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Trends in Death Associated with Pediatric Dental Sedation and General Anesthesia

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Abstract

Background—Inadequate access to oral health care places children at risk for caries. Disease severity and inability to cooperate often result in treatment with general anesthesia (GA). Sedation is increasingly popular and viewed as lower risk than GA in community settings. Currently, few data are available to quantify pediatric morbidity and mortality related to dental anesthesia.

Objective—Summarize dental anesthesia-related pediatric deaths described in media reports.

Methods—Review of media reports in the Lexis-Nexis Academic database and a private foundation website.

Settings—Dental offices, ambulatory surgery centers, and hospitals.

Patients—U.S.-based children (< 21 y.o.) who died subsequent to receiving anesthesia for a dental procedure between 1980–2011.

Results—Most deaths occurred among 2–5 year-olds (n=21/44); in an office setting (n=21/44), and with a general/pediatric dentist (n=25/44) as the anesthesia provider. In this latter group, 17/25 deaths were linked with a sedation anesthetic.

Conclusions—This series of media reports likely represent only a fraction of the overall morbidity and mortality related to dental anesthesia. These data may indicate an association between mortality and pediatric dental procedures under sedation, particularly in office settings. However, these relationships are difficult to test in the absence of a database that could provide an estimate of incidence and prevalence of morbidity and mortality. With growing numbers of children receiving anesthesia for dental procedures from providers with variable training, it is imperative to be able to track anesthesia-related adverse outcomes. Creating a national database of adverse outcomes will enable future research to advance patient safety and quality.

Keywords

Anesthesia; Patient safety; Child; Conscious Sedation/adverse effects; Dental Anxiety/drug therapy; Treatment Outcome

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Background

Despite an increase in the number of pediatric dental sedations administered over the past two decades, mortality related to pediatric dental anesthesia has not been quantified in the U.S.(1, 2) The literature on dental anesthesia complications has focused on specific anesthesia providers in adult age groups,(1, 3, 4) procedural locations,(5) or the general dental population.(6) Few publications have characterized the risk factors associated with the use of sedation and general anesthesia in pediatric dentistry.(5, 7) We sought to understand pediatric anesthesia-related mortality risks in light of the evidence that increasing numbers of children were receiving anesthesia for dental procedures.(1) Because systematic data collection on outcomes of pediatric dentistry was lacking, we examined media reports of pediatric deaths that occurred in the context of dental sedation or anesthesia in order to better understand the circumstances under which such deaths occurred.

Methods

Source of Data

Two sources of media reports were used: the Lexis-Nexis Academic search engine and the Raven Maria Blanco Foundation (RMBF, www.rmbfinc.org) website. The RMBF supports a website that lists children who have died in association with a dental procedure. Because both of these sources are publicly available data, this study was exempt from review by the University of Washington's Institutional Review Board.

A Lexis-Nexis search was initially conducted to identify news reports of deaths associated with dental procedures occurring between January 1980 and May 2011. Search terms included "death dental procedure" for "all news" source types. The search strategy yielded 997 reports. The reports were screened for the following eligibility criteria: U.S.-based news sources, U.S.-based cases, and dental deaths related to anesthesia of patients up to age 21. Sources were excluded if they only included obituaries or reports of clinical and basic science articles. Seventy-three reports describing the deaths of 33 patients met the inclusion criteria. Three patients were excluded: the first because the death was related to a methadone overdose, which was not prescribed or used by the dental provider; the second because the patient sustained a hypoxic brain injury; and the third patient did not have anesthesia for her procedure.

The RMBF website identified 36 pediatric patients who died in association with a dental procedure. Correspondence with an administrator of this list led to web links that verified some of these deaths. Eighteen patients not identified by the Lexis-Nexis search were identified through the RMBF website. Four of these cases from the RMBF website were excluded due to absence of confirmatory news stories. Media reports of one child provided by the RMBF administrator (DL) indicated the possibility of a "natural cause" of death. However, this patient was included because the possibility of seizure activity leading to hospital admission, then death, indicated a possible systemic toxic reaction to a local anesthetic overdose. Forty-four patient reports were included in this study.

Measures

The lead author reviewed each report to record the following data: year and age of the child at death, dental procedure, facility type where the procedure was performed (office vs. hospital vs. surgery center), predominant anesthetic administered (local anesthesia, moderate sedation or general anesthesia), anesthesia provider and presence or absence of adverse legal or professional judgments. All reports were reviewed a second time to verify correct coding. Discrepancies in coding were resolved by reading multiple media reports on the individual patient. Dental procedures were categorized as follows: routine/preventive (e.g. cleanings);

filling/crown; extraction; other (other oral surgeries); and not reported. If multiple procedures were reported, the most invasive procedure was identified as the indication for anesthesia.

