Impact of Instituting General Anesthesia on Oral Sedation Care in a Tertiary Care Pediatric Dental Clinic

David L Moore, MD,* Lili Ding, PhD,† Gang Yang, MS,‡ and Stephen Wilson, DMD, PhD§

*Department of Anesthesiology and Pediatrics, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, †Division of Biostatistics and Epidemiology, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, and Department of Pediatrics, College of Medicine, University of Cincinnati, Cincinnati, Ohio, ‡Division of Biostatistics and Epidemiology, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, and §Department of Dentistry, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio

Tertiary pediatric medical centers disproportionately care for low-income, underserved children with significant dental needs. Long wait times for hospital operating room treatment increase tooth loss rather than restoration. Oral sedation has commonly been provided to avoid the long waits for operating room treatment. However, this can be challenging with young, anxious patients. High failure rates and repeat visits for oral sedation have resulted in continued waiting for definitive dental services in the operating room. The Division of Dentistry requested the Department of Anesthesiology to create a general anesthesia program in the dental clinic to increase the use of anesthesia services but align the cost of the anesthetic with the revenue stream. Our aim was to objectively measure the performance of a dental clinic anesthesia service by comparing the percentage of case completions, percentage of complete radiographs, and number of serious adverse events to clinic-based oral sedations. We were also interested in total number of cases completed. We retrospectively studied data regarding an in-office general anesthesia (IOGA) program for dentistry and compared it to oral sedations before and after instituting the IOGA program. Patients received either a general endotracheal anesthetic or nonintubated total intravenous general anesthesia. Successful case completion increased from 88.6% (oral sedation) to 99.5% (IOGA). One hundred percent of IOGA cases had complete radiographs, as opposed to 63.4% for oral sedation. This was an increase from 53.5% from the previous 2 years with oral sedation. Serious adverse event rate was 0% (0/508) for oral sedation and 0.2% (1/418) for IOGA. Comparing 2 years before and after IOGA revealed a decrease in oral sedations from 930 to 508, whereas IOGA increased from 0 to 418 cases. Anesthesia services in dental clinic increased complete dental care and complete radiographs, reduced failed sedations, and were performed safely.

Key Words: Office-based general anesthesia; Intravenous anesthesia; Dental care; Child; General anesthesia.

According to the American Academy of Pediatric Dentistry, patients who need extensive treatment and those with anxiety, uncooperative behavior, cognitive delays, disabilities, or medical conditions may require sedation or general anesthesia (GA) to receive comprehensive dental care.¹ Although sedation allows many patients to receive treatment, some children will require GA in order to receive comprehensive dental care.¹

Dental treatment with GA can be completed in a single visit, whereas moderate sedation or local anesthesia often requires 3 or more visits.² Many children

who are young or anxious do not cooperate for routine dental procedures unless they receive sedation. In the dental clinic, radiographs are not always performed during sedation because there is limited time to complete treatment in orally sedated patients. This can result in treatment of only clinically detected carious lesions, leading to less than optimal care. Therefore, primarily because of behavioral and maximum allowable local anesthesia considerations, repeat oral sedations are needed for complete treatment.

However, dental care with GA is expensive and reimbursement for these procedures is usually poor. Provision of these services in an operating room (OR) setting is often cost prohibitive, has long waiting times, and both anesthesia and facility fees are often not covered or inadequately covered by insurance.³ Hospitals are often reluctant to provide OR time for long, inadequately reimbursed dental cases.⁴ Providing anesthesia services in

Received July 2, 2018; accepted for publication December 19, 2018.

Address correspondence to Dr David L. Moore, Associate Professor of Clinical Anesthesia and Pediatrics, Cincinnati Children's Hospital Medical Center, 3333 Burnet Avenue, MLC 2001, Cincinnati, OH 45229; david.moore@cchmc.org.

