Blue Cross Blue Shield Blue Care Network of Michigan

CHRT Center for Health and Research Transformation

BLUE CROSS BLUE SHIELD OF MICHIGAN AND THE CENTER FOR HEALTH AND RESEARCH TRANSFORMATION

The value of integrating dental benefits

White Paper

NOVEMBER 19, 2024

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Introduction

Objective

The purpose of this paper is to analyze peer-reviewed clinical research to understand the value of integrating dental with medical benefits to provide whole person care. This paper investigates the relationship between oral health and chronic conditions to identify the health and financial benefits of treating oral health to manage chronic conditions. The paper also discusses how payment models can be used to incentivize dental and medical integration to achieve these benefits, as well as recommendations for next steps.

Key findings

- **Periodontal disease is the most reported oral condition linked to chronic systemic diseases**.[1] As the bacteria in the oral cavity infiltrates the bloodstream, systemic inflammation can occur and eventually influence the progression of certain chronic diseases.[2, 3]
- **Many systematic reviews and epidemiological studies have confirmed that both type 1 and type 2 diabetes and periodontal disease have a true bidirectional relationship. For example,** in individuals who do not have diabetes, the diagnosis of severe periodontitis is associated with a 19 to 33 percent increased risk of developing diabetes.
- **Both cardiovascular disease (CVD) and Alzheimer's disease are strongly correlated with periodontal disease.**[4] Individuals with periodontal disease are two to three times more likely to experience a cardiovascular event.[5] Individuals living with chronic periodontitis for 10 years are 1.7 times more likely to develop Alzheimer's disease.[6]
- **Periodontal treatment has been found to improve glycemic control, decrease diabetic-related complications, reduce CVD inflammatory markers, and improve chronic obstructive pulmonary disease (COPD) lung function.** Periodontal treatment led to decreases in blood glucose by 43 percent, on average, within three to four months after the first treatment.[7] The same treatment was also effective at reducing CVD inflammatory markers at three months and improving COPD exacerbations and lung function tests at one and two-year follow-ups.[8, 9, 10]
- **Periodontal treatment was also associated with lower rates of inpatient admissions.** A retrospective cohort study found significantly lower rates of inpatient admissions for diabetes (40 v. 67 admissions/1,000), CAD (47 v. 65 admissions/1,000), and CVD (350 v. 444 admissions/1,000).[11]
- **Oral health treatments ranging from preventative care to periodontal treatment can lower annual medical costs for individuals with diabetes, CVD, and COPD.** Annual medical costs decreased between $407 to $1,799 for diabetic patients.[12, 13] On

average, periodontal treatment led to a 20 percent decrease in medical costs for patients with CVD and COPD.[14]

- **Including dental providers in accountable care organizations (ACOs) may increase value-based payments (VBP) for oral care and medical-dental integration efforts.** Successful efforts have focused on improving primary care referrals to oral health providers and coordinating care between the two. Any efforts to pursue this path should address the greatest and most cited challenge: the lack of an integrated electronic health record (EHR) infrastructure[15, 16] EHRs are key to collecting performance data to meet reporting requirements and are integral to a closed-loop referral process.[17]

Causes and consequences of dental-medical siloes

The importance of whole person care has been gaining traction within the U.S. healthcare system, but despite longstanding and widespread calls for reform, dental care has been slow to integrate. In 2000, the U.S. Surgeon General famously acknowledged oral health as an integral component of one's health and well-being.[18] This report called for action to create an evidence base and infrastructure for integrating oral health care into overall health care. Additionally, the Institute of Medicine (IOM) has cited concerns about dental policy and financing as far back as 1980.[19]

The separation between dentistry and medicine can be traced back to the exclusion of dentistry in the establishment of U.S. medical schools and the creation of the U.S. health insurance system. This separation led to a system that excluded dental services, with large ramifications for the most vulnerable Americans.[20] Service delivery and payment models continue to reinforce the separation today, despite evidence-based calls for change.

Through the 1960s, dental care costs were predominantly covered by direct consumer payments and were not considered an insurable risk.[21] This was the case until the dental insurance prepaid benefit plan, created in the 1950s as a benefit that labor unions could propose during bargaining, became more widespread.[22] But after four decades, dental insurance still only covers predictable, low-cost preventative care, while low prevalence, high-cost dental disease treatments are typically not covered or are reimbursed at lower rates.[23, 24]

As a consequence of the siloed dental delivery system, low-income, minority, immigrant, and rural populations are less likely to have access to dental services or quality oral health care,[25] exacerbating inequities. As of 2023, one in every five Americans lives in a dental health professional shortage area (HPSA).[26]

Adults with three or more chronic conditions are 50 percent more likely to report having had one or more medical visits in the past year, but no dental visits.[27] Furthermore, data analyzed from the Medical Expenditures Panel Survey (MEPS) in 2016, found that nearly two million adults reported unmet dental needs; the number one reason, they said, was affordability

concerns.[28] These concerns are worsened for the 68.5 million adults who do not have dental insurance, more than twice the rate of adults who don't have medical insurance.[29, 30]

Dental access and affordability barriers result in individuals skipping needed dental care or obtaining avoidable care at emergency departments (ED). Every 15 seconds someone visits an emergency department to treat dental conditions. The estimated cost of treating dental needs in emergency settings was $2.7 billion in 2017 alone.[31]

The connection between oral health and systemic health

Some systemic diseases, such as diabetes, anemia, and human immunodeficiency virus (HIV), can affect oral health. Crohn's disease, for example, can trigger ulcers and orofacial granulomatosis, a condition that causes lip swelling.[32] Certain immunosuppressants, like prednisone therapy, can accelerate dental disease. And both selective serotonin reuptake inhibitors (SSRI's) and antipsychotic medications are frequently known to cause xerostomia (dry mouth) which can lead to cavities, infections, and inflammation of the gums.[33]

Conversely, oral diseases, such as periodontal disease, can affect various systemic conditions, including:[34]

- Gastrointestinal diseases, such as Crohn's, ulcerative colitis, inflammatory bowel disease, and gastroesophageal reflux disease
- Chronic Liver Diseases, such as Hepatitis C
- Hematologic diseases, such as anemias and sickle cell disease
- Immune diseases, such as systemic lupus erythematosus, scleroderma, Sjogren's syndrome, and human immunodeficiency virus
- Endocrine diseases, such as diabetes, thyroid disorders, parathyroid disorders, and adrenal disorders

It is important to recognize that many oral-systemic interactions are known and demonstrate the importance of oral health care; however, in this paper we primarily focus on conditions that originate in the oral cavity and spread systemically, increasing the risk of certain chronic conditions.

What we know about oral cavity dysbiosis

After the gut, the oral cavity is the second most diverse microbiome in the body, with more than 700 bacterial species.[35] While researchers have significant knowledge about the relationship between chronic conditions and gut dysbiosis, the imbalance in bacterial composition, the relationship between oral cavity dysbiosis and chronic diseases are still being explored.[36]

Research has revealed that bacterial imbalance in the mouth can lead to the development of periodontitis.[37] Periodontal disease, also known as gum disease, is a chronic, multifactorial inflammatory disease caused by an infection in the gums. It is also the most reported oral

condition linked to chronic systemic diseases, according to a systematic review of the literature in 2019.[38]

A startling two in five U.S. adults aged 30 years and older have some form of periodontal disease.[39] In the early stages, it causes gingivitis, inflammation, redness, and swelling of the gums (gingiva). In later stages, the inflammation worsens causing loss of the tissue and bone that support the teeth, tooth decay, and eventually loss of the tooth. Left untreated, the bacteria in gum infections can continue to propagate until the immune response is unable to control them, resulting in a chronic inflammatory state. As the bacteria in the oral cavity infiltrates the bloodstream, systemic inflammation can occur and eventually influence the growth of certain systemic diseases.[40, 41]

The relationship between oral health and specific chronic diseases

Research reveals that scientists have identified oral microbes in many distant organs: heart, lungs, small intestines, placenta, and brain—indicating that these microbes can travel throughout the body. Varying levels of evidence further link multiple systemic diseases to oral microbiome dysbiosis, including diabetes, atherosclerosis, hypertension, stroke, rheumatoid arthritis, systemic lupus, irritable bowel disease, hepatic steatosis, chronic kidney disease, obesity, cancers, multiple sclerosis, dementia, and Alzheimer's disease.

As indicated in CHRT's market landscape analysis, diseases linked to periodontal disease are some of the most prevalent, rapidly increasing, and costly.

