"Association between dental care and reduced hazard of emergency department utilization in individuals with diabetes"

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Executive Summary of Findings

- Literature suggests that that periodontal care may reduce diabetes-related complications, and poor periodontal disease control may exacerbate diabetes symptoms and increase the risk of diabetes-related complications.
- All measured forms of dental care were associated with reduced emergency department (ED) visits for uncontrolled diabetes after accounting for numerous other claims-based indicators of diabetes management and comorbidities (e.g., chronic obstructive pulmonary disease, congestive heart failure, hypertension, etc.).
- In those members with two or more diagnostic dental visits, the hazard of an ED visit is reduced nearly 60% ($p < 0.0001$). Additionally, there may be a potential dosage effect where individuals with two or more periodontal treatments had a 59% ($p = 0.004$) reduced hazard, where individuals with one periodontal treatment (after adjustment) did not have a reduced hazard over those who had no dental claims.

Background

Uncontrolled diabetes frequently results in avoidable health care utilization, such as emergency department (ED) visits. ED visits for uncontrolled diabetes are costly,[1] and appropriate management of diabetes can prevent avoidable ED utilization.[2,3,4] Management of diabetes requires a multifaceted approach that includes appropriate oral health care.

Individuals with diabetes are at greater risk of developing periodontitis[5] and gingivitis,[6] and tend to have more periodontal symptoms, including increased bleeding and gingival inflammation. Additionally, the severity of gingivitis may be directly related to glycemic control where those with more poorly controlled diabetes also have greater levels of inflammation.[7]

While the exacerbating effects of diabetes on periodontal disease have long been studied and established, the relationship may not be unidirectional.[8] Poor periodontal disease control may exacerbate diabetes symptoms[9] and increase the risk of diabetes-related complications.[10,11,12] The apparent duality between periodontal disease and diabetes is also supported by a number of clinical trials demonstrating that periodontal treatments improve glycemic control [8,12,13,14,15,16] and reduce hemoglobin A1c (HbA1c) levels.[15,17,18] Although the precise physiological mechanisms remain unclear, it has been proposed that inflammation from infections related to periodontal disease may negatively affect metabolic control of diabetes. As a result, inflammation control through periodontal treatment may be beneficial for appropriately managing diabetes.[8]

Given the impact appropriate and routine dental care may have on improving diabetes management, and the importance of diabetes management in averting ED visits for uncontrolled diabetes, this paper examines a reduced risk of ED visits for uncontrolled diabetes in individuals receiving dental care.

Methods

Administrative claims history of Health First Colorado (Colorado's Medicaid Program) members with diabetes in calendar year 2016 was examined. All included members were covered by Colorado Access, a nonprofit health plan based in Colorado. All claims were analyzed retrospectively to determine if dental care, specifically periodontal treatment, was associated with reduced incidence of emergency department visits for uncontrolled diabetes. See Appendix D for all counties included in the analyses.

Preventive Oral Health Exposures

Dental care was coded into four categories of interest: 'diagnostic' (procedure codes D0100-D0999), 'preventive' (D1000-D1999), 'periodontal' (D4000-D4999), and 'other' (D3000-D3999, D5000-D9999). If many claims existed for the same category in the same day, data were collapsed so that each category was represented a maximum of once per day. All claims were then summed over the relevant time period per individual and classified as 0, 1, or 2 or more claim events in that time period.

Outcomes

The outcome of interest in this analysis was an ED visit for uncontrolled diabetes, defined by Current Procedural Terminology (CPT) codes between 99281 and 99285 or revenue codes including 0450, 0451, 0452, 0459, 0981 with a place of service code of 23 and an accompanying International Classification of Diseases (ICD) code for uncontrolled diabetes as defined by the Agency for Healthcare Research and Quality, Prevention Quality Indicator #14 (E10.649, E10.65, E11.649, E11.65). If many claims existed for the same event type in the same day, data were collapsed to represent one event in that day.

Covariates

Potential confounders explored included time-invariant characteristics: sex, age, county, and race/ethnicity. Race/ethnicity was grouped into five levels and non-Hispanic white was used as the reference group. Race/ethnicity groupings were non-Hispanic white, Hispanic, African American, Asian, and other/missing.

