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Expediting dental treatment for patients with diabetes mellitus in a university-based dental clinic.

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Expediting Dental Treatment for Patients with Diabetes Mellitus
in a University-Based Dental Clinic

by

Michelle Baxter

Paper submitted in partial fulfillment of the
requirements for the degree of

Doctor of Nursing Practice

School of Nursing, University of Louisville


July 18, 2021

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Abstract

Oral health and diabetes are connected in a reciprocal relationship linked through the pathological mechanisms of bacteremia, inflammation, and the immune response. Dental patients experience a delay in receiving treatment at a university-based dental clinic secondary to obtaining required medical consultation from the patients' private providers for complex medical conditions. This project was implemented to minimize barriers in access to care, reduce the risk for oral health and systemic diabetes complications, and optimize the health outcomes for diabetic patients seeking comprehensive dental treatment. The intervention group included 32 patients with diabetes who participated in hemoglobin A1c (HbA1c) testing during their initial dental screening appointment. The participants whose HbA1c value was $\leq 9.0\%$ were expedited into the scheduling queue for the next comprehensive examination appointment. The timeframe between screening and dental treatment plan development was measured and compared to a retrospective cohort of diabetic patients. Health literacy was assessed regarding patients' understanding of the connection between oral health and diabetes. The mean number of days between screening and treatment plan development was decreased from 125 to 68 days, a 45% reduction. Most of the eligible participants in the intervention group with an HbA1c value $\leq 9.0\%$ rated their understanding of the connection between diabetes and gum disease as "poor" (44%), whereas 86% of the patients who consented to participate but were ineligible due to an HbA1c value $\geq 9.1\%$ rated their understanding as "very good" or "excellent". Diabetic patients will continue to benefit from this quality improvement project to minimize barriers to dental care and improve overall health outcomes as this intervention is adopted as a permanent practice change.

Keywords: HbA1c; Glycated hemoglobin; Diabetes; Oral Health; Dental; Periodontal; Screening; Integrated Health Care; Point of Care

Expediting Dental Treatment for Patients with Diabetes Mellitus in a University-Based Dental Clinic

The Surgeon General's Report on Oral Health in America was released in 2000 to highlight oral health and its implications on whole-body, general health, and well-being. The United States Department of Health Services, The National Institute of Dental and Craniofacial Research, and The National Institutes of Health have aligned in support of the phrase; "the mouth is a mirror of health or disease and an early indicator of disease in other tissues and organs in the body" (U.S. Department of Health and Human Services, 2000). In the interest of providing whole-person care, healthcare providers should be aware of specific systemic disease processes which can produce oral manifestations.

Problem and Significance

In 2020, the Center for Disease Control and Prevention published the National Diabetes Statistics report which details the incidence of diabetes in the United States. The report estimates that in 2018, 34.2 million people of all ages had diabetes, while another 88 million people in the US over 18 years of age have prediabetes. Diabetes mellitus encompasses a group of systemic metabolic diseases characterized by the body's inability to produce or adequately respond to insulin which leads to high levels of glucose in the blood. Glycated hemoglobin or hemoglobin A1c (HbA1c) is a measurement of glucose attached to red blood cells and provides a useful long-term gauge of an individual's blood glucose control over an 8-12 week period of time. If this state of hyperglycemia is not well-managed, systemic complications will follow with damage to nearly every organ in the body. Macro- and microvascular systemic complications that develop secondary to poorly controlled diabetes include cardiovascular disease, kidney disease, retinopathy, neuropathy, and delayed tissue healing (Chinnasamy & Moodie, 2020; Nascimento

et al., 2018). Oral complications of uncontrolled diabetes are manifested as inflammatory disease and soft tissue abnormalities in diabetic patients. These pathologies include periodontitis, gingivitis, salivary dysfunction, oral infections, oral mucosal lesions, dental caries, and tooth loss (Al-Maskari et al., 2011).

When considering oral disease, dental caries, and periodontitis are the biggest threats to overall dental health. Individuals with diabetes are at a greater risk for developing dental caries due to the systemic microvascular changes associated with the disease. Salivary gland dysfunction in diabetics leads to xerostomia which produces greater susceptibility to tooth decay due to the loss of the cleansing and buffering characteristics of saliva (Al-Maskari et al., 2011).

Periodontitis is a disease process that encompasses bacterial infection and inflammation of the tissues that support the teeth. Bacteria reside in the dental plaque that accumulates on the surface of the teeth. If this dental plaque is not removed daily, toxins are released from the bacterial microorganisms and the gingival inflammatory process ensues. This inflammatory process results in the gum tissue detaching from the tooth surface and the development of a periodontal pocket filled with bacteria and toxins (Al-Maskari et al., 2011). When this process is left untreated, periodontitis will progress, affecting the gum tissues, fibers, and ligaments (Nascimento, 2018). The periodontal pocket continues to deepen and the measure of gingival detachment from the tooth surface increases until reaching the alveolar bone. Once the periodontal tissues reach this erosive level, destruction of the bone eventually manifests, and tooth loss occurs (Al-Maskari et al., 2011). Patients with poorly controlled diabetes mellitus are susceptible hosts for this progressive inflammatory process. Periodontitis begins to emerge in adolescence and becomes clinically significant during an individual's mid-thirties. The US

periodontal disease incidence in this age group and older is 47.2% and increases to 70.1% in adults aged 65 years and older (Eke et al., 2015).

