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The Use of General Anesthesia for Pediatric Dentistry in Saskatchewan: A Retrospective Study

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Cite this as: *J Can Dent Assoc* 2022;88:m9

ABSTRACT

Introduction: The rate of general anesthesia (GA) use for pediatric dental treatment in Saskatchewan is among the highest in Canada. Although the prevalence of and risk factors for early childhood caries (ECC) has been reviewed nationally, few studies have focused on Saskatchewan. The objective of this study was to determine the prevalence of and predictive factors for dental treatment under GA in Saskatchewan.

Methods: This retrospective review focused on pediatric patients who required dental treatment under GA in Saskatchewan between 2015 and 2018. Demographic, dental diagnostic and treatment data and number of previous exposures to GA were collected and analyzed.

Results: We reviewed 570 patient records. Dental treatment needs among the sample were complex; children had 10.85 ± 3.56 (mean ± standard deviation) teeth treated, for an average cost of $3231.72 ± $898.95 per child. Children who lived in less accessible or remote locations had a significantly higher caries experience, number of teeth treated and cost of treatment. In addition, children who lived in such locations were more likely to have had previous dental treatment under GA (odds ratio [OR] 1.29, 95% CI 1.029–1.645) compared with those who lived in easily accessible/accessible areas (OR 0.81, 95% CI 0.700–0.953).

Conclusion: Our findings confirm previous research that children who require dental treatment under GA have extensive caries and treatment needs. Our results suggest that children who live in less accessible and more remote areas of the province have a higher burden of disease and are more likely to require repeated GA exposures for dental treatment.

Published: September 29, 2022

Dental caries is the most common chronic disease of childhood; when left untreated, it can result in severe pain, infection and impaired quality of life.[1,2] In Canada, nearly 2 thirds of children aged 6–11 years have experienced some form of dental caries.[3] For children < 6 years, the presence of ≥ 1 decayed, missing (due to caries) or filled tooth surfaces in the primary dentition (dmft) is defined as early childhood caries (ECC). Despite advances in clinical and community-based prevention strategies to reduce the overall burden of disease and a shift toward minimally invasive approaches to manage ECC,[4,5] the treatment of extensive disease still requires a surgical approach to restore or remove teeth to maintain optimal oral health.

For many young children, cooperation in a traditional dental setting is a considerable challenge. This could be because of young age, lack of emotional or psychological maturity or the presence of a disability.[6] In such instances, admission to hospital and general anesthesia (GA) may be required for treating ECC, which adds significant risk and expense.[6] In addition, treatment under GA may be the only option for providing safe, efficient and effective dental care for children for whom local anesthesia is ineffective because of an acute infection, anatomic anomaly or allergy; those requiring complex and lengthy surgical procedures; those who are extremely anxious, fearful and uncooperative; and those requiring emergency dental care.[6]

A growing body of evidence suggests that rates of dental treatment under GA have been increasing over time.[7–10] In Canada, Schroth et al.[11] reported an overall rate of dental treatment under GA of 12.1 per 1000 children < 5 years. This accounts for 31% of all outpatient surgeries in this age bracket, and represents about $21 million annually in total hospital-associated costs.[11] Furthermore, children from vulnerable populations are disproportionately affected by ECC. This includes children living in remote communities, low-income households and Indigenous communities, who, on average, experience higher rates of GA use for dental treatment.[11] Although the risk of adverse events associated with the use of GA for dental treatment has been relatively low,[12] there is still concern over the high rates of caries recurrence and retreatment for children who have undergone dental treatment under sedation.[13,14] Pre-clinical evidence of an association between early exposure to GA and neurotoxicity is also emerging, as well as concerns that multiple exposures to GA before the age of 3 years may be associated with decreased processing speed and fine-motor abilities and greater deficits in reading and behaviour.[15–17] Given these potential associations, there is incentive to investigate risk factors and trends associated with dental treatment under GA, with the aim of developing strategies for prevention.

A recent review using national administrative data showed that Saskatchewan has one of the highest rates of GA use for pediatric dental treatment and average costs per child compared with other jurisdictions.[11] Although the prevalence of and risk factors for ECC have been reviewed in Canada,[18] few studies have examined the use of GA for pediatric dental treatment in Saskatchewan. Before strategies to reduce the rates of dental treatment under GA are developed, a more thorough understanding of the underlying causes unique to Saskatchewan is required. Thus, the objective of this study was to determine the prevalence of and predictive factors for dental treatment under GA in Saskatoon, Saskatchewan.