Additionally, there were 46 utilization variables examined as time-variant, claims-based health events. These included diabetes-related services such as HbA1c testing, LDL-C testing, and nephropathy screening; claims noting a comorbid diagnosis including hypertension, congestive heart failure (CHF), and chronic obstructive pulmonary disease (COPD); and other non-diabetes related claims involved in outpatient (OP), inpatient (IP) and ED visits (see Appendix A-C for definitions). Consideration of these covariates, specifically, was used to attempt to correct for self-care effects. As previously mentioned, multiple claims for the same category of event in a day were collapsed into one event for the day. These events were then summed over the time period preceding censor per individual and classified into three levels: 0, 1, and 2 or more.

Analytic Methods

These data were prepared in a manner that allowed a sequential time of events analysis. More specifically, data were lagged so that the sum of events that preceded right censor was aligned with an ED visit. This lagging corrected for potential biases where the sequence of events may have been meaningful. Additionally, this allowed for an assessment of potential dosage effects of multiple dental visits within a time interval preceding censor. Individuals were right censored at an ED visit, or at the end of the study period if they did not have an ED visit within calendar year 2016. The time in days between care events and the ED visit outcome is also calculated and utilized in the Cox proportional hazards analysis discussed below.

All summed utilization claim counts were highly right-skewed. Given this substantial nonlinearity, all included service utilization predictors were classified into 0, 1, and 2 or more claims prior to analyses. Some individuals had more than one ED visit. Table 1 presents simple associations between the dental exposures and the first ED visit experienced by an individual. Two by three tables and two degrees of freedom chi-square statistics are presented for all outcomes of interest in Table 1.

Multivariate Cox proportional hazards regression was used to assess reduced hazard of ED visits (Table 2). While the data construction and analyses are appropriate for repeated measures, numerous individuals had multiple ED visits. The multiple visits in these analyses required a gamma frailty term that corrected standard errors and intercepts. Assumptions were assessed by Schoenfeld residual analysis over time and were valid. Multivariate models were reduced using a mixed selection procedure that maintained covariates where $p < 0.05$. For brevity, only dental visits are presented in Table 2.

Results

Population

The total included population was 21,861 Health First Colorado members with a mean age of 50 and an age range 18 to 75. Approximately 42% of the population was male and 58% was female. Two people were missing age data and ten people were missing sex information. The categorized race/ethnicity breakdown was as follows: 3,676 (17%) white, 3,860 (18%) Hispanic, 1,643 (7.5%) African American, 464 (2.1%) Asian, and 12,218 (56%) were other/missing.

Emergency Department Analysis

Table 1 displays strong statistical differences between dental treatment groups and first ED visit. In general, those receiving dental care have fewer ED visits for complications of uncontrolled diabetes.

	No ED Visit N (column %)	Yes ED Visit N (column %)	Statistic
Diagnostic Dental Claims			$X^2 = 234$, df = 2, p <0.0001
No Claims	13,191 (65.4%)	1,417 (83.4%)	
1 Claim	3,788 (18.8%)	186 (10.9%)	
2 or More Claims	3,182 (15.8%)	97 (5.7%)	
Preventive Dental Claims			$X^2 = 138$, df = 2, p <0.0001
No Claims	17,010 (84.4%)	1,613 (94.9%)	
1 Claim	1,887 (9.4%)	58 (3.4%)	
2 or More Claims	1,264 (6.3%)	29 (1.7%)	
Periodontal Dental Claims			$X^2 = 92$, df = 2, p <0.0001
No Claims	18,737 (92.9%)	1,667 (98.1%)	
1 Claim	708 (3.5%)	21 (1.2%)	
2 or More Claims	716 (3.6%)	12 (0.07%)	

Table 1

	No ED Visit N (column %)	Yes ED Visit N (column %)	Statistic
Other Dental Claims			
No Claims	16,363 (81.2%)	1,534 (90.2%)	
1 Claim	2,409 (11.9%)	125 (7.4%)	
2 or More Claims	1,389 (6.9%)	41 (2.4%)	

Table 1 Continued

Similarly, the multivariate hazard analysis presented below in Table 2 suggests an association between dental care and reduced hazard of a subsequent ED visit for uncontrolled diabetes. Notably, after adjusting for numerous factors, the hazard of an ED visit is reduced nearly 60% ($p < 0.0001$) in those who had two or more diagnostic dental visits. Additionally, there may be a potential dosage effect where individuals with two or more periodontal treatments had a 59% ($p = 0.004$) reduced hazard, while individuals with one periodontal treatment (after adjustment) did not have a reduced hazard over those who had no dental claims.

