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Impact of Establishing Dental Access for Preventable Infectious Dental Diseases (PIDD) in Medical Settings: Case Study from Rural Wisconsin

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Objective: The frequency of Preventable Infectious Dental Disease (PIDD) visits in medical centers was examined pre and post establishment of expanded dental access and adoption of an integrated medical-dental care delivery model. ***Methods***: A retrospective observational study of patient attributes and frequency of unscheduled PIDD visits between January 1, 1990 and February 29, 2020. Chi-squared tests compared (a) the number of PIDD visits (pre/post dental center establishment), (b) age at first diagnosis, (c) gender, (d) race, (e) primary insurance at the time of PIDD visits and (f) healthcare setting where visit occurred. ***Results***: System-wide, 21,957 unique patients were documented with a total of 34,892 PIDD visits as the primary diagnosis. Patients between 18-30 years and patients with Medicaid had the highest frequency of PIDD visits in medical settings. Following the establishment of dental centers, reduced relative risk of PIDD visits was observed for patients with no health insurance or self-pay/other coverage. PIDD visits in primary care settings was 0.87 times as likely as PIDD visits at ED/UCs after dental centers opened. ***Conclusions***: The number of PIDD visits to medical centers increased before the dental infrastructure was established, followed by a decline afterwards, inclusive of disparity populations. Some residual persistence of PIDD visits to primary care settings was identified. This study reinforced importance of dental healthcare access for achieving appropriate PIDD management while reducing PIDD visits to medical settings.

Keywords*: Dental diseases, Emergency treatment, Integrated care model, rural and disparity population, Dental infrastructure establishment*

Introduction

In the late 1990s and early 2000s, a steadily escalating dental access problem in the state of Wisconsin achieved a critical apex with patients unable to obtain care due to increasing access barriers. In 2009, 32,000 Emergency Room visits for dental emergencies collectively cost approximately $7 million, and continued to rise, with a 20% increase from 2006-2010 (Pew Charitable Trusts, n.d.).

In rural settings, persistent oral healthcare access barriers contributed to the rise in access to medical settings for management of non-traumatic dental conditions (NTDC) (Douthit *et al*., 2015). Barriers to preventive care included: 1) lack of dental infrastructure, 2) the shortage of dental health professionals, 3) lack of dental insurance including lack of Medicare coverage for adult dental procedures, and 4) policies of dental professionals unwillingness to accept Medicaid due to its poor reimbursement policies. (Douthit *et al*., 2015) In 2016, Medicaid only reimbursed dentists 46.1% of what commercial dental insurance agencies paid for adult services (Gupta *et al*., 2017). To date, state and federal leaders and employers have been unable to provide low-income individuals with affordable dental coverage across insurance categories.

As the crisis escalated, State officials approached Federally Qualitied Community Health Centers (FQHC) to plan to improve dental access (Nycz *et al*., 2020). In response, the Family Health Center of Marshfield, Inc. FHCM) expanded its dental infrastructure between 2002-2022 to comprise 11 dental clinics across its service area. This area overlaps that of another clinic (Marshfield Clinic Health System (MCHS)). Among the largest physician-owned private group medical practices in the USA, MCHS provides regional patient care across a service area spanning central, northern, and western Wisconsin. In collaboration the two clinics provided integrated care across their service areas. The dental centers (Figure 1) were established to reduce dental access disparity, with the intention of providing affordable and accessible dental healthcare for low-income and underserved individuals. As well as increasing the availability of care, the dental centers have sliding fee scales that permit treatment at partial or no cost, based on federally defined poverty status for those 100% to 200% of the Federal Poverty Line.

Gingival and periodontal disease (G/PD) and dental caries are common dental conditions that are both preventable and treatable through regularly scheduled traditional dental care. The prevention and early treatment of both conditions can minimise the risk of pain, disfigurement and tooth loss. Severe periodontitis is also a risk for systemic infection including septicemia, subacute bacterial endocarditis and aspiration pneumonia (Glurich *et al*., 2019). Moreover,