Oral health and diabetes

Diabetes is a top contributor to healthcare costs, accounting for roughly 25 percent of every dollar spent.[42] As health systems and payers work to stem the rising cost and prevalence of diabetes, many researchers are trying to identify the role oral health plays in influencing diabetes. The most recent data finds that 11.6 percent of Americans (38.4 million) have diabetes and that diabetes is currently the eighth leading cause of death in the U.S.[43] A 2018 projection suggests that the number of adults with diagnosed diabetes will increase threefold from 2014 to 2060.[44]

Many systematic reviews and epidemiological studies have confirmed that diabetes and periodontal disease have a true bidirectional relationship.[45, 46] Some reviews have found a causal link and strong association between the two diseases. Type 1 and type 2 diabetes, for example, increase the risk of periodontitis. And periodontitis can hinder glycemic control,[47] the practice of maintaining blood sugar levels in an optimal range.

Researchers postulate that the presence of a bacterial infection in the gums causes an increase in inflammatory markers, such as Interleukin 6 (IL-6), tumor necrosis factor (TNF-α),

and C-reactive protein (CRP), all of which can result in oxidative stress throughout the body.[48, 49] Oxidative stress, in turn, is thought to contribute to many of the common complications associated with diabetes such as retinopathy, nephropathy, and cardiomyopathy.[50]

It's important to note that while periodontitis is the primary oral condition studied, any dental condition associated with an increased risk of infection, such as caries and tooth loss, can result in increased inflammatory responses triggering increases in blood glucose levels.[51] Oral inflammation, for example, is a recognized cause of insulin resistance; treatments targeted at the underlying cause of the inflammation could subsequently improve glycemic control.[52]

Several systematic reviews have demonstrated that individuals with periodontal disease have a greater probability of developing diabetes. A 2020 review concluded that the diagnosis of severe periodontitis is associated with a 19 to 33 percent increased risk of developing diabetes, as compared to those with no periodontal disease.[53] A 2018 review reported that overall, those with diabetes were more than twice as likely to be diagnosed with moderate or severe periodontitis, and those aged 30-44 years who had poorly controlled diabetes were three times as likely to be diagnosed with moderate or severe periodontitis as non-diabetics.[54] Other evidence found a positive association between the severity of periodontitis and heightened blood glucose levels.[55] Both men and women with uncontrolled glucose levels (HbA1c >7 percent) were more likely to have severe periodontal disease.[56]

Furthermore, a systematic review of 14 studies found that periodontal disease increases the risk of diabetic complications because established periodontitis decreases insulin resistance, thus leading to increases in blood glucose levels, oxidative stress, and the risk of complications.[57] The review used odds ratios to quantify the strength of the association between the two events. For example, an odds ratio of 2 means that diabetics with periodontal disease are twice as likely to have a cardiovascular complication, compared to diabetics without periodontal disease.

Within this review, six studies evaluated diabetes-related cardiovascular complications for those with periodontal disease, five of which found an increased risk by 1.3 to 2.6 times. The sixth study found an even greater odds ratio, 17.7 times higher risk of cardiovascular complications over a six-year follow up period. Another study identified mortality rates increased by 2.3 to 8.5 times for individuals diagnosed with severe periodontal disease. In Figure 1 below, all but two of the 14 studies had a fair or good quality grading, indicating minimal bias. While some discrepancies between studies exist, findings conclusively indicate that the presence of periodontal disease can lead to serious health consequences for diabetics.

Figure 1

Periodontal disease increases the risk of diabetic complications

Summary of odds ratios for diabetic complications

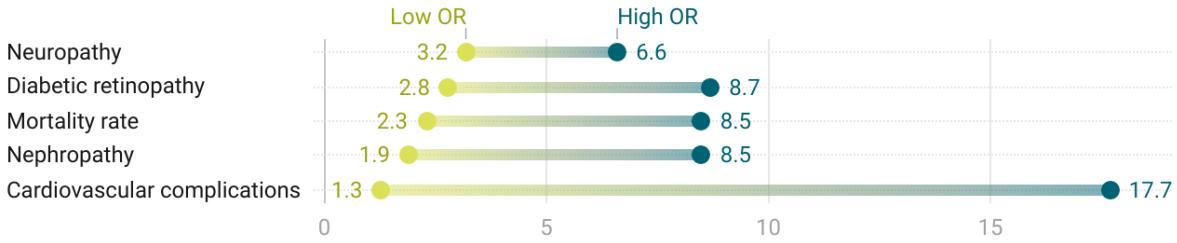


Chart: CHRT • Source: Nguyen et al. 2020 • Created with Datawrapper

Oral health and cardiovascular disease

The relationship between periodontal disease and cardiovascular disease (CVD) has also been well-characterized in the literature. An association between dental infections and myocardial infarctions can be traced back to the late 1980s.[58] We define CVD as an umbrella term for several linked pathologies including "coronary heart disease (CHD)/[coronary artery disease (CAD)], cerebrovascular disease (i.e. stroke), peripheral arterial disease, rheumatic and congenital heart diseases, and venous thromboembolism." [59] Diseases under this umbrella are the leading cause of death for men and women in the United States. CVD is so widespread, in fact, that it takes a life every 33 seconds and costs the healthcare system $254billion per year and an additional $168 billion in lost workforce productivity.[60, 61]

Individuals who are predisposed to CVD due to genetics or lifestyle habits may have accelerated plaque formation and complications as a result of periodontal disease.[62] There are a few possible theories for this association.

1. Bacteria (often P. gingivalis) released from the destruction of the local dental epithelium can wind up either directly in the bloodstream or indirectly within immune cells, resulting in systemic inflammation.[63] Like diabetes, this could set off the inflammatory cascade associated with periodontal disease that may contribute to plaque formation (atherosclerosis).
2. Systemic inflammation can destroy the endothelial lining of the blood vessels, leading to high blood pressure which then increases the risk of adverse events such as myocardial infarctions and strokes.[64]
3. Periodontal disease can exacerbate CVD through oral bacterial pathogens entering the bloodstream and traveling to the heart; this pathway can play a role in the development of bacterial endocarditis.[65]

Meta-analyses conducted in the early 2000s illustrate the correlation between periodontal disease and CVD, distinguishing the former as a risk factor for the latter.[66] Despite these early findings, the present literature lacks standardized definitions of CVD outcomes and uses different oral health indicators, making it difficult to come to any causal inferences between oral health and CVD.[67] Regardless of this, an association between the two remains clear; individuals with periodontal disease are two to three times more likely to experience a cardiovascular event.[68]

Other studies have corroborated these findings. A meta-analysis of five combined cohort and case-control studies (86,092 patients) identified a range of 1.14 – 2.22 times higher risk of individuals with periodontal disease developing coronary heart disease, as compared to the control groups.[69] Another meta-analysis of cross-sectional studies found that the prevalence of CHD was 1.59 times higher in patients with periodontal disease as compared to those without it.[70]

Two case-control studies revealed a noteworthy correlation between periodontal disease and both ischemic and hemorrhagic strokes.[71, 72] Specifically, the former exhibits a dose-dependent relationship, suggesting that a greater depth of infection in the periodontal pocket the greater the probability of experiencing an ischemic stroke (odds ratio: 8.5).[73] Moreover, the American Heart Association (AHA) concluded that atherosclerosis and periodontal disease are associated independent of their shared risk factors.[74]

Oral health and Alzheimer's disease

New evidence draws strong bidirectional associations between oral bacteria detected in the brain and Alzheimer's disease.[75] Alzheimer's disease, a progressive, neurogenerative brain disease, affects 7 million Americans, one in every nine adults aged 65 years and older.[76] Alzheimer's is also the seventh leading cause of death in the U.S. and, in 2024, cost an estimated $360 billion in care.[77] By 2060, the number of seniors with Alzheimer's is predicted to double to 14 million.[78]

Many studies have identified a direct link between neuronal inflammation/infection and Alzheimer's progression. Given this and the fact that the etiology of Alzheimer's disease remains unclear, researchers have further explored the infectious hypothesis, including the role of periodontal disease. Research clearly delineates the association that individuals with Alzheimer's disease and other dementias are more likely to have inadequate oral health due to cognitive impairments, which can increase their risk of developing periodontitis and other oral diseases.[79] However, the reverse is also true, that oral bacteria can lead to chronic inflammatory damage, including neuroinflammation, which can then lead to neurodegeneration and the development of Alzheimer's disease.[80] This is backed by multiple epidemiological studies that found periodontitis increases the risk of developing Alzheimer's.