	Hazard Ratio	L95%CI	U95%CI	Pr(>|z|)
1 diagnostic claim	0.49	0.40	0.59	<0.0001
2 or more diagnostic claims	0.43	0.33	0.56	<0.0001
1 preventive claim	0.63	0.48	0.84	0.002
2 or more preventive claims	0.60	0.40	0.89	0.001
1 periodontal claim	0.76	0.47	1.23	0.26
2 or more periodontal claims	0.41	0.22	0.75	0.004
1 other claim	0.78	0.63	0.98	0.034
2 or more other claims	0.56	0.39	0.81	0.002

Table 2

Conclusions and Limitations

Dental care was consistently associated with reduced ED visits for uncontrolled diabetes. When combined with literature that identifies preventive effects of periodontal treatment on diabetes complications, these findings suggest that dental care may also extend to a preventive role in uncontrolled diabetes ED visits as well.

Health care seeking and maintenance behaviors may confound these findings, such that a patient engaging in high levels of self-care will have reduced ED visits regardless of periodontal treatment. With this in mind, these longitudinal analyses accounted for 50 potential confounding factors such as other types of dental care and HbA1c monitoring. While this is a broad attempt, it may not have accounted for all self-care effects. However, given numerous clinical trials identifying preventive effects of periodontal treatment on diabetes symptoms,[8,12,13,14,15,16] these findings support the role of periodontal treatments and other dental care in reducing ED visits. Additionally, there may be a dosage effect of periodontal treatments on reduced hazard of ED visits. Independent of other dental care, periodontal treatment dosage (i.e., progressively increased periodontal treatment is associated with progressively reduced hazard) bolsters these associations and reaffirms the importance of appropriate dental care in diabetes management.

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Appendix A - Colorado Access Definition

Variable: Emergency Department (ED) Visit

Type of Variable: Utilization

Definition:
The ED visit variable will be defined by administrative claims data and will reflect the utilization of an ED service. This will include both visits resulting in a "treat and release" as well as visits resulting in an inpatient admission. This will include both paid and denied claims.

It is important to note that free-standing EDs, although categorized as urgent care centers, legally operate under a hospital facility and can bill for a visit as an ED visit. As such, these sites will be included in the ED definition.

Inclusion Criteria:
A claim must have one of the following scenarios to count as an ED visit. Duplicates will be removed by client ID plus service date.

Scenario	CPT	Revenue Code	Place of Service	Claim Type		Methodology
				RCCO	CHP+	
#1	99281 -- 99285					
Or						
#2		0450, 0451, 0452, 0459, 0981		C		Methodology
Or						
#3			23			

Appendix B - Colorado Access Definition

Variable: Inpatient - Acute Care

Type of Variable: Utilization

Definition:
The inpatient-acute care visit variable will be defined by administrative claims data and will reflect the utilization of an acute care hospital. This will include both paid and denied claims.

It is important to note that physical health sub-acute care visits (such as physical therapy rehabilitation centers, etc.) are most often billed as an inpatient stay and will be lumped into this definition.

Inclusion Criteria:
A claim must have one of the following scenarios to count as an inpatient-acute care visit. Duplicates will be removed by client ID plus service date.

Scenario	Place of Service	Revenue Code	Bill Type	Claim Type		Category of Service	Methodology
				RCCO	ABC/ CHP+		
#1 - RCCO Files			01XX, 1XX	I (inpatient)			OR
OR							
#2 – RCCO Files				B		05	AND

Data Restrictions:
The inpatient-acute care variable only reflects utilization. This variable should not be used to identify admit or discharge status.

Appendix C - Colorado Access Definition

Variable: Outpatient or Preventive Visit – Physical Health

Type of Variable: Utilization

Definition:
The outpatient visit variable will be defined by administrative claims data and will reflect a physical health services visit with a qualified provider. This will include both paid and denied claims.

Inclusion Criteria:
A claim must have one of the following scenarios to count as an outpatient physical health visit. Duplicates will be removed by client ID plus service date.

Scenario	CPT	Revenue Code	Place of Service	Claim Type		Methodology
				RCCO	ABC/ CHP+	
#1	99201-99205 99211-99215 99381-99397					

Appendix D - Colorado Access Definition

Counties covered under these analyses:

- Adams
- Arapahoe
- Cheyenne
- Denver
- Douglas
- Kit Carson
- Lincoln
- Logan
- Morgan
- Phillips
- Sedgwick
- Washington
- Weld
- Yuma