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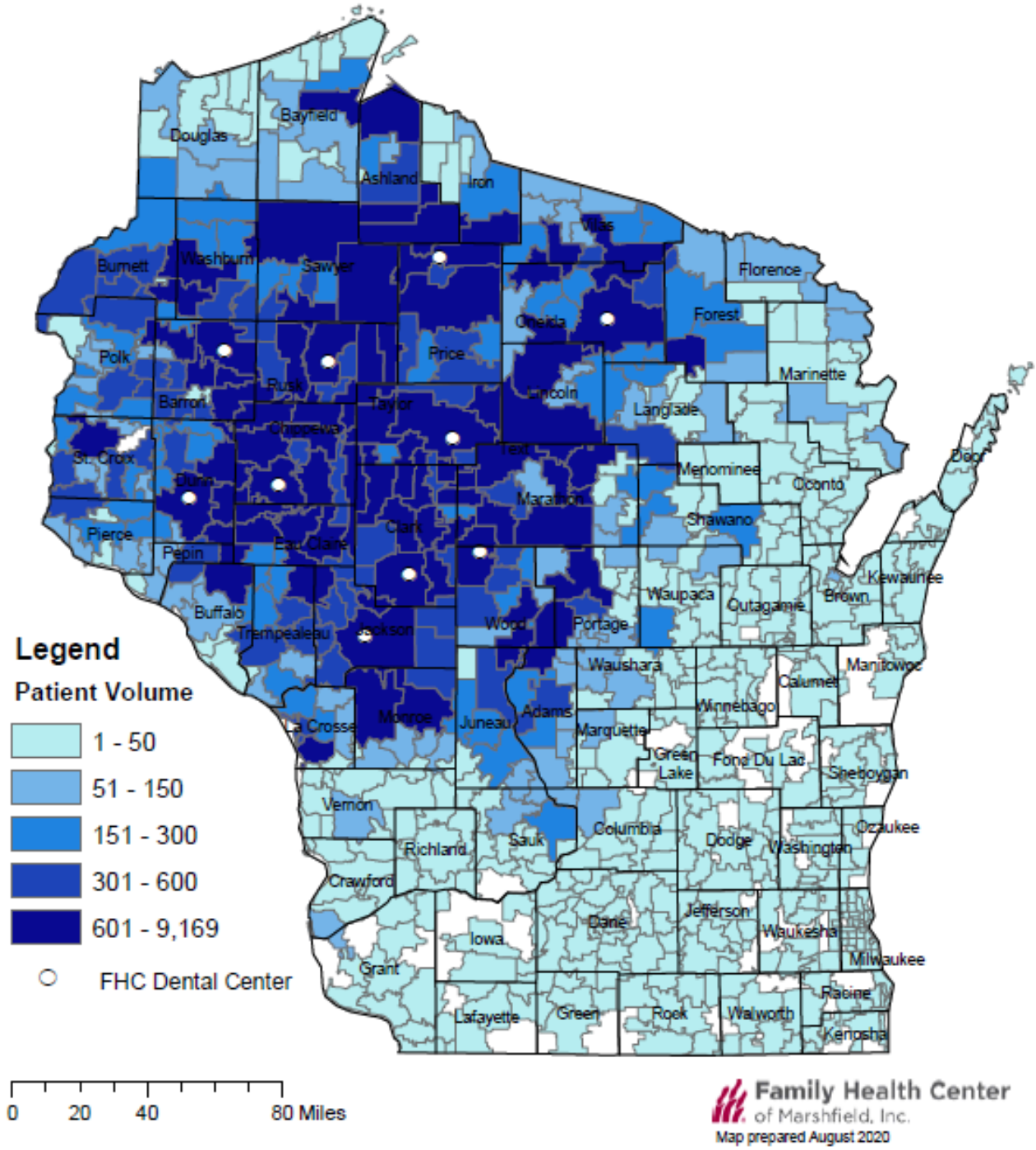

Figure 1. *Geographic distribution of Family Health Center of Marshfield, Inc. Dental Centers in the state of Wisconsin.*

mounting evidence supports exacerbation of chronic diseases (E.g. uncontrolled diabetes) by PD-associated infectious/inflammatory processes. Thus, PIDD may indirectly contribute to acute care visits at medical centers by exacerbating other chronic conditions that may emergency management.

However, patients with acute exacerbations of these conditions frequently attend Emergency Departments (ED) for urgent care (UC) and can be regarded as a form of NTDC. The aim of this case study was to examine the impact of expanded dental access on reducing patient attendance to medical centers for preventable infectious dental diseases (PIDD), pre and post implementation of regional dental centers. We also aimed to identify factors associated with attendance for medical urgent care (UC) at EDs and primary care centers (PCC) for PIDD. Longitudinal trends in PIDD visits in PCC and UC settings of medical centers were also explored in relation to the expansion of dental infrastructure across time.