Rationale

Retrospective data collection and evaluation completed in 2018 with my involvement in the Duke-Johnson & Johnson Nurse Leadership Fellowship Program revealed that 32% of the medical consults written to private medical providers seeking medical clearance for patients presenting to the University of Louisville School of Dentistry (ULSD) screening clinic were for diabetes mellitus, both type 1 and type 2 (Baxter, 2018). This initial project involved retrospective data retrieval to determine the frequency and character of the medical conditions experienced by patients seeking dental treatment at a university-based dental clinic. During my interprofessional practice at ULSD, I observed that the complex medical conditions of dental patients induced a delay in receiving treatment secondary to the requirement of obtaining medical consultation with the patients' private providers according to the standing Oral Medicine Clinical Patient Management and Medical Consultation Guidelines at ULSD (Firriolo, 2021). Retrospective data evaluation allowed for the quantifying of patients' medical diagnoses and treatments with the goal of developing interventions to be offered and implemented in an integrated medical-dental primary care clinic, University of Louisville Care Partners (ULCP), housed within ULSD. The development of these interventions would focus on alleviating barriers and increasing access to timely dental care (Baxter, 2018). ULSD clinic policies prohibit any patient from receiving elective dental treatment prior to obtaining medical consultation and recommendations from the patients' private provider. In the case of diabetic patients, this includes documentation of well- or moderately managed diabetes as determined by HbA1c values updated at least every six months (King et al., 2011).

Purpose and Specific Aims

The purpose of this doctoral nursing project was to minimize barriers in access to care and optimize the health outcomes for patients seeking treatment in a university-based dental clinic. This project involved a quality improvement process change to expedite the comprehensive dental treatment of diabetic patients beginning at their initial screening appointment. Building upon data compilation from the 2018 study, an intervention was developed to take proactive steps to increase access to dental care for diabetic patients (Baxter, 2018). Hemoglobin A1c was offered and measured for diabetic patients through point of care (POC) testing in conjunction with ULCP, the on-site integrated medical-dental clinic. Participants whose HbA1c value was $\leq 9.0\%$ were expedited in their assignment to a student group for scheduling of their next dental appointment with subsequent treatment plan development. During the three-month implementation period of my project, the goal was to reduce the time between initial screening to treatment plan development by 10% in the mean number of days. Oral-systemic health literacy data was gathered from a self-report patient evaluation assessing participants' understanding of the connection between oral health and diabetes. The purpose of this data collection was to direct future projects regarding patient education needs.

Environment

The setting for this project was the ULSD screening clinic during the initial dental screening appointment. This appointment consists of a medical history interview, oral examination, and panoramic x-ray. The appointment goal is to determine the appropriate assignment with a dental student for treatment based on the complexity of both dental and medical diagnoses. The dental school houses a variety of clinics with student providers and

faculty oversight. The dental clinic is also comprised of dental hygiene students, dental assistants, administrative staff, and sterilization technicians.

The school is open to all individuals seeking dental treatment and is a tertiary referral center in the community. Commercial insurance, Medicaid, and Kentucky Children's Health Insurance Program are accepted. More than 100,000 patient visits occur each year where our students and faculty provide millions of dollars of dental services in comprehensive dental care, including diagnosis, treatment, prevention, and follow-up. In 2018, ULSD partnered with the School of Nursing to open an in-house nurse practitioner-managed clinic, ULCP. This medical-dental integrated clinic provides the opportunity to address the medical needs of our patients as well as the public and conducts limited POC testing.

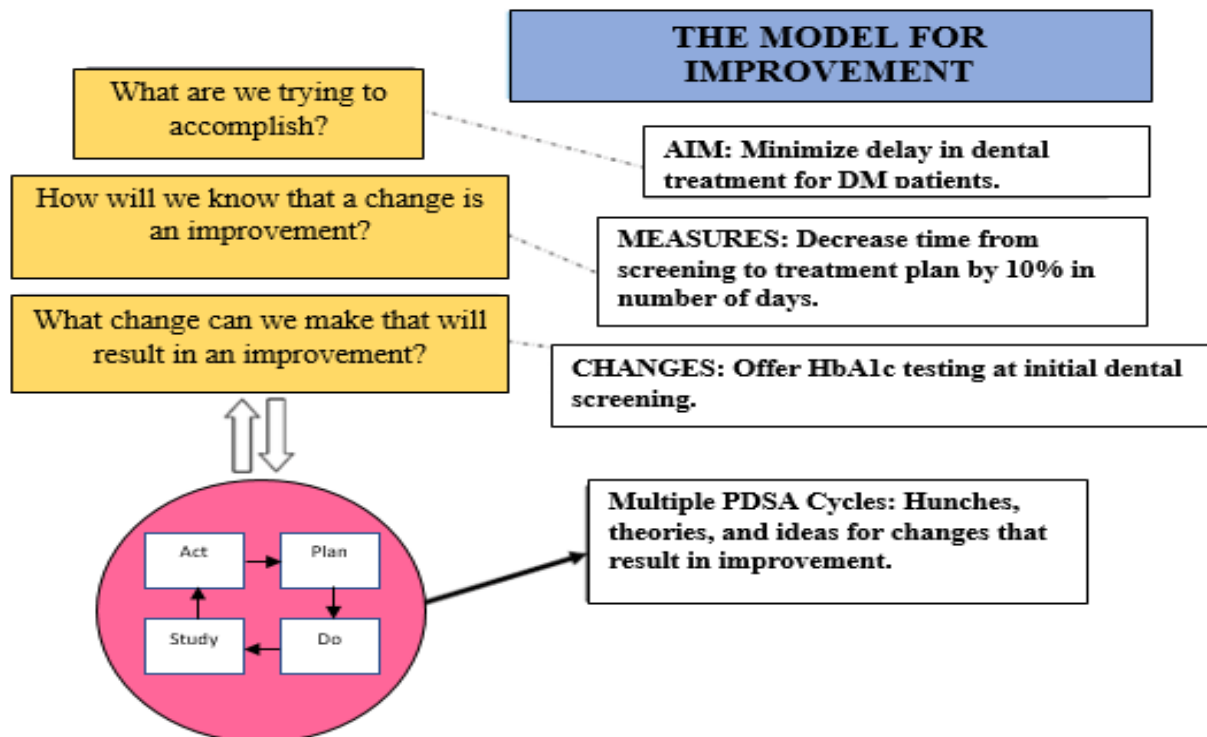
The dental school is devoted to "a leadership position serving the oral health needs of our Commonwealth and nation by educating and training competent health care professionals and engaging in sponsored research" (T. Bradley, personal communication, January 7, 2020). The mission statement of the school was recently eliminated and replaced by a concise vision statement that reads, "To be the benchmark for dental education, patient-centered care, and groundbreaking research" (T. Bradley, personal communication, January 7, 2020). The school's strategic plan and curriculum support fostering an environment of patient-centered care and optimally expanding treatment services to a wide population. Faculty are encouraged to engage in innovative research activities to impact the health outcomes of our patients. The stakeholders for this project include diabetic patients seeking dental care at ULSD, administration, faculty, staff, dental students, ULCP faculty and staff, and U of L School of Nursing.