Anesth Prog 66:183–191 2019 | DOI 10.2344/anpr-66-02-02
© 2019 by the American Dental Society of Anesthesiology

Dental Clinic Outpatient Anesthesia Key Driver Diagram (KDD)

Project Leader(s): David L Moore, MD; Stephen Wilson, DMD, PhD

Revision Date: 02/28/2016 (v4)

Figure 1. Key driver diagram—dental in-office general anesthesia. Steps needed to initiate the process. Once these steps were in place, volume of cases was able to increase to 3/d, 5 d/wk.

a dental clinic setting can help give complete care to a portion of this group waiting for the OR. Performing GA in an office or clinic setting is time and cost effective, eliminates OR charges, and is associated with cost savings of approximately \$5000 per patient.^{3,5}

At Cincinnati Children's Hospital Medical Center, in-office GA (IOGA) for procedures in the pediatric dental clinic patient began in 2012 with conversations between dentistry and anesthesiology, defining the issues and potential solutions. With OR capacity near maximum, and a lack of timely access for patients needing GA for dental care, there were a growing number of patients waiting for care via the OR. This was compounded by relative ineffectiveness of oral sedation in the dental clinic related to failure rate (14.8%), capacity limitations, and medical complexity. The impetus for performing the cases in the clinic borrows from the concept of the "medical home," in which patients go to the clinic while anesthesia and consultation services come to them.

Although there are always concerns about performing GA in remote locations of a hospital or in an off-site setting, from the medical home concept of accessibility and patient centeredness, the clinic provided the best patient-centered alternative to the OR.⁶

Our strategy involved multiple changes to scheduling, personnel, processes, and equipment as described in the key driver diagram (Figure 1). Once anesthesia agreed to offer services in the clinic, we first had to address important logistical issues. These included the room size, the dental chair, and the remote location of the clinic in the hospital. Clinical engineering outfitted the space to be Occupational Safety and Health Administration compliant. Only 3–4 adults can fit and function in this room, along with the patient. We adapted by placing an anesthesia cart just outside of the operatory, within 2.4 m (8 feet) of the anesthesiologist. The code cart also had to remain in the hall, 9.1 m (30 feet) from the patient. (By comparison, our 30 ORs have 5 code carts, some

more than that distance away.) The malignant hyperthermia kit was stored 3 m (10 feet) from the patient. Physically, the dentistry chair has not been a difficult hurdle. It converts easily to a recumbent position. Children are not too fearful of it, so it helps with our typically anxious population, but it does occupy a large amount of space in the room. There are some adaptations to accommodate differences in patient size.

We conducted a retrospective analysis to compare access to anesthesia services, efficacy of anesthesia services, and safety of the technique to the performance of oral sedation. We feel that IOGA, provided by Cincinnati Children's Hospital Medical Center pediatric anesthesiologists in the Cincinnati Children's Hospital Medical Center dental clinic, enables children to have dental care using anesthetic methods that are timely, effective, and safe. Going forward, increased use of IOGA in our dental clinic would provide greater access to safe and effective comprehensive dental care with improved efficiency and lower costs.

METHODS

This retrospective analysis was approved by the Institutional Review Board of Cincinnati Children's Hospital Medical Center (date of approval: January 26, 2015; ID#2015-0624). Our study population consisted of all patients receiving IOGA ($n = 418$) or oral sedation ($n = 508$) in the dental clinic between June 7, 2012, and June 6, 2014. These patients were compared to those patients receiving oral sedation in the 2 years preceding this study (pre-IOGA), between June 7, 2010, and June 6, 2012 ($n = 930$).

Inclusion criteria for dentistry with IOGA consisted of American Society of Anesthesiologists (ASA) 1 or stable ASA 2 patients scheduled for 1 hour of dental work. Patients were excluded from IOGA for obesity (body mass index >35), age less than 20 months, active illness (eg, URI/emesis), unstable ASA 2 or above, or developmental delay. The criteria for bypassing oral sedation in favor of IOGA included one or more of the following: (a) scope of work requiring more than one oral sedation, (b) local anesthetic dose limitations, (c) parental choice/consent, (d) poor child temperament, (e) anticipated airway obstruction issues, (f) relative retrognathia/tongue position, and (g) history of failed oral sedations.