Methods

The study was approved by expedited review by Marshfield Clinic Research's Institutional review board. The retrospective observational design involved data acquisition from MCHS's data warehouse for adult patients aged 21 years and over presenting with PIDD as the primary diagnosis over 30 years from January 1, 1990 to February 29, 2020. The eligible population included patients who sought medical and dental care at the MCHS and FHC-M dental centers during the study period.

Data examined in this study were extracted for 54 MCHS medical centers and included those with ER, UC and PCC closest to nine dental centers with most available longitudinal data. Two recently opened dental centers were excluded from analyses due to limited longitudinal data. Data extracted included patient's age at first PIDD visit, diagnosis date, International classification of disease (ICD) ICD-9/10 Clinical modification (CM) diagnostic codes, race, ethnicity, insurance status at time of diagnosis, provider facility, distance from medical centers in close proximity to FHC-Mdental centers, and all documented PIDD visits between 1/1/1990 and 2/29/2020. PIDD-associated ICD 9/10 CM codes were categorised as associated with a) dental caries, periapical abscess and pulpitis; (b) G/PD-; (c) loss of teeth or problems consequential to dental treatment including, but not limited to procedures that may be related to risk of periodontal disease and periapical infection (E.g. endodontic failure, orthodontic appliance adjustment, fracture of dental restoration or fitting a dental prosthesis); and d) dental disorders otherwise not specified (Table 2). The ICD9 CM code 525.11/ ICD10 CM K08.415 corresponding to 'Loss of teeth due to trauma' was excluded.

Descriptive characteristics (counts and percentages for categorical measures and means and standard deviations for continuous measures) were reported for PIDD visits and patient attributes. Age was categorized into (18-30; 31-40; 41-50; 51-60; 61-70; 71+ years) (Shimpi *et al*., 2018). Because the racial/ethnic distribution of our patient population is predominantly White, non-Hispanic/non-Latino, we grouped race and ethnicity as (a) White (non-Hispanic/non-Latino) and (b) Not White/Multiracial (includes all races, Hispanic and Latino ethnicity, and multiracial). Primary insurance was defined as the insurance status at time of PIDD visit, grouped as follows: (a) Medicaid; b) Medicaid and/or Medicare; (c) commercial-private medical insurance that may include dental; (d) no health insurance and (e) self-pay/ other. Patients with multiple insurance were grouped by primary insurance category. PIDD visits to Medical centers were categorised as (a) UC/ED, defined as UC, ED and walk-in center visits and (b) PCC, including primary care medical domains including Internal/Family Medicine, Pediatrics and Obstetrics/Gynecology departments. Each medical center was affiliated with only one dental center based on distance, which was calculated by determining distance from medical setting zip code centroid to nearest dental center zip code centroid. Distances between medical-dental affiliations were categorised as: 0-9.9 miles; 10-29.9 miles, and greater than 30 miles. A medical center 'before' or 'after visit' was defined as a visit pre or post establishment of the closest dental center. Chi-squared tests were used to compare the number of reported (a) PIDD visits (before-vs-after dental center establishment), (b) age at first diagnosis, (c) gender, (d) race, (e) primary insurance at the time of PIDD visits, and (f) type of medical practice (UC versus PCC). Total pre/post dental center establishment PIDD visits were tabulated for each dental center. Medical centers with more than 100 PIDD visits per year were defined as 'high volume centers'. Trends in the PIDD visits over time are presented only for high volume centers.

Adjusted risk ratios were estimated using a quasi-Poisson model where visit timing (before and after dental center establishment) was regressed on variables including patient age, gender, race, ethnicity, primary insurance, and medical setting type. The significance level was set $p<0.05$. All data analyses were carried out using R version 3.6.0 and positive Poisson model was estimated using the VGAM package.

Results

During the 30-year study period, 21,957 patients made 34,892 documented visits to medical centers with PIDD as their primary diagnosis. Patients' mean age was 40.2 + 17.1 years, 53% were female and nearly 77% were Caucasian or non-Hispanic/Latino. More than half (54%) had Medicaid and/or Medicare insurance status at the time of the visits.

Of the 54 included medical settings, 14 were categorized as UC/ED (5 UC, 6 ER, 3 Walk-in Centers). Primary Care Centers (PCC) attended by patients with PIDD (n=40) included 10 Internal Medicine/Family Practices, 22 Pediatric departments and 8 Obstetrics/Gynecology departments. Approximately 71% of PIDD visits to medical settings were to UC, with the remainder to PCC (Table 1). Of the 17,599 visits after the dental centers were established, 61% were to medical centers more than 10 miles from the dental center.