One 2016 retrospective study found that those who lived with chronic periodontitis for ten years were 1.7 times as likely to develop Alzheimer's disease.[81] An observational cohort study found that chronic, active periodontitis is associated with a marked increase in cognitive decline over a six-month follow-up period.[82] In this study, cognition was tested using two

assessments, the Alzheimer's Disease Assessment Scale (ADAS-cog) and the Mini-Mental State Examination (MMSE).[83]

While scientists are yet to elucidate the relationship between the degree of periodontal disease and the severity of Alzheimer's disease,[84] a systematic review published in 2023 concluded that there is a moderate association between oral bacteria and Alzheimer's disease.[85] Of the ten studies examined, the association became stronger depending on the specific oral bacteria detected in the brain.[86] A pooled sample size of 158 subjects found a ten-fold increased risk of Alzheimer's disease when any periodontal bacteria was detected in the brain and a six-fold increased risk of Alzheimer's disease when P. gingivalis was detected in the brain.[87] Additionally, a 2024 national survey of nearly 3,000 participants indicates that certain infections (such as Hepatitis C and Herpes Simplex Virus 2) and specific periodontal pathogens (P. gingivalis and Streptococcus oralis) are associated with an increased risk of developing Alzheimer's disease and all-cause dementia, especially at higher levels of infection burden. Individuals with P. gingivalis antibodies had a 19 percent higher risk of developing Alzheimer's disease, while those with Streptococcus oralis antibodies had a 26 percent higher risk.[88]

While researchers need to gather more rigorous evidence to illuminate the relationship between oral diseases and Alzheimer's disease, oral health management, including periodontitis treatment, should be considered in the care strategy for Alzheimer's disease.[89]

Other relationships

Chronic obstructive pulmonary disease and other respiratory conditions. 16 million Americans live with COPD and many others suffer from common respiratory conditions such as asthma, bronchitis, and pneumonia.[90] No systematic reviews were identified that evaluate the relationship between oral health and chronic obstructive pulmonary disease (COPD) or other respiratory conditions.[91] However, several valuable case control and cohort studies elucidate the association between respiratory and periodontal disease. The theory is that dental plaque can serve as a reservoir for respiratory pathogens which can then spread to the lower airways and be disseminated systemically via blood circulation.[92] Supporting this theory is the fact that individuals with periodontal diseases are three times more likely to develop a hospital-acquired pneumonia infection.[93] A cross-sectional study found that low income populations with respiratory disease were 4.4 times more likely to have poor periodontal health as compared to high-income populations.[94] Significant evidence suggests that mechanically ventilated patients who receive routine oral hygiene care have better outcomes.[95]

Rheumatoid arthritis. In the United States, 1 in 5 adults, 53 million, live with arthritis: the leading cause of disability.[96] While some evidence points to an association between periodontal disease and rheumatoid arthritis, there are few rigorously designed studies published, making it difficult to come to a strong conclusion. The most significant study, the atherosclerosis risk in communities prospective cohort study, evaluated 6,931 non-rheumatoid arthritis subjects and found that individuals with severe periodontitis who were non-smoking and had not yet been diagnosed with arthritis had a five-fold risk of developing

rheumatoid arthritis in the future.[97] Furthermore, a majority of evidence supporting associations between periodontal disease and rheumatoid arthritis with a possible bi-directional relationship comes from case-control studies, with odds ratios ranging from 1.8 to 20.6.[98] This large discrepancy in odds ratios signals that the extent of association has yet to be pinpointed.

Pregnancy. Oral microbiota changes occur in pregnant women due to hormonal changes, increased pH related to vomiting, and changes in diet, placing them at increased risk for oral diseases like gingivitis and periodontitis.[99] One study found 40 percent of pregnant women had clinical evidence of periodontal disease.[100] A systematic review indicated associations between periodontal disease and adverse pregnancy outcomes, such as a three time greater risk of pre-term delivery and low infant birth weight.[101, 102] Additionally, P. gingivalis was associated with an increased risk of premature birth in three studies, and women with pre-eclampsia who developed an adverse birth outcome also tended to have higher levels of P. gingivalis and more diagnoses of periodontal disease.[103] However, the most recent systematic review and meta-analysis identified inconclusive findings and illuminated the need for future studies using the same outcomes to truly understand the association between oral microbiota during pregnancy and birth outcomes.[104]

Cancer. Periodontitis has been strongly associated with head and neck, gastrointestinal, prostate, and lung cancers, while new evidence is emerging on breast and uterine cancers.[105, 106] The common thread between all of these associations is that oral bacteria have been present and positively correlated with tumor growth.[107] A meta-analysis study analyzing 3,183 individuals with periodontal disease, found these individuals had an increased susceptibility to developing oral cancer.[108] Of all the cancers studied, the highest reported increased risk was an 81 percent higher risk found for prostate cancer in individuals with periodontal disease as compared to individuals without periodontal disease.[109]

Medical Treatments. While a newer topic of discovery, researchers are uncovering the effect periodontitis can have on the outcomes of certain medical treatments and procedures. A retrospective analysis looked at hospitalized stem cell transplant recipient data in the US between 2004 and 2010. The results showed that individuals with gingival or periodontal conditions had higher hospital charges ($397,518 versus $270,943), longer length of stay in hospitals (34.4 days versus 26.3 days), and higher odds of developing infectious complications (52.1 percent versus 32.8 percent).[110] Another recent study found that patients with gingivitis/periodontitis who underwent a heart valve replacement also had statistically significant higher hospital charges, lengths of stay, and rates of bacterial infections.[111] Similarly, patients with tooth abscesses undergoing extracorporeal circulation (ECMO) during open heart surgery had 2.5 higher odds of developing sepsis compared to those who did not have a tooth abscess.[112]

Benefits of delivering oral interventions to manage chronic disease

While much of the literature focuses on periodontal disease and periodontal treatments, preventative dental services such as routine exams, cleanings, and education are key to identifying periodontitis and other oral health conditions and treating them before problems escalate. Access to regular dental services may reduce painful and costly dental complications, thus positively impacting chronic disease outcomes. The detection and treatment of dental conditions is a viable pathway for improving some chronic disease indicators and lowering the risk of other chronic disease complications.[113]

Definition of periodontal therapy. Most journal articles do not explicitly define periodontal interventions, but generally refer to non-surgical periodontal interventions. However, periodontal treatment can apply to multiple interventions including surgical treatments. The most common non-surgical intervention is subgingival instrumentation also known as scaling and root planing (SRP), which consists of a deep cleaning above and below the gum line to reduce bacterial biofilms on the tooth and root surface.[114] Surgical periodontal interventions may refer to gingival flap surgery, mucogingival surgery or gingivectomy, and osseous surgeries.[115, 116] Studies also broadly define periodontal therapies using the Codes on Dental Procedures and Nomenclature (CDT), specifically D4000 through D4999.[117]

Health Outcomes

Improves glycemic control. The results of more than 30 different studies with 2,443 subjects conclude that periodontitis treatment, specifically subgingival instrumentation, reduces blood glucose, as measured by HbA1C, on average by 0.43 percentage points, or from 7.43 percent to 7 percent within three to four months after the first treatment.[118] Reductions in blood sugar continued, with a decrease of 0.30 percent, at six months and 0.50 percent at one year.[119] This systematic review concluded with moderate certainty (given that some studies had a high risk of bias) that periodontal treatment is an effective tool to control blood glucose levels.[120] Furthermore, the magnitude of this decrease is similar to effects of the anti-diabetic medication Metformin, and thus clinically significant. A one percentage point decrease in HbA1C levels may reduce diabetes-related microvascular complications by 37 percent, diabetes-related mortality by 21 percent, and myocardial infarctions by 14 percent.[121]

Decreases diabetic-related complications. While many rigorous studies have established that periodontal therapy improves glycemic control, few academic studies have explicitly evaluated periodontal therapy's effects on diabetic-related complications. To address this gap in the literature, a 2020 cost-effectiveness analysis modeled the effect of expanding non-surgical periodontal coverage to 100 percent for all diabetic patients across the nation.[122] The analysis predicted that expansion of this benefit would result in a 34 percent decrease in tooth loss, a 7 percent decrease in CVD incidence, and a 19 percent decrease, on average, in microvascular diseases such as neuropathy, retinopathy, and nephropathy (17.7 to 20.5

percent).[123] Based on these predicted findings and existing evidence linking periodontal disease to increases in diabetic complications, we can extrapolate that periodontal therapy would likely result in a decrease in common diabetes-related complications.

