primary etiological agent, the host's immune response is a key factor in the existence and rate of periodontal destruction (Newman et al., 2019). Biofilm is a complex matrix of not only many different microorganisms, but a protective matrix of extracellular polymorphic substances, which was historically referred to as dental plaque (Newman et al., 2019). Biofilm starts to form where the gingival margin meets the tooth (Lang et al., 2009). As the biofilm advances into the gingival sulcus it creates a chronic inflammatory state which causes most of the periodontal destruction (Newman et al., 2019). Eventually, this chronic inflammatory state is clinically evident in changes in the

gingival color, contour, and texture (Lang et al., 2009). The gingiva is more red in color than the coral pink seen in health, and will become swollen (Newman et al., 2019).

Gingivitis is an inflammatory disease which can be a precursor to periodontitis, and it is reversible. In 2009, Lang and colleagues published a 26 year-long study on the effects of gingivitis. This study was performed to determine the effects gingivitis and inflammation, or lack thereof, have on tooth loss and periodontitis (Lang et al., 2009). A cohort of 565 well-educated and healthy men in Norway was followed over 26 years (Løe et al., 1978). A second group of 480 men from Sri Lanka were also recruited. These men were mostly illiterate tea-workers. This group was chosen because the tea estates offered one of the few employment opportunities, and this group had very little contact with the outside world. The participants were evaluated six times after the initial evaluation, each evaluation being years apart. The Norwegians were seen after two years, four years, five years, and seven years (Lang et al., 2009); the Sri Lankans were on a similar schedule, being examined after one year, two years, four years, and seven years (Lang et al., 2009; Løe et al., 1978). The evaluation consisted of a plaque index, a gingival index, calculus index, probing depths, attachment loss, recession, and a caries index (Løe et al., 1978).

Most of the Norwegian participants studied maintained excellent oral hygiene throughout the study and only 30-40% of tooth surfaces had plaque (Lang et al., 2009). In contrast, the Sri Lankan participants had considerable mineralized and non-mineralized deposits and debris on their teeth (Løe et al., 1986). Very few Norwegian teeth were lost over a lifetime; at 16 years of age, the subjects had 27.4 teeth, and at 60 years of age, the subjects had 27.1 teeth (Lang et al., 2009). The Sri Lankan group lost a mean of 13.1 teeth by 55+ years of age (Ramseier et al., 2011). In the Norwegian group, attachment

loss was predominately caused by recession, and pocket formation did not start until 50 years of age (Løe et al., 1978). Bleeding on probing was also monitored. In the sites without bleeding on probing, 99.5% of teeth were retained (Løe et al., 1978). This finding suggested gingival health gives a high prognosis of tooth longevity (Lang et al., 2009). According to the interpretation of the data in the study above by Lang and colleagues, areas which consistently bled on probing, thus indicating long-standing inflammation, periodontitis may occur, therefore the researchers determined gingivitis is a necessary precondition of periodontitis (Lang et al., 2009). The limitation of this study could be not having a radiographic comparison to make further assessments.

The reason gingivitis does not always cause periodontitis is due to the host response, as well as other risk factors; for example, both diabetes and smoking can exacerbate periodontal disease (Newman et al., 2019). Cytokines play an extremely important role in the host's response; they signal to the rest of the body there is a problem, which starts the immune response by flooding neutrophils to the area. In the oral cavity, cytokines are produced after initiation by certain key periodontal pathogens, notably *P. gingivalis*, *A. Actinomycetemcomitans*, *F. nucleatum*, and *Prevotella intermedia* (Newman et al., 2019; Pan et al., 2019). Cytokines are released in the gingival crevicular fluid (GCF), which comes from the gingival sulcus. If the activation of these cytokines initiates dysbiosis by signaling excess neutrophils to the area, the immune system will become overactive, which then contributes to hard and soft tissue destruction (Pan et al., 2019). Historically, it was believed bacteria were the problem, but it is the dysregulation of the immune system which causes most of the damage (Pan et al., 2019).

In 2019, Pan et al., published a review of the current literature on the effects of cytokines on the immune response. The purpose of this study was not only to review the role of cytokines in periodontitis, but also to examine recently discovered cytokine-related therapeutic measures that could impact the course of the disease (Pan et al., 2019). This article focused on the members and function of cytokines, discussed the influences cytokines have with certain cell subsets that lead to a complex immune response, and how the anti-inflammatory cytokines impact periodontitis (Pan et al., 2019). Proinflammatory cytokines discovered were interleukin (IL)-1, IL-6, and tumor-necrosis factor (TNF) (Pan et al., 2009). Cytokines cause chronic inflammation, thus exacerbating certain conditions like autoimmune diseases, cardiovascular disease, and cancers. (Pan et al., 2009). Proinflammatory cytokines increase in GCF during the course of periodontal disease (Pan et al., 2019). Fortunately, after non-surgical periodontal therapy (NSPT) the IL-1 cytokines in the GCF are reduced (Pan et al., 2019). The cytokines IL-6 and TNF also directly influence changes in the alveolar bone by disrupting the balance of osteoblast and osteoclast activity (Pan et al., 2019). TNF could also be a link between periodontitis and certain systemic conditions, (i.e. cardiovascular disease) as an increase in TNF would affect many other areas of the body by initiating inflammation (Pan et al., 2019).

This study by Pan et al. (2019) also discussed how the constant increasing body of knowledge about the immune system has led to anticytokine-related therapy, which has the potential to block the pathogenic cytokines in the inflammatory process of periodontal disease (Pan et al., 2019). However, as of 2019, the development of targeted anticytokine therapy in periodontics has gained little traction and requires more research. These

authors concluded additional research is needed on anticytokine therapy in periodontitis and the protective effects on the bone by inhibiting certain cytokines. However, initiating too much anticytokine therapy could also lead to the dysbiosis of the homeostasis of the immune system (Pan et al., 2019).

Prevalence

In 2018, Eke et al. published research results about the prevalence of periodontal disease by compiling six years of National Health and Nutrition Examination Survey (NHANES) data from 2009-2014. Periodontitis for this study was determined by a full-mouth periodontal examination; whereas in previous years, this data was collected by a more limited exam (Eke et al., 2018). The prevalence of periodontitis was 42.2%, in adults aged ≥ 30 years, and 7.8% of these cases were classified in the severe periodontitis category (Eke et al., 2018). While most periodontitis increases with age, this “severe” periodontitis category remained around 10% or less throughout the older adult age groups (Eke et al., 2018). The burden of periodontitis is highest in Mexican Americans (59.7%), non-Hispanic blacks, current smokers (62.4%), and those with incomes below the federal poverty level (60.4%) (FPL). The limitations of the study include the gaps which might have led to an underestimation of disease, for example, lack of exposure to radiographs to help determine the extent of bone loss.

Helmi et al., (2019) also published a study specifically on the prevalence of periodontitis at one dental school. The purpose of this study was to determine the prevalence of periodontitis by reviewing bitewing radiographs for alveolar bone loss. Bitewing radiographs are ideal for determining alveolar bone loss because the

way they are taken causes the least distortion. For this study, over 1100 records were mined from the electronic health records system AxiUm (Helmi et al., 2019). Data collected were: specific chronic systemic diseases (cardiovascular disease (CVD), type 2 diabetes, and hypertension), gender, age, body mass index (BMI), tobacco use, race/ethnicity, and the alveolar bone loss from the radiographs (Helmi et al., 2019). Socioeconomic status was calculated by reviewing the patient's zip code. The results showed an average bone loss of 1.30 millimeters, ranging between 0.77mm in the youngest participants, to 2.03mm for the oldest (Helmi et al., 2019). Periodontitis increased with age in every age group, and the overall prevalence of periodontitis was 55% (Helmi et al., 2019). It is important to note this study showed the prevalence of periodontitis being substantially higher than in the general population reported by Eke and colleagues (42.2%) (Eke et al., 2018).

The Helmi et al. (2019) study also determined that periodontitis was the most prevalent in those with systemic disease (CVD, stage 2 hypertension, and type 2 diabetes), men who were over 65 years of age, and former smokers (Helmi et al., 2019). After adjusting for the other variables (age, sex, BMI, race/ethnicity, systemic conditions, smoking, household income), the mean increase of periodontitis was greatest among the highest age group (65+ years) compared to the lower age group (<30 years). Males and persons from the Asian race compared to the White race showed statistically significant higher bone loss (95% CI and $p < .0001$ in both categories). Further, those with greater household income showed statistically significant less bone loss than those with less household income (Helmi et al., 2019). Smokers (former or current) also showed statistically

significant higher mean levels of bone loss. Those with a higher BMI also had statistically significant less bone loss, but, due to the limitations of calculating a BMI rather than percentage of body fat, these results should be considered with caution (Helmi, 2019). The limitations of this study included only looking at posterior teeth, as only bitewings in the posterior are routinely taken. Further, reviewing radiographs alone does not create a comprehensive periodontal picture, as clinical factors play an important part. Also, any detailed characteristics such as the individual's oral hygiene, were not studied (Hemi et al., 2019).

Diagnosing Periodontal Disease

The AAP has updated its classification system several times throughout the years; the most recent change was in 2018 (American Academy of Periodontology, 2018). This new, simplified system has four different disease categories: periodontal health, gingivitis, periodontitis and peri-implantitis (periodontitis surrounding an implant). Periodontitis is now classified using a staging and grading system (American Academy of Periodontology, 2018). With this system, periodontitis is classified depending on the extent, range, and distribution of the disease. The stages in the classification systems range from I-IV, depending on the severity and type of alveolar bone loss. Alveolar bone loss can occur in a horizontal pattern or vertical pattern. The staging of periodontitis is determined by the percentage of horizontal bone loss and other mitigating factors such as vertical bone loss being greater than three millimeters and the presence of furcation involvement. Furcation involvement occurs when the bone has receded to expose the roots of a multirooted tooth. Where the roots diverge is called a furcation, meaning there is a space created between the roots (basically a hole in the alveolar bone under the tooth)

due to bone loss which is prone to bacterial invasion. This process can occur under the tissue, where it is a significant challenge for an individual to keep clean. As the furcation deepens, the prognosis of the tooth is considerably impacted.

Periodontitis is graded A, B, or C, depending on the rate of destruction. The rate of destruction is easily determined by a simple mathematical formula of dividing the amount of bone loss by the patient's age. If the result is less than 25%, the patient would fall into Grade A, if the result is greater than 1.0, they fall into Grade C, and everything in between is Grade B. In addition, if someone smokes more than 10 cigarettes a day or has diabetes, they fall into the Grade C category as these factors accelerate periodontal disease. Finally, the distribution of the disease is considered, if the patient has a molar/incisor pattern, or a more generalized pattern of bone loss. The pattern of this distribution is important, because it affects the diagnosis. The majority of periodontitis progresses in a generalized pattern of bone loss, but a certain type of periodontitis progresses far more rapidly, usually at a young age, and has a tendency to target the first molars and lower incisors.

Tooth loss is a natural sequelae to periodontitis (Helmi et al., 2019; National Institute of Dental and Craniofacial Research, 2019; Ramseier et al., 2017; Varela-Centelles et al., 2016). Ramseier et al., (2017) reported on the natural history of periodontitis using data from a decades long study on periodontitis (Ramseier et al., 2017). Loe and colleagues studied the effects of uninterrupted periodontitis from 1969-1990, and Ramsier completed the study with a final visit in 2010. This cohort study examined the periodontal parameters of patients with no oral hygiene instruction, or access to dental care outside of teeth extractions. The purpose of this study was to

determine the factors that influence periodontal tooth loss (PTL) and what effect uninterrupted human interaction has on PTL (Ramseier et al., 2017). Participants were not given any oral hygiene instruction, and special efforts were made to avoid disrupting the biofilm and calculus (a professional debridement). The study does address the lapse of ethics with the Sri Lankans having received no preventive or therapeutic dentistry from 1970-2010. In the final 20 years of observation, attachment loss progressed considerably more than in the first 20 years of study, and one-sixth of the subjects were completely edentulous after 40 years (Ramseier et al., 2017). A small percentage of the population (5.3%) experienced no PTL at all, but, in general, a mean of 13.1 teeth were lost due to periodontitis (Ramseier et al., 2017). Caries were not present at any observation period, so tooth loss could not be attributed to decay (Ramseier et al., 2017). A limitation of this study is the severe attrition of the participants: 480 patients were examined in 1970, and only 75 of the original cohort had an exam in 2010. The attrition rate throughout this study was quite high, losing 67.9% of the subjects in the first 20 years, and 84.4% of participants for the final study. This study was a landmark study in the field of periodontics because it demonstrated that while bacteria is the primary etiological factor of periodontal disease, the host response has a significant effect. While almost 90% of the population had moderate to rapid progression of periodontal disease, almost 11% of the original population had no signs of the disease during the first visits (Löe et al., 1986).

