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Dental Utilization for Communities Served by Dental Therapists in Alaska's Yukon Kuskokwim Delta: Findings from an Observational Quantitative Study

Final Report

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Executive Summary

Background. Dental Therapists have provided preventive and restorative dental care in Yukon Kuskokwim (YK) Delta communities since 2005. In this retrospective program evaluation, there were two goals: (1) to examine whether dental utilization rates in Alaska Native communities were associated with the number of Dental Therapist treatment days; and (2) to quantify differences in dental utilization rates between communities with no Dental Therapist treatment days versus communities with the highest number of Dental Therapist treatment days during the study period.

Methods. We analyzed Yukon Kuskokwim Health Corporation dental clinic electronic health record (EHR) data and Medicaid claims data (10 years, spanning from 2006 to 2015). We identified all dental services provided by Dental Therapists in the YK Delta using EHR data to calculate the total number of Dental Therapist treatment days provided in each community during the study period. Based on the number of Dental Therapist treatments days, we identified communities with no Dental Therapist treatment days and communities with the highest number of Dental Therapist treatment days.

We assessed five outcomes at the community-level using both EHR and Medicaid data. The three child outcomes were: preventive dental care use, extraction of the four front teeth (D-E-F-G), and dental care under general anesthesia. The two adult outcomes were: preventive dental care use and extraction of any teeth. There were two questions: (1) Is the total number of Dental Therapist treatment days associated with dental utilization? and (2) What are the differences in dental utilization between communities with no Dental Therapist treatment days and communities with the highest number of Dental Therapist treatment days? For question one, we calculated Spearman partial correlation coefficients, adjusted for two confounders (number of dentist treatment days and baseline poverty). For question two, we compared percent differences.

Results. During the study period, there were 13 Dental Therapists who provided 9,012 days of treatment.

Based on EHR and Medicaid data, increased Dental Therapist treatment days was significantly associated with:

- More children and adults who received preventive care
- Fewer children under age 3 with extractions of the front four teeth
- Fewer adults ages 18 and older with permanent tooth extractions

In the EHR data, increased Dental Therapist treatment days was significantly associated with fewer children with dental care under general anesthesia for children under age 6. However, in the Medicaid data, Dental Therapist treatment days was not significantly associated with dental care under general anesthesia.

Consistent across both datasets, preventive care rates were higher and treatment rates were lower in communities with the highest number of Dental Therapist treatment days. Child and adult preventive care utilization rates were 9.3 to 16.4 percentage points and 2.4 to 11.8 percentage points higher in communities with the highest number of Dental Therapist treatment days, respectively, compared to communities with no Dental Therapist treatment days. D-E-F-G extraction rates for children were 5.4 to 15.2 percentage points lower, child general anesthesia rates were 2.4 to 3.1 percentage points lower, and adult extraction rates were 2.5 to 13.5 percentage points lower in communities with the highest number of Dental Therapist treatment days.

Conclusions. Increased Dental Therapists treatment days at the community-level in the YK Delta were positively associated with preventive care use and negatively associated with extractions. Dental Therapists treatment days were not associated with increased general anesthesia rates for children. There appear to be clinically meaningful differences between communities with no Dental Therapists and communities with the highest number of Dental Therapist treatment days, with the latter communities exhibiting utilization patterns consistent with improved outcomes (e.g., more preventive care, fewer extractions, less general anesthesia).

Background

Tooth decay is a significant public health problem among vulnerable populations, including Alaska Native communities (Chi 2013). Untreated tooth decay leads to pain, problems chewing food and sleeping, hospitalization, systemic infection, and, in rare cases, death (Casamassimo et al. 2009). Dental disease is also linked to systemic health problems and chronic diseases (Hayashi et al. 2010). Life-course consequences include school absences, low self-esteem, and problems finding jobs (Jackson et al. 2011; Guarnizo-Herreño and Wehby 2012; Glied and Niedell 2010).

Tooth decay is a multifactorial disease caused by a high sugar diet, inadequate fluoride exposure, and poor access to dental care services. The unique historical and physical contexts of Alaska Native communities exacerbate these risk factors and have led to high rates of tooth decay (CDC 2011; Chi et al. 2015). U.S. settler colonial practices introduced sugars, flour, fats, and salts into indigenous communities (Price 1936). These Western staples quickly displaced healthy native diets. Sugar fueled the tooth decay epidemic observed in indigenous communities. Alaska Native communities are small, geographical isolated, and situated on permafrost, making piped in fluoridated water a costly public health intervention (Atkins et al. 2016). Further complicating local acceptance of water fluoridation is the only documented death that resulted from insufficient monitoring of water fluoridation that occurred in the 1990s in an Alaska Native community (Gessner et al. 1994). Coupled with dentist provider shortages, geographic isolation makes it difficult for most Alaska Native communities to have a regular and local source of dental care services (Chi 2013).