Reduces CVD inflammatory markers. Two systematic reviews found that for those with either chronic heart disease or hyperlipidemia, periodontal treatment was effective at reducing inflammatory markers TNF-α, IL-6, CRP, and LDL at three months.[124] A 2017 Cochrane systematic review on the effectiveness of periodontal therapy for CVD patients with chronic periodontitis found "low-quality evidence" that was "insufficient to support or refute whether periodontal therapy can prevent the recurrence of CVD."[125] However, even though periodontal therapy interventions cannot be said to *prevent* CVD events, they *may slow the progression* of CVD.[126]

Improves COPD lung function. To date, no systematic reviews have been published evaluating the effects of periodontal treatment on health outcomes for those with COPD.[127] However, two randomized control trials (RCT), a non-randomized control trial, and a retrospective cohort study found that periodontal treatment could lead to improvements in lung function as measured by forced expiratory volume in the first section (FEV1) and forced vital capacity (FVC) at two years.[128] Additionally, RCTs using patient-reported data found reductions in the mean frequency of COPD exacerbations one and two years after receiving periodontal treatment. At the two-year mark, researchers recorded that only 30 percent of patients in the treatment group experienced frequent exacerbations, compared to the control group where 66.7 percent of patients experienced frequent exacerbations.[129]

Healthcare cost and utilization

Most healthcare cost and utilization data come from primary studies of insurance claims. These studies have produced mixed results on the effect of periodontal treatment to reduce healthcare use and costs for patients with chronic diseases.[130] While some retrospective cohort studies have found promising results, few high-quality academic studies have produced conclusive results on the effects of preventive dental care or periodontal therapy to reduce healthcare utilization or costs for individuals with diabetes, CVD, or COPD.[131]

Costs and benefits - diabetes. Five fair-quality studies found periodontal treatment for individuals with diabetes was associated with lower costs.[132] A commercial claims analysis using the Truven Health MarketScan Research database found that individuals newly diagnosed with diabetes, who had not yet initiated prescription drug therapy and had received a periodontal intervention within two years after diagnosis, had lower healthcare costs at the three and four-year mark.[133] Total healthcare costs were $1,799 lower, on average; medical costs (excluding pharmacy costs) were $1,577 lower; and diabetes-related healthcare costs were $408 lower.[134] A study of New York Medicaid members with diabetes found that those who received more than one preventive dental care visit had $407 fewer inpatient costs, on average.[135]

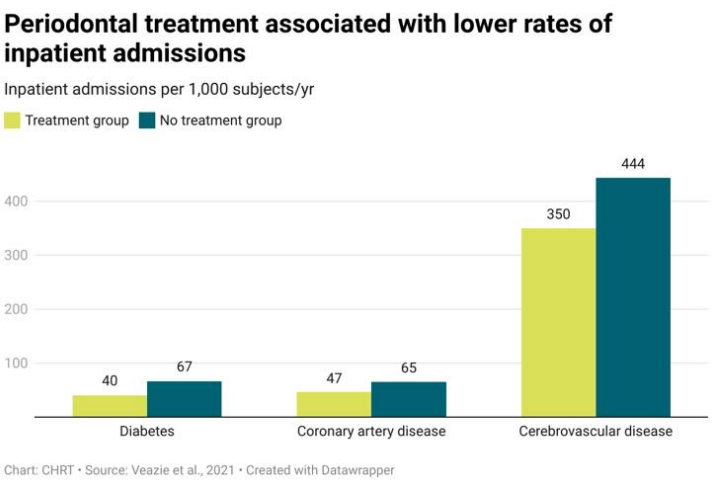
The cost-effectiveness analysis detailed above also predicted lifetime costs and health gained from expanding nonsurgical periodontal treatment to all individuals diagnosed with diabetes and periodontitis. This study estimated a net savings of $5,904 with an estimated gain of 0.6 quality-adjusted life years (QALY) per capita.[136] A strong willingness-to-pay threshold for an incremental cost-effectiveness ratio (ICER) is typically below $50,000; this study produced an ICER of $10,542 saved per QALY gained, making periodontal treatment a very good value for the cost.[137] In contrast, a fair-quality, retrospective cohort study based on claims data from 2001-2002 found that when adjusting for disease burden, those with diabetes who received periodontal treatment had higher per-member per-year medical costs compared to those who received other dental services or no dental services.[138]

Costs and benefits – cardiovascular disease. Regarding cardiovascular disease, several retrospective cohort studies have found evidence that periodontal treatment can reduce patients' medical costs, although notably other studies have found increases in medical costs.[139] For instance, one retrospective cohort study found that those with CAD who received periodontal treatment had a statistically significant 11 percent reduction in annual medical costs.[140] Another study of adults with CAD found an even greater reduction in annual medical costs: 23 - 24 percent in the periodontal treatment group; however these results were not statistically significant.[141] This same study found similar reductions in medical costs for those with congestive heart failure (25 - 26 percent).[142] Conflicting results were found for patients with cerebrovascular diseases. While one retrospective cohort study discovered increased medical costs after patients received periodontal treatment, another study with the same design found a statistically significant 41 percent reduction in annual medical costs.[143]

Costs and benefits – chronic obstructive pulmonary disorder. Additionally, a poor-quality retrospective cohort study found that periodontal treatment lowered annual medical costs for patients with COPD anywhere from 18 - 27 percent (depending on medical compliance).[144] The study was identified as poor quality due to low strength of evidence and not clearly reporting whether individuals in the no treatment group had periodontal disease or were periodontally healthy.

Reduced emergency department visits and hospitalizations. Dental-related conditions accounted for 2 million emergency department (ED) visits in the U.S. in 2018 (1.4 percent of all visits).[145] While most dental-related visits resulted in a same day discharge from the ED, 5.5 percent resulted in subsequent hospital admissions. 10 percent of these admissions were principally for the dental condition.

Figure 2



Eighty-five percent of these subsequent dental admissions were

due to diseases of the pulp and periapical tissues (including periodontitis).[146] The other 90 percent of these admissions were primarily related to septicemia and diabetes complications, which were likely worsened or caused by the secondary dental condition.[147] Given this data, it's feasible to assume that providing periodontal treatments may reduce ED visits and inpatient admissions.

A New York state analysis of Medicaid members with diabetes found receiving more than one preventative dental care visit was associated with a 4 percent lower rate of emergency department visits and an 11 percent lower rate of inpatient admissions.[148] Other studies have found promising results on healthcare utilization, however, generally they've been categorized as poor-quality due to insufficient strength of evidence and conflicting results. One of these poor-quality retrospective studies found that periodontal treatment was associated with significantly lower rates of hospital admissions compared to the control group for chronic diseases such as:

- Diabetes (40 v. 67 inpatient admissions/1,000 subjects/year),
- CAD (47 v. 65 inpatient admissions/1,000 subjects/year), and
- CVD (350 v. 444 inpatient admissions/1,000 subjects/yr.) See figure 2 above.

These studies did not, however, produce statistically significant differences between the number of outpatient physician visits or the occurrence of emergency department visits.[149]

A retrospective observational cohort study using insurance claims data reported decreases in hospitalizations for individuals who received periodontal treatment by disease group. Individuals with diabetes experienced a 39.4 percent reduction in hospitalizations, followed by CAD (28.6 percent) and CVD (22.2 percent).[150]

Table 1 provides a high-level overview of the findings outlined in the above paragraphs for the three main chronic disease diagnoses: type 2 diabetes, cardiovascular disease (including coronary artery disease, congestive heart failure, and cerebrovascular disease), and COPD.

Table 1

Summary benefits of periodontal therapy for chronic disease groups

	Type 2 Diabetes	Cardiovascular Disease	COPD
Health Outcomes	Decrease in HbA1c at 3, 6, and 12 months	CVD: Improved TNF- α, IL-6, CRP, & LDL at 3 months in periodontal tx group v. no tx group	Decrease in COPD exacerbations at 1 and 2 years Increase in lung function (FEV1/FVC) at 2 years
Healthcare costs	($17,131 vs. $18,617) **8%** reduction in total all cause healthcare costs	CAD: mixed results; ($9,133 vs. $10,222; p<.04)* **11%** reduction in annual medical costs ($15,549-$16,271 vs. $20,502-$21,202; depending on medical compliance) **23% - 24%** reduction in annual medical costs	($12,938-$38,450 vs. $15,817-$52,484; depending on medical compliance) **18% - 27%** reduction in annual medical costs
	($12,534 vs. $13,957) **10%** reduction in annual all cause medical costs	CHF: ($35,669-$36,172 vs. $47,332-$49,064 depending on medical compliance) **25% - 26%** reduction in annual medical costs	
	($2,330 vs. $2779) **16%** reduction in type 2 diabetes-related healthcare costs	Cerebrovascular disease: mixed results; ($8,214 vs. $13,895; p <0.4)* **41%** reduction in annual medical costs	
ER visits/inpatient admissions	Lower rates of inpatient admissions (40 v. 67)	CAD: lower rates of inpatient admissions (47 v. 65) Cerebrovascular disease: lower rates of inpatient admissions (350 v. 444)	N/A

Table: CHRT · Source: Veazie et al., 2021 * Indicates statistical significance

The Blue Cross Blue Shield of Michigan Experience

Between 2017 and 2021, the BCBSM medical and specialty team analyzed claims data for commercial and Medicare Advantage members with diabetes and cardiovascular disease who had continuous medical and dental coverage throughout this period.[151] The analysis found that diabetic members who received recommended preventive dental care, defined as 9 or more visits over the study period, had a 2.6 times lower rate of tooth loss compared to members who didn't receive any preventive dental care. Diabetic members who received periodontal treatment in 2021 also had a one to four percent lower per member per month (PMPM) spend. Members with cardiovascular disease, defined as a primary diagnosis of CAD, CHF, hypertension, dyslipidemia, or stroke between 2019-2021, were found to have 30 percent fewer ER visits and hospital inpatient visits per person and lower spend per person if they had received any amount of preventive dental care, as compared to none. The results of this study are congruent with the findings in the literature.