Appropriate Prevention and Treatment of Periodontal Disease

Kumar (2019) published an update on evidence-based practices for the prevention of periodontal disease (Kumar, 2019). According to Kumar (2019), preventing

periodontal disease starts with an individualized risk assessment for every patient. Smoking and diabetes are two of the main risk factors as indicated by the AAP (American Academy of Periodontology, 2018). The patient's age, history of periodontal treatment or surgeries, contributing iatrogenic dental conditions, mineralized and non-mineralized deposits on the teeth, furcation involvement, bleeding on probing, pocket depth, and attachment loss all need to be considered (Kumar, 2019). Tooth brushing, using interdental brushes to clean between the teeth, and chemical agents have all been supported by the literature to prevent and treat gingivitis (Kumar, 2019). A professional debridement is also necessary because mineralized deposits under the gingival tissue must be removed.

When it comes to the rate and progression of periodontal disease, landmark research was published with the Norwegian/Sri Lankan studies mentioned previously in this review. An additional purpose of the study was to determine how prevention effects the rate of periodontal progression (Löe et al., 1978). This study compared two populations: one in Oslo, Norway, and the latter in Sri Lanka due to the large differences in socioeconomic status as well as access to and knowledge of dental care. This study was divided into several parts to offer a comprehensive picture of periodontal disease. In Norway, 565 males were divided into two groups: one group included subjects under the age of 17 which were recruited from three high schools, and a group that included persons over the age of 17 who were recruited with census data. At that time, young Oslo children and adolescents received continued access to preventive, restorative, and surgical dental care in the school system. Furthermore, young adults younger than 21 who had graduated high school were offered a dental reimbursement program. This group

had consistent access to dental care throughout their lives. The Sri Lankan group consisted of 480 male Sri Lankans between the ages of 15 and 30 years. These participants had never been exposed to any preventive care or treatment related dental care. Toothbrushing was not taught or practiced by this group (Löe et al., 1978). All of the patients were given a caries, plaque and calculus index, and a periodontal exam including a gingival index and measurement of attachment loss. The periodontal exam consisted of measuring both the pocket depth and recession on six surfaces of every tooth. The subjects from the Norwegian groups and the Sri Lankan groups were then examined at different intervals for up to seven years. This study found significantly more attachment loss in the untreated group. By the age of 15, 80% of the Sri Lankan population demonstrated a quantitatively unhealthy periodontium, and at 19 years of age 7% had experienced severe periodontal loss. These figures were compared to 90% of Norwegian 19 year-olds who only displayed an attachment loss of less than one millimeter. At 31 years of age the Norwegians saw a mean loss of attachment of .98 mm, whereas the mean loss of attachment in Sri Lankans was 3mm. In addition, 26% of Sri Lankans showed at least one tooth surface (taken from one the six measurements per tooth) of 10mm or more of attachment loss (Löe et al., 1986). By the age of 31, the Norwegian participants only presented with a mean loss of attachment of one millimeter, whereas the mean loss of attachment in the Sri Lankans was 3.11mm. Periodontal disease only progressed by a mean of .05mm annually in the Norwegian study group in their 20s, but the Sri Lankan participants had a mean annual attachment loss six times greater at .3mm. This study suggested that without preventive care, periodontal disease starts earlier

and progresses faster. In individuals with regular access to preventive dental care, the rate of periodontitis can be remarkably slow.

The Sri Lankan participants periodontal disease could partially be explained by their almost complete lack of knowledge of how prevention could influence the onset and progression of periodontal disease. Varela-Centelles et al. (2016) published a systematic review exploring gaps in knowledge in the general public regarding periodontitis. The researchers identified periodontal gaps in knowledge by reviewing quantitative and cross-sectional community-based studies in six languages (English, German, French, Spanish, Portuguese and Italian), to create a more global picture. A total of 21 studies were reviewed, all with a requirement of no more than 6% being minors. Identifying gaps in knowledge is important because individuals who are unable to identify periodontal disease will be less likely to seek treatment (Varela-Centelles et al., 2016). Unfortunately, the results found a knowledge deficit in relation to periodontal awareness and etiology in developed countries (80% and 75%, respectively) (Varela-Centelles et al., 2016). However, over 63% of the populations studied are aware of how the disease is prevented. The authors concluded while much of the population knows how the disease is prevented, without appropriate awareness of the disease (bleeding gums), they are less likely to seek treatment (Varela-Centelles et al., 2016). Furthermore, patients could perceive less severe disease, or susceptibility, thus forsaking treatment. The limitations of this study included data that was only collected from developed countries, and as socioeconomic status (SES) has been shown to influence health, gaps in periodontal knowledge could be greater in undeveloped nations (Varela-Centelles et al., 2016).

Treatment of Periodontitis

There are many different treatments available for periodontitis. Most treatment begins with non-surgical therapy in the form of a professional debridement also known as scaling and root planing. The purpose of non-surgical periodontal therapy is to remove as much of the mineralized (calculus) and non-mineralized deposits (biofilm and debris) as possible. Removing these deposits are important as the deposits harbor biofilm and can be a local irritant to the gingiva. These deposits are removed with manual, sonic, and ultrasonic instruments, in order to preserve as much of the periodontium as possible (G. A. Van der Weijden et al., 2019). Occasionally, treatment is augmented with chemotherapeutics and behavior-modification techniques (i.e. smoking cessation and home care instructions) (Graziani et al., 2017).

Graziani et al., (2017) reviewed the various treatments for periodontitis. The goal of periodontal therapy is to arrest the disease by restoring attachment where possible, and maintaining the dentition (Graziani et al., 2017). There are two key components to non-surgical periodontal therapy: the person's home care and non-surgical professional debridement. Neither one of these treatment modalities alone was effective in restoring health, and oral hygiene instruction alone was less effective than a professional debridement in combination with oral hygiene instruction (Graziani et al., 2017). While oral hygiene can help prevent and slow the progression of periodontal disease, it is not sufficient. In fact, one three-year study reviewed for this article demonstrated continued downhill progression of periodontal disease when the subjects only received oral hygiene instruction (Westfelt et al., 1998). Further, another study suggested only providing oral hygiene instruction once is not sufficient to control the disease, so repeated oral hygiene

instruction is necessary (Graziani et al., 2017; Nyman et al., 1977). This study also illustrated the effects of a professional debridement on bleeding on probing that resulted in reduced pocket depths, exhibiting a reduction of 1.26 mm in pockets of 5-6 mm, and 2.2 millimeters reduction for deeper pockets. Clinical attachment level also improved from 0.5-2mm (Graziani et al., 2017). Naturally, not all subjects or sites respond to non-surgical therapy; smokers and individuals with poorly controlled diabetics will respond less favorably. In addition, different sites in the mouth did not respond the same due to anatomic anomalies (i.e. furcation involvement), or intrabony defects (Graziani et al., 2017). Single rooted teeth demonstrated a better response rate (Graziani et al., 2017).

Pharmacologic interventions are used with some success in treating periodontitis. The use of systemic antibiotics demonstrated limited success in treating periodontal disease, and as such, are reserved for the most severe and aggressive cases. Local antibiotic therapies demonstrated a limited improvement of less than a millimeter in clinical attachment gain (Graziani et al., 2017). Laser treatment to remove diseased tissue in periodontal pockets have not been shown to be effective treatment (Graziani et al., 2017). Periodontal surgery has been shown to be successful in individuals with good oral hygiene. Periodontal surgery is typically only considered after non-surgical therapy proves ineffective, and the goal is often to alleviate any anatomical or bony defects that interfere with periodontal healing. The final necessary component to periodontal therapy is placing the patient on a regular maintenance schedule (Graziani et al., 2017). Bacterial recolonization returns to pretreatment levels about 9-11 weeks following treatment, so the recommended interval for the regular maintenance is three months (Newman et al., 2019).

Van der Weijden and colleagues (2019) reported on the success of non-surgical treatment in dentistry (G. A. Van der Weijden et al., 2019). The purpose of this study was to evaluate the success of non-surgical treatment of periodontal disease. The researchers extracted data from a periodontist's office and retrospectively analyzed the data of 1182 patients. The data extracted were probing depths, percentage of sites with bleeding on probing, furcation invasion, age, percentage of endodontic treatment, and smoking status. In health, the gingival sulcus will not bleed with the insertion of the blunt end of the probing instrument. The absence of bleeding on probing (BOP) is a strong indicator of periodontal stability, however, the reverse is not true; BOP *alone* is not an indicator of disease progression). Chapple et al., (2018) demonstrated periodontal health is achieved when there is BOP in fewer than 10% of sites. For this study, successful therapy was determined by pocket depths $\leq 5\text{mm}$, and BOP in less than 10% of sites. The parameters for success are a steep challenge for any practitioner. According to Graziani et al., (2017) one can expect a decrease of 2mm in sites that contain a 7mm pocket, and 1.29 mm of improvement in shallower pockets of 5-6mm. According to the parameters in this study (pockets $\leq 5\text{mm}$, and BOP in less than 10% of sites), only 19% of the patients were deemed "successfully" treated. Nearly 40% of patients were deemed successfully treated if bleeding on probing was removed from the equation, and greater success was found in the anterior teeth than the posterior teeth (85% and 45%, respectively). Defining periodontal health as less than 10% of sites which bleed upon probing, regardless of the depth, made success cases rise to 44%. Endodontic treatment also influenced success in 8-11% of cases (Van der Weijden et al., 2019).

The severity of periodontitis also influenced success. In patients with probing depths one quarter of patients began with pockets $\geq 9\text{mm}$, which indicates a decrease in pocket depth of $\geq 4\text{mm}$ after non-surgical periodontal treatment. Smoker success rates (29%) were less than non-smokers success rates (43%). Furcation involvement also influenced success; 55% of multirooted molar teeth did not respond to successful treatment. The results indicated furcation involvement, endodontically treated teeth, and smoking are significant risk factors for periodontal disease. The limitations of this study are examining patients who only received initial therapy, and not supported maintenance therapy (discussed in the next section). In addition, the parameters defining health (pockets $\leq 5\text{mm}$, and BOP in less than 10% of sites) were quite strict, so the oral cavity can be considered “unhealthy” when large portions of it might be quite healthy.

Periodontal Maintenance

Maintaining the conditions in the mouth after non-surgical and surgical therapy is extremely important to tooth longevity, and has been documented in several long-term studies. Approximately 9-11 weeks after treatment, the pathogens return to pretreatment levels where destruction is the greatest, so supportive periodontal maintenance following active periodontal therapy is a key component in maintaining health in the oral cavity (Newman et al., 2019). Trombelli et al., (2015) published a systematic review on the effects of a professional debridement to prevent re-infection of the periodontium. The purpose of this study was to determine if a professional debridement performed at specific intervals known as supportive periodontal maintenance (SPT) prevented periodontal disease from recurring. This systematic review evaluated prospective clinical trials to determine the clinical outcomes of patients who received SPT.

The results from the systematic review suggested that SPT is effective in reducing tooth loss; with few changes in the gains achieved in probing depth and attachment level. Bleeding on probing increased in long-term studies, but decreased or only slightly increased in short-term (5-7 year) studies, plaque and calculus changed little, with plaque scores increasing if the patient was seen in a general dentist's office versus a specialist such as a periodontist office (Trombelli et al., 2015). Radiographic alveolar bone loss during these long-term studies changed little in general (within 1mm), but showed a significant increase in persons who are at high risk for periodontitis, versus those who are not high risk (.8mm to .3mm, respectively). Much of the results were determined by the compliance of the patients. In patients with erratic compliance, BOP increased, with also suppuration significantly increasing. This study demonstrated periodontal parameters change little with SPT, and the conditions achieved during active periodontal therapy (APT) APT were maintained. One study illustrated less than 1% of sites demonstrated an increase in pocket depths to >6mm (Lindhe & Nyman, 1984). These success rates ultimately impact the number of teeth which are lost to periodontitis. One study reported a three time decrease in tooth loss over a period of five years (Costa et al., 2014). In general, studies have established SPT works to achieve a stabilized periodontium and reduce tooth loss (Trombelli et al., 2015). The greatest success of SPT is the number of teeth retained, which is the overall goal of periodontal therapy. The limitations of this study are the heterogeneous study designs, and a lack of specific protocols in defining SPT (Trombelli et al., 2015).