Among the high-volume dental centers (Chippewa Falls, Marshfield, Rhinelander and Rice Lake, >100 PIDD visits annually) there was a decline in visits to the medical settings following establishment of the Marshfield and Chippewa Falls dental centers (Figure 2).

The most common diagnoses associated with PIDD visits were 'dental disorder not otherwise classified' (44%) (Table 2). Approximately one third (30.63) were for dental caries, of which approximately were for periapical abscess and pulpitis.

Table 3 shows the distribution of PIDD 'after' visits in relation to distance from the associated dental center. As shown in Figure 2, higher access to the regional medical centers of Marshfield and Chippewa Falls, two high-volume dental centers initially had more PIDD visits. However, over time, the pattern indicated that these two centers also exhibited fewer PIDD visits. Notably, for low volume centers such as Menomonie and Neillsville, no PIDD visits at nearby medical settings were documented following establishment of dental center access.

Younger patients between 18-30 years of age made up the largest patient age group accounting for 43% of PIDD visits to medical settings before the dental centers were established (Table 4). Visits from this age group fell after opening the dental centers, whereas visits from 51-60 year olds and 61-70 year olds increased by 3% and 2%, respectively. Compared to patients with commercial insurance, patients with Medicare, self-pay/other, or no health insurance were 40%, 36% and 43% less likely to present to a medical setting with a PIDD, independent of other factors. Visits to primary care centers following the establishment of the dental centers were 13% less likely compared to visits to ED/UC settings. PIDD visits after the dental centers opened were more common for non-white, multiracial or Hispanic or Latino patients.

Table 1. Patient characteristics for PIDD visits at a medical setting before and after dental centers were established.

Patient characteristic	*All Visits*[1] *(n = 34,892) %*	*Before (n = 17,293) %*	*After (n = 17,599) %*	*p Chi sq.*
Age (years)				<0.001
18-30	40.1	43.0	37.3	
31-40	22.4	21.4	23.4	
41-50	15.7	16.4	5.1	
51-60	10.5	8.9	12.0	
61-70	5.8	4.8	6.7	
71+	5.5	5.6	5.5	
Gender				<0.001
Female	55.4	53.8	57.0	
Male	44.6	46.2	43.0	
Race[2]				<0.001
White	94.4	95.0	93.9	
Not white or multiracial	5.6	5.0	6.1	
Ethnicity[3]				<0.001
Not Hispanic or Latino	97.9	98.4	97.4	
Hispanic or Latino	2.1	1.6	2.6	
Primary Insurance[4]				<0.001
Commercial	34.3	32.4	35.9	
Medicaid	56.8	54.9	58.3	
Medicaid/Medicare	0.9	0.9	0.8	
Medicare	3.2	4.6	2.0	
Self-pay/Other	0.5	0.7	0.3	
No Health Insurance	4.4	6.5	2.6	
Department				<0.001
Emergency/Urgent	71.0	68.8	73.1	
Primary Care Center	29.0	31.2	26.9	

[1] Table shows counts of visits, not patient counts. [2] 4,496 visits without race data excluded. [3] 2,050 visits without ethnicity data excluded . [4] 3,865 visits without insurance data excluded