Methods

This retrospective cross-sectional study was conducted at the Royal University Hospital (RUH) and the College of Medicine, University of Saskatchewan, Saskatoon, Saskatchewan. This is a primary referral site for dental surgeries in the province. Patient records for children < 6 years who received dental treatment under GA between 1 Jan. 2015 and 31 Dec. 2018 were selected for review. Each patient record was assigned a random number to conceal patient identities.

The following variables were considered to be important for this investigation and were abstracted directly from patient records: age, date of birth, gender, postal code, date of surgery, history of previous GA, American Society of Anesthesia (ASA) physical status score, duration of surgery (minutes), dental diagnosis and a summary of dental procedures completed (class I and II dental restorations, crowns, root canal therapy, extractions, sealants).

The remoteness of primary residence was determined by matching postal codes to data from Postal Code Conversion File (PCCF 2019) from Statistics Canada and using the “manual classification of the remoteness index based on natural breaks, population and number of census subdivisions” method described by Subedi et al.[19] Here, a remoteness index (RI) is first determined by considering the distance that separates a community from all the population centres in a given travel radius, as well as their size. Remoteness is then further divided into 5 categories: easily accessible (RI < 0.1500), accessible (RI 0.1500–0.2888), less accessible (RI 0.2889–0.3898), remote (RI 0.3899–0.5532) and very remote (RI > 0.5532).[19] This remoteness variable was then combined into 2 categories based on the distribution of data: “easily accessible/accessible” and “less accessible/remote/very remote.” The dmft index was determined based on the World Health Organization criteria for dental surveys.[20]

Total cost of dental treatment per child is an estimate of the direct costs associated with dental services and was determined using the Saskatchewan Dental Fee Guide produced by the College of Dental Surgeons of Saskatchewan. Total anesthesia cost per child is an estimate of the direct costs associated with anesthesia services and was determined using data provided by the Department of Anesthesia, College of Medicine, and University of Saskatchewan.

Primary data abstraction was completed by AL and audited by KD as a measure of quality control. Data analysis began with descriptive statistics including the frequencies, means and standard deviations for our main variables. Results are presented as means or proportions, as appropriate. Differences in means or proportions were compared using independent *t* tests and X^2 tests, respectively. A p value < 0.05 was considered significant. All analyses were performed using STATA 15 software (StataCorp, College Station, Texas, USA).

This study was approved by the University of Saskatchewan Biomedical Research Ethics Board (BioID #659).

Results

We reviewed 570 patient records for this study. The demographic characteristics of the sample population are shown in **Table 1**. The mean age of the children was 4.57 ± 0.73 years, and 55.5% were males. Most children requiring treatment were relatively healthy and classified as ASA I (72.9%) or ASA II (25.4%). Based on children's documented history of dental treatment, 15.4% had previously required GA at least once at this site, while 6% had experienced ≥ 2 previous dental surgeries under GA. Although 49.5% of children lived in an easily accessible/accessible area, 50.5% lived in an area that was less accessible/remote/very remote.

The mean time that children were spending under GA for their dental treatment was 104.46 ± 27.40 minutes (**Table 2**). The overall burden of disease was high: children had a mean dmft index of 11.52 ± 3.84, and a mean of 10.85 ± 3.56 teeth per child required some form of treatment. An analysis of treatment provided revealed that more teeth required restoration (8.62 ± 3.06) than extraction (2.22 ± 2.53). A further breakdown of treatment revealed that more stainless steel crowns (6.11 ± 3.13) were placed per child compared with class I or II dental restorations (2.51 ± 2.93). When estimating costs, we calculated that, on average, $3231.72 ± $898.95 was attributed to the direct costs of dental treatment, and $784.33 ± $159.81 was attributed to the direct costs of anesthesia services.

Comparisons based on remoteness are presented in **Table 3**. Children in our sample who lived in less accessible/remote/very remote areas presented with a greater overall burden of disease. These children had statistically significant higher mean dmft index scores (mean difference [MD] = 1.287, 95% confidence interval [CI] = 0.621–1.858, $p = 0.000$), mean number of teeth treated per child (MD 1.452, 95% CI 0.887–2.034, $p = 0.000$), mean total number of restorations placed (MD 0.587, 95% CI 0.057–1.042, $p = 0.028$) and mean number of extractions (MD 0.933, 95% CI 0.522–1.319, $p = 0.000$).

In addition, children who lived in less accessible/remote/very remote areas were more likely to have required GA at least once in the past (odds ratio [OR] 1.29, 95% CI 1.029–1.645) than those who lived in an easily accessible/accessible area (OR 0.81, 95% CI 0.700–0.953). In terms of cost of treatment, children who lived in less accessible/remote/very remote areas were associated with a significantly higher cost of dental treatment per child (mean difference in cost [MD] 359.71, 95% confidence interval for the mean difference [CI] 213.54–496.46, $p = 0.000$). No significant differences were found between the groups in terms of age, procedure time, sealants placed and estimated anesthesia costs.