Clinical Medical-Dental Integration

The strong association and sometimes causal relationship between oral health and chronic diseases conveys the importance of coordinating primary prevention of oral and systemic diseases.[152] Clinical medical-dental integration (MDI) efforts can be achieved across a continuum, from a formal referral process to full integration.[153]

1. **Formal referral process:** bidirectional referral and tracking process between medical and dental providers
2. **Electronic Health Record (EHR)/telehealth integration**: interoperable EHRs and access to telehealth services
3. **Shared clinical and financial accountability:** performance payments for providers or ACOs and establishment of dental home with an in-network provider
4. **Co-location of medical and dental office providers**: primary care providers and dental providers deliver care in the same physical location or are proximally located
5. **Full integration:** dental providers are part of the medical care delivery team and share financial accountability

Even though the National Academy of Medicine has called for better integration of medical and dental visits, integration remains limited outside of pediatric populations, managed care, and community health centers.[154] Healthy People 2020 calls for an increase in dental settings providing chronic disease screenings, including testing and referrals for glycemic control and screenings for oral and pharyngeal cancer, among others.[155] These calls to action are furthered by the evidence highlighted above, which supports addressing oral health to improve systemic health outcomes, as well as to reduce healthcare costs and achieve potential savings. According to the CDC, "the health care system could save up to $100 million each year if dental offices performed screenings for diabetes, high blood pressure, and high cholesterol."[156]

High-level synopsis of integration efforts

In 2018, the University of Iowa's public policy center conducted a thorough environmental scan of MDI initiatives.[157] These initiatives varied across the MDI continuum with many of them targeting cardiovascular health and diabetes within the oral health setting. Most of these programs targeted integration efforts that encourage dental providers to conduct chronic disease screenings and education within a co-located space. For example, the ElderSmile program is one of the most well-established community-based programs, providing prevention, transportation, and treatment services at 51 sites (including co-located sites with senior centers) throughout Manhattan, New York.[158] The program provides chairside HbA1c and blood pressure screenings to dental patients and provides referrals to local primary care facilities if abnormal results are identified. Other studies using national

data estimate that between 30 - 60 percent of individuals screened in dental settings have abnormal HbA1c results.[159]

Alternatively, integration programs may target primary care providers (PCPs), wherein they educate providers on oral health assessments and implement referral processes. Many more patients see a PCP than a dental provider in any given year; therefore, integration programs that have PCPs assess and refer patients with specific chronic diseases to dental providers show promise. Currently, most residency programs spend up to three hours on the oral health curriculum.[160] To cover this gap, educators have created online trainings, such as Smiles for Life, a national oral health curriculum that is most commonly used to educate PCPs before the implementation of medical-dental integration models.[161]

Whether integration programs are co-located or not, it is critical to ensure that referrals are completed promptly. Research has identified that referrals are most effective when medical and dental providers have shared EHR systems, but even with shared EHR systems, explicit referral protocols must be in place.[162] Other barriers hinder the effectiveness of primary care referrals to oral health care providers, such as the lack of dental insurance. Specifically, low-income individuals who don't have private dental insurance are less likely to carry out referrals due to cost concerns. [163] Furthermore, while many programs boast promising results such as improved health outcomes, there is very little published information about specific guidelines, protocols, or outcomes associated with these integration efforts.[164]

Encouraging integration through shared accountability

Because dental providers aren't generally included in accountable care organizations (ACOs), most dental services are still reimbursed under a fee-for-service (FFS) model.[165] ACOs are key to encouraging dental providers to participate in value-based payment (VBP) arrangements with primary care providers, multi-specialty groups, federally qualified health centers (FQHCs), and health systems. VBP has the potential to achieve improved health outcomes and lower costs,[166] serving as a pathway to advance the field of oral health through greater integration with providers of physical health, further emphasis on prevention rather than treatment, and increase attention to quality measures, including cost containment.[167, 168]

VBP models in the dental space are improving incrementally. Between 2013 and 2017, dental claims reimbursed with alternative payment models (APMs) increased by six percent (27 to 33 percent).[169] As of 2016, 14 percent of ACOs included dental care among their services, with 10 percent of these responsible for commercial contracts, compared to 25 percent for Medicaid contracts.[170] Currently, only 16 states use APMs for a portion of their dental beneficiaries.[171] More recent data collected in 2022, found that just 3 percent of ACOs include dental services in their care coordination strategies.[172]

ACOs promoting VBP models include Minnesota's Hennepin Health model and Kaiser Foundation Health Plans associated with Permanente Dental Associates (PDA).[173] Both show

very different real-world examples of using financial incentives to integrate and coordinate dental services with medical care.

Hennepin Health[174]

The first example, Hennepin Health, is a county-based, provider-led ACO that serves the Medicaid population in Hennepin County, MN. This model is designed to improve coordination of Medicaid population dental services. Before integration efforts, Medicaid enrollees experienced difficulties with dental pain caused by untreated oral health problems and unaffordable dental procedures. Hennepin accepts a global capitation from the state's Medicaid program and pays dentists under FFS with additional bonus payments for meeting specific quality measures. Dentists in this model experienced shared savings and did not incur any downside risk.

The integrated dental program focused heavily on streamlining access to same-day dental care for patients who often utilized the ED for dental pain. This included marketing an ED diversion program and hiring a case manager and community health workers (CHWs) who were stationed at various sites in the community. The CHWs identified patients who were seeking care at EDs for dental pain and provided them with appropriate referrals to on-site and co-located dental providers.[175] Additionally, the CHWs facilitated transportation to dental appointments as needed and helped beneficiaries establish a dental home.[176] These efforts resulted in a 9 percent decrease in ED visits for dental pain, with a subsequent 3 percent increase in outpatient visits in the ACO's first year of operation.[177]

Permanente Dental Associates[178]

Permanente Dental Associates (PDA) has integrated dental care into its coordinated health program since 1974. While PDA is not exactly an ACO, given its vertically integrated status with Kaiser Permanente, it shares many of the same workings as one including care coordination, capitated arrangements, and an outcomes orientation. PDA is dentist owned and operated and primarily serves private or employer-sponsored members; however, it does serve a small Medicaid population in Oregon. It receives capitated payments from Kaiser Permanente and goes on to pay dentists based on three methods of reimbursement: fixed salary (55 percent), dental office/group performance (20 percent), and individual performance (25 percent).

Because PDA and Kaiser Permanente share the same EHR platform, this model allows for easier care coordination, referral tracking, and data collection. Care is coordinated through a patient support tool (PST), which notifies dental providers of other elements of the patient's care plan, such as overdue screenings, vaccinations, or tests at the time of service. The PST allows patients to secure same-day services at any Kaiser facility. These additional touchpoints with patients close many care gaps and result in higher adherence to healthcare effectiveness data and information set (HEDIS) prevention measures.

Challenges to implementing value-based payments

Many barriers stand in the way of VBP for dental services; the greatest and most cited challenge is electronic health record data infrastructure.[179, 180] An integrated EHR is often necessary to collect key performance indicator data to meet reporting requirements and is integral to a successful referral process.[181] While not impossible, coordinated care is significantly more difficult for providers without an EHR. Eighty-seven percent of ACOs surveyed did not include dental services and cited a lack of EHR integration as the reason. The same reason was cited for why dental providers are less likely to uptake VBP or participate in ACOs.[182] Additionally, developing an EHR interface that satisfies both medical and dental providers can prove difficult since the needs of each provider often differ.[183]

Other commonly cited challenges for lack of coordination between medical and dental care providers include the lack of standardized diagnostic codes for oral health, standardized oral health quality measures that are set by evidence-based guidelines, dental provider's knowledge about alternative payment models, and the high number of dental practices that operate in small or solo practices.[184]

Another large challenge is the lack of insurance coverage for oral health care. Given that patients are responsible for paying for most dental service out of pocket, third parties like ACOs have little power to hold providers accountable.[185] Any efforts to obtain MDI through ACOs and VBP models should attempt to address these challenges prior to implementation.