Conceptual Framework

This quality improvement project was informed by The Model for Improvement (MFI); specifically, the Plan-Do-Study-Act (PDSA) rapid cycle process embedded within this theoretical framework (Deming, 1994). The PDSA cycle allows for testing and measuring the results of small changes implemented in clinical practice which ultimately produce positive effects that ripple throughout a healthcare organization (Langley et al., 2009).

Figure 1

The Model for Improvement



Note. The Plan-Do-Study-Act cycle was developed by W. Edwards Deming (1994). (Langley et al., 2009).

Ethics

The University of Louisville Institutional Review Board approved this project (#20.0825; Not Human Subjects Research). Dr. F. John Firriolo, DDS, Ph.D., the Director of the Division of Oral Medicine at ULSD has provided a letter stating a commitment to the support of this quality improvement project (see Appendix A).

Intervention

Diabetic patients presenting for dental treatment were offered POC fingerstick HbA1c testing at ULCP at the time of their initial dental screening. Participants whose HbA1c value was $\leq 9.0\%$ were expedited into the scheduling queue with an assignment to an appropriate dental student provider. The timeframe between the screening date and the date of treatment plan development was measured in this cohort of expedited diabetic patients. The $\leq 9.0\%$ parameter for HbA1c was selected to align with the present guidelines for elective comprehensive dental treatment at ULSD. Considering the focus of this project was those treated for diabetes mellitus, patients who presented with multiple significant medical conditions were excluded as consultation with each specialized medical provider interjected multiple confounding factors into the delay in dental treatment.

Prior to the implementation of this project, the process for diabetic patients' initial dental screening appointment involved writing a medical consult to their private medical provider requesting the most recent HbA1c, indications of systemic complications attributable to diabetes, and specific recommendations regarding the proposed dental treatment. The pre-project process involved holding all diabetic patients in a "medical consult pending" queue without knowing their current HbA1c until we receive a response from their provider. This process translated into a delay in dental treatment which could be weeks or months, depending on the response time of

the provider. It was also common to receive an outdated HbA1c from the provider. For eligible participants, obtaining a current HbA1c during the screening appointment eliminated this delay. When a patient's HbA1c value is documented $\geq 9.1\%$, a designation of American Society of Anesthesiologists (ASA) Classification IV is given to the patient as they are considered high risk for dental treatment (American Society of Anesthesiologists, 2014; Dronge et al., 2006; King et al., 2011). During this project, participants whose POC HbA1c result was $\geq 9.1\%$ were provided with verbal patient education and encouraged to follow up with their private provider. For these patients, a medical consult was written to their provider and elective dental treatment was deferred until achieving glycemic control and improved management of their diabetes. A referral to emergency, hospital-based dental providers within one of the university-based graduate-level dental programs was completed as warranted, based on the urgency of the patient's dental needs.

Literature Synthesis

The foundational intervention of this project is to conduct POC HbA1c testing during dental patients' initial screening appointments on known diabetic patients to expedite comprehensive dental treatment in a university-based dental clinic. No comparable studies could be located which stated a similar purpose and implemented this intervention in a similar setting. The interprofessional collaboration of having a nurse practitioner on-site for all dental patient screening is a novel and innovative practice. This literature review located one study within a similar setting that evaluated the effectiveness of a Nurse Practitioner-Dentist Model for Primary Care at the Harvard Dental Center. The study resulted in significant positive improvements in the clinical parameters of blood pressure, weight, body mass index, and HbA1c for a convenience sample of Medicare patients with a previous diagnosis of hypertension and/or diabetes, thus

advocating for interprofessional practice focusing on whole-person wellness and health promotion (Dolce, et al, 2020).

Several studies supporting the rationale for the development of this project were located and included in this literature synthesis. The articles represent varying methodological approaches to the study of the interrelationship between periodontal disease and diabetes mellitus. Clinical trials have demonstrated the benefits of periodontal therapy for diabetic patients; however, the evidence is inconsistent and causal relationships have not definitively been established. The articles are organized in Table 1 according to Evidence Levels and rigor (Johns Hopkins University, 2019), as well as presented with main concept grouping.

Various methods of non-surgical periodontal treatment (NSPT) have been implemented in studies including scaling and root planing (SRP), systemic antimicrobials, intraoral topical antimicrobials, and mouthwash. Randomized controlled trials with the objective of evaluating the effect of NSPT on HbA1c values and periodontal status have shown significant improvements in all clinical periodontal and metabolic parameters leading to enhanced periodontal health and metabolic outcomes (El-Makaky & Shalaby, 2019; Mauri-Obradors et al. 2018; Rapone et al., 2021).

