Dental therapists linked to improved dental outcomes for Alaska Native communities in the Yukon-Kuskokwim Delta

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Abstract

Objectives: Dental Health Aide Therapists (DHATs) have been part of the dental workforce in Alaska's Yukon-Kuskokwim (YK) Delta since 2006. They are trained to provide preventive and restorative care such as filling and extractions. In this study, we evaluated community-level dental outcomes associated with DHATs.
Methods: This was a secondary data analysis of Alaska Medicaid and electronic health record data for individuals in Alaska's YK Delta (2006-2015). The independent variable was the number of DHAT treatment days in each community. Child outcomes were preventive care, extractions, and general anesthesia. Adult outcomes were preventive care and extractions. We estimated Spearman partial correlation coefficients to test our hypotheses that increased DHAT treatment days would be associated with larger proportions utilizing preventive care and smaller proportions receiving extractions at the community-level.
Results: DHAT treatment days were positively associated with preventive care utilization and negatively associated with extractions for children and adults ($P < 0.0001$). DHAT treatment days were not associated with increased dental treatment under general anesthesia for children.
Conclusions: Dental therapists are associated with more preventive care and fewer extractions. State-level policies should consider dental therapists as part of a comprehensive solution to meet the dental care needs of individuals in underserved communities and help achieve health equity and social justice.

Introduction

Poor oral health is common in Alaska Native communities (1-3). Untreated tooth decay leads to pain, difficulties eating and sleeping, systemic diseases, hospitalization, and, in rare cases, death (4,5). Other consequences include school absences, poor grades, low self-esteem, and employment problems (6-8). There are persisting oral health inequalities in Alaska Native communities (9,10).

Tooth decay is a multifactorial disease linked to a high sugar diet, inadequate fluoride, and poor access to dental care (11). Sugar-sweetened beverages comprise a large portion of modern Alaska Native diets and have fueled the tooth decay epidemic (12,13). In addition, piped-in water is not universal in Alaska Native communities, making water fluoridation costly (14). Further complicating local fluoride acceptance is the only documented death linked to water fluoridation in Hooper Bay, Alaska (15). Finally, Alaska Native communities are remote, making it difficult to provide a regular, local source of dental care. Seeking care involves traveling long distances, usually by airplane. As a result, most individuals are unable to receive preventive care or needed restorative treatment.

To begin addressing dentist shortages, the Alaska Native Tribal Health Consortium trained Dental Health Aide Therapists (DHATs) for deployment in areas like Alaska's Yukon-Kuskokwim (YK) Delta. The DHAT program is based on a model in place for decades in New Zealand and more than 50 other countries (16,17). The first DHATs began providing dental care in the YK Delta in 2006. DHATs are recruited

from local communities and are trained to provide preventive care as well as restorative care for primary teeth (e.g., fillings, crowns, pulp therapy, extractions) and permanent teeth (e.g., simple fillings and extractions) under general supervision in local communities by dentists located in the hub city of Bethel (18). Dental therapists currently provide care in Alaska, Minnesota, and parts of Washington state and Oregon (19). Vermont and Maine have authorized the practice of dental therapy, and other states are considering similar legislation (19).

Studies have documented initial outcomes associated with the DHAT program in the YK Delta. DHATs provide care that is similar to care provided by dentists in terms of clinical quality (20,21). Residents of YK Delta communities served by DHATs have reported shorter wait times for dental appointments and satisfaction with the care provided by DHATs (22). No studies to date have documented longer-term outcomes associated with this innovative workforce program.

Persisting oral health inequalities in underserved communities underscore the importance of research aimed at advancing social justice (23). Dental therapists are part of an upstream approach that could help to address oral health inequalities by diversifying the dental workforce, removing barriers to care, and closing the health gap between individuals in resource-rich and resource-poor communities.