Provider anesthesia training was classified by type (e.g. anesthesiologist vs. oral surgeon) with the exception that general and pediatric dentists were categorized together. This was because news reports often identified providers as a “children’s dentist,” and it was unclear whether this referred to a trained pediatric dentist or a general dentist whose practice catered to children. The categorical assignment of anesthesiologist included dental and medical anesthesiologists due to the lack of reported specificity.

Some reports detailed official investigations regarding whether the case involved malpractice or deviation from the standard of care. A state board of dentistry or a professional regulating body usually provided these judgments. Occasionally a report included a ruling from a legal trial. All adverse legal or professional judgments were recorded.

Analysis

Descriptive statistics were used to identify factors associated with pediatric dental sedation-related deaths.

Results

Patient characteristics

Table 1 reports the characteristics of the 44 patients and the circumstances of their deaths. Half of the patients were female and approximately half were 5 y.o. Three had pre-existing medical conditions, of which two were known pre-operatively: a 10 y.o. with Treacher-Collins syndrome and a history of a tracheostomy and a 2 y.o. with congenital pulmonary stenosis. The third child, a 13-month-old, died on induction of general anesthesia with a volatile anesthetic. The autopsy revealed an undiagnosed heart defect.

The majority of deaths occurred amongst the 2–5 y.o. (n=21, 46.7%) and 13–21 y.o. (n=13, 29.6%) age groups. Twenty deaths (45.5%) occurred in children who were sedated, with the 2–5 y.o. comprising the largest group of children (n=10, 50% of sedation deaths). However, it was not possible to identify the type of anesthesia in nearly 23% of the cases.

Deaths by anesthesia depth, provider, and setting

The majority of deaths occurred in dental office settings (n=31, 70.5%). The office setting was the most common facility type for general dentists (n=21, 84%) and oral surgeons (n=14, 88%). Figure 1 shows the number of children seen by provider type. General/pediatric dentists were the provider of record for more than half of the deaths overall (n=25, 56.8%) and for two-thirds of the deaths for the 2–5 year age group (n=14/21). When examined by anesthetic depth and provider (Fig. 2), most deaths involving general/pediatric dentists occurred with moderate sedation.

Adverse legal or professional judgments

Eleven cases were reviewed by an external body to determine whether a deviation from standard practice contributed to the cause of death. Deficient practice patterns alleged in these reports fell within the following categories: medication error, inadequate monitoring, inadequate resuscitation, global practice issues, erroneous medication dosing, and inadequate pre-operative preparation. An adverse ruling was made in nine cases. Most adverse judgments concerned care that occurred in an office (n=8) rather than a hospital/

surgery center (n=1). Alleged errors that occurred pre-operatively included inadequate discussion of anesthetic risks and a lack of medical evaluations. There were several reports of problems with medication dosing, including inappropriate doses of a sedative, a local anesthetic, or a paralytic agent contributing to or directly resulting in cardiac arrest. Monitoring problems included reports of an untrained staff member who did not recognize respiratory failure in the post-anesthesia setting and absence of vital sign monitoring, equipment, or documentation. Concerns in the global practice category included general statements such as “grossly negligent or incompetent care” and “unprofessional conduct”. Alleged inadequacies in resuscitation ranged from failure to recognize cardiac arrest to inadequate or no resuscitation efforts. Some resuscitation efforts were limited due to untrained staff or inadequate equipment.

Conclusions

The use of mass media reports as a source of information and influence in health utilization for the general public and medical professionals has been well described.(8, 9) The conclusions nevertheless are limited by selection bias inherent to news events and the factors associated with the kinds of cases that reach media attention. It is unclear whether these cases are representative of all pediatric dental deaths, but it is likely that they represent only a subset of a larger number of deaths. Additionally, these results are limited by the lack of a reportable total number of cases and deaths. These limitations preclude us from reporting the incidence or prevalence of pediatric dental anesthesia-related mortality. However, given the limitations of available data, the media reports reviewed in this study indicate the need for systematic reporting of adverse events within pediatric dental anesthesia. Deaths associated with clinical care are required to be reported to a state dental board. However, collection and storage of data varies state to state, which has made prior efforts to utilize state boards as a database problematic (7). Standardization of data collection across state dental boards would contribute to efforts to estimate morbidity and mortality and, more importantly, may inform systems-level interventions to prevent them. The objective of this study was to explore the readily available data sources and present data to generate hypotheses.