Axelsson et al., (1981) compared two groups to determine the importance of SPT. One group was placed in a strictly controlled maintenance program (recall patients), and

the other group was sent back to their general dentist with instructions to monitor periodontal conditions and give home care instruction (non-recall patients). The purpose of this study was to evaluate the effectiveness of SPT on patients who have undergone surgical treatment for severe periodontitis. During ACT, 90 patients were given a comprehensive periodontal exam, oral hygiene instruction, scaling and root planing, and surgical periodontal treatment. Following ACT, patients were given a professional debridement every two weeks for the first two months. Following that, one-third of the patients were sent back to their general dentist to check oral hygiene, calculus formation, pocket depths, and the state of the gingiva; the other two-thirds were enrolled in a carefully controlled maintenance program. At the end of six years, 77 patients were still enrolled in the study.

The differences between the recall patients and the non-recall patients were significant. As far as oral hygiene, all patients showed a dramatic decrease in their plaque scores during active therapy. The initial plaque scores for the recall group decreased from 83-21% plaque-free surfaces, and the non-recall group's plaque scores decreased from 78-20%. The three and six-year exams revealed a much different picture with the recall group having mean scores of 18% and 16%, while the non-recall patients' mean plaque scores were 56% and 66%. The recall group maintained healthy gingiva, with bleeding scores of 2%, but the non-recall patients' bleeding units increased to 55%. The probing depth increase between the two groups was alarming. The recall group maintained the probing depths achieved during APT. The non-recall group showed increases in probing depths of 2.6mm and 2.9mm at three and six years, respectively. This figure is significant. In another study completed by Lindhe and Nyman (1984) results revealed

patients enrolled in a maintenance program retained pocket depths of less than 4mm in 92-99% of sites for 14 years (Lindhe & Nyman, 1984). The comparison between the two maintenance studies demonstrated an increase in probing depth three times greater than the natural progression of the disease after only six years. The Axelsson & Lindhe (1981) study revealed periodontally healthy conditions can be achieved in patients who receive surgical treatment during APT, however, without regular professional debridements, the periodontal destruction occurs at an alarming rate. Limitations in this study include not using a radiographic comparison in alveolar bone loss between the two groups, and it was only completed on male patients.

One study followed patients on a maintenance program for 14 years after APT. The purpose of this study was to determine the effectiveness of SPT by monitoring a group of patients with advanced periodontal disease (Lindhe & Nyman, 1984). A group of 75 patients who had more than 50% of alveolar bone loss were previously treated for advanced periodontal disease were selected for the study. Fourteen patients were lost during the study, so the sample consisted of 61 patients aged 26-71 years. These patients had an initial examination, underwent APT, then were placed on SPT in 3-6 month intervals. The patient's probing depths, clinical attachment levels, gingival conditions (oral hygiene status), were recorded at the initial examination, after APT, and then at yearly intervals. Radiographs were taken at 2-3 year intervals following the APT initial examination. In addition, the number of teeth that were lost and the reasons why were recorded. The patients maintained a high level of oral hygiene, with results changing little over 14 years. In addition, there was no significant changes in clinical attachment levels. There were, however, 15 patients that experienced significant attachment loss in certain

sites. Because the attachment loss was site specific on certain patients, attachment loss was not a generalized phenomenon. Interestingly, these patients were included in all five age groups and the 30-39 year-old group consisted of twice as many patients as the ≥ 60 year-old group (4 and 2 patients, respectively), an indication the reoccurrence of periodontitis is not age related. Tooth mortality was quite low: out of 1330 teeth at the beginning of the study, 16 teeth were lost for periodontal reasons, and 14 teeth were lost to other reasons. In total, 2.3% of teeth were lost. Effectively, this study determined patients could maintain a high degree of periodontal health for 14 years following treatment. Like the Norwegian/Sri Lankan studies mentioned above, the participants had a rate of attachment loss similar to the healthy Norwegian population who received regular preventive dental care throughout their lives: 0.1mm per/year.

Periodontal disease is preventable, and when it is not prevented the rate of progression is significantly greater, and the age of onset is much younger. The treatment of periodontal disease consists of non-surgical periodontal therapy, or surgical treatment. Without regular maintenance at appointments, either therapy is ineffective, and the rate of progression of periodontal disease can occur at a significantly higher rate of destruction. With appropriate SPT, the gains achieved during APT can be successfully maintained for many years.

Dental School Curricular Models

Dental student curricular models were intended to be a system in which licensed dentists provide most of the patient care, and dental students only perform treatment within their capabilities (Formicola, 2008). However, this curricula eventually evolved into clinics in which students provide most of the patient care (Formicola, 2008). In this

system, patient care is far more inefficient, and has become a “secondary bi-product of education” (Formicola, 2008, pp 1273). Therefore, many different clinical curricula models have been tested.

Important information on clinical curricular models can be gleaned from a sister discipline to dentistry: medicine. One study published in medicine examined the importance of clerkship experiences in clinical medical education (Wimmers et al., 2006). The purpose of this study was to determine the value of these clinical experiences, and if the number of procedures completed added to student competence. Dental schools have something similar to clerkship experiences, called rotations. This research in the medical field followed 227 medical students at 14 different hospital sites for a 12-week clerkship experience. They were required to keep a logbook of the patient’s age, gender, diagnosis and the date of the procedure. Their competence was assessed by a practical and theoretical exam, and the rating of the student by the onsite supervisor. Site specific information on each hospital was also included such as information about the staff, peer clerks, the total occupancy of the hospital, and number of teaching beds available. The average patient stay for that hospital, and number of times the patients were admitted were also recorded. Students were asked five questions about the amount of supervision they received and by whom, and if they received a performance review. The students were also evaluated every three weeks by their supervisor regarding the level of overall competence. Other competency areas evaluated included data gathering, attitude, knowledge level and quality of interactions with supervisor, staff, and patients. Of the 227 students, 152 students completed their logbooks; incomplete logbooks were not evaluated. There was significant variation between hospital sites regarding the number

of patients and diseases encountered, variation of diseases, the quality of supervision, and the clinical examination scores. The theoretical examination and the supervisor's evaluation of performance on an individual did not vary significantly between hospital sites. The site of the rotation did influence a student's knowledge at the end of the clerkship; significant differences were detected in how the student performed in their clinical exams. This study illustrated where a student completes a clerkship experience has an impact on their learning, but was unable to draw a direct correlation between the number of procedures completed and the level of competence. Instead, this research suggested the quality of supervision had "significant and direct effect" on what the students learned (Wimmers et al., 2006, p. 456). The limitations of the study are the accuracy of the log books, and the subjective nature in determining the quality of supervision.

Spector et al., (2008) was also interested in how quantity relates to quality in a dental school setting, and performed a 22-year retrospective study comparing the number of clinical experiences and the faculty's assessment of the students' competence. The purpose of this study was to determine if there is a correlation between the volume of these experiences and the student's clinical competence. The quantity of student experiences at the University of Iowa were tracked in a course (114:187) taken in the students senior year by using clinical experience units (CEUs). The CEU of a procedure is determined by the time it takes to complete a procedure, and the difficulty. For example, at this school an amalgam which is placed on two surfaces of the tooth is worth six CEUs, and a porcelain fused to metal crown is worth 40. In general, students are advised to have a goal of completing six CEUs per hour of clinic time. Faculty members

can adjust the CEUs if a procedure is definitively more complex or particularly simple on a particular patient. There is a grading scale in place which assigns a letter grade dependent on the amount of CEUs a student has acquired. The quality of student experiences is recorded in a concurrently running course labeled 114:188) with a sophisticated system where faculty are taught at the very beginning of the year and calibrated on three times throughout the year in an attempt to mitigate subjective grading. Every 10 weeks, faculty meet to discuss the progress of the student. Strengths and shortcomings are ascertained and communicated with the student. If a student earns a failing grade, a robust remediation plan is put into place. This study examined if there was a correlation between these two grades. The results did show a correlation, but the correlation varied greatly over 22 years ranging from moderately strong to negligible. In addition, this correlation decreased over time. The authors postulated that while it might be intuitive to think if a student has a high quantity of experiences, they will produce higher quality results as well, but the results of this study did not support this theory. The authors postulated several hypotheses as to why the results did not match the extant theory quantity produces quality. One could be a student's particular emphasis on quality verses quantity. The students who value quality may take more time to complete a procedure, thus resulting in less CEUs overall. In addition, if a student is entering a post-doctoral dental school program, they may not have aggressively sought quantity of experiences because they have a year more of practicing under supervision. The authors also thought the generation of the students may have played a part, and could be a contributing factor in why the correlation declined over time. The Millennial generation are known to be high-achievers, so this generation may have sought more clinical

experience. The limitation of this study were that the researchers only acquired data from one university.

Many dental schools have a set number of patient requirements for students designed to increase competence levels, because many clinical curricular models require a certain amount of specific patient experiences to graduate. One study compared two different curricular models at one predoctoral dental program (Park et al., 2011). The purpose of this study was to compare the effects of a comprehensive care curriculum (CCC) to the traditional discipline-based, numerical procedural curriculum. The numerical procedural based curriculum had inherent problems. First, once the students completed their requirements, they were more likely to stop seeing their patients (Park et al., 2011). Because the students stopped coming to clinic when their requirements were finished, learning opportunities and production waned (Park et al., 2011). This resulted in incomplete patient cases after the students graduated. This system was based on student requirements and faculty-driven care, rather than on patient care, so a case completion system using the CCC model was implemented to encourage more quality patient care (Park et al., 2011).

For the CCC model, the students were assigned to a senior tutor, a faculty member who oversees clinical operations and student progress (Park et al., 2011). This senior tutor had many functions including mentoring and supervising students, as well as reviewing individual cases (Park et al., 2011). Further, a case classification system was implemented based on the degree of difficulty and durations the procedures required. Six case types ranging from simple preventive procedures, to interdisciplinary care without prosthodontics, interdisciplinary care with certain prosthodontic procedures, and ending

in full dentures were identified including preventive and simple operatory procedures to more complex surgical procedures, complex interdisciplinary management, and finally to prosthodontic procedures. The students were expected to complete a minimum number of these certain case types to pass or pass with honors. At the same time as the CCC was being implemented, Harvard School of Dental Medicine also launched a new Electronic Health Records (EHR) system—AxiUm—to track procedures, student progress, patient histories and lab procedures (Park et al., 2011). Comprehensive care case completion increased dramatically (Park et al., 2011). The number of completed comprehensive patient care cases went from an average of 12.8 cases per student per year to 22.8 completed cases (Park et al., 2011). The number of transfer patients from 4th to 3rd year students decreased from 16.4 to 4.6 cases per year (Park et al., 2011). The authors postulated the change to a CCC model provided an avenue for teaching students a new model of thinking. The authors developed a new philosophy that encouraged patient-centered care, rather than care based on only recognizing the students own interests or requirements needed to graduate (Park et al., 2011). Further, with students' continued exposure to the clinic combined with the expectation of quality patient care, earning experiences could also be increased (Park et al., 2011). In addition, the patients likely received better quality of care because of the continuity of their providers. A senior tutor provided valuable mentorship, as the senior tutors met with students one-on-one, creating a rich experience for the students to assess how they managed their patient pools, and provided better patient care (Park et al., 2011). Lastly, the students learned how to incorporate the “big picture” into practice management by preparing treatment plans and delivering them in a sequential order (Park et al., 2011). The small class size at Harvard

School of Dental Medicine (HSDM) could impact how larger schools implement this curriculum, as this type of mentorship is a time-consuming process (Park et al., 2011). In this study, each mentor was assigned less than 20 students (Park et al., 2011). In addition, specific procedures and whether they were completed on time was not tracked.