Systematic reviews and meta-analysis of randomized controlled trials have presented positive results including significant reductions in HbA1c values, systemic inflammatory markers, and fasting blood glucose values (Baeza et al., 2019; Chen et al., 2021; Madianos & Koromantzios, 2018; Teshome & Yitayeh, 2017). However, an umbrella review of systematic reviews with or without meta-analysis of randomized controlled trials evaluated the response of individuals with type 2 diabetes mellitus after receiving NSPT compared to no treatment. The conclusion of this umbrella review confirms the bidirectional relationship between diabetes and

periodontal health through the inflammatory process, however, the causality of the relationship is unclear secondary to inconsistent results, statistically insignificant changes in HbA1c values, and low-quality studies (Lavigne & Forrest, 2021).

Additional systematic reviews of a combination of study types produced inconsistent results. Pérez-Losada et al. (2016) examined the effect of non-surgical periodontal treatment on HbA1c values and periodontal status which revealed no clear evidence between periodontal treatment and glycemic control in type 2 diabetic patients. Conversely, Graziani et al. (2018) evaluated the effect of periodontitis on diabetes mellitus incidence and complications, and HbA1c values. Graziani et al. (2018) produced good quality results revealing periodontitis has a significant impact on the development of diabetes in those not previously affected, as well as increased diabetic complications, a decline in glycemic control, and a higher overall risk of mortality in those diagnosed with both periodontal disease and diabetes mellitus.

Limitations and design flaws noted across the span of the studies implicate future research recommendations for larger, multicenter randomized controlled trials with longer durations and spans of measurement for periodontal parameters, metabolic parameters, and systemic inflammatory markers.

Table 1

Evidence Level and Quality of Evidence

Study Design	Umbrella Review of Systematic Reviews with or without Meta-Analysis	Systematic Review and Meta-Analysis	Systematic Review and Meta-Analysis	Randomized Controlled Trial	Systematic Review
Evaluation Method Level (e.g., John Hopkins)	I	I	I	I	II
Rigor	A	A	B	A	B
Article by author (s)	Lavigne & Forrest (2021)	Baeza et al. (2019)	Madianos & Koromantzios (2018); Teshome, & Yitayeh (2017)	Mauri-Obradors et al. (2018); El-Makaky & Shalaby (2019)	Pérez-Losada et al. (2016); Chen et al. (2021); Graziani et al. (2018)

Method**Design**

The intervention was implemented for 90 calendar days between January 25, 2021, to April 24, 2021. This included 34 days of screening clinic with appointments scheduled in both the morning and afternoon sessions. This nonexperimental project design was implemented in the dental screening clinic of ULSD in Louisville, Kentucky utilizing a convenience sample of patients presenting to the clinic seeking comprehensive dental treatment. Prior to the implementation of this project in January 2021, the detailed project design was disseminated by

email and Clinic Operations and Patient Care Committee presentation to all faculty, staff, and dental students who function in a patient care role in the dental clinics at ULSD. Retrospective chart review data were collected for the 90-day period between January 25, 2019, and April 4, 2019. This period included 44 screening clinic days with appointments scheduled in the afternoon session only.

Procedures

Diabetic dental patients who had no other medical condition warranting additional medical consultation were solicited for their participation in the project during their initial screening appointment by me, dental students, faculty, and clinic staff. Once potential participants were identified, they were provided a brief verbal summary and purpose of this project along with offering a POC HbA1c test. Consent for both dental and medical procedures is electronically signed during the registration and check-in process for each patient at each appointment at ULSD. The HbA1c test was completed by the medical assistant for ULCP or me during the screening appointment. All potential participants completed the Participant Data Collection Form before having the HbA1c test. Diabetic patients whose HbA1c was $\leq 9.0\%$ were expedited to the dental student assignment group for scheduling their next comprehensive evaluation appointment and treatment plan development. A ULCP consult note was entered in the Electronic Health Record (EHR) with the HbA1c results. Patients were given a printed copy of this note before dismissal from their appointment (see Appendix B). A notation of the HbA1c result was also documented in the Admissions/Triage Medical History form. To ensure these patients were expedited in scheduling their next dental appointment, at the end of each clinic day, an intra-EHR email including the patient identification number was sent to the designated dental faculty who placed these patients in the scheduling queue. For continuity of care purposes,

during the intervention phase of this project these patients had a modified medical consult sent to their medical provider stating the dated HbA1c result and soliciting recommendations for dental care. Patients whose HbA1c results were 9.1% or greater had a standard medical consult written to their provider and were held in the “medical consult pending” queue for elective dental treatment. These patients were not released to the dental student group for elective dental treatment scheduling until information and recommendations were received from the patients’ provider and reviewed by the Oral Medicine faculty, as is the current policy.

The timeframe between the screening date and the date of treatment plan development was measured in the new cohort of expedited diabetic patients seeking comprehensive dental treatment. For comparative purposes, retrospective data from the EHR system was collected and evaluated to determine the pre-intervention measurement of time between diabetic patients’ initial screening until an individualized treatment plan is written. Patients who were referred to specialty dental clinics within ULSD for consultation were excluded as this would induce a delay in treatment planning development unrelated to the current medical consultation process. These specialty clinics included Advanced Prosthodontic Clinic and Removable Prosthodontic Clinic.

Privacy, Data Storage & Confidentiality

Data collection forms were in my possession throughout the intervention implementation process and were kept in my locked desk and locked office at ULSD when not in use. All electronic media was kept on a password-protected laptop. No identifiable or personal health information was stored.