To improve access to dental care, the Alaska Native Tribal Health Consortium trained and deployed Dental Therapists (DTs) in the Yukon Kuskokwim (YK) Delta in 2006. The DT model has been in place in New Zealand and other countries for nearly 100 years (Nash et al. 2008). In the YK Delta, DTs are recruited from local communities, are trained to provide preventive and basic restorative dental care, and work under general supervision by dentists located in Bethel (Willard 2012).

Studies have evaluated initial process and outcome indicators associated with the DT program in the YK Delta. In terms of quality of care, dental care provided by DTs was not significantly different from care provided by dentists (Bolin 2008; Bader 2011). Residents of the YK Delta served by DTs reported shorter wait times for care and satisfaction with DTs (Wetterhall et al. 2011). No studies to date have examined longer-term outcomes in Alaska Native communities served by DTs.

Study Goal and Hypotheses

The goal of this study was to evaluate the DT program within YK Delta communities in Alaska since DTs were deployed in 2006. There were two main research questions and hypotheses:

(1) Is the total number of Dental Therapist treatment days associated with dental utilization (e.g., more preventive care, less invasive treatment)? We hypothesized that the number of DT provider days would be associated with dental utilization patterns consistent with good oral health (more preventive care, fewer extractions, less general anesthesia).

(2) What are the differences in outcomes between communities with no Dental Therapist treatment days and communities with the highest number of Dental Therapist treatment days? We hypothesized that communities with the highest number of DT treatment days would be more likely to have dental utilization patterns consistent with good oral health than community with no DT treatment days.

Methods

Study Location and Context. This study focused on communities in the Bethel Service Area of the YK Delta. The Yukon Kuskokwim Health Corporation (YKHC) services about 25,000 people from 58 federally recognized tribes (IHS 2006). The YK Delta is about the size of Oregon. Prior to 2006, patients traveled from remote communities to Bethel to obtain dental care. Dentists traveled to communities on an annual basis. Since 2006, DTs have provided care within decentralized Sub-Regional Clinics and travel to remote communities to provide care.

Study Design and Time Period. This was a retrospective observational study from calendar years 2006 to 2015, corresponding to the 10-year period in which DTs started providing care under general supervision in the YK Delta (2006) to when the most recent data were available at the time data were requested (2015).

Data Sources. The study focused on data corresponding to children under age 18 years and adults ages 18 years and older. Age was calculated on December 31 of each calendar year in the study period. There were two data sources, each with a unique study population.

(1) Alaska Medicaid Data. These data were for individuals enrolled in Alaska Medicaid at any point between January 1, 2006 and December 31, 2015. Medicaid data consisted of two file types: 1) monthly enrollment data (e.g., first name, last name, date of birth, sex, whether the individual was eligible for Medicaid by month and year, most recent address on file, any changes of address); and 2) dental claims data, indicating all dental procedures for which a claim was submitted by a dental provider and corresponding dates of service.

(2) Electronic Health Record (EHR) Data from the YKHC Dental Clinic. These data consist of dental diagnosis and service data for all YKHC patients who received any dental care from January 1, 2006 to December 31, 2015. Variables included enrollee demographics (e.g., first name, last name, date of birth, sex, most recent city of residence, months enrolled in Medicaid), tooth surface-level diagnosis and existing treatment data (decay, restorations), dental treatment received, individual who provided the dental treatment within a YKHC clinic, location of service, and dates of service.

Classifying Individuals into Communities. The goal of this step was to classify individuals from the two datasets (Medicaid and EHR) into YK Delta communities for each study month. These individuals would be the final study populations on which each outcome was measured.

For the 322,578 unique individuals in the Alaska Medicaid dataset, 22,645 unique individuals were associated with a YK Delta zip code or city during the 10-year study period. We used monthly address data to geocode individuals into mutually exclusive YK Delta communities using the Google Maps Geocoding API. There were 22,353 individuals geocoded into a YK Delta community. The geocoding algorithm accounted for individuals who lived in different YK Delta communities during the study period. These individuals were geocoded into mutually exclusive communities during each study month based on where they lived that month. In addition, YK Delta residents who lived outside of the YK Delta for at least one month during the study period were geocoded into a YK Delta community only during the months in which they resided in the community.

We reconciled address data for 1,034 individuals with overlapping dates of residence (e.g., an individual listed as living in community A from 5/1/2007 to 9/30/2009 and in community A from 7/1/2008 to 10/31/2010). A total of 27 unique individuals were removed from the analyses because of missing or invalid dates of residence. The final Medicaid dataset contained 22,326 unique Medicaid-enrolled individuals who lived in the YK Delta for at least one month during the study period.