In this study, over 50% of the deaths occurred in children aged 2–5 years. This correlates with prior findings related to the prevalence of tooth decay in this age group(10). There is evidence that the relative disease burden is increasing for this age group: the Centers for Disease Control and Prevention reported an increase in caries prevalence amongst children ages 2–5 years.(10) This age group may also require more pharmacological anxiolysis compared to older children.

The finding that pediatric deaths occurred more frequently under sedation differs from Krippaehne and Montgomery’s analysis of mortality reports from nine state dental boards. In their study, 56% of deaths occurred following general anesthesia and 44% occurred under sedation.(7) That study included both adults and children and possibly minimizes the risks of pediatric sedation. The findings presented here are consistent with a study by Cote and colleagues of pediatric moderate sedations in which the authors reported a greater distribution of adverse events in outpatient compared to inpatient settings, as well as for children < 6 y.o.(5).

The majority of the pediatric deaths that we studied involving a general/pediatric dentist were associated with moderate sedation (n=17), which may reflect the limits of general dentists’ scope of anesthesia practice and lower intensity of procedures compared to oral surgeons. One might expect a higher incidence of adverse events among general dentists, as a provider category, by virtue of the much larger number of patients they see as compared to other providers. However, patients being sedated by a general dentist would be expected to

be healthier and have a lower anesthesia risk compared to patients treated by oral surgeons or anesthesiologists. In this study, general anesthesia-related deaths were more likely to involve anesthesiologists and oral surgeons. This may reflect that anesthesiologists have a higher intensity case mix or use a greater number of total general anesthetics (vs. moderate sedation) for dental procedures compared with other providers.

Although our data do not permit evaluation of relative risks in different clinical settings, our data are consistent with prior literature suggesting that errors may be more likely in office settings than in surgery centers or hospital settings (5, 7, 11), possibly due to fewer resources, a lack of trained resuscitation providers, or differing anesthesia practices in office settings.(5, 11) Several studies have emphasized the importance of monitoring for preventing adverse outcomes.(5, 7, 11) Inadequate monitoring could reflect problems with staff training and/or inadequate equipment resulting in an inability to recognize and respond appropriately to an adverse event. Furthermore, adequate resuscitation depends upon the availability of equipment and staff who are trained in basic life support techniques. The 2006 AAP/AAPD Sedation Guidelines recommend that providers have advanced pediatric airway skills and that support personnel be capable of providing basic pediatric life support. (5) Our study includes several reports that indicate some deaths may have been related to inadequate resuscitation efforts. It is unclear whether inadequate efforts resulted from practitioners and/or support personnel with inadequate training or skill maintenance or inadequate equipment. Our findings emphasize the need to follow guidelines, which recommend regular training drills for the entire care team. Because these events are so rare, resuscitation certification, as well as regular adverse event training will improve the ability of staff to recognize and respond appropriately to a cardiac arrest.

Only three patients in our series were reported to have pre-existing medical diagnoses that placed them at increased risk for anesthesia-related complications. Of these, one child's heart defect was discovered only on autopsy. Absent this information about her pre-existing health condition, she was appropriately assigned to receive treatment in an ambulatory surgery center with an independent anesthesia provider. In contrast, a 10 y.o. with Treacher-Collins syndrome died after being sedated by a general/pediatric dentist in an office setting. This patient's death highlights the risks of cardiac arrest in an office setting where advanced resuscitation equipment may not always be available. With a known difficult airway, this patient would best be anesthetized in a setting where skilled airway and resuscitation providers are available to prevent or treat anesthesia complications. The clinical decision regarding the appropriate type and depth of anesthesia, facility site, and anesthetic provider is a balance of risks and benefits, and ultimately falls upon the judgment of the provider.

