Ethics Rounds: Death After Pediatric Dental Anesthesia: An Avoidable Tragedy?

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Early childhood caries (ECC) is the single most common chronic childhood disease. In the treatment of ECC, children are often given moderate sedation or general anesthesia. An estimated 100 000 to 250 000 pediatric dental sedations are performed annually in the United States. The most common medications are benzodiazepines, opioids, local anesthetics, and nitrous oxide. All are associated with serious adverse events, including hypoxemia, respiratory depression, airway obstruction, and death. There is no mandated reporting of adverse events or deaths, so we don't know how often these occur. In this article, we present a case of a death after dental anesthesia and ask experts to speculate on how to improve the quality and safety of both the prevention and treatment of ECC.

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THE CASE

A 4-year-old boy presented to a dentist's office for treatment of rampant ECC. The provider is a pediatric dentist, and his clinic specializes in treating young children with severe caries. The dentist has a license to provide moderate sedation, and his staff is certified in pediatric advanced life support.

The mother reports that the child complains of pain while eating and occasionally wakes up in the night because of tooth pain. Previous visits to the family's regular dentist are difficult because the child has behavioral issues and is uncooperative with oral examinations. The family's dentist is able to determine that the child has decay affecting his front teeth but is unable to provide treatment because of the child's behavior. The family's dentist does not feel comfortable sedating children and therefore refers the child to a pediatric dentist. Because of the child's clinical symptoms, there is concern for extensive disease affecting the child's molars. The family dentist explains that a pediatric dentist is trained to treat a child's cavities with the aid of anesthesia.

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The pediatric dentist recommends moderate sedation in the office to perform a thorough examination and treat decay. A separate provider, the dental assistant, provides sedation and monitors the child during the procedure. The child is given oral midazolam and inhaled nitrous oxide. He requires an extra dose of midazolam because of his inability to tolerate the procedure.

After the procedure, the dentist leaves the child in the recovery area to speak with the mother about the procedure. The recovery area is staffed by a dental assistant, who clinically monitors children recovering from sedation. When the mother and dentist arrive in recovery, the child is noted to be cyanotic. There is no pulse oximeter, and respiratory efforts are absent. The staff initiates cardiopulmonary resuscitation and calls 911. Paramedics initiate cardiopulmonary resuscitation, but the child is pronounced dead on arrival at the hospital.

As a matter of medical ethics and health policy, how should we respond to such a case? Are there ways to prevent such deaths in the future?

PETER MILGROM, DDS, COLLEEN E HUEBNER, PHD, MPH, AND PHILIP WEINSTEIN, PHD, COMMENT

This unnecessary death has resulted from a failure of the dentist to follow the current standard of pediatric dental care. In 2016, the American Academy of Pediatric Dentistry (AAPD)[1] announced, "Because restorative care to manage ECC often requires the use of sedation and general anesthesia with its associated high costs and possible health risks, and because there is a high recurrence of lesions following the procedures, there now is more emphasis on prevention and arrestment of the disease processes." The AAPD's policy statement goes on to enumerate methods of chronic disease management, active surveillance, and interim therapeutic restorations and states, "Non-surgical interventions should be implemented when possible to postpone or reduce the need for [previously accepted] surgical treatment approaches."

A common rationale for aggressive surgical treatment with sedation or general anesthesia has been the vastly overstated association between tooth decay in primary teeth and subsequent decay in permanent teeth. In fact, this connection is modest, with the relative risk ratios ranging from 1.4 to 2.6.[2,3] One reason the association it not strong is that the shedding of decayed primary teeth eliminates sites for bacterial colonization in the mouth and thus reduces risk of caries in the permanent dentition. The loss of primary teeth with replacement by permanent teeth is a normal developmental process that requires no professional intervention.

In the case presented, it is unlikely that the caregiver who consented to the care was made aware of the 2016 recommendations even as this change has been discussed among dental professionals for some time.[4] Primary teeth damaged by tooth decay can be managed with less invasive, less risky procedures than those offered to this family. Today's options allow children to be comfortable during treatment and resume school and home activities quickly. A highly effective option available to both dentists and primary care practitioners is to treat diseased teeth with 38% silver diamine fluoride.[5] Silver diamine fluoride is a topical drug that is simply painted on the tooth decay itself. The procedure arrests active caries and is quick, painless, and extremely safe. It can be accomplished without radiographs, anesthesia, or drilling.[6] Its use has become nearly universal in US pediatric dentistry residency programs since it became available in 2015. Medicaid and other insurers are increasingly providing coverage for this procedure, which has been recognized with its own dental insurance billing code (D1354). Treatments of the affected teeth should be repeated at 6-month intervals to attain and maintain maximal tooth decay arrest.[7] The action of silver diamine fluoride should not be confused with that of fluoride varnish. Fluoride varnish, currently used by dentists and primary care providers and applied throughout the mouth, is effective in reversing superficial cavities in the tooth enamel but is not effective in remineralizing deeper cavities.[8]