Budget

The cost for printing and copying data collection forms and miscellaneous office supplies was covered by my employment cost center at ULSD. The upfront cost of the POC HbA1c

testing device, cartridges, and lancets was absorbed by ULCP. Participants' medical insurance was billed for the POC HbA1c service at a rate of \$17 per test or the patient was able to pay out-of-pocket directly to ULCP. This service is billable to commercial insurance and Centers for Medicare and Medicaid Services. Time invested in this project by me, my department chairman, faculty and staff colleagues, and dental students was covered by our existing employment contract and student curriculum requirements with no incursion of expense. All capital costs and ongoing costs of software licensing and maintenance fees are incorporated into existing programs at ULSD and did not add additional expense to this project.

Measurement

Three data collection forms were utilized for this project and are included in the appendices of this manuscript. These forms were written specifically for this project. The Retrospective Chart Review Data Collection Form includes the ASA Classification, age, gender, patient comorbidities, screening date, and treatment plan presentation date (see Appendix C). The Participant Data Collection Form includes demographics with an option "prefer not to answer", one oral-systemic health literacy assessment question, and an acknowledgment of the intervention and receiving the result of the test (see Appendix D). The oral-systemic health literacy question was adapted from a patient questionnaire utilized by Shimpi et al. (2020) to assess patient awareness of the association between periodontal disease and diabetes mellitus. This questionnaire was developed at a fifth-grade reading level. The Intervention Data Collection Form includes ASA Classification, age, gender, acceptance, or declination of the HbA1c test at screening, response to questions on the participant data collection form, patient comorbidities, screening date, and treatment plan presentation date (see Appendix E). The fingerstick blood sample for HbA1c was tested using the resources of ULCP. The HbA1c testing device is the

Alere Afinion™ AS100 Analyzer. The ASA classification system is utilized to categorize each patient at ULSD according to their medical status and stability (American Society of Anesthesiologists, 2014).

Data were analyzed using IBM SPSS 27 Statistical Software. Demographic data was collected for the intervention and retrospective groups. Retrospective data regarding the timeframe between screening until the treatment plan development was compared to an equivocal timeframe in the new cohort of expedited diabetic patients whose HbA1c is $\leq 9.0\%$ at their initial screening appointment. Patient acceptance rates for POC HbA1c testing were evaluated. Patient awareness of the oral-systemic bidirectional relationship between periodontal disease and diabetes was evaluated through the health literacy question. Descriptive statistics were computed to summarize all collected data.

Outcome Measures

The preeminent outcome measure for this project was to decrease the time from dental screening to treatment plan development for diabetic patients by 10% in the mean number of days. Data were obtained regarding the participants' understanding of the relationship between periodontal disease and diabetes to direct future intervention developments and studies. The long-term outcome measure for this project is to improve overall health outcomes for diabetic patients' receiving dental care at ULSD by improvements in clinical parameters of periodontal disease and HbA1c at the primary care providers' stated goal.

Results

There was a 100% acceptance rate for all diabetic patients who were offered the HbA1c testing at their dental screening appointment. A total of 32 diabetic patients (mean age = 55.34, SD = 11.82, range 27-76) agreed to participate in POC HbA1c testing during their initial dental

screening appointment. Twenty-five patients with a diagnosis of diabetes mellitus met the eligibility requirement by obtaining an HbA1c value of $\leq 9.0\%$ (mean value = 6.97%, SD = 1.16, range 5.2-9.0%) on the day of their initial dental screening. Seven diabetic patients initially recruited were found to be ineligible due to an HbA1c value of $\geq 9.1\%$ (mean value = 10.67%, SD = 1.17, range 9.3-12.5%) during their initial dental screening appointment. Participant demographics and ASA classification are displayed in Table 2. All patients in both the intervention and retrospective group were diagnosed with type 2 diabetes mellitus. Eight of the 25 eligible intervention patients had progressed from screening to treatment plan development at the time of this writing. The mean number of days from initial dental screening until treatment plan development for these eight patients was 68.25 days (SD = 22.06, range 39-108). Most of the eligible participants in the intervention group with an HbA1c value $\leq 9.0\%$ rated their understanding of the connection between diabetes and gum disease as poor (44%), whereas 86% of patients who consented but were ineligible due to an HbA1c value $\geq 9.1\%$ rated their understanding as very good or excellent. The results of the self-report oral-systemic health literacy question are displayed in Table 3.

Twelve diabetic patients (mean age = 56.58, SD = 16.21, range 34-76) were identified in the pre-intervention retrospective data cohort. These patients had a traditional medical consult written to their private provider seeking recent HbA1c results and information regarding their diabetes status prior to dental treatment plan development. According to ULSD protocol, these patients were held in a scheduling queue until a response was received from their provider. The mean number of days from initial dental screening until treatment plan development for these 12 patients was 124.58 days (SD = 51.47, range 29-204). Table 4 displays the data analysis for the

measured time in numbers of days from screening to treatment plan development for the retrospective cohort.

Table 1

Demographics

Participant characteristics	Intervention group HbA1c \leq 9.0% (n = 25)	Intervention group, Uncontrolled diabetes HbA1c \geq 9.1% (n = 7)	Total Intervention group (n = 32)	Retrospective group (n = 12)
Age in years				
Mean	58.08	45.57	55.34	56.58
SD	10.65	11.25	11.83	16.21
Range	39-76	27-60	27-76	34-76
Sex				
Male	8	4	12	7
Female	17	3	20	5
Diabetes Mellitus				
Type 1	0	0	0	0
Type 2	25	7	32	12
ASA Classification				
ASA II	14		14	10
ASA III	11		11	2
ASA IV (qualified by HbA1c \geq 9.1%)		7	7	
HbA1c Value %				
Mean	6.97	10.67		7.04
SD	1.16	1.17		0.999
Range	5.2-9.0	9.3-12.5		5.9-8.7