The goal of this study was to evaluate YK Delta's DHAT program. The main research question was whether DHATs are associated with improved oral health outcomes since 2006. We hypothesized that a larger number of DHAT treatment days would be associated with dental utilization patterns consistent with improved oral health over time (e.g., more preventive care, fewer extractions, less general anesthesia). This is based on two premises: 1) indigenous communities have low rates of preventive care utilization and high rates of extractions and treatment under general anesthesia; and 2) dental therapists have the potential to influence these trends. The long-term goals of this research are to provide policymakers with information on existing dental therapy programs and to develop strategies to optimize the DHAT program.

Methods

Study location

This study focused on communities served by the Yukon-Kuskokwim Health Corporation (YKHC). Prior to 2006, patients traveled from remote communities to Bethel to obtain dental care. Dentists traveled to communities on an annual basis. DHATs work in decentralized Sub-Regional Clinics and travel to remote communities to provide care.

Study design and data sources

This was a retrospective observational study (calendar years 2006–2015), corresponding to the 10-year period in which DHATs started providing care under general supervision in the YK Delta to when the most recent data were available. The study was approved by the YKHC Human Studies Committee and the University of Washington Institutional Review Board.

There were two data sources. The first was Medicaid data provided by the Alaska Department of Health and Human Services. These consisted of data on 1) monthly enrollment (e.g., name, age, sex, address) and 2) dental claims, indicating all procedures for which a claim was submitted by a dental provider and corresponding dates of services. The second was electronic health record (EHR) data provided by the YKHC dental clinic. These data consist of diagnosis and treatment data for all YKHC patients who received any dental care during the study period.

Classifying individuals into communities

We classified individuals into a mutually exclusive YK Delta community for each study month. Of the 322,578 individuals in the Medicaid dataset, 22,645 lived in the YK Delta at some point during the 10-year study period. We used monthly address data to geocode these individuals using the Google Maps Geocoding API. There were 22,353 individuals with a geocodable address. Our geocoding algorithm accounted for individuals who moved within the YK Delta and YK Delta residents who lived outside of the YK Delta for at least 1 month during the study period. We reconciled address data for 1,034 individuals with overlapping dates of residence (e.g., an individual listed as living in a community May 1, 2007 to September 9, 2009 and July 1, 2008 to October 31, 2010). Twenty-seven individuals were excluded because of missing or invalid dates of residence.

The resulting Medicaid dataset contained 22,326 unique individuals who lived in the YK Delta for at least 1 month during the study period. The resulting EHR dataset contained 28,821 unique individuals who utilized dental care through a YKHC dental clinic at least once during the study period, all of whom were geocoded into a YK Delta community.

Predictor variable

The main community-level predictor variable was the total number of days in which a community had $\geq$1 DHATs providing care (DHAT treatment days). This continuous variable was created from the EHR data. We identified all dental claims in the EHR dataset with a valid Current Dental Terminology (CDT) code submitted by a DHAT during the study period. For each day on which a DHAT provided dental care, the location of service (as indicated in the EHR) was noted and counted as one DHAT treatment day.

Outcome variables

There were three child and two adult outcomes, each measured at the community-level using both the Medicaid and EHR data.

Child outcomes

a) Proportion of children <18 years utilizing preventive care, defined as an exam (D0120/D0145/D0150), cleaning (D1110/D1120), fluoride (D1203/D1204/D1206/D1208), or cleaning and fluoride (D1201/D1205). b) Proportion of children <3 years who had their four front teeth (D-E-F-G) extracted (D7111/D7140). c) Proportion of children <6 years who received ≥5 stainless steel crowns on a single day, a proxy measure of general anesthesia (D2930).

Adult outcomes

d) Proportion of adults ≥18 years utilizing preventive care, defined as an exam (D0120/D0150), cleaning (D1110), fluoride (D1204/D1206), or cleaning and fluoride (D1205). e) Proportion of adults ≥18 years with any tooth extraction (D7111/D7140).

The two datasets had different denominators. For the Medicaid data, the yearly denominators consisted of individuals classified into a community and enrolled in Medicaid for ≥1 month during the calendar year. For the EHR data, the yearly denominators consisted of individuals who were classified into a community and had at least one dental claim in the calendar year.