For the EHR data, only the most recent city of residence was available for classifying individuals into communities. The initial dataset contained 28,821 unique individuals who utilized dental care through a YKHC dental clinic at least once during the study period. After removing claims associated with locations of service outside of the YK Delta area, there were 28,191 unique individuals in the EHR data. These individuals were classified into a YK Delta community based on the city of residence listed in the EHR for the months in which the individual was enrolled in Medicaid.

Predictor Variable. The main community-level predictor variable was the total number of days in which a community had a DT providing dental care in the community (DT treatment days). This variable was created from the EHR data. We identified all dental claims in the EHR dataset with a valid CDT code submitted by a DT during the study period (2006-2015). For each day on which a DT provided dental care, the location of service (as indicated in the EHR) was noted and counted as one DT treatment day. This variable was measured in two ways. For question one, it was measured as a continuous variable. For question two, a subset of communities was identified based on communities with no DT treatment days and communities with the highest number of DT treatment days during the 10 year-period. Two communities with near zero DT treatment days were classified as having no DT treatment days. To identify communities with the highest number of DT treatment days, we created three periods based on study years: 2006-2009, 2010-2012, and 2013-2015. Communities with the highest number of DT treatment days were designated as communities where the number of DT treatment days per population size was above the 75th percentile among the communities with one or more DT treatment days in a time period (>0.114 for 2006-2009, >0.196 for 2010-2012, and >0.222 for 2013-2015).

Outcome Variables. There were three child outcomes (a, b, and c) and two adult outcomes (d and e). Outcomes were measured at the community-level using both the Medicaid and EHR data. There were differences in (1) variable operationalization because information on tooth number was not available in the Medicaid data and (2) denominator estimates.

Child Outcomes

(a) Proportion of children under age 18 who received preventive dental care. In both the Medicaid and EHR datasets, preventive care was defined as an exam (D0120, D0145, or D0150), cleaning (D1120), fluoride (D1203, D1204, D1206, or D1208), or cleaning and fluoride (D1201 or D1205).

(b) Proportion of children under age 3 who had teeth D, E, F, and G extracted. In the Medicaid dataset, D-E-F-G extractions were defined as having four extractions (D7111 or D7140) on the same day; in the EHR dataset, it was defined as extractions (D7111 or D7140) corresponding to teeth D, E, F, and G on the same day.

(c) Proportion of children under age 6 who received five or more stainless steel crowns on a single day, a proxy measure for general anesthesia. In the Medicaid dataset, general anesthesia was defined as five or more stainless steel crowns (D2930) on the same day; in the EHR dataset, it was defined as five or more stainless steel crowns (D2930) corresponding to teeth A, B, I, J, K, L, S, or T on the same day.

Adult Outcomes

(d) Proportion of adults ages 18 and older who received preventive dental care. In the Medicaid and EHR datasets, preventive care was defined as an exam (D0120 or D0150), cleaning (D1120), fluoride (D1204 or D1206), or cleaning and fluoride (D1205).

(e) Proportion of adults ages 18 and older who had any teeth extracted. In the Medicaid dataset, this was defined as any extraction (D7111 or D7140); in the EHR dataset, it was defined as any extraction (D7111 or D7140) on a permanent tooth (numbers 1 to 32);

For the Medicaid data, the yearly denominators consisted of individuals who were classified into a community and enrolled in Medicaid for at least one month during the 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 year.

Confounder Variables. Our model for question one included two potential confounders that could affect the associations between the predictor variable (DT treatment days) and outcomes (dental utilization). The first is dentist treatment days, defined as the total number of days in which communities had a dentist providing treatment. The second is baseline poverty. There was no standardized community-level poverty measure that could account for potential differences in resources and social conditions across the study communities. Therefore, we adopted a proxy measure from the U.S. Census Bureau indicating the proportion of individuals in each community below poverty in 1999.

Analyses. The Medicaid analyses were restricted to dental services provided during the study period in 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. First name, last name, date of birth, dental procedure code, and date of service from the Medicaid data were matched with corresponding data from the EHR to determine the location of service for each dental service. We excluded dental claims with missing location of service information and dental services provided outside of the YK Delta. After the matching process and excluding claims, 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. Therefore, there were 28,191 unique individuals in the final analytic population for the EHR data, the same number of individuals in the study population.

For each dataset, we generated descriptive statistics on the predictor variables and each outcome variable. For question one, Spearman correlation coefficients were generated for the confounder analyses. Our models included both confounders. Spearman partial correlation coefficients were used to evaluate the correlations between the continuous predictor variable and each outcome variable. The analyses were aggregated by year for each community, and generalized estimating equations were used to account for clustering by community. Three communities with very small populations were excluded from the analyses. For question two, we calculated percent differences for communities with no DT treatment days and those with the highest number of DT treatment days. One community with a very small population was excluded from the analyses.