Another dental school illustrated their findings of following three different curricular models over 20 years (White et al., 2017). This current study aimed to determine how these differing curricula might influence student experiences and overall patient care. The purpose of this study was to compare differing clinical curricula: Discipline Based Curricula (DBC), Comprehensive Care Curriculum (CCC), and Procedural Requirement Curriculum in addition to Externships (PRCE). The DBC curriculum spanned the years from 1992-1994, the CCC model was implemented from 1996-2005, and the PRCE model began in 2005, and is extant today. Prior to 1992, the University of San Francisco (UCSF) also used a Procedural Requirement Curriculum (PRC) which emphasized individual procedure counting, and was not directly compared with the three other curriculum. Important to note, the literature search the authors conducted could not find data to support that competence comes from repetition (as in the PRC model), i.e. the more a student does a procedure, the better they will be. In fact, a study performed within medicine determined there was no direct link between an increase in the number of procedures and competence, but rather the quality of supervision had the greatest impact on competence level (Wimmers et al., 2006).

The DBC approach used relative value units (RVUs) to determine a student's competence, which valued assessing the students within a dental discipline, rather than on individual requirements. With the RVU driven curriculum, the students had to complete a

certain amount of restorative procedures, but there were no requirements for the type of restorative procedure performed (White et al., 2017). This system also saw a large amount of student neglect regarding patient procedures and preventive care not being emphasized, and was discarded after four years. As previously mentioned, the CCC model focused on patient-centered care, based on the assumption that if the student simply focused on the patient, enough clinical experience to demonstrate competence would be gained (Park et al., 2011).

The UCSF used data from their Electronic Health Records (EHR) from 1992-2013 from the third- and fourth-year classes (White et al., 2017). The data collected were patient visits (PVs), equivalent amounts (EQAs), and relative value units (RVUs). The EQAs represented the dollar amount assigned to the procedure, and the RVUs represented a point system for course requirements that considers the complexity of the procedures, materials used, as well as the skill level of the practitioner. Minimum experience thresholds (MET) and a high experience thresholds (HET) were calculated using one standard deviation above and below the mean when using a discipline-based curriculum. Students were evaluated based on if they were less than or equal to the MET (designated low achievers) or greater than or equal to HET (designated high achievers). The CCC approach granted students course credit for putting the patient first, and the school allowed general practice faculty to cover students, rather than specialist faculty, so students can more easily acquire appointments for their patients. In fact, it was implemented in part because under the DBC model preventive procedures (such as prophylaxis and exams) were deemphasized by students. In 2005, there was a schoolwide reform to shift from a “comprehensive care” approach to a more “patient-centered”

approach. The procedural-requirement system returned to UCSF, but was altered to incorporate credit for externships.

There were significant differences in all three curricula in every dental specialty except fixed prosthodontics (White et al., 2017). The mean clinical experience for the students in PRCE was much higher than the other two curricula, but the PVs, RVUs, and EQAs were much lower. There were more high achieving students and fewer low achievers in the PRCE curriculum. The PRCE curriculum showed significantly higher totals in restorative dentistry, but had lower totals in the other dental specialties. The RVUs were highest in the PRCE curriculum, when they included externships. The EQAs were higher in the CCC approach than the other two disciplines. The PRCE curriculum also offered students a variety of experiences and exposure to rural and underserved populations. This alternative clinical exposure offers a richer educational experience because students are exposed to different clinical faculty, and different clinical experiences.

Changing the curriculum from a DBC to CCC demonstrated a significant increase in clinical experience, possibly since the requirements were removed, the students took responsibility for patient-centered care (White et al., 2017). However, the students' experience in removable prosthodontics continued to steadily decline once the CCC began. This finding could have been a change in the patient population, or that the students did not pursue complex procedures once the requirement was taken away. After the DBC curricula were removed, there was not a way to record if students graduated with any removable or full denture experience, because of the way data was measured. In

addition, if the students completed bridges or crowns in fixed prosthodontics was also not able to be determined (White et al., 2017).

Students may not work effectively to provide preventive procedures under certain curricular models (like the DBC model discussed above) for a variety of reasons. Providing this care may not be one of the student's individual remaining requirements, the number of the clinic sessions available to the students may be limited and more faculty supervision may be needed (White et al., 2017; Chandra, 2017). And, as stated above, the student's priorities for certain requirements needed for graduation may not place providing preventive or supportive periodontal care as a high importance (White et al., 2017; Chandra, 2017). The proposed current study can determine how often the students do provide adequate preventive care.

One dental school assessed if dental student graduates felt they were able to deliver quality periodontal care within their curriculum (Chandrasekaran et al., 2017). The purpose of the study was to examine how students felt about the quality of periodontal care provided to their patients. The research contained both a quantitative and qualitative component. In the final year of dental school, students were asked to self-assess the adequacy and timeliness of the periodontal care provided to patients, and then a reason of why that statement is justified. All of the statements were analyzed to determine common themes. The themes were categorized as "patient-related" (i.e. finances, appointment compliance, and medical status) or "student/school-related" (i.e. requirements, rotations, and a greater focus on other aspects of dentistry). Only 36.9% of the combined ISP and DS students believed they were able to deliver good periodontal care to their patients, and there was a drastic difference in the reporting between the

traditional dental students (DS) and international dental students (ISP). Only 19.7% DS reported good periodontal care contrasting with 60.4% of ISP students. Patient-related themes of inadequate periodontal care were identified as compliance with appointments (61.6%), finances (46.4%), patient's medical status (20.5%), patient's emphasis on other dental care needs (17.4%), more urgent dental needs (18.3%), patient awareness of the importance of periodontal care (16.4%), and oral hygiene compliance (11.4%). The student/school related themes of inadequate periodontal care were multiple providers in patient care (22.8%), student oversight (21.3%), academic requirements (20.9%), not enough operator sessions (19.4%), clinical rotations (18.3%) and students' preference to focus on other dental procedures (17.9%).

The drastic difference in the student self-assessments between the international and traditional dental students (only 19.7% traditional dental students versus 60.4% ISP students thought they provided good periodontal care) could be attributed to the international students having previous training in dentistry. Not surprisingly, the biggest problem the students identified for lack of adequate periodontal care could be attributed to a lack of compliance with scheduled appointments and patient finances. The ISP students considered the third most reported patient related theme to be the medical status of their patients; medically compromised patients will also have barriers to access to care because of mobility issues, finances, and scheduling conflicts. Over 1/5 of the students (21.3%) reported personal oversight as the reason the patients' poor periodontal care. Other common themes such as being overwhelmed by student requirements (20.9%) and limited operator sessions (19.4%) were reported.

Student rotations were a constant disruption problem in a 4th year DS schedule, and could be another reason for the drastic difference between the ISP and DS reporting. The ISP classes do not participate in clinical rotations. The problems of patient emphasis on other procedures (17.5%), student emphasis on other dental procedures (17.9%), more urgent dental needs (18.3%), and lack of knowledge about periodontal care (16.4%) were also common. One student commented when the patient comes in for a dental procedure, they can see what was done, but do not really understand what happens subgingivally. The limitations of this study included not having quantitative data from the school to correlate with student subjective perceptions, and it was only conducted with data from one dental school.

One way to encourage better periodontal care in a dental school setting is to create a CODA requirement that addresses periodontal preventive and maintenance care. One university changed their clinical curriculum specifically to address preventive and maintenance care, citing that the Commission of Dental Accreditation (CODA) does not mandate this requirement, and many dental schools struggle with this aspect of dentistry (Afshari et al., 2019). The primary goal of this research was to determine if dental schools perceived a problem with preventive and maintenance care. The secondary goal of this study was to develop a competency statement which could be used by CODA. There were three parts to this study. The first part involved sending a survey to the deans of dental schools and directors of advanced prosthodontics with the intent of determining their current practices in preventive and maintenance care. In the second phase of this study, the authors developed a committee to discuss the needs of a preventive and maintenance care standard for CODA. In the final phase of this project, a consensus was

made of what the competency statement should include. The response rate of the predoctoral dental schools was 46%, and the response rate from the advanced prosthodontic programs was 47%. The results from the survey suggested the participating schools were not primarily focused on preventive, maintenance, and supportive periodontal care. The committee of researchers met on April 12, 2018 for a one-day workshop. Following the workshop, the following competency statement was created:

Graduates should be able to organize and implement an evidence-based recall program/system customized to each patient. Graduates should possess knowledge, skills, and values to assess, prevent, and manage dental caries while providing periodontal and prosthesis supportive care and head and neck cancer screening.

Graduates should have the knowledge and skills to promote a supportive, patient-centered home maintenance program (Afshari et al., 2019, p. 775).

The authors determined a need for a more robust clinical curriculum to address prevention and supportive care for dental and periodontal therapy, and suggested future models include working with dental hygienists to address this need. The authors suggested a means to include a more robust preventive and maintenance program: establish a system with efficient forms in the electronic health record (EHR) to address prevention, faculty calibration, student assessments, and a reward system for students. This reward system would include focusing on using RVUs, rather than on requirements.

Clinical curricular models in dentistry often have the students complete a set number of required procedures, even though repetition has not been directly correlated with competence. Different curricular models have been tested, and under these new models, students sometimes provided far more patient care in general. Prevention and

maintenance care has not historically been emphasized in dental schools, and in one study, the students self-assessed they did not provide quality periodontal care to their patients. In recent decades, dental schools have attempted to place more of an emphasis in prevention and maintenance of periodontal disease, and have even postulated creating a new CODA requirement.

Summary of Chapter 2

Clinical curricula models in dental schools have undergone many changes over decades, and have inherent problems because they can prioritize student requirements over thorough patient care. To address this problem, many different curricula models have been tested over decades, and have shown various success rates in emphasizing prevention of disease in the oral cavity rather than just treating the existing disease. Students do not perceive themselves as providing good periodontal care, and a new CODA standard might need to be created.

Chapter 3 Methodology

The purpose of this study was to evaluate if patients at one dental education institution are receiving appropriate care based on their periodontal diagnosis in a timely manner. The sections in this chapter were designed to provide a comprehensive overview of the research design, context, participants, collection of data, procedures and protocols, limitations, and proposed analysis.

Research Design

This study used a retrospective design to evaluate data from July 2018-February 2020 from the University of Colorado School of Dental Medicine to determine if patients at one dental school received appropriate care based on their diagnosis in a timely manner. Extracting existing data was chosen for this research because data could be sorted into different categories using different computer parameters and variables. Data was organized into a spreadsheet to identify procedures that were completed on patients. According to Creswell & Creswell (2018) a quantitative research design can be used to predict a relationship between certain variables. The process in the study tested how often patients receive timely preventive and periodontal care. The patient records were also screened to determine if patients received a periodontal diagnosis, whether it was based on the 2018 AAP Classification Guidelines, and if appropriate preventive and therapeutic procedures were completed. In addition, determining how the type or year dental student influenced decisions in providing timely preventive care was assessed. The parameters for determining if an appropriate diagnosis was made by comparing the 2018 Classification Guidelines with an evaluation of the extent, distribution, and severity of the

disease in addition to a risk assessment. The parameters assessing appropriate preventive procedures included if the patient received a debridement determined by their diagnosis.

Research Context

Data was obtained from the University of Colorado School of Dental Medicine, which is located on the Anschutz Medical Campus in Aurora, CO. Aurora is the third largest city in Colorado, with 381,000 diverse residents. The University of Colorado School of Dental Medicine has around 100 faculty members, and provides 100,000 clinical visits per year. The University of Colorado School of Dental Medicine is an institution in which there are 320 traditional dental students and 80 international dental students.

Research Participants

This study did not include research participants per se, but examined charts of patients, and the type and year of dental student.

Sample Description

The purposive sample of patient charts was obtained from the University of Colorado School of Dental Medicine. Any individual who had a comprehensive oral evaluation in the time frame between July 2018-Feb 2020 was sorted by the electronic record keeping system (AxiUm) to determine if they had periodontal preventive care within 90 days of that evaluation. Those charts were further electronically sorted into two categories: ones who had other dental treatment (anything outside of the procedures listed in Appendix B) in those 90 days, and those who did not. Those who had dental treatment outside of preventive or therapeutic periodontal procedures were further sorted. AxiUm also eliminated any records of patients who had dentures placed at any time following the

appointment, or had preventive or therapeutic periodontal care within 30 days of the evaluation.

Inclusion/Exclusion Criteria

Patient records which indicated a comprehensive oral evaluation was performed, did not have preventive or therapeutic periodontal procedure within 90 days, and had treatment outside of the procedures listed in Appendix B were included. These charts were further scrutinized to determine if a preventive or therapeutic periodontal was indicated, but was not completed within the 90-day time frame. Charts of patients seen between the time frame of July 2018-February 2020 were included.