Oral Sedation and GA Protocols

Oral sedation utilized combinations of 1 to 3 of the following agents: chloral hydrate, meperidine, hy-

droxyzine, midazolam, and diazepam. Personnel performing oral sedations were all residents or attendings in an advanced pediatric dental training program (DMD/DDS) who had completed basic life support and pediatric advanced life support training and a 4-week rotation in pediatric anesthesia in the OR.

IOGA begins with an inhalational induction with parental presence using sevoflurane up to 8% by a pediatric anesthesiologist, typically in the dental chair. Standard monitors are placed shortly after induction, as many of these patients are fearful of them. A registered nurse inserts an intravenous catheter, and the anesthetic is changed to total intravenous anesthesia (TIVA), which consists of a propofol infusion and fentanyl boluses. The native airway is supplemented by nasal cannula oxygen and end-tidal carbon dioxide monitoring. Rubber dams are used to isolate the teeth and to protect the airway from fluids and particulate matter during nasal cannula cases. After several months, it was determined that if the case was planned for longer than 1 hour, more than 2 quadrants of restorative care, or more than 2 extractions, then the patient could be electively intubated. GA maintenance is at the discretion of the anesthesiologist, who may utilize a TIVA technique or a balanced technique with sevoflurane. Also, if airway issues (coughing, major obstruction, oxygen saturation consistently $<90\%$) occurred before, during, or shortly after induction, then the patient could also be electively intubated. Choice of airway, anesthesia drugs, and use of paralytics is at the discretion of the anesthesiologist. Following emergence, the patient passes through both phase 1 and phase 2 recovery in the dental chair and is discharged after recovery is complete (Figure 2).

Outcome Measures

The records of qualifying patients were examined according to demographics, including age, gender, race, and insurance status (private payer vs Medicaid). We wanted to know if IOGA would help more patients complete the entire amount of planned dentistry. Therefore, we were most interested in percentage of completed cases (defined by dentistry as all work completed) as our primary outcome. Secondary outcome measures included the percentage of complete dental radiographic examinations, serious adverse events, procedure time, and repeat patients. We were also interested in the number of total cases using GA versus oral sedation.

Figure 2. Process map—dental in-office general anesthesia. Detailed process map of patient flow from intake to discharge.

In our institution, we routinely monitor the incidence of anesthesia-related serious adverse events, defined as an “untoward occurrence during anesthesia care or within 24 hours of the end of anesthesia care that results in life threatening injury, requiring unplanned admission or prolongation of hospitalization, resulting in disability, incapacity or death.”⁷ In addition, measures of anesthesia interventions (eg, intubation rate, succinylcholine use) and complications (eg, recorded obstruction, hospital admission) can highlight potential problems, some of which may be unique to dental clinic anesthetics.

Statistical Analysis

We used descriptive statistics (mean and standard deviation for continuous variables, and frequency and percentage for categorical variables) to describe the population and the outcome measures.

We compared oral sedation conducted in the 2 years prior to the start of IOGA to IOGA and oral sedation over the same period of time to analyze differences between the rates of procedure completion, complete radiographic examinations, and serious adverse events. All analyses were carried out in SAS 9.4 (SAS Institute, Cary, NC).

RESULTS

Characteristics of the Study Population

The pre-IOGA oral sedation population consisted of 930 ASA 1 or stable ASA 2 patients, scheduled for 1 hour of dental work. The mean age was 4.6 ± 1.6 years (range, 21 months–13 years). Gender distribution was 471 males (50.6%) and 459 females (49.4%). Racial distribution was 50.9% Caucasian, 26.8% African American, and 14.6% Hispanic. Of the patients, 19.1% had private insurance, 75.8% Medicaid, and 5.1% self-pay.