Results

Study Communities and Population. There were 48 communities in the YK Delta (**Table 1**). Seventeen communities had no dental services provided by a DT within the community. In the Medicaid data, about 25% of the individuals in the final analyses were adults and the remaining 75% were children (**Table 2**). In the EHR data, about 55% of the individuals in the final analyses were children and the remaining 45% were adults, with the number of individuals for each study year ranging from 9,453 (2008) to 12,432 (2012) (**Table 3**). The mean proportion of individuals at the community-level in 1999 that were below poverty was 28%.

DT Exposure Variable. In 2006, there were two DTs who provided care in the YK Delta. The number of DTs increased to 10 by 2015 (**Table 4**). Across the 10-year period, there were a total of 9,012 DT days. The number of DT days peaked in 2013.

Dental Utilization Outcomes. Below is a summary of each outcome measure.

Child Outcomes

(a) Proportion of children under age 18 who received preventive dental care (new patient or periodic exam, cleaning, or fluoride) (**Table 5a** and **Table 5b**). The mean preventive utilization rate was 15.4% in the Medicaid data and 31.8% in the EHR data. Across the 10-year period, the proportion of children who received preventive care increased five-fold based on Medicaid data (7.4% to 35.6%) and doubled in the EHR data (30.5% to 57.8%).

(b) Proportion of children under age 3 who had teeth D, E, F, and G extracted (**Table 6a** and **Table 6b**). The mean D-E-F-G extraction rate was 3.1% in the Medicaid data and 14% in the EHR data. Across the 10-year period, the proportion of D-E-F-G extractions increased based on Medicaid data (1.9% to 16.3%) and decreased in the EHR data (19.2% to 12.1%).

(c) Proportion of children under age 6 who received dental care under general anesthesia (**Table 7a** and **Table 7b**). The mean general anesthesia rate was 5.4% in the Medicaid data and 5.7% in the EHR data. Across the 10-year period, the proportion of children receiving dental care under general anesthesia increased based on Medicaid data (1.6% to 15.8%) and decreased in the EHR data (7.3% to 4.8%).

Adult Outcomes

(d) Proportion of adults ages 18 and older who received preventive dental care (new patient or periodic exam, cleaning, or fluoride) (**Table 8a** and **Table 8b**). The mean preventive dental care utilization rate for adults was 3.8% in the Medicaid data and 18.7% in the EHR data. Across the 10-year period, adult preventive care utilization rates in the Medicaid data started at 1.1% (2006), peaked to 8.5% (2014), and decreased to 6.4% (2015). For the EHR data, preventive rates fluctuated during the 10-year study period, starting at 24% (2006) and ending at 35.3% (2015).

(e) Proportion of adults ages 18 and older who had any teeth extracted (**Table 9a** and **Table 9b**). The mean adult extraction rate was 7.8% in the Medicaid data and 32.9% in the EHR data. Adult extraction rates fluctuated over the 10-year period in both datasets, increasing from 6.6% to 10.3% in the Medicaid data and decreasing from 34.5% to 30.9% in the EHR data.

Question 1. Is the total number of Dental Therapist treatment days associated with dental utilization (e.g., more preventive care, less invasive treatment)? In terms of the confounder analyses, dentist treatment days were positively associated with the predictor variable and significantly associated with most outcomes (**Table 10a** and **Table 10b**). Baseline poverty was not significantly associated with the predictor variable and significantly associated with most outcomes (**Table 10c** and **Table 10d**). Both confounders were included in the final models.

Across the 10-year study period in both EHR and Medicaid datasets, increased DT treatment days was positively associated with preventive care for children and adults (outcomes a and d), and negatively associated with D-E-F-G extractions for children and extractions for adults (outcomes b and e) (**Table 10e**). From the EHR data, increased DT treatment days were negatively associated with treatment under general anesthesia for children, but this association was not statistically significant in the Medicaid data.

Question 2. What are differences in outcomes between communities with no Dental Therapist treatment days and communities with the highest number of Dental Therapist treatment days?
There were 16 communities with no DT treatment days (no members of the community received dental care from a DT) and 10 different communities with the highest number of DT treatment days during the study period. Across both datasets, communities with the highest DT treatment days exhibited higher rates of preventive care and lower rates of invasive dental treatment (**Table 11**). For example, in the Medicaid dataset, there was a 9.3 percentage point difference in child preventive care utilization rates (24.8% in the highest DT treatment day communities and 15.5% in the no DT treatment day communities). Children in the highest DT treatment day communities had a D-E-F-G extraction rate that was 5.4 percentage points lower and a general anesthesia rate that was 2.4 percentage points lower than children in the no DT treatment day communities. Adults in the highest DT treatment day communities had a preventive care utilization rate that 2.4 percentage points higher and an extraction rate that was 2.5 percentage points lower than adults in the no DT dental treatment day communities. Differences in outcomes were similar in the EHR data although the magnitudes were larger.