Some dental providers are reluctant to use silver diamine fluoride because the treatment turns arrested tooth decay dark. In contrast, caregivers see the color change as evidence that the treatment has successfully arrested the decay. And given a choice, caregivers choose this atraumatic approach over the alternative of extensive treatment under heavy sedation or general anesthesia.[9] In areas of the mouth where cosmetics are a concern, such as in the upper anterior teeth, the application of silver diamine fluoride can be followed by topical potassium iodide to reduce the color change and then covered with tooth-colored filling material by using an atraumatic technique without local anesthesia. If minimal drilling is needed to prepare the teeth for the tooth-colored filling material, local anesthesia is not required because the teeth are insensitive. Cavitated lesions in primary molars that involve multiple surfaces can be sealed atraumatically by using the Hall Technique.[10] In this approach, preformed crowns are cemented in place with glass ionomer cement without local anesthesia or drilling.[7] This is highly acceptable to parents and children.[11] Both silver diamine fluoride and glass ionomer cement treat the underlying disease by being

antimicrobial and helping prevent lesions in the other teeth.[7]

The care approach that resulted in the death of this young boy is outdated and inequitable. Dental disease occurs disproportionately in children from low-income families and children with special health care needs, yet proportionately few of them receive dental care. The small proportion who do receive care often receive it late, after there has been a lot of damage to the teeth and infection affecting the surrounding tissues. To treat conditions of this severity effectively requires extensive time and expense and consumes an inordinate proportion of available resources.[12]

Treating tooth decay as illustrated in this case presentation, whether in outpatient practices or in hospital settings and influenced by the availability of public and private insurance coverage, is unethical and wasteful. Ethical standards demand that the 2016 AAPD policy guidance is disseminated widely among primary care providers and put into routine practice. Caregivers should be fully informed as to the current standard of care.

HELEN LEE, MD, MPH, COMMENTS

The death of this child is a tragedy. It should also be a sentinel event. Children should never, ever die during sedation for a dental procedure. Such deaths are eminently preventable. Yet, they continue to happen. The key ethical and policy questions raised by this case are how to prevent such tragedies.

According to the Surgeon General, childhood caries is "the single most common chronic childhood disease."[13] Because of age, behavior, and disease severity, children often receive moderate sedation or general anesthesia for dental treatment. Demand for anesthesia for treatment of caries is increasing,[14–16] with an estimated 100 000 to 250 000 pediatric dental sedations performed annually.[17]

The fact that children die as a result of sedation in dental offices indicates that there is a serious safety issue.[18] It is hard to tell just how many such deaths occur. There is no mandatory reporting system. Two imperfect sources of information are media reports and lawsuits.[19] Lawsuits resulting from dental, maxillofacial, and otolaryngology procedures outnumber those that result from orthopedic, cardiothoracic, abdominal, or other surgical procedures. The greatest proportion of severe adverse events was associated with general dentists who provided moderate sedation, although it is not clear if this is due to the fact that most children are treated by general dentists.[20] Because there is no standardized or mandatory reporting mechanism, we have no way to assess how the deaths occur. Still, we can hypothesize several etiologic factors that place a pediatric dental patient at risk for an adverse event, including the following: medications, provider and location, and health system.

The medications and inhaled anesthetic used in pediatric dentistry are common to moderate sedation for medical procedures. The most common are benzodiazepines, opioids, local anesthetics, and nitrous oxide. Adverse events (eg, hypoxemia, respiratory depression, airway obstruction, and death) have been reported with each class of medication.[21–23] No medication seems inherently safer than others.

Location appears to matter. Dental sedation is usually administered outside of the operating room, typically in an office setting. Someone who is not an anesthesiologist is often the provider of anesthetics. The practices of these sedation providers are widely variable in terms of the use of physiologic monitoring.[24] Although guidelines were issued by the American Academy of Pediatrics, the American College of Emergency Physicians, and the American Society of Anesthesiologists for those who are not anesthesiologists, barely half of such providers adhere to these recommended practices.[24]

Provider type aside, the risk of death is also associated with the sedation being administered in the office setting. Procedures on adults performed in physician offices have been associated with up to a 10-fold–greater mortality compared with ambulatory surgery centers,[25] a disparity that has been supported in closed-claims analysis.[26] The increased risk of anesthesia in remote locations for a predominantly adult population have been related to oversedation and inadequate oxygenation and/or ventilation. Many cases would have been prevented with better monitoring.[27] It is unlikely that outcomes are better for children.

This etiologic analysis offers little in terms of providing systematic solutions. We should be asking which systems-level factors put patients at greatest risk for adverse events. Safety should not be exclusively defined by the success or failure of individuals but also by including systems of safety that govern the practices of individuals.

Efforts to improve safety should be based on data gleaned from each adverse event. A data set of adverse events should include deaths as well as sentinel events, such as hypoxemia, laryngospasm, and airway obstruction requiring intervention. Greater details than what are provided in a media report would enable the identification of systems-level deficiencies and directed solutions. Ultimately, effective solutions cannot be proposed until root-cause analyses of all adverse events are performed.