The IOGA study population consisted of 418 ASA 1 or stable ASA 2 patients, scheduled for 1 hour of dental work. The mean age was 4.5 ± 1.9 years (range, 21 months–13 years). Gender distribution was 221 males (53%) and 197 females (47%). Racial distribution was 53.4% Caucasian, 26.8% African American, and 13.5% Hispanic. Of the patients, 36.2% had private insurance, 59.9% Medicaid, and 3.9% self-pay.

The post-IOGA oral sedation population consisted of 508 ASA 1 or stable ASA 2 patients, scheduled for 1 hour of dental work. The mean age was 4.6 ± 1.7 years (range, 21 months–15.5 years). Gender distribution was 254 males (50%) and 254 females (50%). Racial distribution was 41.9% Caucasian, 30.7% African American, and 18.5% Hispanic. Of the patients, 15.5% had private insurance, 77.6% Medicaid, and 6.9% self-pay (Table 1).

Table 1. Population Characteristics*

	<i>Dental Clinic Population Characteristics</i>							
	<i>IOGA</i>				<i>Oral Sedation</i>			
	<i>Year 1</i>	<i>Year 2</i>	<i>Total</i>	<i>2-y %</i>	<i>2 y Pre-IOGA</i>	<i>%</i>	<i>2 y Post-IOGA</i>	<i>%</i>
No. of patients	94	324	418		930		508	
Sex, No.								
Male	61	160	221	52.9	471	50.6	254	50
Female	33	164	197	47.1	459	49.4	254	50
Total	94	324	418		930		508	
Age, y								
<2	0	3	3	0.7	2	0.1	1	0.2
2–5	67	235	302	72.2	774	82.3	420	66.1
6–8	25	76	101	24.2	135	15.5	74	28.7
>8	2	10	12	2.9	19	2	13	4.9
Total	94	324	418		930		508	
Race/ethnicity								
White	65	160	225	53.4	473	50.9	213	41.9
African American	16	95	111	26.8	249	26.8	156	30.7
Hispanic	8	48	56	13.5	136	14.6	94	18.5
Other	5	21	26	6.3	72	7.7	45	8.9
Total	94	324	418		930		508	
Insurance status								
Private insurance	91	60	151	36.2	178	19.1	79	15.5
Medicaid	1	250	251	59.9	705	75.8	394	77.6
Self Pay	2	14	16	3.9	47	5.1	35	6.9
Total	94	324	418		930		508	
IOGA ages	<i>No. of Patients</i>	<i>Age, y</i>	<i>Sum</i>					
21 mo	1	0.88	0.9					
22 mo	2	0.92	1.8					
2 y	59	2	118.0					
3 y	84	3	252.0					
4 y	81	4	324.0					
5 y	78	5	390.0					
6 y	57	6	342.0					
7 y	27	7	189.0					
8 y	17	8	136.0					
9 y	5	9	45.0					
10 y	3	10	30.0					
11 y	1	11	11.0					
12 y	2	12	24.0					
13 y	1	13	13.0					
Total	418		1876.7					
Mean age, y			4.49			4.59		4.55
Age range						21 mo–13 y		21 mo–15.5 y

* Notable because two thirds of our patients were 2–5 years of age, but they had about three-fourths of the obstructions and more than 90% of the emergent succinylcholine usage. IOGA indicates in-office general anesthesia.

Percentage of Procedure Completions

The percentage of completed cases has minimally fallen for oral sedation, from 88.6% pre-IOGA to 85.2% post-IOGA. With IOGA, 99.5% of cases are completed (Figure 3). Of the 2 IOGA cases not completed, 1 was cancelled because of a difficult intubation, later evaluated by otolaryngology and determined to be a previously unknown subglottic cyst. The second case was a nearly completed case that had a laryngospasm

near the end of the case, and the dentist felt the remaining work was not worth escalating care.