Patient records which had preventive or therapeutic treatment within 90 days of their comprehensive evaluation were excluded. In addition, patients records which showed a combination of partial and full dentures at any time were excluded. The charts which ‘had other treatment’ were hand sorted to determine what the treatment was. Excluded charts from this data set included patients who had necessary emergency treatment prior to preventive or therapeutic periodontal procedures. In addition, any patient who received preventive or therapeutic periodontal treatment in the 30 days prior to receiving an exam were excluded.

Human Subjects Protection

An application was sent to the Idaho State University Human Subjects Committee seeking exempt status approval, and the institutional review board declared it did not meet the definition of research, and therefore was not subject to review by the Institutional Review Board. The records from the patients who received a comprehensive oral evaluation, but no preventive treatment within 90 days from the time frame of July

2018-February 2019 were then screened. Data was kept confidential by using a chart number which has no patient identifiers, and was kept confidential in One Note which is password protected. Once the charts are identified for inclusion in the study and the data is extracted, data will then be kept in a locked file cabinet at Idaho State University (ISU) for seven years, and destroyed according to university protocol.

Data Collection

Data was collected from patient charts from the time frame of July 2018-February 2020. Data was included from patient charts which had a comprehensive periodontal evaluation or a comprehensive oral evaluation, and did not have preventive or therapeutic periodontal diagnosis or treatment within 90 days. Any of these charts of patients who received dentures after the evaluation, or preventive or therapeutic periodontal procedures within 30 days, were not collected.

Procedures and Protocols

A computer generated a list of patients from July 2018 to February 2020 was examined at the University of Colorado School of Dental Medicine. The patient records were sorted by AxiUm to determine if the individuals had a comprehensive oral evaluation by dental codes (See Appendix A). From the patient files that had received a comprehensive evaluation, these files were further electronically sorted into two categories of patients. The first category of patients were those who received preventive or therapeutic periodontal therapy (See Appendix B) within 90 days, and those who did not. The charts of patients who did not receive preventive or periodontal therapy within 90 days were further electronically sorted to determine if they had any dental procedures outside of Appendix B. Of these files, patients who had dentures on either or both of the

maxillary and mandibular arches, and those who received a preventive or periodontal procedure 30 days prior to their comprehensive oral evaluation were eliminated. Patient files which determined the patient was under 18 years old were eliminated. In addition, if the patient had emergency treatment, a consult, or limited oral evaluation the chart was not considered further. At this point, patient records were individually sorted to determine if they received a periodontal diagnosis, and if it was based on a comprehensive assessment. The researcher then confirmed if the periodontal diagnosis was based on the new 2018 AAP Classification Guidelines. If these criteria were met, it was determined if preventive prophylactic or appropriate therapeutic periodontal treatment were rendered based on the diagnosis. Finally, the year of dental student, and type of dental student was identified. Appendix C is a table of the inclusion and exclusion procedures.

Limitations

The limitation of this study was the population being studied was only taken from one dental institution, and therefore cannot be generalized to every dental institutions' population. In addition, curricula systems vary between dental schools, so this particular curriculum cannot be generalized to every dental school. In addition, significant record data could not be collected beyond February 2020 due to the impact of COVID-19 when the dental school completely shut down for a period of time and then was only partially operating for the entirety of 2020. Therefore, the time frame of the study was limited from July 2018 to February 2020. Nevertheless, the sample of patient records reviewed was substantive for this time period.

Proposed Statistical Analysis

Descriptive and inferential statistics was used to analyze the results. Descriptive statistics includes both frequencies and percentages. A chi square test of association was used to test for statistical significance among variables.

Summary

This chapter described the methodology for this retrospective study on whether or not dental students at one dental school are providing timely and appropriate preventive and periodontal care to their patients based on their diagnosis. A manuscript has been prepared for the Journal of Dental Education. Instructions for the authors can be found at: <https://onlinelibrary.wiley.com/page/journal/19307837/homepage/author-guidelines>

References

- Afshari, F. S., Campbell, S. D., Curtis, D. A., Garcia, L. T., Knoernschild, K. L., & Yuan, J. C. (2019). Patient-Specific, Risk-Based Prevention, Maintenance, and Supportive Care: A Need for Action and Innovation in Education. *Journal of Prosthodontics*, 28(7), 775-783. <https://doi.org/10.1111/jopr.13059>
- American Academy of Periodontology. (2018). Staging and Grading Periodontitis. <https://www.perio.org/sites/default/files/files/Staging%20and%20Grading%20Periodontitis.pdf>
- American Academy of Periodontology. (2019). Comprehensive Periodontal Examination. <https://www.perio.org/consumer/perio-evaluation.htm>
- American Dental Association. (2015). CSA defines oral health through cross-organizational effort. <https://www.ada.org/en/publications/ada-news/2015-archive/January/csa-defines-oral-health-through-cross-organizational-effort>
- American Dental Association. (2020). Dental Quality Alliance. <https://www.ada.org/en/science-research/dental-quality-alliance/about-dqa>
- American Dental Education Association. (2019a). ADEA Policy Statements: Recommendations and Guidelines for Academic Dental Institutions. https://www.adea.org/about_adea/governance/Documents/ADEA_Policy_Statements__Recommendations_and_Guidelines_for_Academic_Dental_Institutions.html
- American Dental Education Association. (2019b). ADEA Snapshot of Dental Education 2019-2020. https://www.adea.org/uploadedFiles/ADEA/Content_Conversion_Final/deansbriefing/2019-20_ADEA_Snapshot_of_Dental_Education.pdf

- American Dental Education Association. (2019c). Dental School Curriculum.
https://www.adea.org/GoDental/Future_Dentists/Dental_School_Curriculum.aspx
- American Dental Education Association. (2019d). International Students.
https://www.adea.org/GoDental/Non-traditional_Applicants/International_students.aspx
- Axelsson, P., & Lindhe, J. (1981). The significance of maintenance care in the treatment of periodontal disease. *Journal of Clinical Periodontology*, 8(4), 281-294.
<https://doi.org/10.1111/j.1600-051x.1981.tb02039.x>
- Buset, S. L., Walter, C., Friedmann, A., Weiger, R., Borgnakke, W. S., & Zitzmann, N. U. (2016). Are periodontal diseases really silent? A systematic review of their effect on quality of life. *Journal of Clinical Periodontology*, 43(4), 333-344.
<https://doi.org/10.1111/jcpe.12517>
- Centers for Disease Control and Prevention. (2011). Oral Health Preventing Cavities, Gum Disease, Tooth Loss, and Oral Cancers.
<https://stacks.cdc.gov/view/cdc/11862>
- Centers for Disease Control and Prevention. (2013). Periodontal Disease.
<https://www.cdc.gov/oralhealth/conditions/periodontal-disease.html>
- Chandrasekaran, S., Powell, C., De la Rosa, L., Mittal, A., & Johnson, L. (2017). Dental Students' Reflections on Quality of Periodontal Care in Dental School Clinics. *Journal of Dental Education*, 81(1), 14-21. <https://doi.org/10.1002/j.0022-0337.2017.81.1.tb06242.x>
- Chapple, I. L. C., Mealey, B. L., Van Dyke, T. E., Bartold, P. M., Dommisch, H., Eickholz, P., Geisinger, M. L., Genco, R. J., Glogauer, M., Goldstein, M., Griffin,

- T. J., Holmstrup, P., Johnson, G. K., Kapila, Y., Lang, N. P., Meyle, J., Murakami, S., Plemons, J., Romito, G. A., Shapira, L., Tatakis, D. N., Teughels, W., Trombelli, L., Walter, C., Wimmer, G., Xenoudi, P., & Yoshie, H. (2018). Periodontal health and gingival diseases and conditions on an intact and a reduced periodontium: Consensus report of workgroup 1 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *Journal of Periodontology*, 89 Suppl 1, S74-s84. <https://doi.org/10.1002/jper.17-0719>
- Costa, F. O., Lages, E. J., Cota, L. O., Lorentz, T. C., Soares, R. V., & Cortelli, J. R. (2014). Tooth loss in individuals under periodontal maintenance therapy: 5-year prospective study. *Journal of Periodontal Research*, 49(1), 121-128. <https://doi.org/10.1111/jre.12087>
- D'Souza, S., & Addepalli, V. (2018). Preventive measures in oral cancer: An overview. *Biomedicine and Pharmacotherapy*, 107, 72-80. <https://doi.org/10.1016/j.biopha.2018.07.114>
- Eke, P. I., Dye, B. A., Wei, L., Slade, G. D., Thornton-Evans, G. O., Borgnakke, W. S., Taylor, G. W., Page, R. C., Beck, J. D., & Genco, R. J. (2015). Update on Prevalence of Periodontitis in Adults in the United States: NHANES 2009 to 2012. *Journal of Periodontology*, 86(5), 611-622. <https://doi.org/10.1902/jop.2015.140520>
- Eke, P. I., Thornton-Evans, G. O., Wei, L., Borgnakke, W. S., Dye, B. A., & Genco, R. J. (2018). Periodontitis in US Adults: National Health and Nutrition Examination

- Survey 2009-2014. *Journal of the American Dental Association*, 149(7), 576-588.e576. <https://doi.org/10.1016/j.adaj.2018.04.023>
- Formicola, A. J. (2008). Dental school clinics as patient care delivery centers: a paradigm shift in dental education. *Journal of Dental Education*, 72(2 Suppl), 18-20.
http://www.jdentaled.org/content/jde/72/2_suppl/18.full.pdf
- Formicola, A. J., Myers, R., Hasler, J. F., Peterson, M., Dodge, W., Bailit, H. L., Beazoglou, T. J., & Tedesco, L. A. (2006). Evolution of dental school clinics as patient care delivery centers. *Journal of Dental Education*, 72(2 Suppl), 110-127.
- Gil-Montoya, J. A., de Mello, A. L., Barrios, R., Gonzalez-Moles, M. A., & Bravo, M. (2015). Oral health in the elderly patient and its impact on general well-being: a nonsystematic review. *Clinical Interventions in Aging*, 10, 461-467.
<https://doi.org/10.2147/cia.S54630>
- Glick, M., & Meyer, D. M. (2014). Defining oral health: a prerequisite for any health policy. *Journal of the American Dental Association*, 145(6), 519-520.
<https://doi.org/10.14219/jada.2014.41>
- Goodson, J. M., Haffajee, A. D., & Socransky, S. S. (1984). The relationship between attachment level loss and alveolar bone loss. *Journal of Clinical Periodontology*, 11(5), 348-359. <https://doi.org/10.1111/j.1600-051x.1984.tb01331.x>
- Graziani, F., Karapetsa, D., Alonso, B., & Herrera, D. (2017). Nonsurgical and surgical treatment of periodontitis: how many options for one disease? *Periodontology* 2000, 75(1), 152-188. <https://doi.org/10.1111/prd.12201>
- Helmi, M. F., Huang, H., Goodson, J. M., Hasturk, H., Tavares, M., & Natto, Z. S. (2019). Prevalence of periodontitis and alveolar bone loss in a patient population

- at Harvard School of Dental Medicine. *BMC Oral Health*, 19(1), 254.
<https://doi.org/10.1186/s12903-019-0925-z>
- Highfield, J. (2009). Diagnosis and classification of periodontal disease. *Australian Dental Journal*, 54 Suppl 1, S11-26. <https://doi.org/10.1111/j.1834-7819.2009.01140.x>
- Holmes, D. C., Trombly, R. M., Garcia, L. T., Kluender, R. L., & Keith, C. R. (2000). Student productivity in a comprehensive care program without numeric requirements. *Journal of Dental Education*, 64(11), 745-754.
<https://onlinelibrary.wiley.com/doi/abs/10.1002/j.0022-0337.2000.64.11.tb03378.x?sid=nlm%3Apubmed>
- Johnson, G. (1999). A comprehensive care clinic in Swedish dental undergraduate education: 3-year report. *European Journal of Dental Education*, 3(4), 148-152.
<https://doi.org/10.1111/j.1600-0579.1999.tb00084.x>
- Kawar, N., & Alrayyes, S. (2011). Periodontitis in Pregnancy: The Risk of Preterm Labor and Low Birth Weight. *Disease-a-Month*, 57(4), 192-202.
<https://doi.org/https://doi.org/10.1016/j.disamonth.2011.03.005>
- Kumar, S. (2019). Evidence-Based Update on Diagnosis and Management of Gingivitis and Periodontitis. *Dent Clin N*, 63(1), 69-81.
<https://doi.org/10.1016/j.cden.2018.08.005>
- Lang, N. P., Schätzle, M. A., & Loe, H. (2009). Gingivitis as a risk factor in periodontal disease. *Journal of Clinical Periodontology*, 36(supplement), 3-8.
<https://doi.org/10.1111/j.1600-051X.2009.01415.x>