Confounders

We identified two potential confounders. The first was dentist treatment days, which is the total number of days in which communities had one or more dentists providing treatment. We identified all EHR dental claims submitted by a dentist and estimated the total number of treatment days provided by a dentist in each community. The second was baseline poverty, which accounted for potential differences in resources and social conditions. Because there was no standardized community-level poverty measure, we adopted a proxy measure from the US Census Bureau indicating the proportion of all individuals living below poverty in 1999 in each community (potential range: 0 to 100).

Analyses

The analyses were restricted to dental services provided within YK Delta communities. Location of service was unavailable in the Medicaid data. Therefore, we used the EHR data to determine the location of service for each Medicaid dental service. We matched on name, sex, and date of birth. After excluding claims without a match, there were 13,810 unique individuals in the final analytic population for the Medicaid data. The EHR claims data included information on location of service. After removing claims associated with locations of service outside of the YK Delta, there were 28,191 unique individuals in the final analytic population for the EHR data.

We used Spearman partial correlation coefficients for the confounder analyses (24). Spearman partial correlation coefficients were used to evaluate our study hypotheses ($\alpha = 0.05$), adjusting for dentist treatment days and baseline poverty. We adjusted for dentist treatment days to control for background differences in dental care due to dentists and as a surrogate measure for other potential secular trends in the availability of dental care. The analyses were aggregated by year for each community (48 communities × 10 years, $n = 480$), and generalized estimating equations were used to account for clustering within village due to multiple observation years (25). Observations from different villages were assumed to be independent. Three communities with small populations were excluded. We used SAS version 9.4 for the statistical analyses (SAS Institute, Inc., Cary, NC, USA).

Results

Study communities

There were 48 study communities. Sixteen communities had no dental services provided by a DHAT. The mean proportion of individuals at the community-level in 1999 that were below poverty was 28 percent (range: 10.7 to 64.5 percent).

Predictor variable

The predictor variable was the number of DHAT treatment days. In 2006, there were two practicing DHATs in the YK Delta. The number of DHATs increased to 10 by 2015. In the 10-year period, there were a total of 9,012 DHAT treatment days.

Child outcomes

Mean preventive utilization for children was 15.4 percent in the Medicaid data and 31.8 percent in the EHR data (Table 1). Over the 10 years, the proportion of children who received preventive care increased fivefold in the Medicaid data (7.4 to 35.6 percent) and doubled in the EHR data (30.5 to 57.8 percent). The mean proportion of D-E-F-G extractions for children was 3.1 percent in the Medicaid data and 14 percent in the EHR data. The proportion of D-E-F-G extractions increased in Medicaid data (1.9 to 16.3 percent) and decreased in the EHR data (19.2 to 12.1 percent). The mean proportion of children utilizing dental care under general anesthesia was 5.4 percent in the Medicaid data and 5.7 percent in the EHR data. The proportion of children undergoing

Table 1 Dental Utilization for Individuals in Alaska's Yukon-Kuskokwim Delta by Year (2006 to 2015)

	Year (%)										All years (%)
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Child preventive dental care, Medicaid data	7.4	9.0	10.7	8.7	13.4	13.3	17.7	21.1	30.4	35.6	15.4
Child preventive dental care, EHR data	30.5	24.2	30.4	29.5	35.4	27.4	35.4	42.2	52.7	57.8	31.8
Child D-E-G-F extraction, Medicaid data*	1.9	3.2	2.3	2.7	2.9	3.4	3.4	5.4	8.0	16.3	3.1
Child D-E-G-F extraction, EHR data	19.2	20.1	20.6	26.4	13.1	9.7	9.1	12.5	14.4	12.1	14.0
Child general anesthesia, Medicaid data†	1.6	2.4	2.1	2.0	4.0	5.5	6.4	7.4	13.7	15.8	5.4
Child general anesthesia, EHR data	7.3	7.8	7.6	7.7	8.1	5.9	5.6	5.9	6.3	4.8	5.7
Adult preventive dental care, Medicaid data	1.1	2.6	2.6	2.5	3.0	4.3	4.3	5.6	8.5	6.4	3.8
Adult preventive dental care, EHR data	24.0	19.8	15.7	16.7	24.4	22.8	20.7	28.9	36.9	35.3	18.7
Adult extraction, Medicaid data	6.6	8.9	7.3	6.6	8.1	6.9	7.8	7.6	10.7	10.3	7.8
Adult extraction, EHR data	34.5	32.7	33.2	33.7	31.9	29.2	27.5	29.1	31.0	30.9	32.9