Conclusion

The integration of dental and medical benefits presents a significant opportunity to enhance whole-person care and improve both health and financial outcomes, particularly within chronic disease management. The literature demonstrates strong associations between oral health conditions, such as periodontal disease, and systemic health issues like diabetes, cardiovascular disease, and Alzheimer's disease. Evidence supports that preventative dental care, and periodontal treatments can improve glycemic control, decrease diabetic complications, reduce cardiovascular inflammatory markers, and enhance lung function in COPD patients. Furthermore, integrating dental services with medical care within health systems and accountable care organizations can potentially reduce healthcare costs and improve care coordination. However, the lack of interoperable electronic health records (EHRs) and differing payment models remain significant barriers. Moving forward, fostering collaboration among healthcare providers, developing robust EHR systems, and pursuing value-based payment models will be crucial steps toward fully realizing the integration of dental and medical care.

Endnotes

[1] Max W. Seitz et al., "Current Knowledge on Correlations Between Highly Prevalent Dental Conditions and Chronic Diseases: An Umbrella Review," *Preventing Chronic Disease* 16 (September 26, 2019): E132, https://doi.org/10.5888/pcd16.180641.
[2] Oindrila Paul et al., "Inflammation in Periodontal Disease: Possible Link to Vascular Disease," *Frontiers in Physiology* 11 (January 14, 2021): 609614, https://doi.org/10.3389/fphys.2020.609614.
[3] Daniela Liccardo et al., "Potential Bidirectional Relationship Between Periodontitis and Alzheimer's Disease," *Frontiers in Physiology* 11 (2020): 683, https://doi.org/10.3389/fphys.2020.00683.
[4] M. Aldossri et al., "Oral Health and Cardiovascular Disease: Mapping Clinical Heterogeneity and Methodological Gaps," *JDR Clinical & Translational Research* 6, no. 4 (October 1, 2021): 390–401, https://doi.org/10.1177/2380084420953121.
[5] Paul et al., "Inflammation in Periodontal Disease."
[6] Sixin Liu, Stuart G. Dashper, and Rui Zhao, "Association Between Oral Bacteria and Alzheimer's Disease: A Systematic Review and Meta-Analysis," ed. Jin–Tai Yu, *Journal of Alzheimer's Disease* 91, no. 1 (January 3, 2023): 129–50, https://doi.org/10.3233/JAD-220627.
[7] Terry C. Simpson et al., "Treatment of Periodontitis for Glycaemic Control in People with Diabetes Mellitus," *The Cochrane Database of Systematic Reviews* 4, no. 4 (April 14, 2022): CD004714, https://doi.org/10.1002/14651858.CD004714.pub4.
[8] Stephanie Veazie, Kathryn Vela, and Nicholas J. Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes* (Evidence Synthesis Program (ESP), 2021), https://www.ncbi.nlm.nih.gov/books/NBK569277/pdf/Bookshelf_NBK569277.pdf.
[9] Veazie, Vela, and Parr.
[10] Veazie, Vela, and Parr.
[11] Veazie, Vela, and Parr.
[12] Kamyar Nasseh, Marko Vujicic, and Michael Glick, "The Relationship between Periodontal Interventions and Healthcare Costs and Utilization. Evidence from an Integrated Dental, Medical, and Pharmacy Commercial Claims Database," *Health Economics* 26, no. 4 (2017): 519–27, https://doi.org/10.1002/hec.3316.
[13] Ira B. Lamster et al., "Preventive Dental Care Is Associated with Improved Health Care Outcomes and Reduced Costs for Medicaid Members with Diabetes," *Frontiers in Dental Medicine* 3 (2022), https://www.frontiersin.org/articles/10.3389/fdmed.2022.952182.
[14] Veazie, Vela, and Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes*.
[15] Greg Howe et al., "Moving Toward Value-Based Payment in Oral Health Care" (Center for Health Care Strategies Inc., February 2021), https://www.chcs.org/resource/moving-toward-value-based-payment-in-oral-health/.
[16] Ann Claire Greiner and Anita Duhl Glicken, "What Primary Care Innovation Teaches Us About Oral Health Integration," *AMA Journal of Ethics* 24, no. 1 (January 1, 2022): 64–72, https://doi.org/10.1001/amajethics.2022.64.
[17] Greiner and Glicken.
[18] U.S. Department of Health and Human Services, "Oral Health in America: A Report of the Surgeon General" (Rockville, MD: National Institutes of Health, 2000), https://www.cdc.gov/oralhealth/publications/federal-agency-reports/sgr2000_05.htm.
[19] Elizabeth Mertz, "The Dental-Medical Divide: Analysis & Commentary," *Health Affairs (Project Hope)*, December 2016, https://doi.org/10.1377/hlthaff.2016.0886.
[20] Mertz.
[21] Lisa Simon, "Overcoming Historical Separation between Oral and General Health Care: Interprofessional Collaboration for Promoting Health Equity," *AMA Journal of Ethics* 18, no. 9 (September 1, 2016): 941–49, https://doi.org/10.1001/journalofethics.2016.18.9.pfor1-1609.

[22] Simon.
[23] Yara Halasa and Michael Doonan, "Integrating Oral and General Health: The Role of Accountable Care Organizations," *Issue Brief: The Massachusetts Health Policy Forum*, October 2016.
[24] Simon, "Overcoming Historical Separation between Oral and General Health Care."
[25] Simon.
[26] "Health Worfoce Shortage Areas," data.HRSA.gov, March 13, 2023, https://data.hrsa.gov/topics/health-workforce/shortage-areas.
[27] Liang Wei et al., "Dental Health Status, Use, and Insurance Coverage among Adults with Chronic Conditions," *The Journal of the American Dental Association* 153, no. 6 (June 2022): 563-571.e2, https://doi.org/10.1016/j.adaj.2021.12.012.
[28] Heather Taylor, Ann M. Holmes, and Justin Blackburn, "Prevalence of and Factors Associated with Unmet Dental Need among the U.S. Adult Population in 2016," *Community Dentistry and Oral Epidemiology* 49, no. 4 (August 2021): 346–53, https://doi.org/10.1111/cdoe.12607.
[29] "Uninsured and in Need," CareQuest Institute for Oral Health, accessed November 13, 2024, https://www.carequest.org/resource-library/uninsured-and-need.
[30] Howe et al., "Moving Toward Value-Based Payment in Oral Health Care."
[31] "Emergency Department Visits for Dental Conditions - A Snapshot" (Health Policy Institute, American Dental Association, April 2020), https://www.ada.org/-/media/project/ada-organization/ada/ada-org/files/resources/community-initiatives/action-for-dental-health/emergency-department-referrals/ed_referral_hpi_infographic.pdf.
[32] Danielle Furgeson, "Oral Manifestations of Crohn's Disease," *Decisions in Dentistry* (blog), May 1, 2016, https://decisionsindentistry.com/article/oral-manifestations-crohns-disease/.
[33] Romesh P Nalliah, "Oral-Systemic Interaction. The Opportunities and Barriers for Advancing Healthcare."
[34] Nalliah.
[35] Liu, Dashper, and Zhao, "Association Between Oral Bacteria and Alzheimer's Disease."
[36] Barbara Giordano-Kelhoffer et al., "Oral Microbiota, Its Equilibrium and Implications in the Pathophysiology of Human Diseases: A Systematic Review," *Biomedicines* 10, no. 8 (July 27, 2022): 1803, https://doi.org/10.3390/biomedicines10081803.
[37] Sameera G. Nath and Ranjith Raveendran, "Microbial Dysbiosis in Periodontitis," *Journal of Indian Society of Periodontology* 17, no. 4 (2013): 543–45, https://doi.org/10.4103/0972-124X.118334.
[38] Seitz et al., "Current Knowledge on Correlations Between Highly Prevalent Dental Conditions and Chronic Diseases."
[39] "Periodontal Disease in Adults (Age 30 or Older)," National Institute of Dental and Craniofacial Research, August 2021, https://www.nidcr.nih.gov/research/data-statistics/periodontal-disease/adults.
[40] Paul et al., "Inflammation in Periodontal Disease."
[41] Liccardo et al., "Potential Bidirectional Relationship Between Periodontitis and Alzheimer's Disease."
[42] "The Most Expensive Medical Diseases and Procedures | USC EMHA," *USC EMHA Online* (blog), February 9, 2023, https://healthadministrationdegree.usc.edu/blog/most-expensive-disease-to-treat-infographic/.
[43] CDC, "Diabetes Basics," Diabetes, July 19, 2024, https://www.cdc.gov/diabetes/about/index.html.
[44] Ji Lin et al., "Projection of the Future Diabetes Burden in the United States through 2060," *Population Health Metrics* 16, no. 1 (June 15, 2018): 9, https://doi.org/10.1186/s12963-018-0166-4.
[45] Chen-Zhou Wu et al., "Epidemiologic Relationship between Periodontitis and Type 2 Diabetes Mellitus," *BMC Oral Health* 20, no. 1 (July 11, 2020): 204, https://doi.org/10.1186/s12903-020-01180-w.
[46] Anh Thi Mai Nguyen et al., "The Association of Periodontal Disease with the Complications of Diabetes Mellitus. A Systematic Review," *Diabetes Research and Clinical Practice* 165 (July 2020): 108244, https://doi.org/10.1016/j.diabres.2020.108244.
[47] Nguyen et al.
[48] Wu et al., "Epidemiologic Relationship between Periodontitis and Type 2 Diabetes Mellitus."
[49] Veazie, Vela, and Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes*.
[50] Veazie, Vela, and Parr.