Table 1: Summary of patient demographics ($n = 570$).

Demographic	No. (%)
Age, years	
≤ 2	78 (13.7)
3	129 (22.6)
4	143 (25.0)
5	138 (24.2)
6	83 (14.5)
Mean ± SD	4.57 ± 0.73
Sex	
Male	317 (55.5)
Female	251 (44.5)

Table 1 continued ▶

Demographic	No. (%)
Population of centre where primary residence located	
Small (1000–29 999)	257 (45.1)
Medium (30 000–99 999)	141 (24.7)
Large (≥ 100 000)	172 (30.2)
Location of residence (remoteness)	
Easily accessible	181 (31.8)
Accessible	101 (17.7)
Less accessible	158 (27.7)
Remote	98 (17.2)
Very remote	32 (5.6)
History of treatment under GA	
First experience	448 (78.6)
≥ 1 previous experience(s)	122 (21.4)
Frequency of repeat treatment under GA	
0	448 (78.6)
1	88 (15.4)
2	15 (2.6)
3	9 (1.6)
≥ 4	10 (1.8)
ASA classification	
ASA I	416 (72.9)
ASA II	145 (25.4)
ASA III	8 (1.4)

Note: *ASA = American Society of Anesthesia, GA = general anesthesia, SD = standard deviation.*

Table 2: Summary of clinical findings and dental treatment provided.

	Mean ± SD
Total time under GA, minutes	104.46 ± 27.40
dmft index (decayed, missing, filled teeth)	11.52 ± 3.84
Total teeth treated	10.85 ± 3.56
Total restorations placed	8.62 ± 3.06
Class I or II dental restoration	2.51 ± 2.93
Stainless steel crown	6.11 ± 3.13

Table 2 continued ▶

	Mean ± SD
Total extractions	2.22 ± 2.53
Total sealants	0.31 ± 1.05
Total cost of dental treatment per child, $	3231.72 ± 898.95
Total cost of anesthesia per child, $	784.33 ± 159.81
Note: *GA = general anesthesia, SD = standard deviation.*	

Table 3: Comparison of outcome measures based on remoteness of primary residence.

Outcome measure Ŧ	Easily accessible/ accessible area (mean ± SD)	Less accessible/ remote/very remote area (mean ± SD)	Mean difference	95% CI of difference		p
				Lower	Upper	
Age, years	4.57 ± 1.23	4.62 ± 2.09	−0.054	−0.335	0.231	0.709
Total time under GA, minutes	105.21 ± 28.45	103.49 ± 26.21	1.724	−3.098	5.929	0.522
dmft index	10.87 ± 3.75	12.16 ± 3.76	−1.287	−1.858	−0.621	0.000
Total teeth treated	10.08 ± 3.62	11.62 ± 3.40	−1.452	−2.034	−0.887	0.000
Total restorations placed	8.35 ± 3.22	8.94 ± 2.92	−0.587	−1.042	−0.057	0.028
Class I and II restorations	2.71 ± 2.85	2.13 ± 2.56	0.577	0.095	0.971	0.017
Stainless steel crown	5.59 ± 3.23	6.62 ± 3.15	−1.029	−1.558	−0.532	0.000
Total extractions	1.72 ± 2.27	2.65 ± 2.75	−0.933	−1.319	−0.522	0.000
Total sealants	0.34 ± 1.03	0.26 ± 1.01	0.078	−0.094	0.230	0.414
Total cost of dental treatment per child, $	3059.01 ± 905.02	3418.72 ± 861. 68	−359.71	−496.46	−213.54	0.000
Total cost of anesthesia per child, $	789.40 ± 162.23	781.02 ± 154.34	8.38	−19.27	35.16	0.510
Outcome measure ¥	**Easily accessible/ accessible area, OR (95% CI)**	**Less accessible/ remote/very remote area OR (95% CI)**	**X_2**	**Degrees of freedom**	**—**	***p***
Repeat treatment under GA (OR)	0.81 (0.700–0.953)	1.29 (1.029–1.645)	5.689	1	—	0.016
Note: *GA = general anesthesia, OR = odds ratio, SD = standard deviation, Ŧ Independent T-Test, ¥ Chi-Squared Test*						

Discussion

In this retrospective study, we examined and profiled a cohort of pediatric patients who have received dental treatment under GA in Saskatoon, Saskatchewan. Consistent with other published studies, we confirm that children who are being referred for treatment under GA have a high severity of ECC and require extensive dental rehabilitation as measured by the number of teeth requiring treatment. Our data also revealed that almost half the patients in our sample lived in less accessible or remote locations and that these children presented with greater dental treatment needs. These findings highlight the geographic disparities that exist with respect to the burden of oral disease and timely access to dental care.