Discussion
This is the first known study to evaluate long-term dental utilization patterns associated with Dental Therapists (DTs). There are two main findings. The first is that increased DT treatment days were significantly associated with increased rates of preventive care and decreased rates of extractions for children and adults. The findings regarding general anesthesia for children were mixed across the two datasets – DT treatment days were negatively associated with general anesthesia in the EHR data but not significant in the Medicaid data. In other words, DT treatment days were not associated with increased general anesthesia rates. These findings indicate improved dental utilization patterns associated with DT treatment days in the YK Delta. There are no studies to which these findings can be directly compared. However, these findings are consistent with a study reporting significant associations between pediatric dentist density and preventive dental care use for children in Medicaid (Heidenreich et al. 2015).

The second finding is that communities with the highest number of DT treatment days exhibited higher rates of preventive care and lower rates of invasive dental treatment for children and adults than communities with no DT treatment days. For example, child and adult preventive care rates were 9.3 to 16.4 and 2.4 to 11.8 percentage points higher, respectively, in communities with the highest number of DT treatment days compared to communities with no Dental Therapist treatment days. Child D-E-F-G extraction rates were 5.4 to 15.2 percentage points lower, child general anesthesia rates were 2.4 to 3.1 percentage points lower, and adult extraction rates were 2.5 to 13.5 percentage points lower in communities with the highest number of DT treatment days. These findings suggest that clinically meaningful differences in dental utilization rates can be achieved by incorporating DTs into the dental care delivery system.

The main study strength is that we had two data sources to evaluate our study hypotheses. However, there are four main limitations. First, this was an observational study. We are unable to draw causal conclusions and all findings are associations. Randomized clinical trials would be one way to examine causal outcomes of DTs, but this approach is not feasible because of cost and ethical implications. Second, because this was an observational study, there is the potential for selection bias (Lee et al. 2005). We attempted to address this limitation in question one by adjusting for confounders identified through our conceptual model. Using a measure of baseline poverty from 1999 may not be an optimal measure of potential differences across communities, particularly because the study began in 2006. Future work should continue to identify additional ways to measure community-level resources that could serve as model confounders. Third, our study focused on utilization. We did not assess unmet dental care needs, disease prevention, and quality of life. Future prospective studies should be conducted to evaluate ways in dental provider density can lead to other potentially beneficial outcomes as previously demonstrated (Guarnizo-Herreño and Wehby 2014). In addition, qualitative work within communities based on varying degrees of DT treatment days could reveal other important differences associated with DTs. Fourth, dental care use is not a panacea. This underscores the importance of other behaviors relevant in oral health such as limiting sugar intake, optimizing fluoride exposure, and tobacco cessation. Future work should examine the extent to which the Alaska Native dental care delivery system provides patients with relevant behavior change strategies and how these other preventive behaviors and norms are influenced by the presence of DTs. This is especially relevant in in the YK Delta in which DTs 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.

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Table 1
Yukon Kuskokwim Delta Communities (N=48) Identified from Geocoding of Electronic Health Record Patient Addresses with Bolded Communities Indicating No Dental Services Provided within the Community by a Dental Therapist (N=17)

1	**AKIACHAK**	**45**	**TULUKSAK**
2	**AKIAK**	**46**	**TUNTUTULIAK**
3	ALAKANUK	47	TUNUNAK
4	ANIAK	48	UPPER KALSKAG
5	ANVIK		
6	**ATMAUTLUAK**		
7	BETHEL		
8	CHEFORNAK		
9	CHEVAK		
10	CHUATHBALUK		
11	CROOKED CREEK		
12	**EEK**		
13	EMMONAK		
14	GRAYLING		
15	HOLY CROSS		
16	HOOPER BAY		
17	**KASIGLUK**		
18	**KIPNUK**		
19	**KONGIGANAK**		
20	KOTLIK		
21	**KWETHLUK**		
22	**KWIGILLINGOK**		
23	LIME VILLAGE		
24	**LOWER KALSKAG**		
25	MARSHALL		
26	MEKORYUK		
27	MT VILLAGE		
28	**NAPAKIAK**		
29	**NAPASKIAK**		
30	NEWTOK		
31	NIGHTMUTE		
32	NUNAM IQUA		
33	**NUNAPITCHUK**		
34	**OSCARVILLE**		
35	PILOT STATION		
36	PITKA'S POINT		
37	**QUINHAGAK**		
38	RUSSIAN MISSION		
39	ST MARYS		
40	SCAMMON BAY		
41	SHAGELUK		
42	SLEETMUTE		
43	STONY RIVER		
44	TOKSOOK BAY		