[51] Wenche S. Borgnakke, "IDF Diabetes Atlas: Diabetes and Oral Health – A Two-Way Relationship of Clinical Importance," *Diabetes Research and Clinical Practice* 157 (November 1, 2019): 107839, https://doi.org/10.1016/j.diabres.2019.107839.
[52] Simpson et al., "Treatment of Periodontitis for Glycaemic Control in People with Diabetes Mellitus."
[53] Nguyen et al., "The Association of Periodontal Disease with the Complications of Diabetes Mellitus. A Systematic Review."
[54] Borgnakke, "IDF Diabetes Atlas." 2019.
[55] Borgnakke.
[56] Borgnakke.
[57] Nguyen et al., "The Association of Periodontal Disease with the Complications of Diabetes Mellitus. A Systematic Review."
[58] Aldossri et al., "Oral Health and Cardiovascular Disease."
[59] Paul et al., "Inflammation in Periodontal Disease."
[60] CDC, "Heart Disease Facts," Heart Disease, October 24, 2024, https://www.cdc.gov/heart-disease/data-research/facts-stats/index.html.
[61] CDC, "Fast Facts: Health and Economic Costs of Chronic Conditions," Chronic Disease, August 26, 2024, https://www.cdc.gov/chronic-disease/data-research/facts-stats/index.html.
[62] Paul et al., "Inflammation in Periodontal Disease."
[63] Paul et al.
[64] Veazie, Vela, and Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes*.
[65] Paul et al., "Inflammation in Periodontal Disease."
[66] Paul et al.
[67] Aldossri et al., "Oral Health and Cardiovascular Disease."
[68] Paul et al., "Inflammation in Periodontal Disease."
[69] Fiona Q. Bui et al., "Association between Periodontal Pathogens and Systemic Disease," *Biomedical Journal* 42, no. 1 (February 2019): 27–35, https://doi.org/10.1016/j.bj.2018.12.001.
[70] Amol Ashok Bahekar et al., "The Prevalence and Incidence of Coronary Heart Disease Is Significantly Increased in Periodontitis: A Meta-Analysis," *American Heart Journal* 154, no. 5 (November 1, 2007): 830–37, https://doi.org/10.1016/j.ahj.2007.06.037.
[71] A. R. Pradeep et al., "Periodontitis as a Risk Factor for Cerebrovascular Accident: A Case-Control Study in the Indian Population," *Journal of Periodontal Research* 45, no. 2 (April 2010): 223–28, https://doi.org/10.1111/j.1600-0765.2009.01220.x.
[72] Hyun-Duck Kim et al., "Association between Periodontitis and Hemorrhagic Stroke among Koreans: A Case-Control Study," *Journal of Periodontology* 81, no. 5 (May 2010): 658–65, https://doi.org/10.1902/jop.2010.090614.
[73] Pradeep et al., "Periodontitis as a Risk Factor for Cerebrovascular Accident."
[74] Veazie, Vela, and Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes*.
[75] Liccardo et al., "Potential Bidirectional Relationship Between Periodontitis and Alzheimer's Disease."
[76] CDC, "Fast Facts," August 26, 2024.
[77] "Health and Economic Costs of Chronic Diseases | CDC," March 23, 2023, https://www.cdc.gov/chronicdisease/about/costs/index.htm.
[78] CDC, "About Alzheimer's," Alzheimer's Disease and Dementia, September 30, 2024, https://www.cdc.gov/alzheimers-dementia/about/alzheimers.html.
[79] Liccardo et al., "Potential Bidirectional Relationship Between Periodontitis and Alzheimer's Disease."
[80] Liccardo et al.
[81] Liu, Dashper, and Zhao, "Association Between Oral Bacteria and Alzheimer's Disease."
[82] Leslie Borsa et al., "Analysis the Link between Periodontal Diseases and Alzheimer's Disease: A Systematic Review," *International Journal of Environmental Research and Public Health* 18, no. 17 (January 2021): 9312, https://doi.org/10.3390/ijerph18179312.
[83] Mark Ide et al., "Periodontitis and Cognitive Decline in Alzheimer's Disease," *PLOS ONE* 11, no. 3 (March 10, 2016): e0151081, https://doi.org/10.1371/journal.pone.0151081.

[84] Borsa et al., "Analysis the Link between Periodontal Diseases and Alzheimer's Disease."
[85] Liu, Dashper, and Zhao, "Association Between Oral Bacteria and Alzheimer's Disease."
[86] Liu, Dashper, and Zhao.
[87] Liu, Dashper, and Zhao.
[88] May A. Beydoun et al., "Infection Burden, Periodontal Pathogens, and Their Interactive Association with Incident All-Cause and Alzheimer's Disease Dementia in a Large National Survey," *Alzheimer's & Dementia* 20, no. 9 (2024): 6468–85, https://doi.org/10.1002/alz.14141.
[89] Borsa et al., "Analysis the Link between Periodontal Diseases and Alzheimer's Disease."
[90] "Health and Economic Costs of Chronic Diseases | CDC."
[91] Veazie, Vela, and Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes*.
[92] Bui et al., "Association between Periodontal Pathogens and Systemic Disease."
[93] Bui et al.
[94] Nikhil Sharma and H. Shamsuddin, "Association Between Respiratory Disease in Hospitalized Patients and Periodontal Disease: A Cross-Sectional Study," *Journal of Periodontology* 82, no. 8 (August 2011): 1155–60, https://doi.org/10.1902/jop.2011.100582.
[95] Shawn F Kane, "The Effects of Oral Health on Systemic Health," *GENERAL DENTISTRY*, 2017.
[96] CDC, "Fast Facts: Health and Economic Costs of Chronic Conditions," Chronic Disease, August 26, 2024, https://www.cdc.gov/chronic-disease/data-research/facts-stats/index.html.
[97] Jerián González-Febles and Mariano Sanz, "Periodontitis and Rheumatoid Arthritis: What Have We Learned about Their Connection and Their Treatment?," *Periodontology 2000* 87, no. 1 (2021): 181–203, https://doi.org/10.1111/prd.12385.
[98] González-Febles and Sanz.
[99] Bui et al., "Association between Periodontal Pathogens and Systemic Disease."
[100] Bui et al.
[101] Bashayer H. Alnasser et al., "The Potential Association Between Periodontal Diseases and Adverse Pregnancy Outcomes in Pregnant Women: A Systematic Review of Randomized Clinical Trials," *Cureus* 15, no. 1 (January 1, 2023): e33216, https://doi.org/10.7759/cureus.33216.
[102] Hoonji Jang et al., "Oral Microflora and Pregnancy: A Systematic Review and Meta-Analysis," *Scientific Reports* 11, no. 1 (August 19, 2021): 16870, https://doi.org/10.1038/s41598-021-96495-1.
[103] Jang et al.
[104] Jang et al.
[105] Giordano-Kelhoffer et al., "Oral Microbiota, Its Equilibrium and Implications in the Pathophysiology of Human Diseases."
[106] Yvonne L Kapila, "Oral Health's Inextricable Connection to Systemic Health: Special Populations Bring to Bear Multimodal Relationships and Factors Connecting Periodontal Disease to Systemic Diseases and Conditions," *Periodontology 2000* 87, no. 1 (October 2021): 11–16, https://doi.org/10.1111/prd.12398.
[107] Allan Radaic et al., "Paradigm Shift in the Pathogenesis and Treatment of Oral Cancer and Other Cancers Focused on the Oralome and Antimicrobial-based Therapeutics," *Periodontology 2000* 87, no. 1 (October 2021): 76–93, https://doi.org/10.1111/prd.12388.
[108] Bui et al., "Association between Periodontal Pathogens and Systemic Disease."
[109] Radaic et al., "Paradigm Shift in the Pathogenesis and Treatment of Oral Cancer and Other Cancers Focused on the Oralome and Antimicrobial-based Therapeutics."
[110] V. Allareddy et al., "Important Impact of Gingival and Periodontal Conditions on Outcomes in SCT Recipients," *Bone Marrow Transplantation* 50, no. 4 (April 1, 2015): 604–7.
[111] Veerasathpurush Allareddy et al., "Presence of Gingivitis and Periodontitis Significantly Increases Hospital Charges in Patients Undergoing Heart Valve Surgery," *Journal of the Massachusetts Dental Society* 63, no. 4 (2015): 10–16.
[112] Veerasathpurush Allareddy et al., "Impact of Periapical Abscess on Infectious Complications in Patients Undergoing Extracorporeal Circulation Auxiliary to Open-Heart Surgical Procedures," *The Journal of Evidence-Based Dental Practice* 17, no. 1 (March 2017): 13–22, https://doi.org/10.1016/j.jebdp.2016.10.002.

