Learning From Others:

A Case Report From the Anesthesia Incident Reporting System

Anesthesia Quality Institute
ANESTHESIA INCIDENT REPORTING SYSTEM (AIRS)

Review of unusual patient care experiences is a cornerstone of medical education. Each month, the AQI-AIRS Steering Committee abstracts a patient history submitted to the Anesthesia Incident Reporting System (AIRS) and authors a discussion of the safety and human factors challenges involved. Real-life case histories often include multiple clinical decisions, only some of which can be discussed in the space available. Absence of commentary should not be construed as agreement with the clinical decisions described. Feedback regarding this article can be sent by email to the AIRS Committee: **airs@asahq.org**. Report incidents or download the AIRS mobile app at **www.aqiairs.org**.

Case 2016-11: LAST chance for safety

Patient was a 10 kg infant who presented to the operating room for bilateral syndactyly repair. After induction of general anesthesia, the plastic surgery resident infiltrated the left hand, right hand and right groin with lidocaine 1 percent for a total of 16 mL (160 mg). Fifteen minutes later, the attending plastic surgeon infiltrated the right hand with another 7 mL of lidocaine 1 percent with epinephrine for a total of 23 mL (230 mg). In both circumstances, the surgical technician confirmed with the surgeon the request for lidocaine. The anesthetic and surgical courses were uneventful and no signs of local anesthetic toxicity were detected.

In this patient who weighed 10 kg, the maximum recommended dose of lidocaine for local infiltration would be 45 mg (4.5 mL) without epinephrine and 70 mg (7 mL) with epinephrine. The initial infiltrative amount of 16 mL was a significant overdose of local anesthetic. The second dose of 7 mL was an appropriate dose, but was given only 15 minutes after the initial overdose. At no time was the maximum recommended dose discussed with the anesthesia team.

Discussion

This case highlights two important lessons regarding the safe use of local anesthetics in infants and children, both of which also have some applicability to adult practice: the importance of individual knowledge about all medications that are administered and the importance of interdisciplinary communication in the O.R.[1] First, the safe administration of any drug requires a full knowledge of its appropriate dose. The surgical resident, most likely coming from adult practice with limited pediatric experience, was likely unaware of how to modify the dose of lidocaine for children, and can well be faulted for administering a drug without knowing the critical information necessary for its safe use or for not asking for help. While this is a basic knowledge deficit, and remediable in an individual case by education, it is demonstrable of a system defect in which knowledge is assumed but no systemic processes are in place to circumvent the need for such an assumption. Especially in teaching institutions, where residents and fellows rotate through the O.R. bearing varying levels of knowledge about pediatrics, reliance on such knowledge is inadequate. Instead, the possibility of human fallibility and error should be assumed and processes instituted to ensure that a shared "mental model" of the patient's condition and allowable local anesthetic dose is in place among all members of the O.R. team.

This situation is made worse with local anesthetics as the "correct" dose may be unclear. Our knowledge of the safe doses of local anesthetics is based primarily on animal studies and anecdotal case reports. The limits that are promulgated in our textbooks and widely quoted are probably not authoritative, and the true limits of toxicity cannot be reduced to a single number because they are related to many factors.[2] In addition to dose, the route of administration or type of block, rate of administration, timing of redoses, regional blood flow, the presence of epinephrine and individual variability all are important determinants of systemic absorption.[3] This concept of local anesthetic toxicity as a continuum and a result of multiple factors was first proposed by Moore in 1977, and it still holds true today.[4] The drug itself, of course, is important as well, because each has different rates of absorption and toxic thresholds.[5] Levo-enantiomers (ropivacaine and levobupivacaine) have a lower risk of toxicity than racemic drugs such as bupivacaine.