Table 2
Age Distribution of Study Population by Community for Individuals in Medicaid Dataset (2006-2015)

	Year																					
	2006		*2007*		*2008*		*2009*		*2010*		*2011*		*2012*		*2013*		*2014*		*2015*		*All*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Age																						
<3 years	1402	13.4%	1387	12.7%	1413	12.4%	1482	12.4%	1533	12.3%	1512	11.7%	1399	10.5%	1166	8.6%	827	6.0%	430	3.1%	12551	10.1%
3 to 5 years	1356	13.0%	1357	12.4%	1402	12.3%	1401	11.7%	1386	11.1%	1412	10.9%	1481	11.1%	1533	11.3%	1513	11.0%	1398	10.2%	14239	11.4%
6 to 12 years	2589	24.8%	2731	25.0%	2816	24.7%	2926	24.5%	3010	24.2%	3107	24.1%	3153	23.6%	3212	23.6%	3237	23.5%	3340	24.3%	30121	24.2%
13 to 17 years	1485	14.2%	1601	14.7%	1631	14.3%	1706	14.3%	1759	14.1%	1780	13.8%	1865	14.0%	1921	14.1%	2041	14.8%	2080	15.1%	17869	14.4%
18 years or older	3606	34.5%	3841	35.2%	4144	36.3%	4420	37.0%	4753	38.2%	5106	39.5%	5435	40.8%	5777	42.4%	6134	44.6%	6505	47.3%	49721	39.9%
All	10438	100.0%	10917	100.0%	11406	100.0%	11935	100.0%	12441	100.0%	12917	100.0%	13333	100.0%	13609	100.0%	13752	100.0%	13753	100.0%	124501	100.0%

Table 3
Age Distribution of Study Population by Year for Individuals in Yukon Kuskokwim Health Corporation Electronic Health Record Dataset (2006-2015)

	Year																				
	2006		*2007*		*2008*		*2009*		*2010*		*2011*		*2012*		*2013*		*2014*		*2015*		*All*	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Age																						
<3 years	308	3.0%	313	3.0%	252	2.7%	245	2.6%	436	4.0%	629	5.1%	597	4.8%	567	4.9%	534	4.5%	680	5.8%	4561	4.1%
3 to 5 years	1149	11.3%	1155	11.0%	1060	11.2%	1004	10.8%	1175	10.7%	1393	11.3%	1344	10.8%	1341	11.5%	1382	11.7%	1425	12.2%	12428	11.3%
6 to 12 years	2611	25.6%	2704	25.7%	2407	25.5%	2173	23.3%	2597	23.6%	3067	24.8%	2832	22.8%	2690	23.1%	2694	22.7%	2682	23.0%	26457	24.0%
13 to 17 years	1665	16.3%	1756	16.7%	1415	15.0%	1319	14.1%	1461	13.3%	1724	13.9%	1838	14.8%	1604	13.8%	1586	13.4%	1468	12.6%	15836	14.3%
18 years or older	4474	43.8%	4601	43.7%	4319	45.7%	4593	49.2%	5326	48.4%	5547	44.9%	5814	46.8%	5421	46.6%	5660	47.7%	5430	46.5%	51185	46.3%
All	10207	100.0%	10529	100.0%	9453	100.0%	9334	100.0%	10995	100.0%	12360	100.0%	12425	100.0%	11623	100.0%	11856	100.0%	11685	100.0%	110467	100.0%

Table 4
Distribution of Dental Therapists and Number of Dental Therapist Exposure Days by Year

	All Years	Year									
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	N	N									
DT											
1	1957	192	202	208	208	199	189	171	193	196	199
2	618	194	205	203	16	.	.	.	.	.	.
3	1109	.	.	.	.	200	177	190	158	189	195
4	790	.	.	23	10	213	204	155	185	.	.
5	960	.	.	.	.	.	201	199	162	182	216
6	770	.	.	.	.	.	210	134	208	190	28
7	804	.	.	.	.	.	213	154	194	177	66
8	468	.	.	.	.	.	6	205	212	45	.
9	790	.	.	.	.	.	4	196	221	204	165
10	324	.	.	.	.	.	.	.	31	124	169
11	148	.	.	.	.	.	.	.	.	.	148
12	183	.	.	.	.	.	.	.	.	.	183
13	91	.	.	.	.	.	.	.	.	.	91
All	9012	386	407	434	234	612	1204	1404	1564	1307	1460