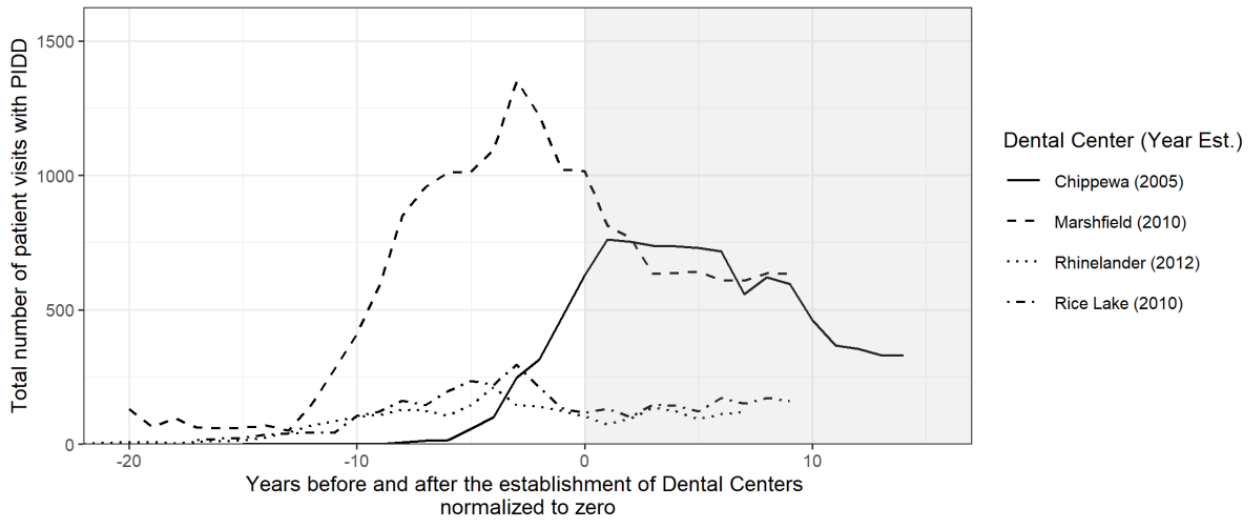

Figure 2*. Trends of PIDD visits to medical centers nearest to high volume dental centers between January 1990 and December 2019. Chippewa and Marshfield dental centers (high volume dental centers) showed a more gradual decline in PIDD visits across time as more dental centers and dental access was expanded regionally. This pattern was less pronounced in low volume dental centers (Rhinelander and Rice Lake dental centers).*

Table 2. Diagnostic codes associated with 41,256 PIDD visits.

Description	*ICD9 and ICD10 CM Codes*	*%**
Dental disorder, not otherwise specified	ICD 9: 525.9 ICD 10: K08.9	44.08
Dental Caries	ICD 9: 521, 521.00, 521.01, 521.02, 521.03, 521.09, 521.1, 521.2, 521.3,521.7, 521.8, 521.81, 521.89,521.9 ICD 10: K01.1, K02.51, K02.61, K02.62, K02.63, K02.9, K03.0, K03.2, K03.7, K03.81, K03.89, K03.9	14.63
Gingival and Periodontal diseases (G/PD)	ICD 9: 522.4, 522.6, 523.00, 523.1, 523.10, 523.2, 523.30, 523.31, 523.33, 523.4, 523.5, 523.6, 523.8, 523.9,525, 525.1 ICD 10: K03.6, K04.4, K05.00, K05.01, K05.10, K05.20, K05.21, K05.219, K05.30, K05.31, K05.319, K05.32, K05.329, K05.4, K05.5, K05.6, K06.0, K06.010, K06.011, K06.020, K06.1, K06.8, K06.9	18.51
Periapical abscess/pulpitis	ICD 9: 522.0, 522.1, 522.5, 522.7, 522.9 ICD 10: K04.0, K04.1, K04.6, K04.7	16.00
Loss of teeth and dental treatment conditions	ICD 9: 525.12, 525.13, 525.19, 525.3, 525.6, 525.64,525.69, 525.8, 525.9 ICD 10: K08.129, K08.139, K08.199, K08.439, K08.499, K08.409, K08.439, K08.499, K08.530, K08.531, K08.59, K08.8, K08.89, K08.9, M27.62, M27.8, Z46.4	6.78

* PIDD visits might have more than one diagnostic code

Table 3. PIDD visits by distance (in miles) between medical facility and dental center after dental access establishment.

Dental Center (Year established)	*No. PIDD visits*	*No. medical centers close to dental center*	*0-9.9m %*	*10-29.9m %*	*≥30m %*
Chippewa Falls (2005)	8 300	9	25.2	74.8	0
Ladysmith (2002)	397	1	100	0	0
Marshfield (2010)	6445	9	44.1	9.4	46.5
Medford (2009)	68	2	0	69.1	30.9
Menomonie (2015)	0	1	0	0	0
Neillsville (2009)	0	3	0	0	0
Park Falls (2008)	129	3	96.1	3.9	0
Rhinelander (2012)	867	3	0	100.0	0
Rice Lake (2010)	1395	5	99.5	0.1	0.4

Discussion

In this study, greater access to dental care appeared to reduce PIDD visits to medical settings. The increasing volume of PIDD visits to medical settings before the establishment of dental centers reflected lower regional access to dental care. As the regional dental centers became operational, such visits declined. Initially, an influx of new patients was noted due to access by patients from other counties statewide as new dental access became available (Figure 2). However, as other dental access became available statewide, fewer PIDD visits were made to high volume dental centers.