Percentage of Complete Radiographs Taken

In the dental clinic, radiographs were performed in only 63.4% of the post-IOGA sedation group, which increased compared to the pre-IOGA group (53.5%). For IOGA, 100% of patients had complete radiographic examinations.

Figure 3. In-office general anesthesia (IOGA) completion rates. Figure demonstrating case and radiograph completion rates for oral sedation against IOGA, both before and since the start of IOGA.

Serious Adverse Events

No serious adverse events were reported for the oral sedation patients. Serious adverse events for IOGA cases were 0.2% (1 case out of 418).⁸ Our initial elective intubation rate was 11.2%, and conversion rates for nasal cannula cases to intubated cases was 8.4%.⁹ Use of succinylcholine emergently for laryngospasm was 2.9%. Usage of succinylcholine does not by itself indicate a serious adverse event, but emergent use does indicate a condition that may lead to one. Recorded obstruction occurred in 18%. Significant aspiration (requiring prolonged oxygen support postoperatively and/or intubation) was not observed. Admission to the hospital for complications was 0.2%. We had only 1

event that could be classified as a serious adverse event, and it was a case in which a laryngospasm occurred, and supplemental oxygen was needed for longer than expected following the procedure. The patient was admitted for observation, but subsequently left without sequela.

Of the 418 patients in the dental clinic for IOGA, 302 (72.2%) were 2–5 years of age (Table 1). This group was responsible for 73.9% of the recorded obstructions in nonintubated patients. Also, 91.7% of our patients with obstruction requiring emergent usage of succinylcholine were between the ages of 2 and 5 years (11 of 12 patients). The 2–5-year-olds also contained the 2 cases where the full procedure was not completed and the lone admission.

Table 2. Comprehensive Outcomes*

	<i>Pre-IOGA</i>	<i>Post-IOGA</i>
Access		
Total dental cases—operating room	3307	3758
Total oral sedation cases—dental clinic	930	508
Total IOGA cases—dental clinic	N/A	418
No-shows—oral sedation	12.3%	10.1%
No-shows—IOGA	N/A	2%
Success		
Repeat patients—oral sedation, %	11.1	5.9
Repeat patients—IOGA, %	N/A	0.9
Failed oral sedation cases, %	11.4	14.8
Failed IOGA cases, %	N/A	0.5
Complete x-rays—oral sedation, %	53.5	63.4
Complete x-rays—IOGA, %	N/A	100
Procedure time—oral sedation, min	67.9	68.1
Procedure time—IOGA, min	N/A	84.9
Safety		
Serious adverse events—oral sedation, %	0	0
Serious adverse events—IOGA, %	N/A	0.2
Aborted procedures—IOGA, %	N/A	0.5
Elective intubation—IOGA, %	N/A	11.2
Converted to intubation—IOGA, %	N/A	8.4
Hospital admission—IOGA, %	N/A	0.2
Emergent succinylcholine usage—IOGA, %	N/A	2.9

* IOGA indicates in-office general anesthesia; N/A, not applicable. Outcomes for IOGA in the domains of access, success, and safety. Oral sedation outcomes presented to give reference for progress of IOGA.

Procedure Time

Prior to the implementation of IOGA, oral sedation procedure time included (a) drug onset latency (time for drug to work) and (b) duration of treatment (working time). This procedure time averaged 67.9 minutes. Post-IOGA, procedure time averaged 68.1 minutes. The sedation recovery time was typically between 15 and 30 minutes, depending on sedation regimen. For IOGA, procedure time (anesthesia time including phase 1 recovery) approximated 84.9 minutes and phase 2 recovery lasted about 15 minutes. As there is only 1 anesthesiologist for this service per day, there is typically 30 minutes for room turnover and readying the next patient.