Table 2*Oral-systemic health literacy*

How would you rate your understanding of the connection between diabetes and gum disease?	Intervention group HbA1c \leq 9.0% (n = 25)	Intervention group HbA1c \geq 9.1% (n = 7)	Total Intervention group (n = 32)
Poor	44.0% (n = 11)	-	34.4% (n = 11)
Fair	8.0% (n = 2)	14.3% (n = 1)	9.4% (n = 3)
Good	16.0% (n = 4)	-	12.5% (n = 4)
Very Good	28.0% (n = 7)	57.1% (n = 4)-	34.4% (n = 11)
Excellent	4.0% (n = 1)	28.6% (n = 2)	9.4% (n = 3)

Table 3*Screening to Treatment Plan Development*

Number of Days	Intervention group HbA1c \leq 9.0% Progressed to Treatment Plan Development (n = 8)	Retrospective group (n = 12)
Mean	68.25	124.58
SD	22.06	51.47
Range	39-108	29-204

Discussion

Oral health and diabetes mellitus are connected in a reciprocal relationship linked through the pathological mechanisms of bacteremia, inflammation, and the immune response. Diabetes is the only chronic systemic disease established as a known risk factor for periodontal disease (Lalla & Papapanou, 2011) as well as a contributing factor in the development of tooth decay, burning mouth syndrome, xerostomia, candida infection, tooth eruption abnormalities, and salivary gland hypertrophy (Lamster & Meyers-Wright, 2017). Individuals diagnosed with

diabetes are at an 86% increased risk of the development or progression of periodontal disease which further emphasizes the association between these disease processes (Nascimento, 2018). The bidirectional association between periodontal disease and diabetes has been further implicated with periodontitis contributing to the progression of diabetes and its systemic complications through the interdependent action between hyperglycemia and the hyperinflammatory response in periodontal tissues (Casanova et al., 2014; Genco & Genco; 2014; Wang et al., 2014). Periodontitis can produce adverse effects on glycemic control resulting in systemic complications from excess serum glucose, insulin dysfunction, and a heightened inflammatory response (Lalla & Papapanou, 2011). The clinical impact of addressing the correlating relationship between periodontal disease and diabetes mellitus will prove to be significant in improving overall health outcomes considering every 1% decrease in HbA1c can have up to a 20% reduction in the risk of diabetic complications and subsequent mortality (Stratton et al., 2000).

Data on the medical conditions of patients at ULSD was compiled and evaluated in 2018 and built the framework for this project (Baxter, 2018). The purpose of this intervention was to minimize barriers to dental care and increase access to dental treatment. As a nurse practitioner functioning in a full-time interprofessional practice role at ULSD, I was in an ideal position to collaborate with dental patients, dental students, and faculty to implement this innovative project. This quality improvement project evaluated the potential to expedite comprehensive dental care for diabetes patients in a university-based dental clinic with the goal of decreasing the time from initial dental screening to treatment plan development in the mean number of days by 10%. The long-term goal underlying this intervention is the improvement of overall health outcomes for patients based on the established systemic relationship of oral health and diabetes and the

interconnection of these two disease processes through the inflammatory pathway. There are no publications available that evaluate the implementation of an intervention into interprofessional clinical practice based on the known bidirectionality of the oral health-diabetes relationship.

The development of this project was directed by the PDSA rapid cycle process embedded within MFI. The MFI theoretical framework is often employed in healthcare settings (Agency for Healthcare Research and Quality, 2013) utilizing PDSA cycles for small intervention implementation in clinical practice settings to produce magnified positive results within a healthcare organization (Langley et al., 2009). The core structure of the MFI framework is built upon identifying improvement goals, selecting appropriate interventions for improvement, and establishing measurable outcomes for significant change. Once a PDSA cycle is complete, the change agent or intervention is adjusted based on what is learned through the process and these refined changes are placed into practice as the PDSA cycle repeats. Measurements made through the PDSA cycle will indicate ways in which changes can be adapted, permanently instituted, or abandoned (Deming, 1994).

Upon identifying the improvement goal of minimizing the delay in receiving comprehensive dental treatment for diabetic patients, the implementation of POC HbA1c testing into the initial dental screening appointment was selected as an agent for change. A 10% reduction in the mean number of days from screening to treatment plan development benchmark was established. These project development steps constituted the planning phase of the initial PDSA cycle. The “do” phase of this project included initiating the implementation of the HbA1c intervention over 90 days as detailed in the methods and procedures section of this manuscript. The study phase encompassed collecting and evaluating the retrospective and intervention data, as well as process evaluation throughout the project implementation timeframe.

During the implementation period, determinations were made regarding the efficacy of this project in reaching the goal to expedite diabetic patients' dental treatment and reduce barriers to care. Feedback was received and evaluated from dental students, patients, and faculty throughout the project implementation period. Changes were developed and implemented into the PDSA cycle with considerations for further minimizing barriers and increasing access to care. The most notable incremental adjustments made to the PDSA cycle after launching this project were training clinic staff to assist in soliciting project participants, frequent reminders and dissemination of the project process to overseeing faculty, dental students, and clinic staff, specifically during weekly rounds with incoming groups of dental students in the screening clinic. Other beneficial adjustments to the PDSA cycle included documenting detailed EHR notes that diabetic project participants with an HbA1c value $\leq 9.0\%$ were able to proceed with expedited scheduling opportunities, and emailed confirmation with scheduling staff of patients' eligibility to proceed with comprehensive dental treatment.