- Lindhe, J., & Nyman, S. (1984). Long-term Maintenance of Patients Treated for Advanced Periodontal Disease. *J Clin Periodontology*, 11(8), 504-514.
<https://doi.org/10.1111/j.1600-051x.1984.tb00902.x>
- Löe, H., Anerud, A., Boysen, H., & Morrison, E. (1986). Natural history of periodontal disease in man. Rapid, moderate and no loss of attachment in Sri Lankan laborers 14 to 46 years of age. *Journal of Clinical Periodontology*, 13(5), 431-445.
<https://doi.org/10.1111/j.1600-051x.1986.tb01487.x>
- Löe, H., Anerud, A., Boysen, H., & Smith, M. (1978). The natural history of periodontal disease in man. The rate of periodontal destruction before 40 years of age. *Journal of Periodontology*, 49(12), 607-620.
<https://doi.org/10.1902/jop.1978.49.12.607>
- Manresa, C., Sanz-Miralles, E. C., Twigg, J., & Bravo, M. (2018). Supportive periodontal therapy (SPT) for maintaining the dentition in adults treated for periodontitis. *Cochrane Database of Systematic Reviews*, 1(1), Cd009376.
<https://doi.org/10.1002/14651858.CD009376.pub2>
- National Institute of Dental and Craniofacial Research. (2019). 2020 Surgeon General's Report. Oral Health in America: Advances and Challenges.
https://www.nidcr.nih.gov/sites/default/files/2019-08/SurgeonGeneralsReport-2020_IADR_June%202019-508.pdf
- Newman, M. G., Takai, H. H., Klokkevold, P. R., & Carranza, F. A. (2019). *Newman and Carranza's Clinical Periodontology* (13th ed.). Elsevier.

- Nyman, S., Lindhe, J., & Rosling, B. (1977). Periodontal surgery in plaque-infected dentitions. *Journal of Clinical Periodontology*, 4(4), 240-249.
<https://doi.org/10.1111/j.1600-051x.1977.tb01896.x>
- Office of Disease Prevention and Health Promotion. (2020). Healthy people 2020 Oral Health. <https://www.healthypeople.gov/2020/leading-health-indicators/2020-lhi-topics/Oral-Health>
- Pan, W., Wang, Q., & Chen, Q. (2019). The cytokine network involved in the host immune response to periodontitis. *Int J Oral Sci*, 11(3), 30.
<https://doi.org/10.1038/s41368-019-0064-z>
- Park, S. E., Timoth  , P., Nalliah, R., Karimbux, N. Y., & Howell, T. H. (2011). A case completion curriculum for clinical dental education: replacing numerical requirements with patient-based comprehensive care. *Journal of Dental Education*, 75(11), 1411-1416.
<http://www.jdentaled.org/content/jde/75/11/1411.full.pdf>
- Ramos-Jorge, J., Pordeus, I. A., Ramos-Jorge, M. L., Marques, L. S., & Paiva, S. M. (2014). Impact of untreated dental caries on quality of life of preschool children: different stages and activity. *Community Dentistry and Oral Epidemiology*, 42(4), 311-322. <https://doi.org/10.1111/cdoe.12086>
- Ramseier, C., Anerud, A., Dulac, M., Lulic, M., Cullinan, M., Seymour, G., Faddy, M., B  rgin, W., Sch  tzle, M., & Lang, N. (2017). Natural history of periodontitis: Disease progression and tooth loss over 40 years. *Journal of Clinical Periodontology*, 44(12), 1182-1191. <https://doi.org/10.1111/jcpe.12782>

- Spector, M., Holmes, D. C., & Doering, J. V. (2008). Correlation of quantity of dental students' clinical experiences with faculty evaluation of overall clinical competence: a twenty-two-year retrospective investigation. *Journal of Dental Education*, 72(12), 1465-1471.
<http://www.jdentaled.org/content/jde/72/12/1465.full.pdf>
- Sun, L., Wong, H. M., & McGrath, C. P. J. (2018). The factors that influence oral health-related quality of life in young adults. *Health Qual Life Outcomes*, 16(1), 187.
<https://doi.org/10.1186/s12955-018-1015-7>
- Trombelli, L., Franceschetti, G., & Farina, R. (2015). Effect of professional mechanical plaque removal performed on a long-term, routine basis in the secondary prevention of periodontitis: a systematic review. *Journal of Clinical Periodontology*, 42 Suppl 16, S221-236. <https://doi.org/10.1111/jcpe.12339>
- U.S. Department of Health and Human Services, N. I. o. D. a. C. R., National Institutes of Health,. (2000). Oral Health in America: A Report of the Surgeon General.
<https://www.hhs.gov/surgeongeneral/priorities/oral-health/index.html>
- van der Weijden, F., & Slot, D. E. (2011). Oral hygiene in the prevention of periodontal diseases: the evidence. *Periodontology 2000*, 55(1), 104-123.
<https://doi.org/10.1111/j.1600-0757.2009.00337.x>
- Van der Weijden, G. A., Dekkers, G., & Slot, D. (2019). Success of non-surgical periodontal therapy in adult periodontitis patients: A retrospective analysis. *International Journal of Dental Hygiene*, 17(4), 309-317.
<https://doi.org/10.1111/idh.12399>

- Van der Weijden, G. A. F., Dekkers, G. J., & Slot, D. E. (2019). Success of non-surgical periodontal therapy in adult periodontitis patients: A retrospective analysis. *International Journal of Dental Hygiene*, 17(4), 309-317.
<https://doi.org/10.1111/idh.12399>
- Varela-Centelles, P., Diz-Iglesias, P., Estany-Gestal, A., Seoane-Romero, J. M., Bugarín-González, R., & Seoane, J. (2016). Periodontitis Awareness Amongst the General Public: A Critical Systematic Review to Identify Gaps of Knowledge. *Journal of Periodontology*, 87(4), 403-415. <https://doi.org/10.1902/jop.2015.150458>
- Walji, M. F., Karimbux, N. Y., & Spielman, A. I. (2017). Person-Centered Care: Opportunities and Challenges for Academic Dental Institutions and Programs. *Journal of Dental Education*, 81(11), 1265-1272.
<https://doi.org/10.21815/jde.017.084>
- Westfelt, E., Rylander, H., Dahlén, G., & Lindhe, J. (1998). The effect of supragingival plaque control on the progression of advanced periodontal disease. *Journal of Clinical Periodontology*, 25(7), 536-541. <https://doi.org/10.1111/j.1600-051x.1998.tb02484.x>
- White, J. M., Jenson, L. E., Gansky, S. A., Walsh, C. J., Accurso, B. T., Vaderhobli, R. M., Kalenderian, E., Walji, M. F., & Cheng, J. (2017). Dental Students' Clinical Experience Across Three Successive Curricula at One U.S. Dental School. *Journal of Dental Education*, 81(4), 366-377.
<https://doi.org/10.21815/jde.016.010>

Wimmers, P. F., Schmidt, H. G., & Splinter, T. A. (2006). Influence of clerkship experiences on clinical competence. *Medical Education*, 40(5), 450-458.

<https://doi.org/10.1111/j.1365-2929.2006.02447.x>

World Health Organization. (2020a). *Constitution*. <https://www.who.int/about/who-we-are/constitution>

World Health Organization. (2020b). The Liverpool Declaration: Promoting Oral Health in the 21st Century.

https://www.who.int/oral_health/events/liverpool_declaration/en/

Appendix A

Table 1 Diagnostic CDT Codes

Procedure	Description
D0150	Comprehensive oral evaluation
D0150-1	Comprehensive oral evaluation - simple
D0150-2	Comprehensive oral evaluation - moderate
D0150-3	Comprehensive oral evaluation - complex
D01501	Comprehensive oral evaluation - simple
D01502	Comprehensive oral evaluation - moderate
D01503	Comprehensive oral evaluation - complex
D0150NC	Comprehensive oral evaluation REFERRAL ONLY
D0180	Comprehensive periodontal evaluation

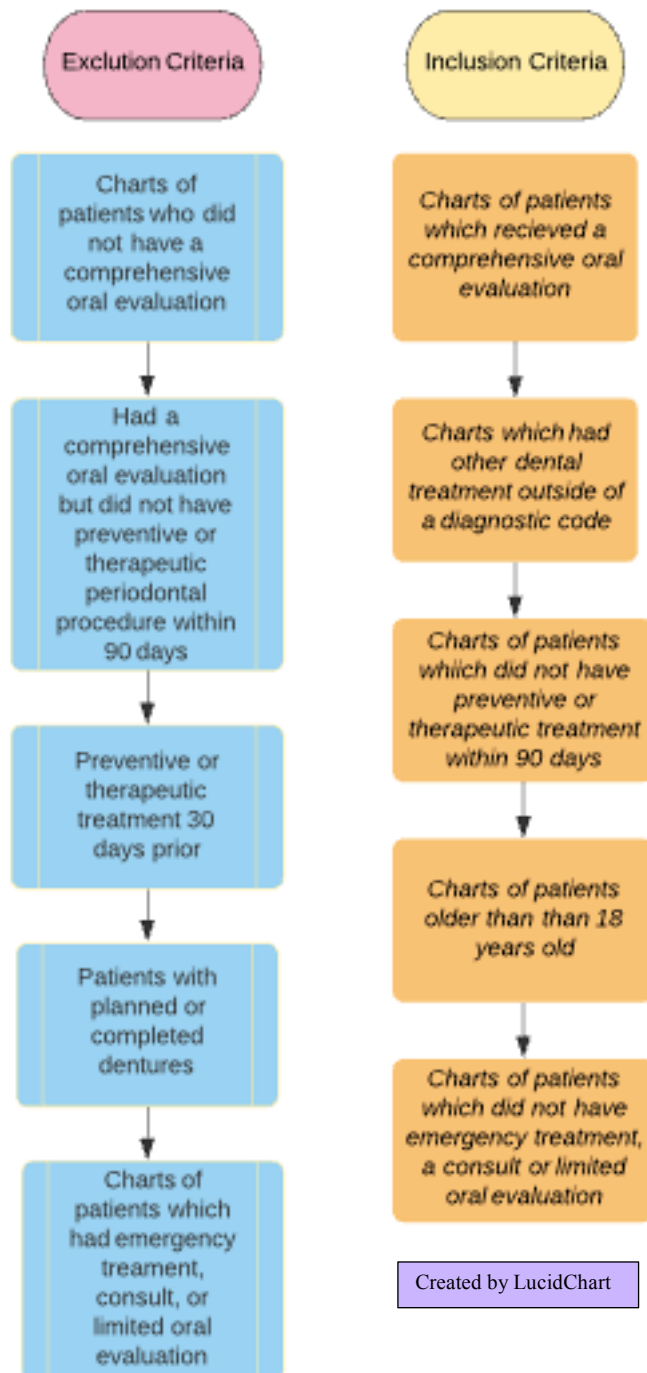
Appendix B

Table 2 Preventive and Therapeutic Periodontal CDT Codes

D1110	Prophylaxis - adult
D1110-5	Adult prophylaxis for 10 teeth or less
D4341	Periodontal scaling and root planing 4+ teeth, per quad
D4342	Periodontal scaling and root planing 1-3 teeth per quad
D4346	Scaling in the presence of gingival inflammation – full mouth
D4355	Full mouth debridement to enable evaluation subsequent visit
D4910	Periodontal maintenance
D4910-5	Periodontal maintenance - limited

Appendix C

Table 3 Patient Records Inclusion and Exclusion Criteria



Title Page of Manuscript

Investigating Periodontal Care Provided at a Dental Education Institution

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Abstract

The purpose of this study was to evaluate if patients at one dental education institution received appropriate care based on their periodontal diagnosis in a timely manner. This study used a retrospective design to evaluate data from July 2018 to February 2020. The patient records were screened to determine if patients received a periodontal diagnosis, whether the diagnosis followed the 2018 AAP Classification Guidelines, and if appropriate preventive and therapeutic procedures were completed in a timely manner. In addition, the type or year of dental student providing the procedure was also recorded. Data was analyzed using descriptive statistics and a chi square test. A total of 612 charts were generated for review and 157 met the inclusion criteria and were evaluated. Results revealed that more than half (56.7%) of the patient records did not demonstrate a periodontal diagnosis and another 10.8% did not follow current AAP Classification Guidelines. Most patients (n=125, 79.6%) had a comprehensive periodontal assessment performed, while 32 (20.4%) had no comprehensive periodontal charting information recorded. Further, of the 157 records reviewed, 96 (61.1%) had no periodontal treatment specified. A statistically significant difference with a modest association was found between type of dental student and year based on periodontal diagnosis (Fisher's Exact Test value = 20.72, $p=0.001$, Cramer's $V = 0.25$). Documentation of key clinical information, diagnostic conclusions, and treatment rendered requires curriculum review. Further studies are warranted to determine if similar findings exist among other dental school education programs.