Setting the foundation for optimal oral health in childhood requires early risk assessment and timely interventions. This is the rational for the recommendation that all children establish a dental home and have their first dental visit before their first birthday (age 1 visit).[21,22] Indeed, previous research has shown that early dental visits are associated with fewer total dental procedures and lower overall costs for children.[23–25] In our sample population, about 63% of children were > 4 years, which is indicative of the need to develop improved prevention strategies targeting preschool children. There are many potential barriers for children seeking timely access to dental care, including socioeconomic status, family structure, race, insurance coverage and geographic location.[26] In addition, the distribution of oral health care providers,[27] their compliance with recommendations[28] and public awareness of the age 1 visit are areas where future work is needed. It is imperative that oral health care providers and policymakers divert resources toward targeted approaches to oral health promotion and early interventions aimed at preventing ECC in preschool children.

When examining clinical data, we noted that among children who presented to the RUH, the severity of ECC (dmft index) and the overall treatment needs represented by number of teeth receiving treatment were high. On the one hand, this demonstrates that oral health care providers in Saskatchewan are generally following recommendations for hospital referrals and selecting cases based on extensive treatment needs in addition to a complete behaviour assessment. However, as Schroth et al.[11] have noted, treatment needs and rates of dental treatment under GA can also serve as an important indicator of population health; thus, the clinical findings from our sample demonstrate a high burden of disease. This was associated with high estimates of direct costs per child associated with providing dental treatment ($3231) and anesthesia services ($784) and likely higher indirect costs per family, which we were unable to capture in this study.

Approximately 21% of our sample had required GA at this location at least once before, and 6% had more than 2 exposures. These findings are consistent with research into risk factors and trends in repeat use of GA for dental treatment, which has ranged from 2% to 17%.[29–31] The many potential explanations for repeat hospital visits include failure to follow up with comprehensive care, limited access to routine preventative care, medical comorbidities and the selection of restorative material and recurrent decay.[13–14,29–31] However, further analysis would be required to ascertain the relation between these risk factors and repeat GA use in Saskatchewan.

Recent Canadian studies have demonstrated that rates of dental treatment under GA are significantly higher among children who live in less accessible and remote regions of the country, compared with those who live in densely populated areas.[7,11] Our postal code analysis allowed us to determine the relative remoteness of the primary residence for our sample population. Consistent with previous research, we found that patients in our sample population who lived in less accessible and more remote areas presented with higher dmft scores and were more likely to have had previous treatment under GA. Access to timely dental care has long been a challenge in northern Canadian communities.[7,32–34] In part, this has been explained by the relatively high proportion of First Nations communities in northern parts of Canada, which are typically underserved, where access to consistent dental care is scarce and where prevalence of ECC is high.[33–35] In addition, many remote communities may not have the benefit of population-based interventions, such as community water fluoridation, as a means of prevention. Given the disparities based on remoteness highlighted in our study, a coordinated effort will be needed to improve the distribution of oral health care providers and resources to the traditionally underserved areas of the province.

This study has several limitations that should be taken into consideration. First, a number of general dentists and pediatric dental specialists provide treatment at the RUH, and, despite a standard philosophy for pediatric dental care, a degree of variability in treatment planning and services provided must be presumed. This study also may not have captured the full extent of a child's previous history of GA, if they had been treated in private facilities. With this retrospective study design, we were unable to make any inferences about the cause of ECC for patients in the sample or the need for treatment under GA. Finally, as with any retrospective chart review, we were limited to the data available in patients' medical records, and, thus, additional confounding risk factors may not have been captured. Nonetheless, given the large sample size and the limited availability of published data, this study offers valuable insight into the use of GA for dental treatment in Saskatchewan that will stimulate further research in the area.

Conclusion

Our findings confirm previous research that children who require dental treatment under GA have a high burden of disease and excessive treatment needs. We also noted significant geographic disparities between children who live in less accessible and remote regions of the province compared with those who live in easily accessible/accessible areas. Targeted prevention strategies to reduce the burden of oral disease for these high-risk children must be considered to reduce the incidence of dental treatment under GA. We further recommend that health care providers and policymakers prioritize addressing geographic disparities that prevent timely access to dental care.

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Funding statement: Funding for this research was provided through the College of Medicine Research Awards (CoMRAD) program at the University of Saskatchewan.

The authors have no declared financial interests.

This article has been peer reviewed.

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