The implementation of this intervention demonstrated a 45% reduction in the mean number of days between screening and treatment plan development from 125 to 68 days. Under the current guidelines at ULSD, diabetic patients seeking comprehensive dental treatment must be held in a medical consultation pending queue and not proceed with scheduling appointments until a current HbA1c value $\leq 9.0\%$ is received from their provider. This protocol often produces a significant delay for a diabetic patient to proceed with their dental treatment, therefore creating the potential for an increased risk in oral health or systemic diabetes complications. Under the pre-intervention ULSD guideline, this delay may affect a large number of patients, considering medical consultations for diabetes mellitus account for 32% of all medical consultations sought before initiating treatment at the dental school (Baxter, 2018). By obtaining an HbA1c result

≤ 9.0% during the patients' initial appointment, this cohort of patients may proceed to their next appointment scheduling opportunity without delay. This expedited status allows for increased accessibility to schedule dental appointments and the potential to decrease the risk for oral health complications which include periodontal disease, tooth decay, burning mouth syndrome, xerostomia, oral candidiasis, salivary gland hypertrophy, and restoration failure (Hartsock & Vieira, 2021; Lalla & Papapanou, 2011; Lamster & Meyers-Wright 2017). Minimizing the delay in receiving comprehensive dental treatment also reduces the risk of developing potential systemic diabetes complications of insulin dysfunction, excess serum glucose, and a heightened inflammatory response (Lalla & Papapanou, 2011).

Limited research has addressed oral-systemic health literacy in patient populations in the United States. One oral-systemic health literacy question was posed to each eligible intervention participant in this project before their POC HbA1c test completion. This question was a patient report self-evaluation of their understanding of the connection between diabetes and gum disease. Data collected from this question corresponds to previously demonstrated low levels of knowledge in patient awareness of the association of diabetes and oral health (Shimpi et al., 2020). Eighty-six percent of the solicited intervention patients who were found to have uncontrolled diabetes (HbA1c value $\geq 9.1\%$) rated their understanding of the connection between gum disease and diabetes as "very good" or "excellent". According to ULSD guidelines, these patients were unable to continue with comprehensive dental treatment until their diabetes status is better managed. Patients in the intervention group who were able to proceed with an expedited scheduling status for dental treatment mostly rated their understanding of diabetes and oral health connection as "poor (44%) with 32% rating their understanding as "very good" or "excellent". It is recognized that this is a patient self-assessment and susceptible to self-report

bias, however, it is noteworthy that this question was posed to each solicited potential participant before the HbA1c test was completed and the result was known. Patient awareness and education of the association between diabetes and oral health must be addressed to prevent poorer overall health outcomes and reduce the risk of systemic complications.

A goal of 50 intervention participants had originally been established upon project development. The total intervention group included 32 participants with 25 reaching criteria for eligibility by having an HbA1c value $\leq 9.0\%$ at their initial screening. A final sample size of eight patients who were able to proceed from initial dental screening to treatment plan development at the time of this writing is included in the intervention data analysis. The sample size is notably small likely due to several incidental factors discovered during the implementation process. This project was implemented during the spring semester at ULSD which may interject limitations of patient appointment scheduling due to final examinations, senior class graduation with lower-class upward progression and transfer of patients, board certification examinations, and an impending limited summer clinic schedule. For equal comparative purposes, the retrospective data collection period was selected to mirror the same timeframe as the intervention period considering patient appointments and scheduling vary throughout the academic year. Variability in the number of days from initial dental screening to treatment plan development may be noted when considering different periods throughout the academic year. This quality improvement project was implemented in a large university-based dental clinic with as many as 20 clinic chairs simultaneously operating during a dental screening session. These dental screening appointments are covered by 240 junior and senior level students on a rotating basis, as well as interchanging dental faculty oversight. Upon the end of each clinic day review with students, it was noted that potential eligible patients had been dismissed from

their appointment before the solicitation for participation in the project. This is likely attributed to the inexperience of the students, the fast-paced nature of the clinic setting, the lack of awareness or understanding of the criteria for soliciting participants for inclusion in the intervention group, and the process and procedures of the overall project.

It is noteworthy to mention that patient EHRs that have entered into a collection status for unpaid treatment are not able to be viewed for data retrieval. This included 75 of the 621 retrospective charts that were reviewed. It is unknown if these locked charts would have provided additional comparable data for comparison.

Considering the immediate outcome measure of this project was a measure of time, an additional foreseen limitation is noted regarding the constraints placed on clinic scheduling and patient appointment times secondary to the Coronavirus pandemic. These limitations could include restrictions placed on ULSD for capacity and appointment scheduling as well as patient hesitancy to seek dental treatment and keep scheduled appointments due to safety concerns. Steps were taken in the development of this project in an attempt to tightly control these variables in patient appointment scheduling and clinic availability compared to pre-pandemic clinic routines.

Limitations

Noteworthy limitations in this project include a small sample size due to the constraints of implementing this project during a doctoral nursing academic semester with a restricted timeframe and a short implementation period. This project would ideally be implemented over a 6-12 month period to collect data from a larger cohort of diabetic patients. Another potential concern is the setting of this project. This university-based dental clinic has an established integrated medical-dental primary care clinic with a full-time interprofessional practice nurse

practitioner as faculty collaborating with dental faculty and students in the initial dental screening clinic each day. Implementing this project within this innovative setting allowed for a zero-budget project to produce significant benefits. Although these circumstances create a unique situation, this beneficial intervention could be easily implemented in other dental settings with minimal training for dental clinic staff.

Conclusions & Implications

Further determination of the bidirectional relationship between oral health and diabetes management and prevention should be evaluated. As this foundation of knowledge continues to grow, the known reciprocal link between oral health and diabetes through the pathology of bacteremia, the inflammation pathway, and the immune system response should be considered in the development and implementation of interventions into clinical practice that will focus on oral-systemic disease relationships. This project achieved the specific aim of expediting dental care for diabetic patients. Diabetic patients who present to ULSD for dental treatment will continue to benefit from this quality improvement project to minimize barriers to care and improve overall health outcomes as this intervention is adopted as a permanent practice change.