Key Words: periodontal diagnosis, dental students, preventive and therapeutic periodontal procedures

INTRODUCTION

Over 70 years ago, the World Health Organization determined health to be a general sense of well-being considering mental, physical, and social aspects, rather than simply the absence of disease.¹ The concept of oral health as a significant contributor to general health and well-being was not completely recognized until the Surgeon General's report in 2000, where it was addressed as a public health issue.² Oral health, or lack thereof, has been linked to cardiovascular disease, diabetes, stroke, malnutrition, aspiration pneumonia, and obesity.³⁻¹⁰ In addition, the decline in quality of life suffered by oral diseases should not be discounted, and several studies illustrate how poor oral health can impact a person's quality of life.^{3,4,7,9-11} Almost half of adults who are at least 30 years old have periodontal disease in some form, and that number increases with age.^{12,13} Fortunately, oral diseases including periodontal disease can largely be prevented.^{2,8,12} Unfortunately, there are many obstacles to achieving good oral health. These social determinants include level of education and income, geographic location (living in an area without access to oral care), sociodemographic status, and even gender, race and ethnicity.^{2,13} In addition, there are external risk factors that affect oral health; they include smoking, the human papilloma virus (HPV), herpes simplex virus (HSV), alcohol intake, and a poor diet, among others.^{14,15} Oral diseases affect an estimated 3.5 billion people world-wide.¹³

The 2000 Surgeon General's Report (2000) stated dentistry needs to shift its focus from simply restoring health to producing a healthy oral cavity, and preventive care is a keystone in maintaining health in the oral cavity.^{2,6,10,16} Focusing on periodontal and preventive care in dental curricula provides a way to produce dental health and address

the needs of the public. Including an emphasis on prevention and maintenance of periodontal disease will likely involve a change in the clinical curricular models in dental schools today. Afshari et al stated: “The goal of both restoring and maintaining dental oral health requires the provider to complete a thorough risk assessment, diagnosis, treatment planning, and completion of planned therapies.”¹⁷ The majority of curricula models in dental schools are spent in clinical instruction.¹⁸ As such, dental school clinics are charged with the difficult task of balancing quality patient care with effective instruction to dental students.

One hundred years ago, Alfred Owre, the dean of two of the dental schools in the United States, postulated the faculty would provide most of the dental care, and the students would only do treatment within their capabilities.¹⁹ Today, the paradigm in dental schools has shifted to one in which the *students* provide most of the patient services under faculty supervision, and, unfortunately, patient care can become a “secondary by-product of education.”¹⁹ In addition, not only do current dental school curricula models show specific treatments might even be selected based on the needs of the student, but also that requirement-based systems neither serve dental student educational purposes, or provide optimal patient care.^{19,20} Providing patient care with requirement-based curricula models were based on the theory that repetition creates competence; however, studies have shown that is not necessarily true.^{21,22} Lastly, with the current system, patient care has become inefficient.¹⁸ Many dental schools have recognized this problem and have addressed it by creating curricula based on person-centered care, rather than student-centered care.^{23,24} In the 1990s, dental school clinics started recognizing the need for a more comprehensive care approach, and by the early

2000s, many different clinical curricula models had been tested.^{21, 24, 25} Instead of focusing on a prescribed amount of procedures to complete, students could actually be more clinically productive in a system which is not procedural-based.^{21, 24}

Predoctoral dental students often have to manage all the patients assigned to them, or a “patient pool,” during their course of study and many of these patients have periodontitis. A study published in 2019 demonstrated evidence of periodontitis being greater in a dental school environment than the general population from a 46% in the general population, to 55% at one dental school.²⁶ In addition, it is logical to conclude that because periodontitis is greater when there is a lower socioeconomic status (SES), patients with lower SES will seek less expensive dental care which can be found in dental schools.²⁷ Treating and managing periodontal disease among this population can be difficult, and if preventive and periodontal care is omitted, the disease could continue to progress. A variety of factors affect the compliance of patients on a maintenance schedule. These factors could be student, patient, or even institution based. There is a strong need for dental schools to evaluate their curricula models, and determine how to include an emphasis on periodontal preventive care. The first step in that process is tracking how often the students provide appropriate periodontal preventive care in a timely manner. Therefore, the purpose of this study was to evaluate if patients at one dental education institution were receiving appropriate care based on their periodontal diagnosis in a timely manner.

METHODS

This retrospective study received exempt IRB approval from the Idaho State Institutional Review Board #20-3157. Patient records were sorted using AxiUm and a

computer-generated listing of charts from July 2018 to February 2020. All records were de-identified to protect patient and student confidentiality.

Records included in the study represented those patients for whom documentation was provided indicating a comprehensive oral evaluation was performed by specific dental codes as provided in Table 1. From these patient files, further categorization occurred based on those patients who received preventive or therapeutic periodontal therapy within 90 days of a comprehensive oral evaluation (referred to as timely treatment) and those who did not. Records were further sorted to determine if a periodontal diagnosis was provided and operationally defined based on the 2018 American Academy of Periodontology (AAP) Classification of Periodontal and Peri-Implant Diseases and Conditions (AAP Classification Guidelines). Inclusion criteria also evaluated for a comprehensive periodontal assessment based on a periodontal charting of gingival depth, bleeding on probing, clinical attachment level, furcation involvement, mobility and radiographic findings. Additional variables included in the study were the type of dental student (traditional vs. international) and year of dental student (third and fourth year traditional and first and second year international).

Exclusion criteria included charts of patients who did receive preventive or therapeutic periodontal therapy within 90 days of a comprehensive oral evaluation, or had any dental procedures outside of the specific dental codes as provided in Table 1. Patients who had dentures on either or both arches, a limited oral evaluation, consults, or those who had emergency treatment as initial procedures were also excluded.

The principal investigator reviewed all charts and created codes for data analysis. Statistical analysis was performed using descriptive statistics and chi square test of association.

RESULTS

A total of 612 charts were generated to be reviewed for this study. Of these patient records, 157 met the inclusion criteria and were evaluated. Of these patient records, it was determined that 89 patients (56.7%) did not receive a periodontal diagnosis, while 17 patients (10.8%) were provided a periodontal diagnosis; however, this diagnosis did not follow current AAP Classification Guidelines. The remaining 51 patients (32.5%) did receive a periodontal diagnosis that followed current AAP Classification Guidelines. Of the total number of patients that did receive any periodontal diagnosis (n=68), 51 patient records (75.0%) had a diagnosis that followed the AAP Classification Guidelines.

Patient records were reviewed to determine if a comprehensive periodontal assessment was performed. Of the 157 patient records examined, 32 (20.4%) had no periodontal charting information noted while 125 (79.6%) did have appropriate periodontal assessment information recorded. For those patients that did receive a periodontal diagnosis (n=68), 8 patients (11.8%) did not have comprehensive periodontal charting information in their patient record while 60 (88.2%) did have appropriate periodontal assessment information provided in the patient records.

Patient records were next evaluated to determine what type of treatment was rendered. Of the 157 records examined, 96 (61.1%) had no treatment specified. Nineteen records (12.1%) provided documentation that prophylaxis was performed while 42

records (26.8%) indicated that therapeutic periodontal treatment was rendered. Of the 68 records indicating a periodontal diagnosis was provided, 8 records (11.8%) did not record any treatment provided; 18 records (26.5%) indicated a prophylaxis was performed; and, 42 (61.8%) noted that therapeutic periodontal treatment was provided. Further review was performed to determine if prophylaxis was performed in a timely manner, i.e. within 90 days of a comprehensive oral evaluation. For this review, 15 charts (78.9%) were eligible for review while 4 charts (21.1%) had missing information. Of the 15 records, 12 (80.0%) showed that treatment was not performed in a timely manner while 3 (20.0%) records indicated that prophylactic treatment was performed in a timely manner. In terms of analysis to determine if therapeutic periodontal treatment was performed in a timely manner, 38 charts (90.5%) were eligible for review while 4 charts (9.5%) had missing data. Of the 38 records, 27 (71.1%) indicated that therapeutic periodontal treatment was not performed in a timely manner while 11 records (28.9%) noted that this treatment was performed within 90 days of a comprehensive oral evaluation.

Additional analysis was performed to determine if there was a relationship between dental student type (international vs. traditional) and year of dental student with periodontal diagnosis, comprehensive assessment, and treatment rendered. Table 2 shows the percentages for type of dental student and year based on periodontal diagnosis. As can be seen from this table in the Diagnosis column labeled 0, a large percentage of each type of dental student did not provide any periodontal diagnosis for their patient. A χ^2 test was performed to determine if there was an association between these variables. Because two cells had expected counts less than five, the Fisher's Exact Test value = 20.72, $p=0.001$, Cramer's $V = 0.25$ indicating a statistically significant difference with a

modest association. These results suggested the first year international dental students and third year traditional dental students were more likely to provide a periodontal diagnosis using the AAP Classification Guidelines than the second year international dental students or the fourth year traditional dental students. Similar analyses were performed for the comprehensive assessment, preventive and therapeutic treatment rendered. Findings are summarized in Table 3. No tests were statistically significant for these variables.

DISCUSSION

It is estimated 47.2% of adults over 30 years old have some form of periodontal disease, and dental schools may have an even higher percentage of the population with periodontal disease.¹⁻³ In addition, the management of periodontal disease is imperative to a functioning dentition, however, data suggests dentists know less about periodontal disease than they do about dental caries.^{28,29}

Assessment of disease is a critical component in treating disease, and this study determined patients who received a diagnosis were more likely to receive subsequent treatment. However, of the records reviewed in this study, the majority of patients (56.7%) did not receive a periodontal diagnosis. This finding may indicate general dentists are not placing an emphasis on periodontal disease which is consistent in some literature; one author described periodontal health as an “afterthought”.²⁸⁻³⁰ On a positive note, for those records that showed a diagnosis was recorded, the majority (75.0%) were based on the most current guidelines for diagnosing periodontal disease. An interesting finding to note was the students who were *less* experienced (the 1st year international and the 3rd year traditional dental students) were statistically significantly *more* likely to

diagnose periodontal disease. This finding could indicate the more experienced dental students either make a diagnosis without documenting it or forgo a periodontal diagnosis because they are more focused on other requirements needed for graduation.

An important part of the periodontal diagnosis is a comprehensive periodontal assessment represented in the periodontal chart and through radiographic findings. This study demonstrated 20.4% of the subjects did not receive a comprehensive periodontal exam during their oral evaluation. This finding could explain why some records showed a lack of periodontal diagnosis or a lack of documentation of periodontal diagnosis.

Another finding of this study determined some patients received treatment without a diagnosis, which may also indicate dental students make a diagnosis but do not document it, or are not taught to make a connection between the significance of diagnosis and treatment. Further, for many records, treatment was not specified. Lack of documentation of important clinical information, diagnostic conclusions, and treatment rendered is an area that requires curriculum review. Dental students must be educated that information cannot be implicit with reference to patient records. The dental record is the vital document that protects the dental care provider if any type of legal action is initiated. If appropriate documentation is not provided, and recorded information is challenged legally, the result will not be in the student's (or eventual practitioner's) favor.^{31, 32}

The timeliness of treatment for most of the subjects was concerning. The majority (80.0%) of records reviewed showed that patients who were diagnosed as having preventive needs were not treated in a timely manner. Similarly, 71.1% of those who were diagnosed with therapeutic needs were not treated in a timely manner.