Repeat Time

Oral sedation pre-IOGA had 11.1% repeat patients, and post-IOGA, repeat oral sedation patients decreased to 5.9%. Because sedation failures and short working times frequently do not allow dentists to complete all planned care, decisions were made about patient disposition for the next visit. Some were scheduled for the OR and

some for another oral sedation visit. Repeat oral sedation patients decrease access, so minimizing repeat patients is desirable. Many sedation failures, however, are funneled into the IOGA group. Repeat patients still occur with IOGA, but far fewer (0.9% repeat), and not because of failure to complete planned care.

Number of Total Cases Using GA Versus Oral Sedation

From the 2 years before IOGA to the 2 years after, oral sedation cases decreased from 930 to 508, whereas IOGA cases increased from 0 to 418 (for comparison, OR cases slightly increased, from 3307 pre-IOGA to 3758 post-IOGA) (Table 2).

DISCUSSION

The Ohio Department of Health has identified that dental care is the number 1 unmet health care need for Ohio children. Children who are socially and economically disadvantaged are most likely to have an unmet need for dental care.¹⁰ Only 12% of Ohio Medicaid consumers under age 3, and 42% of those aged 3–18, had a dental visit in 2008.¹⁰ In 2010, 23% of children in third grade and 28% of 3–5-year-old children in the Head Start program have untreated cavities.¹⁰ Although significant progress has been made with a 30% decline in children with unmet dental care needs over the last 5 years, more needs to be done to address these dental health disparities.¹¹ Tertiary care centers, such as Cincinnati Children's Hospital Medical Center, see a disproportionate number of these socially and economically disadvantaged patients, most of whom are Medicaid patients.

We began the IOGA program by placing peripheral intravenous catheters in awake patients, then proceeding with TIVA. Many of the patients assigned to IOGA have anxiety to intravenous catheter insertion. After 5½ months of dental cases by TIVA, we decided to add an anesthesia machine in the clinic for inhalational induction of anesthesia. The biggest issue was the space occupied by the machine. The sink in the room was removed to increase available space.

After initiating IOGA cases in the dental clinic, the success and demand for IOGA increased. Anesthesia and dentistry agreed to increase block time from 1 case per day, 3 days a week, to 3 cases per day, 5 days a week. Limitations were set on length of time and type of work to be performed. If the case was planned for greater than 1 hour, more than 2 quadrants of restorative care, or more than 2 extractions, then the patient could be

electively intubated. Also, if airway issues (coughing, major obstruction, oxygen saturation consistently <90%) occurred before, during, or shortly after induction, then the patient could also be electively intubated.

Once block time was at 3 cases per day, the effect of no-show patients hindered utilization of dental services. No-shows are patients who are scheduled but do not call to cancel or reschedule and fail to show up for the procedure. To decrease no-shows, the anesthesia nurses began to call the families 2–3 days prior to their procedures to remind them of the appointment and screen for acute health conditions.

The safety of performing anesthetics in remote locations of the hospital was a concern for some anesthesiologists. The morbidity and mortality for office-based procedures using GA is unknown for pediatric patients.¹² Although the mortality associated with anesthesia has decreased over time,⁸ concerns remained about the time for help to arrive if there was a safety event. We tested the anesthesia emergency response system for the dental clinic through in situ simulations, noting the length of time for a dedicated code team to arrive, which averaged 4 minutes. We continue to conduct in situ simulation to test the response system. All anesthesia personnel, anesthesia nurses, dental residents, and attendings must maintain basic life support and pediatric advanced life support certification. The literature suggests a prevalence of untoward respiratory events causing morbidity and mortality that might be preventable with better monitoring of inadequate ventilation.¹³ In the dental clinic, the anesthesia equipment and monitors are the same as in the OR.

The global aim of this anesthesia/dentistry partnership is to ensure more children receive full access to safe and complete care. Improving access to dental service results in more impactful, preventive care. We measured this by counting total number of cases and decrease in no-shows.

We also increased complete radiographic examinations to ensure comprehensive care was rendered, reducing the need for multiple visits typically seen in oral sedation clinic. Decreasing repeat visits and completing all care in one visit clears appointment space reserved for repeat sedation patients, thus allowing for more access.