*There were no tooth numbers available in the Medicaid data. Therefore, this measure was defined as four extractions on the same day.
†There were no tooth numbers available in the Medicaid data. Therefore, this measure was defined as five or more stainless steel crowns on the same day.

general anesthesia increased in the Medicaid data (1.6 to 15.8 percent) and decreased in the EHR data (7.3 to 4.8 percent).

Adult outcomes

Mean preventive dental care utilization for adults was 3.8 percent in the Medicaid data and 18.7 percent in the EHR data (Table 1). Adult preventive care utilization in the Medicaid data started at 1.1 percent (2006), peaked to 8.5 percent (2014), and decreased to 6.4 percent (2015). For the EHR data, preventive utilization fluctuated during the 10-year study period, starting at 24 percent (2006) and ending at 35.3 percent (2015). The mean proportion of adults with extractions was 7.8 percent in the Medicaid data and 32.9 percent in the EHR data. Adult extractions fluctuated in both datasets, increasing from 6.6 to 10.3 percent in the Medicaid data and decreasing from 34.5 to 30.9 percent in the EHR data.

Confounder analyses

Dentist treatment days were positively associated with the predictor ($\rho = 0.31$; $P < 0.0001$) and significantly associated with most outcomes (Table 2). Baseline poverty was not associated with the predictor ($\rho = -0.12$; $P = 0.53$) but significantly associated with most outcomes (Table 2).

Main statistical analyses

Across the 10-year study period in both EHR and Medicaid datasets, increased DHAT treatment days were positively associated with child and adult preventive care, and negatively associated with extractions for children and adults (Table 3). From the EHR data, DHAT treatment days were negatively associated with treatment under general anesthesia for children, but this association was not statistically significant in the Medicaid data.

Discussion

This is first known study to evaluate long-term outcomes associated with DHATs. The main finding is that increased DHAT treatment days were positively associated with preventive care utilization and negatively associated with extractions. These trends suggest that dental outcomes have improved in Alaska's YK Delta with the introduction of

Table 2 Spearman Correlation Coefficients for Model Confounders

	Spearman correlation coefficients *P*-values				
	Child preventive dental care	Child D-E-F-G extraction	Child general anesthesia	Adult preventive dental care	Adult extraction
Dentist treatment days	0.33	0.21	0.16	0.31	0.02
(Medicaid data)	<0.0001	<0.001	0.01	<0.001	0.78
Dentist treatment days	0.25	0.13	0.17	0.26	−0.22
(EHR data)	<0.001	0.09	0.03	<0.001	<0.01
Baseline poverty	−0.12	−0.16	−0.18	−0.10	−0.001
(Medicaid data)	<0.001	<0.01	<0.0001	0.01	0.53
Baseline poverty	−0.15	−0.18	−0.16	−0.20	0.001
(EHR data)	<0.001	<0.01	<0.01	<0.001	0.91

Table 3 Spearman Partial Correlation Coefficients Between DHAT Treatment Days (Continuous Variable) and Each Outcome During 10-Year Study Period Based on Medicaid and EHR Data

	Spearman partial correlation coefficients* *P*-values				
DHAT treatment days	Child preventive dental care	Child D-E-F-G extraction	Child general anesthesia	Adult preventive dental care	Adult extraction
Medicaid data	0.23	−0.17	0.05	0.20	−0.16
	<0.0001	0.03	0.45	<0.001	0.02
EHR data	0.26	−0.28	−0.27	0.30	−0.46
	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

*Adjusted for dentist treatment days and baseline poverty.

dental therapists. These results are consistent with a study reporting positive associations between pediatric dentist density and preventive dental care use for children in Medicaid (26).