A prominent factor underlying the study and advancement of concurrent treatment of diabetes mellitus and oral disease is the key essential of interprofessional collaboration between primary care providers and dental providers. The need has been highlighted for devoted and comprehensive education in practice settings concerning medical and dental collaboration, and patient awareness of the interrelationship between diabetes mellitus and oral disease, specifically periodontal disease which leads to decay and tooth loss. Primary care providers are often the first line of defense against escalating oral disease and optimizing diabetes management. An increase

in oral examinations, assessment of routine oral health behaviors, and referral to dental providers from the primary care setting is warranted.

Data collected from the oral-systemic health literacy question can advance additional research and be utilized to develop health literacy educational tools. These tools can be used to promote improved health outcomes in primary care settings and dental settings, as well as serve as an endorsement for integrated medical-dental healthcare delivery systems.

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Appendix A**Letter of Support from the Oral Medicine Department Chairman**

School of Dentistry
Department of Diagnosis and Oral Health

September 18, 2020.

To whom it may concern,

This letter is to confirm The University of Louisville School of Dentistry Division of Oral Medicine is committed to supporting the DNP project by Michelle Baxter, APRN, titled "*Expediting Dental Treatment for Diabetic Patients in a University-Based Dental Clinic*". Ms. Baxter will have access to resources that will include permission to use data records, site facilities and organization personnel as needed.

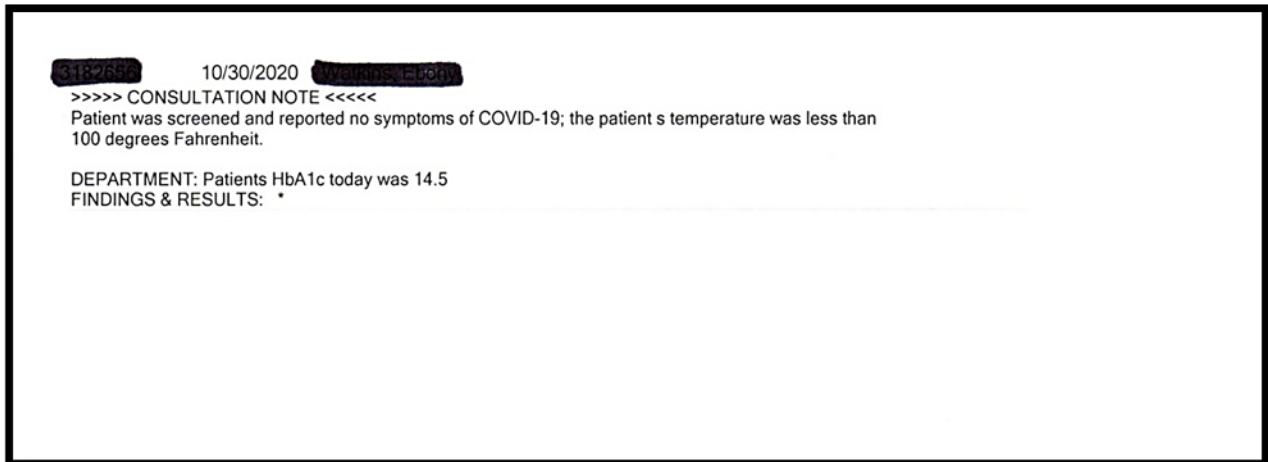
Sincerely,

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Appendix B

Printed HbA1c results given to each project participant.

Patient identification number and provider name are redacted.



Appendix C

Retrospective Chart Review Data Collection Form

Retrospective Chart Review Data Collection Form

Visit date: ____/____/____

ASA Classification:

- ASA I: ____ ASA II: ____ ASA III: ____ ASA IV: ____

Age: ____ years

Gender:

- Male: ____ Female: ____

T1DM: ____ T2DM: ____

Medical Consultation written: Original: ____

Comorbidities: CAD: ____ HTN: ____ Pulmonary: ____ Cancer: ____ Autoimmune: ____
Hepatic: ____ Renal: ____ CVA/TIA: ____ Psychiatric: ____ Thyroid: ____ HIV: ____
Seizure: ____ Other: ____

Screening date: ____ Treatment plan presentation date: ____

Appendix D

Participant Data Collection Form

Participant Data Collection Form

Date: ____/____/____

Age: ____ years Prefer not to answer: ____

Gender:

- Male: ____
- Female: ____
- Prefer not to answer: ____

How would you rate your understanding of the connection between diabetes and gum disease?

Poor: ____ Fair: ____ Good: ____ Very Good: ____ Excellent: ____

I understand that I am having my Hemoglobin A1c checked today by fingerstick and I will be given the results in writing before I leave the dental school today. Yes: ____ No: ____

Appendix E**Intervention Data Collection Form**Intervention Data Collection Form

Visit date: ____ / ____ / ____

ASA Classification:

- ASA I: ____ ASA II: ____ ASA III: ____ ASA IV: ____

Age: ____ years

Gender:

- Male: ____ Female: ____

T1DM: ____ T2DM: ____

HBA1c POC at screening:

Accepted: _____ Result: _____

Declined: _____

Patient response: How would you rate your understanding of the connection between diabetes and gum disease?

Poor: ____ Fair: ____ Good: ____ Very Good: ____ Excellent: ____

Patient response: I understand that I am having my Hemoglobin A1c checked today by fingerstick and I will be notified of the results in writing before I leave the dental school today.

Yes: ____ No: ____

Medical Consultation written: Modified: ____ Original: ____

Comorbidities: CAD: ____ HTN: ____ Pulmonary: ____ Cancer: ____ Autoimmune: ____

Hepatic: ____ Renal: ____ CVA/TIA: ____ Psychiatric: ____ Thyroid: ____ HIV: ____

Seizure: ____ Other: ____

Screening date: ____ Treatment plan presentation date: ____