Table 5a
Proportions of Children under Age 18 Who Received Preventive Dental Care by Year based on Medicaid Data

Preventive dental care	Year										All
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
	7.4%	9.0%	10.7%	8.7%	13.4%	13.3%	17.7%	21.1%	30.4%	35.6%	15.4%

Table 5b
Proportions of Children under Age 18 Who Received Preventive Dental Care by Year based on Electronic Health Record Data

Preventive dental care	Year										All
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
	30.5%	24.2%	30.4%	29.5%	35.4%	27.4%	35.4%	42.2%	52.7%	57.8%	31.8%

Table 6a
Proportions of Children Under Age 3 Year Who Had Four Teeth Extracted by Year based on Medicaid Data*

Extraction of D, E, F, G	Year										All
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
	1.9%	3.2%	2.3%	2.7%	2.9%	3.4%	3.4%	5.4%	8.0%	16.3%	3.1%

* There were no tooth numbers available in the Medicaid data. Therefore, this measure was defined as four extractions on the same day.

Table 6b
Proportions of Children Under Age 3 Year Who Had Teeth D, E, F, and G Extracted by Year based on Electronic Health Record Data

Extraction of D, E, F, G	Year										
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	All
	19.2%	20.1%	20.6%	26.4%	13.1%	9.7%	9.1%	12.5%	14.4%	12.1%	14.0%

Table 7a
Proportions of Children Under Age 6 Who Received Five or More Stainless Steel Crowns on a Single Day, a Proxy Measure of General Anesthesia, by Year based on Medicaid Data*

General anesthesia	Year										All
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
	1.6%	2.4%	2.1%	2.0%	4.0%	5.5%	6.4%	7.4%	13.7%	15.8%	5.4%

* 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.

Table 7b
Proportions of Children Under Age 6 Who Received Five or More Stainless Steel Crowns on a Single Day, a Proxy Measure of General Anesthesia, by Year based on Electronic Health Record Data

General anesthesia	Year										All
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
	7.3%	7.8%	7.6%	7.7%	8.1%	5.9%	5.6%	5.9%	6.3%	4.8%	5.7%

Table 8a
Proportions of Adults Ages 18 and Older Who Received Preventive Dental Care by Year based on Medicaid Data

Preventive dental care	Year										All
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
	1.1%	2.6%	2.6%	2.5%	3.0%	4.3%	4.3%	5.6%	8.5%	6.4%	3.8%

Table 8b
Proportions of Adults Ages 18 and Older Who Received Preventive Dental Care by Year based on Electronic Health Record Data

Preventive dental care	Year										All
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
	24.0%	19.8%	15.7%	16.7%	24.4%	22.8%	20.7%	28.9%	36.9%	35.3%	18.7%

Table 9a
Proportions of Adults Ages 18 and Older Who Had Any Teeth Extracted by Year based on Medicaid Data

Tooth extraction	Year										All
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
	6.6%	8.9%	7.3%	6.6%	8.1%	6.9%	7.8%	7.6%	10.7%	10.3%	7.8%

Table 9b
Percentage of Adults Ages 18 and Older Who Had Any Teeth Extracted by Year based on Electronic Health Record Data

Tooth extraction	Year										All
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
	34.5%	32.7%	33.2%	33.7%	31.9%	29.2%	27.5%	29.1%	31.0%	30.9%	32.9%

Table 10a
Confounder Analyses for Dentist Treatment Days and Predictor Variable (Dental Therapist Treatment Days) – Spearman Correlation Coefficients

	Spearman Correlation Coefficients P-Values
Dentist Treatment Days	Dental Therapist Treatment Days
Medicaid Data	0.31 <0.0001
Electronic Health Record Data	0.31 <0.0001

Table 10b
Confounder Analyses for Dentist Treatment Days and Each Outcome – Spearman Correlation Coefficients

	Spearman Correlation Coefficients P-Values				
Dentist Treatment Days	Outcome a Child preventive care	Outcome b Child D-E-F-G extraction	Outcome c Child general anesthesia	Outcome d Adult preventive care	Outcome e Adult extraction
Medicaid Data	0.33 <0.0001	0.21 <0.001	0.16 0.01	0.31 <0.001	0.02 0.78
Electronic Health Record Data	0.25 <0.001	0.13 0.09	0.17 0.03	0.26 <0.001	-0.22 <0.01

Child Outcomes

(a) Proportion of children under age 18 who received preventive dental care (new patient or periodic exam, cleaning, or fluoride)
(b) Proportion of children under age 3 who had teeth D, E, F, and G extracted
(c) Proportion of children under age 6 who received five or more stainless steel crowns on a single day, a proxy measure of general anesthesia