There are a number of potential explanations. The most plausible mechanism underlying increased preventive care utilization is improved local access to providers, which may have also increased patient demand for care. This is consistent with previous work indicating reduced patient-reported wait times for dental appointments in YK communities (22). Fewer extractions could indicate improvements in oral health behaviors and beliefs, as well as earlier restorative intervention before the need for extractions. These mechanisms could be assessed in the future by further examining restorative claims data and conducting interviews in communities, and comparing oral health behaviors and beliefs across communities that vary on DHAT treatment days. Similar interviews could be conducted with DHATs and dentists to measure provider perceptions of how patient attitudes, beliefs, and behaviors regarding oral health have changed over time.

We had inconsistent findings regarding general anesthesia for children. DHAT treatment days were negatively associated with general anesthesia in the EHR data but not significant in the Medicaid data. There are two possible explanations for this discrepancy. First, population characteristics differed across the two datasets. The EHR data consisted of individuals who utilized dental care, whereas the Medicaid data included all enrollees regardless of utilization of dental care. Second, the Medicaid-based outcome could be misspecified due to lack of tooth-level data. There was a near doubling in the proportion of children in the Medicaid data receiving dental care under general anesthesia between 2013 and 2014, which was not observed in the EHR data. A conservative conclusion is that increased DHAT treatment days were not associated with increased proportions of children receiving dental care under general anesthesia. Future research should continue to examine the associations between DHAT treatment days and child general anesthesia.

Improvements in dental utilization were particularly noticeable in communities where DHATs had the greatest presence. In post-hoc subgroup analyses, we identified communities in which DHATs did not provide any dental treatment ($N = 16$) and communities in which the DHAT treatment day to population ratio was >75th percentile ($N = 7$). Across both datasets, communities with the highest DHAT treatment days exhibited consistently greater

Table 4 Percentage Point Differences in Outcomes Between Communities with No DHAT Treatment Days and the Highest Number of DHAT Treatment Days

	No DHAT treatment day communities $N = 16$ (%)	Highest DHAT treatment day communities $N = 7$ (%)	Percentage point difference between highest and no DHAT treatment day communities (%)
Medicaid data			
Child preventive dental care	15.5	24.8	9.3
Child D-E-F-G extraction	7.3	1.9	−5.4
Child general anesthesia	7.9	5.5	−2.4
Adult preventive dental care	3.2	5.6	2.4
Adult extraction	9.6	7.1	−2.5
EHR data			
Child preventive dental care	30.5	46.9	16.4
Child D-E-F-G extraction	22.6	7.4	−15.2
Child general anesthesia	8.5	5.4	−3.1
Adult preventive dental care	15.3	27.1	11.8
Adult extraction	40.5	27.0	−13.5

proportions of individuals utilizing preventive care and lower proportions utilizing invasive dental treatment (Table 4). Differences were similar in the EHR data although the magnitudes were larger. These findings suggest that clinically meaningful improvements in dental use can be achieved by incorporating DHATs into the care delivery system. Potential challenges to maintaining a cadre of active DHATs include difficulties with recruitment, preventing provider burn out, and managing provider preferences for communities that may not be the areas of greatest need – all of which are similar difficulties in retaining dentists in underserved areas (27-29). These issues should be explored through research involving current and former DHATs so that recruitment and retention strategies can be improved.

DHATs appear to have an impact on the dental care delivery system. Over the 10-year period, 13 DHATs provided 9,012 treatment days in the YK Delta, compared to 23,368 days of treatment provided by 41 full-time dentists and 14 per diem dentists. The mean number of treatment days provided by each DHAT was slightly higher than dentists, but the number of patients treated and the complexity of care are likely to be different.

One goal of the DHAT program is to address pent up demand for emergency and routine dental care needs, which should level off over time. As this happens, one would expect DHATs to spend more of their time on prevention efforts that go beyond the clinic setting. This could come in the form of community- and home-based behavioral and social interventions aimed at reducing sugared sweetened beverages and improving toothbrushing with fluoridated toothpastes. Evidence-based preventive efforts could be incorporated into the scope of dental therapy practice, which might be particularly effective in indigenous communities because of cultural concordance between DHATs and community members.