We believe the best plan to improve access to dental care involved implementing IOGA. As IOGA has increased (0 to 418), oral sedations have decreased by 45% (930 to 508). Using the scheduling protocol, the dentists requested IOGA for the difficult-to-sedate category of patients rather than attempt to sedate and then fail to deliver dental care. Thus, there was a shift from sedation to IOGA that led to improved dental care delivery by completion of comprehensive dental care in a single visit rather than multiple clinic visits or OR time.

Dentistry was noted to have a no-show rate of 12.3% with oral sedation patients. As IOGA drew from the same population, we had anesthesia nursing screen and remind IOGA families via phone calls, resulting in decreasing the no-show rate to 2%. Success of this process enabled increase in utilization of dental anesthesia services from 1 case to 3 cases daily. This results in IOGA for up to a maximum of 750 cases per year.

The percentage of completed cases has also improved with IOGA, even for oral sedation. Pre-IOGA, 11.1% of oral sedation patients were repeat patients, which subsequently fell to 5.9% post-IOGA. There were only 0.9% repeat patients with IOGA, but not because of lack of completed treatment. The percentage of successful case completion was 99.5% for IOGA, which was higher than the 88.6% (pre-IOGA) and 85.2% (post-IOGA) for oral sedation. Thus, more children were able to receive complete dental care per year at our institution.

Success also included taking cases that would previously have gone to the OR but are now being seen with IOGA. Efficiency and utilization of resources are important in maximizing access and decreasing costs. Oral sedation cases had an average charge of \$214/case. Before IOGA, failure to sedate resulted in patients going to the OR, where the charge for minor dental procedures was \$600/15 min and for major dental procedures was \$900/15 min, not including other charges for preoperative and postoperative nursing and anesthesia. For IOGA, the average anesthesia charge was \$1243/case, far less than the total OR charge per case. Interestingly, the number of OR dental cases actually increased after beginning IOGA. It is not clear why this occurred, but OR dental cases are brought by both the pediatric dental clinic dentists and private community-based pediatric dentists. It may have been that community-based dentists were able to increase their OR utilization, thus slightly increasing OR dental cases, but we did not evaluate the data in this regard.

Despite concerns in the hospital community over safety of dental anesthesia, our experience has shown our process appears to be safe. However, because of the relatively small number of patients, we will still require further study to determine safety. In 2 years, there were only 2 aborted cases because of safety concerns. One case received TIVA with a nasal cannula where, after most of dental care was completed, laryngospasm occurred. When the choice was presented to the dentist that intubation would be needed to continue this case, the dentist decided that the dental care was sufficient and treatment stopped. The second case had a subglottic cyst that was unknown to the clinician preanesthesia, resulting in a difficult intubation. The unexpected difficult airway was judged an unacceptable risk for the outpatient clinic. The patient was allowed to emerge

from anesthesia without the dental care performed and referred to the otolaryngology clinic. Our rate of complications is low compared to the literature.¹⁴ As was our experience, children 2–5 years of age (72.2% of IOGA cases) typically have a higher rate of complications from sedation/anesthesia.¹⁴ This group had 73.9% of the recorded obstructions and 91.7% of the patients that required emergent succinylcholine. (Table 2) Historically, this group is particularly difficult to safely anesthetize.^{13,14}

Next Steps

There are plans to double the IOGA capacity (starting March 2019), which could allow for up to 1500 IOGA patients, and improve efficiency by having a separate area for recovery. Successful referral of known patients to the IOGA service, whether they are failed sedations or poor candidates for oral sedation, allows more patients to get access to complete dental care earlier than before. It has begun to reduce overall hospital costs by decreasing the burden on the OR. OR time is costly, and what time is available is often dedicated to our large special-needs patient population.