[113] Veazie, Vela, and Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes*.
[114] Marjorie K. Jeffcoat et al., "Impact of Periodontal Therapy on General Health: Evidence from Insurance Data for Five Systemic Conditions," *American Journal of Preventive Medicine* 47, no. 2 (August 1, 2014): 166–74, https://doi.org/10.1016/j.amepre.2014.04.001.
[115] Simpson et al., "Treatment of Periodontitis for Glycaemic Control in People with Diabetes Mellitus."
[116] .Dr Shahin Safarian, "3 Types of Periodontal Surgery To Repair Your Gums," Irresistible Smiles, March 9, 2021, https://safariandmd.com/types-periodontal-surgery/.
[117] Nasseh, Vujicic, and Glick, "The Relationship between Periodontal Interventions and Healthcare Costs and Utilization. Evidence from an Integrated Dental, Medical, and Pharmacy Commercial Claims Database."
[118] Simpson et al., "Treatment of Periodontitis for Glycaemic Control in People with Diabetes Mellitus."
[119] Simpson et al.
[120] Simpson et al.
[121] Wenche Sylling Borgnakke, "Current Scientific Evidence for Why Periodontitis Should Be Included in Diabetes Management," *Frontiers in Clinical Diabetes and Healthcare* 4 (January 11, 2024), https://doi.org/10.3389/fcdhc.2023.1257087.
[122] Sung Eun Choi, Corneliu Sima, and Ankur Pandya, "Impact of Treating Oral Disease on Preventing Vascular Diseases: A Model-Based Cost-Effectiveness Analysis of Periodontal Treatment Among Patients With Type 2 Diabetes," *Diabetes Care* 43, no. 3 (March 1, 2020): 563–71, https://doi.org/10.2337/dc19-1201.
[123] Choi, Sima, and Pandya.
[124] Veazie, Vela, and Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes*.
[125] Chunjie Li et al., "Periodontal Therapy for the Management of Cardiovascular Disease in Patients with Chronic Periodontitis," *The Cochrane Database of Systematic Reviews* 11, no. 11 (November 7, 2017): CD009197, https://doi.org/10.1002/14651858.CD009197.pub3.
[126] Paul et al., "Inflammation in Periodontal Disease."
[127] Veazie, Vela, and Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes*.
[128] Veazie, Vela, and Parr.
[129] Veazie, Vela, and Parr.
[130] Veazie, Vela, and Parr.
[131] Veazie, Vela, and Parr.
[132] Veazie, Vela, and Parr.
[133] Nasseh, Vujicic, and Glick, "The Relationship between Periodontal Interventions and Healthcare Costs and Utilization. Evidence from an Integrated Dental, Medical, and Pharmacy Commercial Claims Database."
[134] Nasseh, Vujicic, and Glick.
[135] Lamster et al., "Preventive Dental Care Is Associated with Improved Health Care Outcomes and Reduced Costs for Medicaid Members with Diabetes."
[136] Choi, Sima, and Pandya, "Impact of Treating Oral Disease on Preventing Vascular Diseases."
[137] Choi, Sima, and Pandya.
[138] Veazie, Vela, and Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes*.
[139] Veazie, Vela, and Parr.
[140] Veazie, Vela, and Parr.
[141] Veazie, Vela, and Parr.
[142] Veazie, Vela, and Parr.
[143] Veazie, Vela, and Parr.
[144] Veazie, Vela, and Parr.
[145] Pamela Owens, Richard Manski, and Audrey Weiss, "Emergency Department Visits Involving Dental Conditions, 2018" (Agency for Healthcare Research and Quality, August 2021), https://www.ncbi.nlm.nih.gov/books/NBK574495/.
[146]Owens, Manski, and Weiss.

[147] Owens, Manski, and Weiss.
[148] Lamster et al., "Preventive Dental Care Is Associated with Improved Health Care Outcomes and Reduced Costs for Medicaid Members with Diabetes."
[149] Veazie, Vela, and Parr, *Evidence Brief: Detection and Treatment of Dental Problems on Chronic Disease Outcomes*.
[150] Jeffcoat et al., "Impact of Periodontal Therapy on General Health."
[151] BCBSM Specialty Benefits Team, "Specialty Benefits & Analytics COE: Specialty Claims Data Study."
[152] Susan C McKernan et al., "Medical-Dental Integration in Public Health Settings: An Environmental Scan," *The University of Iowa Public Policy Center*, 2018, https://ppc.uiowa.edu/sites/default/files/ced_environmental_scan.pdf.
[153] "Oral Health Integration for MassHealth ACOs" (MassHealth: MA DSRIP TA Marketplace, 2020).
[154] Wei et al., "Dental Health Status, Use, and Insurance Coverage among Adults with Chronic Conditions."
[155] McKernan et al., "Medical-Dental Integration in Public Health Settings: An Environmental Scan."
[156] "Return on Investment: Healthcare System Savings | Infographics," August 27, 2020, https://www.cdc.gov/oralhealth/infographics/roi-healthcare.html.
[157] McKernan et al., "Medical-Dental Integration in Public Health Settings: An Environmental Scan."
[158] McKernan et al.
[159] McKernan et al.
[160] Jesse Feierabend-Peters and Hugh Silk, "Why Should Primary Care Clinicians Learn to Routinely Examine the Mouth?," *AMA Journal of Ethics* 24, no. 1 (January 1, 2022): 19–26, https://doi.org/10.1001/amajethics.2022.19.
[161] Tamanna Tiwari et al., "Medical-Dental Integration Models: A Critical Review of the Last Decade" (Delta Dental Institute, University of Colorado School of Dental Medicine, September 2022), https://www.deltadentalinstitute.com/content/dam/delta-dental-policy/pdf/UCO_MDI_White_Paper.pdf.
[162] McKernan et al., "Medical-Dental Integration in Public Health Settings: An Environmental Scan."
[163] Wei et al., "Dental Health Status, Use, and Insurance Coverage among Adults with Chronic Conditions."
[164] McKernan et al., "Medical-Dental Integration in Public Health Settings: An Environmental Scan."
[165] Carrie H Colla et al., "Dental Care Within Accountable Care Organizations: Challenges and Opportunities," March 2016.
[166] Howe et al., "Moving Toward Value-Based Payment in Oral Health Care."
[167] Tiwari et al., "Medical-Dental Integration Models: A Critical Review of the Last Decade."
[168] Howe et al., "Moving Toward Value-Based Payment in Oral Health Care."
[169] Danielle Apostolon et al., "Alternative Payment Models in Dentistry: A Provider Perspective" (CareQuest Institute for Oral Health, December 2020), https://doi.org/10.35565/CQI.2020.2021.
[170] Beau Meyer and Sue Tolleson-Rinehart, "Making Dental Care A Part Of ACOs," *Health Affairs Forefront*, accessed March 7, 2023, https://doi.org/10.1377/forefront.20160907.056373.
[171] Apostolon et al., "Alternative Payment Models in Dentistry."
[172] Tiwari et al., "Medical-Dental Integration Models: A Critical Review of the Last Decade."
[173] "Dental Care in Accountable Care Organizations: Insights from 5 Case Studies" (Leavitt Partners, n.d.).
[174] "Dental Care in Accountable Care Organizations: Insights from 5 Case Studies."
[175] Tiwari et al., "Medical-Dental Integration Models: A Critical Review of the Last Decade."
[176] Halasa and Doonan, "Integrating Oral and General Health: The Role of Accountable Care Organizations."
[177] Meyer and Tolleson-Rinehart, "Making Dental Care A Part Of ACOs."
[178] "Dental Care in Accountable Care Organizations: Insights from 5 Case Studies."
[179] Howe et al., "Moving Toward Value-Based Payment in Oral Health Care."
[180] Greiner and Glicken, "What Primary Care Innovation Teaches Us About Oral Health Integration."
[181] Greiner and Glicken.
[182] Colla et al., "Dental Care Within Accountable Care Organizations: Challenges and Opportunities."
[183] Meyer and Tolleson-Rinehart, "Making Dental Care A Part Of ACOs."
[184] Howe et al., "Moving Toward Value-Based Payment in Oral Health Care."
[185] Howe et al.