Only limited inferences can be made from this media case series in comparison to the patterns of complications that have been previously described. Domino's analysis of the 1990–2000 Pediatric Perioperative Cardiac Arrest Registry (POCA) revealed that 36% of closed claims reports of pediatric anesthesia were from dental/ENT/maxillofacial procedures. Amongst all reported POCA events, cardiovascular (27%) and respiratory (25%) events were responsible for the majority of intra-operative cardiac arrest.(11) However, equipment (17%) and medication-related (14%) causes also were common.(11) The POCA-analysis reported that an incorrect dose was involved in half of medication-related events. In comparison, our study suggests that the causes of arrest in pediatric dental procedures differ from the POCA findings. This study found that the majority of cardiac arrests appear to be related to an initial respiratory arrest consistent with previously reported complications associated with pediatric moderate sedation in the non-operating room setting. (5) The predominance of respiratory arrests, number of sedations, and age distribution of patients suggests that depth of sedation may be a critical common pathway in these cases. By definition, a patient receiving minimal to moderate sedation should be able to maintain

spontaneous ventilation. However, sedation depth can be difficult to predict and episodes of respiratory obstruction are not uncommon. When combined with other elements (e.g. inadequate monitoring and rescue equipment, untrained personnel.), the risk of respiratory obstruction leading to respiratory, then cardiac arrest is increased. Included in our case series are a few reports of cardiac arrest not precipitated by respiratory arrest. These cardiac arrests may presumably be due to local anesthetic overdose or anaphylactic/anaphylactoid reactions.

Deaths are not the only serious complications related to anesthesia. This study did not include children who suffered neurologic injuries, suffered cardiac arrest and were successfully resuscitated, or those who experienced respiratory arrest but not cardiac arrest. Near misses can be as informative as deaths in the quality improvement process, but are even less likely to be reported by the media. Therefore, this report likely under estimates a larger number of troubling cases involving non-fatal, preventable complications.

The deaths described in this series of media reports suggest that some pediatric deaths related to dental anesthesia are preventable, either through aggressive preventive dental care to decrease the number of patients requiring dental surgery, or through improved adherence to standard-of-care guidelines for those who must have general anesthesia for dental procedures. These deaths also reflect the inherent risks of anesthesia, suggesting the need to examine whether the risk-benefit threshold for sedation vs. general anesthesia in pediatric dentistry should be re-examined. However, more comprehensive data are needed to confirm these findings and provide a foundation for policy action. Currently there are no systematic data collection efforts on outcomes from dental practices. Ideally, all anesthesia-related morbidity and mortality should be tracked, with appropriate privacy protections for practitioners and patients, to provide aggregate data for practice improvement. These data could inform efforts to improve compliance with existing moderate sedation practice guidelines.

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Figure 1. Pediatric dental deaths by anesthesia provider and age categories

Values within each anesthesia provider category represent the number of deaths by age categories. The largest number of deaths was associated with anesthesia providers who were classified as either a general or pediatric dentists. Within this provider category, the largest proportion of children was within the 2–5 year old age group.

Figure 2. Pediatric dental deaths by anesthesia provider and facility type

Values within each anesthesia provider category represent the number of deaths by facility type. With the exception of anesthesiologists, the largest number of deaths across all anesthesia provider type occurred in office facilities.

Table 1

Patient Characteristics of Pediatric Dental Deaths (Total N=44)

Characteristics	N	Percent
<i>Age Category</i>		
0–23 mos. [€]	2	4.6%
2–5 yrs. [§]	21	47.7%
6–12 yrs. [¥]	8	18.2%
13–21 yrs.	13	29.6%
<i>Procedure</i>		
Routine/Prevention	1	2.3%
Filling/Crown	14	31.8%
Extraction (caries, wisdom tooth)	18	40.9%
Other (maxillofacial surgery, root canal)	3	6.8%
Not Reported	8	18.2%
<i>Anesthetic Depth</i>		
Local Anesthesia	4	9.1%
Moderate sedation (oral/intravenous)	20	45.5%
General Anesthesia	10	22.7%
Not Reported	10	22.7%
<i>Anesthesia Provider</i>		
General/Pediatric Dentist	25	56.8%
Oral Surgeon	8	18.2%
Anesthesiologist	7	15.9%
Not Reported	4	9.1%
<i>Facility</i>		
Office	31	70.5%
Surgery Center/Hospital	6	13.6%
Not Reported	7	15.9%

The characteristics of media reports of pediatric dental deaths by patient age, dental procedure type, anesthetic depth, specialty of anesthesia provider, and facility. The total number of deaths and proportion within categories are reported. Notations for patients with pre-existing medical conditions are as follows:

[€] 1 patient with a post-mortem diagnosis of congenital heart disease;

[§] 1 patient with pre-operative diagnosis of pulmonary stenosis;

[¥] 1 patient with pre-operative diagnosis of Treacher-Collins