Efforts by the American Society of Anesthesiologists through the Closed

Claims Project as well as hospital collaborative efforts (the Pediatric Sedation Research Consortium) have addressed issues of adverse outcomes and rare events associated with sedation outside the operating room. The maintenance of national quality-improvement databases by professional societies, such as the Society of Thoracic Surgeons and the American College of Surgeons, has substantially contributed to our understanding of surgical outcomes and has also led to the development of quality performance measures.[28,29] It is time for dentistry to do the same. We can do better. And we must.

WYLIE BURKE, MD, PHD, AND ERIKA BLACKSHER, PHD, COMMENT

The death of a healthy child after a medical procedure is a tragedy. It should also be a call to action.

The patient safety movement has taught us that adverse medical events can be prevented with careful attention to systems factors. The field of anesthesiology has been a leader in patient safety and has identified and implemented many measures to increase the safety of sedation and anesthesia. As the other responses to this case suggest, aggressive steps should be undertaken to apply such patient safety lessons to dental procedures for ECC. In many cases, sedation can be avoided altogether.

The case also highlights a more fundamental societal obligation to prevent ECC.

ECC is the most common chronic childhood disease in the United States. It occurs disproportionately in children from economically and socially disadvantaged families. The reasons for the disparity are tragically straightforward. Poor children do not have the same access to dental services that children from wealthier families do. Efforts to provide dental hygiene education have been largely ineffective. In some jurisdictions, water is not fluoridated, and poor families may have more trouble finding fluoride supplements.[30] The results of these disparities are far reaching for children and their families. ECC causes pain. It can cause infection that leads to missed days at school and poor school performance.[31] ECC can cause speech and eating disorders and developmental delays. Because ECC is a chronic disease, the burdens are lifelong.[32]

Yet, ECC is a highly preventable disease. A few simple measures can reduce dental caries among children. These include twice-daily brushing with a fluoride toothpaste,[33] reduced exposure to sweetened beverages and similar high-sugar foods, and preventive dentistry visits.[34] Nevertheless, prevention is often ineffective, especially in poorer families.

The correlation of ECC with socioeconomic status points to the issues at stake. Adopting a healthy lifestyle requires both agency (ie, the knowledge, motivation, and ability to pursue the necessary actions) and the structural conditions that make action possible.[35] Low-income families face barriers to access to preventive treatments. There are not enough dentists who accept Medicaid. They may be difficult to find. There are long waiting times for appointments and a lack of public transportation to the locales of dentists' offices.[36] Some patients report discriminatory treatment.[37] Innovative approaches can eliminate some of these structural barriers. Some states have enacted regulatory changes to enable care by dental hygienists in underserved areas.[38] Others have developed school-based dental sealant delivery programs.[39]

Addressing barriers to effective tooth care at home is just as important. In a study of rural parents of infants and preschool children, researchers found inadequate tooth brushing among 45% of the children.[40] Some parents expressed misunderstanding about dental hygiene (for example, that excessive brushing could be harmful to teeth) or lacked social supports and role models for twice-daily brushing. Another study found that some parents do not associate preventive dental care with health. Instead, they view dental care as primarily a matter of appearance.[41] Even parents who did understand that dental care lays the groundwork for children's health said it was something "the poor must often set aside" and cited society's emphasis on medical over dental care to support the view that it is less important.

The US approach to health emphasizes individual choice and responsibility. This approach ignores the structural barriers that make healthy choices difficult, or even impossible, for some people. Many poor children with ECC come from families in which dental problems are common, perhaps even accepted as a natural fact of life. Parents may suffer from their own tooth pain, without access to treatment, and struggle with competing priorities and time urgencies. Low-income parents may also have limited food budgets that make cheap, sweetened beverages and sugary food expedient. Community-based preventive efforts must acknowledge these realities and work in constructive partnership with parents and local institutions to overcome them.

The resources required to make a difference may be surprisingly modest. In a United Kingdom study, Davies et al[42] found that advice during pediatric clinic visits and regular provision of toothbrushes and toothpaste led to a 29% reduction in ECC. A study in which researchers use similar approaches is now underway in the United States.[43] Pediatricians can make a difference in children's dental health.

The moral imperative for these efforts cannot be underestimated.

Just as no child should go hungry, no child should suffer a mouthful of pain for the lack of simple protective measures.

JOHN D. LANTOS, MD, COMMENTS

This case can be analyzed as a failure of systems to ensure quality and safety, a failure to use the least risky intervention to treat a chronic childhood disease, or a societal failure to develop programs to prevent that disease. These 3 commentaries illustrate the steps that would be necessary to make progress in each of these domains. No 1 approach will solve the problem, but if they are implemented together, we could reduce the likelihood that children will develop ECC or be harmed by treatment.

ABBREVIATIONS

AAPD: American Academy of Pediatric Dentistry
ECC: early childhood caries

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