The 2009 report of the National Emergency Department Sample, reported that approximately 42% of ED visits for NTDC were related to dental caries (Seu *et al*., 2009). Visits for this condition were lower in this study (30.6%). Notably, the 16% rate of PIDDs presenting as periapical abscess or pulpitis could have been substantively reduced if appropriate dental care had been available to the population. However, the proportions with these diagnoses may be underestimated because 43% PIDDs were documented as 'dental disorder otherwise not classified'. This may be because medical providers lack dental expertise, as has been documented previously (Shimpi *et al*., 2016).

Patients between 18-30 years accounted for 40% of PIDD visits. Data from the 2009-2010 Medical Expenditure Panel Survey (MEPS) showed that people of this age often lack dental insurance and met the definition of the 'working poor' as 18.3% of this age group were below 100% of the Federal Poverty Guidelines. This age group constituted were the least likely to attend the dentist (32.1% making 'at least 1 dental visit') or to have dental insurance (34%). Being 'uninsured' or 'Medicaid-insured' were independent risk factors for ED utilization. An absence of dental care during adolescence among may also increase the risk for PIDD of this age group (Lewis *et al*., 2015).

Historically, especially in rural settings, Medicaid status and lack of insurance have been barriers to dental access, leading to dental disparity. This barrier was the impetus for establishment of dental centers in the FHCM service area (Shimpi, 2019). Greater dental care access to traditional disparity populations impacted by poverty and lack of insurance contributed to the reduction in the PIDDs observed in our medical settings (Figure 2). As well as greater availability and lower fees, our integrated care delivery system includes a referral management tool to facillitate early intervention and triage to preventive dental care.

Table 4. Patient characteristics for PIDD visits after dental center implementation.

Patient characteristic	*Unadjusted Risk Ratio*	*Adjusted* Risk Ratio*	*95% CI*
Age (years)			
18-30	0.94	0.73	0.69-0.77
31-40	1.05	0.83	0.78-0.87
41-50	0.97	0.79	0.75-0.84
51-60	1.15	0.96	0.91-1.01
61-70	1.18	1.01	0.95-1.07
71+ (Reference)	1.00	1.00	---
Gender			
Female	1.07	0.98	0.96-1.00
Male (Reference)	1.00	1.00	---
Race			
Not white or multiracial	1.10	1.07	1.02-1.11
White (Reference)	1.00	1.00	---
Ethnicity			
Hispanic or Latino	1.24	1.32	1.24-1.41
Not Hispanic or Latino (Reference)	1.00	1.00	---
Primary Insurance			
Medicaid	0.98	1.04	1.02-1.07
Medicaid/Medicare	0.92	0.88	0.78-0.99
Medicare	0.60	0.59	0.54-0.64
Self-pay/Other	0.66	0.72	0.59-0.86
No health insurance	0.57	0.65	0.60-0.69
Commercial (Reference)	1.00	1.00	---
Department			
Primary Care Center	0.9	0.87	0.85-0.89
Emergency/Urgent (Reference)	1.00	1.00	---

* Variables regressed included patient age, gender, race, ethnicity, primary insurance, and medical setting type.

Approximately 38% of PIDD visits occurred in medical settings when the dental center was more than 10 miles away (Table 3). The following barriers may continue to contribute to this large proportion of patients seeking PIDD care in PCCs, particularly when dental centers were nearby: 1) dental fear/phobias; 2) lack of dental insurance; 3) patients unaware of dental center access; 4) lack of oral health literacy; 5) mental health issues that may influence pain perceptions and may be associated with poor oral hygiene behavior; beliefs and attitudes; and same-day access (Fingar *et al*., 2015; Nycz *et al*., 2020)

This study has some limitations. The data were collected across a single, large health care system with integrated care delivery serving a relatively homogenous population and may not be generalizable to other populations, regions and care delivery models. However, the study gave insights into trends in PIDD visits across a setting with integrated care. Future evaluation across all centers over time may verify these observations. The current study did not examine whether the PIDD visits occurred during the hours of dental center operation or the distance travelled for care. Further research will examine the impact of distance and time of visit on PIDD visits at medical settings. Studies are also needed to investigate the economic impact of improving dental access on care in medical settings.

In conclusion, there was a decline in PIDD visits after establishment of dental access centers. However, PIDD visits to primary care settings persisted. Access to oral health care supported PIDD management at medical settings across our integrated care system.

Disclosures

None

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