Future research should assess how community-level dental care needs change as dental therapists are integrated into the local delivery care system, and characterize the proper balance for DHATs between restorative and preventive activities based on changing community needs. The ultimate goal is to ensure that dental therapy programs do not simply replicate the existing dental care delivery system that focuses primarily on clinic-based treatment and that dental therapists and dentist are providing care that optimizes health outcomes at the lowest cost possible.

Policymakers considering dental therapy legislation are increasingly interested in outcomes data. One example is cost effectiveness. A recent simulation study from the United Kingdom found that mid-level dental providers working in a public dental care delivery system can be a dominant strategy over dentists (i.e., improved outcomes at a lower cost) (30). These findings may be applicable to the YK communities. Additional cost-effectiveness analyses would help to provide answers applicable to the US context.

Our study findings support dental therapists as part of an upstream approach to help address oral health inequalities and achieve social justice (23). Dental therapists in the YK Delta have diversified the dental workforce, created opportunities for community members to serve as healers, and removed cultural barriers to care – important steps in achieving health equity and social justice within indigenous communities.

The main study strength is that we had two longitudinal data sources. However, there are at least six limitations. First, this was an observational study. All findings are associations. Causal inferences can only be drawn from randomized clinical trials, but such trials are unlikely because of cost. In addition, there are ethical considerations in withholding care that has been shown to be safe and effective. Second, there is the potential for selection bias. We attempted to address this problem by adjusting for confounders. However, baseline poverty in 1999 may not accurately measure differences in resources across communities, particularly because the study period began in 2006. Future work should continue to refine the models by identifying and operationalizing additional covariates.

Third, there were differences between the two datasets. Utilization trends were consistent, but Medicaid proportions were generally lower than EHR proportions (Table 1). One reason is that the annual Medicaid denominators included all enrollees regardless of utilization. When we restricted the Medicaid analyses to those who utilized care, the proportions between the two datasets converged. For instance, Medicaid preventive care use in 2015 increased to 65.5 percent for children and 35.6 percent for adults.

Fourth, there was a relatively low match for location of service in the Medicaid data, which raises potential concerns regarding generalizability. We compared demographic and utilization differences between the 13,810 retained and 8,516 excluded Medicaid enrollees. There were no differences in sex or age distribution between retained and excluded enrollees. Proportions of retained children and adults who utilized preventive care utilization were higher, whereas there were no consistent differences in D-E-F-G extractions, dental treatment under general anesthesia, or adult extractions. These findings make it difficult to draw definitive conclusions regarding the degree of systematic bias represented in the retained Medicaid enrollees. Future studies should develop methods to increase the proportion of matches between individuals in Medicaid and EHR data as well as ways to impute location of service for Medicaid enrollees when matching is not possible.

Fifth, our study focused on utilization. We did not assess other outcomes like unmet dental care needs, disease prevented, or quality-of-life. Future studies should be conducted to evaluate ways dental therapists can help improve patient-centered outcomes. In addition, qualitative work within communities of varying degrees of DHAT treatment days could

reveal other important differences associated with care provided by DHATs.

Sixth, dental care is not a panacea. Preventive care utilization was generally low even in recent years. This underscores the importance of targeting behaviors relevant in oral health such as limiting sugar intake and optimizing fluoride exposure. Future work should examine how preventive behaviors and norms within Alaska Native communities are influenced by the presence of DHATs. There is a need for evidence-based strategies that can be incorporated into the Alaska Native dental care delivery system to help providers like DHATs promote patient-level behavior change. This is especially relevant in the YK Delta in which DHATs maintain familial ties, share a common history, and understand the strengths and challenges as experienced by local populations. The eventual goal would be to harness the dental care delivery system as a way to improve oral health behaviors among individuals and norms within families and communities.

Conclusions

Our results provide evidence of positive benefits associated with dental therapists within underserved communities. These promising findings are relevant to policymakers in states with active or pending dental therapy legislation, which is a step toward meeting the dental care needs of vulnerable populations and achieving oral health equity and social justice.

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