Conclusion

Based on the partnering of the Department of Anesthesia with the Division of Dentistry, we conclude that access to care for underserved children in the community will increase with IOGA in dental clinic. There is an improvement in time utilization and completed procedures. Within the limited scope of this study, safety risks of streamlining dental/anesthesia services do not appear prohibitive.

In our experience, nearly 100% of dental patients can be fully treated following clinical examination and radiographs using IOGA. IOGA therefore allows complete dental care to be achieved. Failed oral sedations delay treatment and waste time for all involved. Furthermore, the time and cost of providing anesthesia in office settings is less than the traditional hospital model.³ Also noteworthy, GA was administered to nonintubated pediatric patients for dental procedures, and appears no less safe than oral sedation.

ACKNOWLEDGMENT

Maria Ashton (Department of Anesthesiology and Pain Medicine, Cincinnati Children's Hospital Medical Cen-

ter, Cincinnati, Ohio) assisted with formatting and editing of this paper.

REFERENCES

1. Dentistry AAoP. Policy on the use of deep sedation and general anesthesia in the pediatric dental office. 2012. Available at: http://www.aapd.org/media/Policies_Guidelines/P_Sedation1.pdf. Accessed Month 00, 0000.
2. Lee JY, Vann WF Jr, Roberts MW. A cost analysis of treating pediatric dental patients using general anesthesia versus conscious sedation. *Anesth Prog*. 2001;48:82–88.
3. Rashewsky S, Parameswaran A, Sloane C, Ferguson F, Epstein R. Time and cost analysis: pediatric dental rehabilitation with general anesthesia in the office and the hospital settings. *Anesth Prog*. 2012;59:147–153.
4. Lewis CW, Nowak AJ. Stretching the safety net too far waiting times for dental treatment. *Pediatr Dent*. 2002;24:6–10.
5. Lalwani K, Kitchin J, Lax P. Office-based dental rehabilitation in children with special healthcare needs using a pediatric sedation service model. *J Oral Maxillofac Surg*. 2007;65:427–433.
6. American Academy of Pediatrics Ad Hoc Task Force on Definition of the Medical Home. The medical home. *Pediatrics*. 1992;90:774.
7. Kurth CD, Tyler D, Heitmiller E, Tosone SR, Martin L, Deshpande JK. National pediatric anesthesia safety quality improvement program in the United States. *Anesth Analg*. 2014;119:112–121.
8. D'Eramo EM. Mortality and morbidity with outpatient anesthesia: the Massachusetts experience. *J Oral Maxillofac Surg*. 1999;57:531–536.
9. Cote CJ, Notterman DA, Karl HW, Weinberg JA, McCloskey C. Adverse sedation events in pediatrics: a critical incident analysis of contributing factors. *Pediatrics*. 2000;105:805–814.
10. Health ODo. Oral health and access to dental care for Ohioans, 2010. 2010. Available at: [https://www.odh.ohio.gov/~media/ODH/ASSETS/Files/ohs/oral health/accessreportexecsumm2010.ashx](https://www.odh.ohio.gov/~media/ODH/ASSETS/Files/ohs/oral%20health/accessreportexecsumm2010.ashx). Accessed August 30, 2017.
11. Health ODo. Ohio's 2016 State Health Assessment (SHA) and State Health Improvement Plan (SHIP). 2016. Available at: <http://www.healthpolicyohio.org/wp-content/uploads/2016/05/SHA-Basic-Info-Updated-05-04-16.pdf>. Accessed August 30, 2017.
12. VanderWalt JH. Searching for the Holy Grail: measuring risk in paediatric anaesthesia. *Paediatr Anaesth*. 2001;11:5.
13. Morray JP, Geiduschek JM, Caplan RA, Posner KL, Gild WM, Cheney FW. A comparison of pediatric and adult anesthesia closed malpractice claims. *Anesthesiology*. 1993;78:461–467.
14. Lee HH, Milgrom P, Starks H, Burke W. Trends in death associated with pediatric dental sedation and general anesthesia. *Paediatr Anaesth*. 2013;23:741–746.