Dental school curriculums have long studied how to place an emphasis on more comprehensive care of their patients.^{7, 8} Afshari et al., discussed the lack of importance placed in the dental student curriculum on preventive, supportive and maintenance periodontal care of the oral cavity and recommended offering an additional CODA requirement inclusive of diagnosing and treating periodontal disease, promoting supportive patient-centered home maintenance programs, and implementing an evidence-based re-care program customized to each patient.⁹

This study is not without limitations. This retrospective review was conducted at one dental school and cannot be generalized to other dental school programs. In addition, significant record data could not be collected beyond February 2020 due to the impact of COVID-19 when the dental school completely shut down for a period of time and then was only partially operating for the entirety of 2020. Therefore, the time frame of the study was limited from July 2018 to February 2020. Nevertheless, the sample of patient records reviewed was substantive for this time period.

Considerations for future research include calibration of general dentist faculty on providing a periodontal diagnosis based on the most current guidelines and determining if education and calibration of dental faculty improves periodontal diagnosis status. In addition, including a periodontal diagnosis in the D0150 template note could prompt both faculty and students to diagnose. Further study should also include a study of documentation practices among each year of dental students to evaluate improvement in accuracy of documentation and outcomes of patient care. A comparison of different dental school curricula and patient records could also be investigated to determine the extent to which comprehensive periodontal diagnosis and treatment are provided.

CONCLUSIONS

A retrospective study was conducted to identify if patients at one dental school received appropriate periodontal care based on their periodontal diagnosis in a timely manner. Findings revealed the majority of patients were not provided a periodontal diagnosis and considerable documentation issues existed. Future studies are warranted to determine if similar findings exist among other dental school education programs.

References

1. World Health Organization. Constitution 2020. Available from: <https://www.who.int/about/who-we-are/constitution>.
2. U.S. Department of Health and Human Services NIOH, National Institutes of Health. Oral Health in America: A Report of the Surgeon General. 2000.
3. Buset SL, Walter C, Friedmann A, Weiger R, Borgnakke WS, Zitzmann NU. Are periodontal diseases really silent? A systematic review of their effect on quality of life. *J Clin Periodontol*. 2016;43(4):333-44. Epub 2016/01/27. doi: 10.1111/jcpe.12517. PubMed PMID: 26810308.
4. Gil-Montoya JA, de Mello AL, Barrios R, Gonzalez-Moles MA, Bravo M. Oral health in the elderly patient and its impact on general well-being: a nonsystematic review. *Clin Interv Aging*. 2015;10:461-7. Epub 2015/02/25. doi: 10.2147/cia.S54630. PubMed PMID: 25709420; PubMed Central PMCID: PMC4334280.
5. Kwar N, Alrayyes S. Periodontitis in Pregnancy: The Risk of Preterm Labor and Low Birth Weight. *Dis Mon*. 2011;57(4):192-202. doi: <https://doi.org/10.1016/j.disamonth.2011.03.005>.
6. Kumar S. Evidence-Based Update on Diagnosis and Management of Gingivitis and Periodontitis. *Dent Clin N*. 2019;63(1):69-81. doi: 10.1016/j.cden.2018.08.005.
7. Manresa C, Sanz-Miralles EC, Twigg J, Bravo M. Supportive periodontal therapy (SPT) for maintaining the dentition in adults treated for periodontitis. *Cochrane Database Syst Rev*. 2018;1(1):Cd009376. Epub 2018/01/02. doi: 10.1002/14651858.CD009376.pub2. PubMed PMID: 29291254; PubMed Central PMCID: PMC6491071 known. Manuel Bravo: none known. Through a poster

competition, Carolina Manresa and Elena Sanz-Miralles were awarded a scholarship by SEPA to the course "Evidence Based Dentistry" (Prof. Ian Needleman, Madrid, 7 to 8 November 2008).

8. Office of Disease Prevention and Health Promotion. Healthy people 2020 Oral Health. 2020.
9. Sun L, Wong HM, McGrath CPJ. The factors that influence oral health-related quality of life in young adults. *Health Qual Life Outcomes*. 2018;16(1):187. Epub 2018/09/19. doi: 10.1186/s12955-018-1015-7. PubMed PMID: 30223844; PubMed Central PMCID: PMC6142382.
10. Varela-Centelles P, Diz-Iglesias P, Estany-Gestal A, Seoane-Romero JM, Bugarín-González R, Seoane J. Periodontitis Awareness Amongst the General Public: A Critical Systematic Review to Identify Gaps of Knowledge. *J Periodontol*. 2016;87(4):403-15. Epub 2015/11/07. doi: 10.1902/jop.2015.150458. PubMed PMID: 26545044.
11. Ramos-Jorge J, Pordeus IA, Ramos-Jorge ML, Marques LS, Paiva SM. Impact of untreated dental caries on quality of life of preschool children: different stages and activity. *Community Dent Oral Epidemiol*. 2014;42(4):311-22. Epub 2013/11/26. doi: 10.1111/cdoe.12086. PubMed PMID: 24266653.
12. Centers for Disease Control and Prevention. Periodontal Disease. 2013.
13. National Institute of Dental and Craniofacial Research. 2020 Surgeon General's Report. Oral Health in America: Advances and Challenges. 2019.

14. D'Souza S, Addepalli V. Preventive measures in oral cancer: An overview. *Biomed Pharmacother.* 2018;107:72-80. Epub 2018/08/07. doi: 10.1016/j.biopha.2018.07.114. PubMed PMID: 30081204.
15. Glick M, Meyer DM. Defining oral health: a prerequisite for any health policy. *J Am Dent Assoc.* 2014;145(6):519-20. Epub 2014/06/01. doi: 10.14219/jada.2014.41. PubMed PMID: 24878702.
16. van der Weijden F, Slot DE. Oral hygiene in the prevention of periodontal diseases: the evidence. *Periodontol 2000.* 2011;55(1):104-23. Epub 2010/12/08. doi: 10.1111/j.1600-0757.2009.00337.x. PubMed PMID: 21134231.
17. Afshari FS, Campbell SD, Curtis DA, Garcia LT, Knoernschild KL, Yuan JC. Patient-Specific, Risk-Based Prevention, Maintenance, and Supportive Care: A Need for Action and Innovation in Education. *J Prosthodont.* 2019;28(7):775-83. Epub 2019/03/30. doi: 10.1111/jopr.13059. PubMed PMID: 30924568.
18. Formicola AJ. Dental school clinics as patient care delivery centers: a paradigm shift in dental education. *J Dent Educ.* 2008;72(2 Suppl):18-20. Epub 2008/04/09. PubMed PMID: 18250372.
19. Formicola AJ, Myers R, Hasler JF, Peterson M, Dodge W, Bailit HL, et al. Evolution of dental school clinics as patient care delivery centers. *J Dent Educ.* 2006;72(2 Suppl):110-27. Epub 2008/04/09. PubMed PMID: 18250387.
20. Walji MF, Karimbux NY, Spielman AI. Person-Centered Care: Opportunities and Challenges for Academic Dental Institutions and Programs. *J Dent Educ.* 2017;81(11):1265-72. Epub 2017/11/03. doi: 10.21815/jde.017.084. PubMed PMID: 29093139.

21. Holmes DC, Trombly RM, Garcia LT, Kluender RL, Keith CR. Student productivity in a comprehensive care program without numeric requirements. *J Dent Educ.* 2000;64(11):745-54. Epub 2001/02/24. PubMed PMID: 11191876.
22. Wimmers PF, Schmidt HG, Splinter TA. Influence of clerkship experiences on clinical competence. *Med Educ.* 2006;40(5):450-8. Epub 2006/04/26. doi: 10.1111/j.1365-2929.2006.02447.x. PubMed PMID: 16635125.
23. Park SE, Timothé P, Nalliah R, Karimbux NY, Howell TH. A case completion curriculum for clinical dental education: replacing numerical requirements with patient-based comprehensive care. *J Dent Educ.* 2011;75(11):1411-6. Epub 2011/11/08. PubMed PMID: 22058389.
24. White JM, Jenson LE, Gansky SA, Walsh CJ, Accurso BT, Vaderhobli RM, et al. Dental Students' Clinical Experience Across Three Successive Curricula at One U.S. Dental School. *J Dent Educ.* 2017;81(4):366-77. Epub 2017/04/04. doi: 10.21815/jde.016.010. PubMed PMID: 28365600.
25. Johnson G. A comprehensive care clinic in Swedish dental undergraduate education: 3-year report. *Eur J Dent Educ.* 1999;3(4):148-52. Epub 2000/06/24. doi: 10.1111/j.1600-0579.1999.tb00084.x. PubMed PMID: 10865350.
26. Eke PI, Dye BA, Wei L, Slade GD, Thornton-Evans GO, Borgnakke WS, et al. Update on Prevalence of Periodontitis in Adults in the United States: NHANES 2009 to 2012. *J Periodontol.* 2015;86(5):611-22. Epub 2015/02/18. doi: 10.1902/jop.2015.140520. PubMed PMID: 25688694; PubMed Central PMCID: PMC4460825.

27. Helmi MF, Huang H, Goodson JM, Hasturk H, Tavares M, Natto ZS. Prevalence of periodontitis and alveolar bone loss in a patient population at Harvard School of Dental Medicine. *BMC Oral Health*. 2019;19(1):254. Epub 2019/11/23. doi: 10.1186/s12903-019-0925-z. PubMed PMID: 31752793; PubMed Central PMCID: PMCPMC6873420.
28. Darby IB, Angkasa F, Duong C, Ho D, Legudi S, Pham K, et al. Factors influencing the diagnosis and treatment of periodontal disease by dental practitioners in Victoria. *Aust Dent J*. 2005;50(1):37-41. Epub 2005/05/11. doi: 10.1111/j.1834-7819.2005.tb00083.x. PubMed PMID: 15881304.
29. Gift HC. Awareness and assessment of periodontal problems among dentists and the public. *Int Dent J*. 1988;38(3):147-53. Epub 1988/09/01. PubMed PMID: 3053461.
30. Mariotti A, Hefti AF. Defining periodontal health. *BMC Oral Health*. 2015;15 Suppl 1(Suppl 1):S6. Epub 2015/09/24. doi: 10.1186/1472-6831-15-s1-s6. PubMed PMID: 26390888; PubMed Central PMCID: PMCPMC4580771.
31. Beemsterboer PL. *Ethics and Law in Dental Hygiene*. 2nd ed. St. Louis, MO: Saunders Elsevier; 2010.
32. Leeuw W. Maintaining proper dental records. *Dent Assist*. 2014;83(2):22-3, 6-30, 2-4 passim. Epub 2014/05/20. PubMed PMID: 24834675.

Table 1: Dental Diagnostic Codes

Procedure	Description
D0150	Comprehensive oral evaluation
D0150-1	Comprehensive oral evaluation - simple
D0150-2	Comprehensive oral evaluation - moderate
D0150-3	Comprehensive oral evaluation - complex
D01501	Comprehensive oral evaluation - simple
D01502	Comprehensive oral evaluation - moderate
D01503	Comprehensive oral evaluation - complex
D0150NC	Comprehensive oral evaluation REFERRAL ONLY
D0180	Comprehensive periodontal evaluation

Table 2: Percentages for Type of Dental Student and Year Based on Periodontal
Diagnosis

Year and Type of Student		0*	1**	2***	Total
1 – international student year 1	Count	8	0	9	17
	%	47.1%	0.0%	52.9%	100%
2 – international student year 2	Count	26	7	5	38
	%	68.4%	18.4%	13.2%	100%
3 – traditional student 3 rd year	Count	31	1	22	54
	%	57.4%	1.9%	40.7%	100%
4 – traditional student 4 th year	Count	24	9	15	48
	%	50.0%	18.8%	31.3%	100%
Total	Count	89	17	51	157
	%	56.7%	10.8%	32.5%	100%

*0 = no periodontal diagnosis provided

**1 = periodontal diagnosis was not based on 2018 AAP Classification Guidelines

***2 = periodontal diagnosis based on 2018 AAP Classification Guidelines

Table 3: Statistical Analysis for Variables by Dental Student Type and Year

Variables by Student Type and Year	Fischer's Exact Test	p-value	Cramer's V
Comprehensive Periodontal Charting	5.55	0.13	0.19
Preventive Treatment	4.51	0.21	0.21
Therapeutic Treatment	4.79	0.18	0.21