Adult Outcomes

(d) Proportion of adults ages 18 and older who received preventive dental care (new patient or periodic exam, cleaning, or fluoride)
(e) Proportion of adults ages 18 and older who had any teeth extracted

Table 10c
Confounder Analyses for Baseline Poverty and Predictor Variable (Dental Therapist Treatment Days) – Spearman Correlation Coefficients

	Spearman Correlation Coefficients P-Values
Baseline Poverty	Dental Therapist Treatment Days
Medicaid Data	-0.12 0.53
Electronic Health Record Data	-0.12 0.53

Table 10d
Confounder Analyses for Baseline Poverty and Each Outcome – Spearman Correlation Coefficients

	Spearman Correlation Coefficients P-Values				
Baseline Poverty	Outcome a Child preventive care	Outcome b Child D-E-F-G extraction	Outcome c Child general anesthesia	Outcome d Adult preventive care	Outcome e Adult extraction
Medicaid Data	-0.12 <0.001	-0.16 <0.01	-0.18 <0.0001	-0.10 0.01	-0.001 0.53
Electronic Health Record Data	-0.15 <0.001	-0.18 <0.01	-0.16 <0.01	-0.20 <0.001	0.001 0.91

Child Outcomes

(a) Proportion of children under age 18 who received preventive dental care (new patient or periodic exam, cleaning, or fluoride)
(b) Proportion of children under age 3 who had teeth D, E, F, and G extracted
(c) Proportion of children under age 6 who received five or more stainless steel crowns on a single day, a proxy measure of general anesthesia

Adult Outcomes

(d) Proportion of adults ages 18 and older who received preventive dental care (new patient or periodic exam, cleaning, or fluoride)
(e) Proportion of adults ages 18 and older who had any teeth extracted

Table 10e
Spearman Partial Correlation Coefficients between Dental Therapist Exposure (Continuous Variable) and Each Outcome during 10-Year Study Period based on Medicaid and Electronic Health Record Data

	Spearman Partial Correlation Coefficients* P-Values				
Dental Therapist Exposure	Outcome a Child preventive care	Outcome b Child D-E-F-G extraction	Outcome c Child general anesthesia	Outcome d Adult preventive care	Outcome e Adult extraction
Medicaid Data	0.23 <0.0001	-0.17 0.03	0.05 0.45	0.20 <0.001	-0.16 0.02
Electronic Health Record Data	0.26 <0.0001	-0.28 <0.0001	-0.27 <0.0001	0.30 <0.0001	-0.46 <.0001

* Adjusted for dentist treatment days and baseline poverty

Child Outcomes
(a) Proportion of children under age 18 who received preventive dental care (new patient or periodic exam, cleaning, or fluoride)
(b) Proportion of children under age 3 who got teeth D, E, F, and G extracted
(c) Proportion of children under age 6 who received five or more stainless steel crowns on a single day, a proxy measure of general anesthesia

Adult Outcomes
(d) Proportion of adults ages 18 and older who received preventive dental care (new patient or periodic exam, cleaning, or fluoride)
(e) Proportion of adults ages 18 and older who got any teeth extracted

Table 11
Percentage Point Differences in Outcomes between Communities with No Dental Therapist Treatment Days and the Highest Dental Therapist Treatment Days

	No Dental Therapist Treatment Days N=16	Highest Dental Therapist Treatment Days N=7	Percentage Point Difference between Highest Dental Therapist Treatment Days and No Dental Therapist Treatment Days
Medicaid Data			
Outcome a Child preventive care	15.5%	24.8%	9.3%
Outcome b Child D-E-F-G extraction	7.3%	1.9%	-5.4%
Outcome c Child general anesthesia	7.9%	5.5%	-2.4%
Outcome d Adult preventive care	3.2%	5.6%	2.4%
Outcome e Adult extraction	9.6%	7.1%	-2.5%
Electronic Health Record Data			
Outcome a Child preventive care	30.5%	46.9%	16.4%
Outcome b Child D-E-F-G extraction	22.6%	7.4%	-15.2%
Outcome c Child general anesthesia	8.5%	5.4%	-3.1%
Outcome d Adult preventive care	15.3%	27.1%	11.8%
Outcome e Adult extraction	40.5%	27.0%	-13.5%

Child Outcomes
(a) Proportion of children under age 18 who received preventive dental care (new patient or periodic exam, cleaning, or fluoride)
(b) Proportion of children under age 3 who had teeth D, E, F, and G extracted

(c) Proportion of children under age 6 who received dental care under general anesthesia

Adult Outcomes

(d) Proportion of adults ages 18 and older who received preventive dental care (new patient or periodic exam, cleaning, or fluoride)
(e) Proportion of adults ages 18 and older who had any teeth extracted