Particularly in pediatric patients, where the tolerances of safe dosing are smaller, the volume necessary for infiltration may exceed the safe dose limits. It may be necessary to decrease the local anesthetic concentration in order to permit the administration of adequate volume to achieve the desired block at a safe dose. Infants under 6 months of age are at greater risk of toxicity because they have low levels of α-acid glycoprotein, which binds local anesthetics, thus leading to a greater unbound fraction of drug.[6,7] This classical explanation has led to the recommendation to reduce doses in these young infants, particularly for infusions. However, it should be noted that α1-acid glycoprotein is also an acute phase reactant that increases after surgery, which might mitigate some of these effects in some infants.[8] The risk of drug accumulation with repeated dosing or continuous infusion is even more problematic in neonates. All these factors must be accounted for when choosing the local anesthetic dose.

Tracking the cumulative dose and timing of intraoperative local anesthetic administration is difficult. Decision support alerts for local anesthetic dosing would ideally be available from anesthesia

information management systems, but no current systems provide this functionality out of the box. Some have taken the somewhat Draconian step of removing 0.5 percent bupivacaine from the operating suite to prevent surgeons from accidentally overdoing with this potentially lethal drug. Frequently, local protocols have the circulating nurse record medications administered on the surgical field on the perioperative record, which is not linked to the anesthesia record. Tracking of all intraoperative medications on a single record might aid in the detection and prevention of inadvertent excessive administration.

The lack of detectable symptoms of local anesthetic systemic toxicity (LAST) in our case despite a multiple-fold overdose can be attributed to several possibilities. There might have been relatively slow or delayed absorption due to the limited vascularity of the location of injection. It is not stated if tourniquets were used for the operation. Were that the case, it would be an obvious reason for retarded absorption. It may also be that our defined limits for lidocaine toxicity are extremely conservative. Should bupivacaine have been chosen rather than lidocaine, this patient might not have been so lucky.[9] We must also remember that early or prodromal symptoms of LAST cannot be recognized in the anesthetized patient. Seizure or cardiac arrest may be the initial sign. In this case, toxicity might have been present, but the drug level might have been below the threshold for detection of symptoms under general anesthesia.

Regular readers will recognize that this case reiterates the second safety issue: the common theme of poor communication. Local anesthetics are among the very few drugs administered during an operation by both the surgeon and the anesthesiologist, and thus clear communication between all members of the O.R. team is necessary to prevent overdose. We might speculate from the narrative that the attending surgeon may not have been aware of the local anesthetic dose administered by the resident, and the anesthesia resident might likewise not have been aware of how much drug was administered until after the fact. The only communication was with the scrub technician, who occupies the role least likely to know the proper dose!

We have established time-out procedures in order to confirm patient identification, ensure the correct laterality of an operation, reiterate patient allergies and confirm consent. An American Society of Regional Anesthesia and Pain Medicine task force recently published a checklist for regional anesthesia with similar aims.[10] This checklist, however, does not target some of the unique problems posed by regional blockade and intraoperative local anesthetic administration in infants and children. To address that problem, a pediatric-specific regional anesthesia checklist has been proposed that is intended for use whenever local anesthetics are administered in children (Clebone et al, *RAPM* 2016, in press). This includes a specific item that delineates all local anesthetics that have been or will be administered prior to or during the case so they can be subtracted from the maximal dose calculation for any individual block. Another method that has proven useful is to mandate that the scrub technician must ask the anesthesiologist what the maximum permissible dose for the surgeon to inject is prior to receiving any local anesthetic from the circulator, and only this volume is drawn up. The same procedure is followed for redosing.

This case highlights both the need for great vigilance and skill in administering local anesthetics to infants and children, and the need for systematic practices that circumvent reliance on a single individual's knowledge. Checklists and time-outs for regional blocks take only seconds to perform and offer critical aids in preventing overdoses when knowledge gaps exist. We expect that these will soon become – or already are – best practices. Communication between all team members, especially regarding drug administration, cannot be overemphasized. Automated solutions, too, have promise in assisting the clinician in tracking cumulative drug doses. Once again, we see that system solutions are likely to be the most effective means of improving the safety of our patients.

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