Learning From Others:

A Case Report From the Anesthesia Incident Reporting System

Anesthesia Quality Institute
American Society of Anesthesiologists®

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 **airs@asahq.org**. Report incidents or download the AIRS mobile app at **www.aqiairs.org**.

Case 2018-12: Local confusion

Pt was an infant (1-3 years), approx 10 kg. Pt presented to the operating room for bilateral syndactyly repair. After the induction of general anesthesia, the plastic surgery resident infiltrated the right hand, left hand and left groin with lidocaine 1 percent for a total of 16 mL (160 mg). Fifteen minutes later, the attending plastic surgeon infiltrated the left hand with lidocaine 1 percent with epinephrine for a total of 7 mL (70 mg). In both circumstances, the surgical technician confirmed with the surgeon the request for lidocaine 1 percent. The anesthetic and surgical courses were uneventful and no signs of local anesthetic toxicity were detected.

The maximum recommended dose of lidocaine for local infiltration without or with epinephrine is 4.5-5 mg/kg (the actual dose differed depending on the source) and 7 mg/kg, respectively. In this patient who weighs 10 kg that would be 45 mg (4.5 mL)-50 mg (5.0 mL) without epinephrine and 70 mg (7.0 mL) with epinephrine. The initial infiltrative amount of 16 mL was a significant (~3.5 times the maximum recommended dose) overdose of local anesthetic. The second dose of 7 mL is an appropriate dose, but it was given only 15 minutes after the initial overdose. At no time was the maximum recommended dose discussed with the anesthesia team.

Discussion

Local anesthetic administration on the surgical field by field block, peripheral nerve block or tumescent infiltration is often performed and can be an effective and useful adjunct to postoperative analgesia. Sometimes local anesthetics are administered by the surgeon in addition to local anesthetics that might have been given in a block by the anesthesiologist. In all of these situations, children are especially at risk to receive local anesthetics that exceed the maximum recommended dose for several reasons. This report raises two different, but related, important questions. The first is more universal: how can we improve communication between the two sides of the ether screen so that errors that can lead to drug toxicity might be minimized? The second touches on a more scientific question: what is the toxic threshold of local anesthetics in infants and children, can we accurately determine that number and is it an absolute, or do other factors modify that dose?

The administration of local anesthetics by the surgeon in the O.R. is one of the circumstances where a potential drug overdose might result when two teams are giving similar drugs to the same patient. Because no order is entered for these drugs, it becomes impossible for potential automated fail-safe systems, such as redundancy checking software in electronic order entry systems, to flag duplicate orders or issue decision support warnings by calculating maximum allowable doses. Software checks like this have reduced duplication of perioperative drug administration; for example, warning about ordering acetaminophen in the postoperative order set when it was given in the preoperative area. While the sophistication and efficacy of these systems are not without flaws and shortcomings,[1-3] there is no question that when two independent physicians can both administer drugs to a patient without physically writing an order, communication between clinicians is the only means to avoid an adverse event. Because there are no orders, per se, the O.R. team must replace the conceptual framework of the "order checks" in the computerized drug entry system and perform that function instead.

As noted by the reporter, even when only the surgeon is administering the drug, that physician might not be cognizant of the allowable volume if he or she is not intimately familiar with the dosing limits of these agents in all ages. This is probably a greater risk in practice settings where physicians care for both adult and pediatric patients, compared with children's hospitals where thinking in terms of mg/kg dosing is more well ingrained in everyday practice. Therefore, having the anesthesiologist serve as the arbiter for dosing of local anesthetics, no matter who is administering them, adds consistency, tracking of the cumulative dose over time and expert knowledge. Knowledge alone, of course, is not enough to prevent these errors; the anesthesiologist must be continuously aware of what is happening on the surgical field and anticipate the next event. Situational awareness and attentiveness are critical skills that enable the expert clinician to recognize potential failure points and preempt and prevent incidents like this.

An expert taskforce of the American Society of Regional Anesthesia and Pain Medicine (ASRA) published a recommended checklist that incorporates nine key items that must be performed in sequence prior to administering a regional anesthetic.[4] Many institutions have incorporated and mandated the use of this time out checklist prior to the performance of any regional block. Because this was devised for adults, however, drug dose was not among the checklist items, nor was it a consideration of the concurrent administration of local anesthetics by others. This shortcoming for the pediatric population prompted a team of pediatric regional anesthesiologists working with a human factors expert to develop a complementary pediatric checklist specific to this patient population.[5] The list incorporates a question regarding the "dose and timing of other local anesthetics by surgeon, by anesthesia, in ED, on floor, topical or I.V."

If a regional block is not performed by an anesthesiologist (as was the case in our AIRS report), what processes might be employed to avoid local anesthetic dosing errors? One common strategy is to require that only the maximum allowable dose of local anesthetic can be available on the field for the surgeon to administer. This mandates that the O.R. nursing team must ask the anesthesiologist what that allowable dose of local anesthetic is prior to drawing it up on the field. In many hospitals this has become standard practice and no local anesthetic is dispensed until the dose (concentration, presence or absence of epinephrine, and volume) is verified by the anesthesiologist. It follows, of course, that the anesthesiologist must be familiar with the usual toxic limits of local anesthetics in infants and children and with the conditions that modify those limits.

Drug error events like this one are not unique to local anesthetics and the O.R. We see similar events occurring when surgeons and anesthesiologists both prescribe medications in the PACU, or when a preoperative physician prescribes a medication in the preoperative area and the intraoperative team is not aware of it and re-administers a similar drug during the anesthetic. Several strategies can be implemented to minimize the risk in this setting. Limiting the class of physician who can write certain PACU orders is the simplest and most effective method of preventing conflicting or duplicative orders – only the anesthesiologist is allowed to enter orders for analgesics, fluids and hemodynamic agents in the PACU, thereby eliminating the possibility of errors of this type altogether. Preoperative drugs can be flagged electronically in the anesthesia record, alerting the anesthesiologist that an antibiotic, for example, has already been administered. One of the advantages of an integrated electronic medical record is that the drug administration record from other locations is available everywhere – assuming, of course, that they were properly charted!

Our second question is a more difficult one to answer. All of us are familiar with the accepted "toxic limits" of local anesthetics. It is far from clear, however, that these numbers are valid in all situations or even that the concept of a uniform toxic limit is a truly meaningful one.[6] Much of what we know about the limits of toxicity of the local anesthetics come from dose-ranging studies in animals, studies that obviously cannot be reproduced in humans. We do not know, however, how much species differences affect these numbers; and there is laboratory evidence that such differences exist. Many other factors can modify what we think are the upper safe limits of local anesthetic administration. Since toxicity is in large part dependent on the amount that enters the systemic circulation, factors that modify the uptake of local anesthetic from the site of deposition – tissue perfusion, use of epinephrine, site of drug administration – will also modify the blood level of the local anesthetic and thereby the level of drug that circulates to the heart and brain. Protein binding, and things that affect protein binding, also play an important role. Alpha-1-acid glycoprotein is the primary plasma protein binding local anesthetics and is relatively deficient in infants under 6 months of age, rendering their free local anesthetic levels higher than those of older children given a weight equivalent dose.[7] At the same time, this protein is an acute phase reactant and rises in response to stresses such as surgery, which might offer a degree of protection.[8]

The complexity of all these factors further reinforces the idea that local anesthetic dosing in the O.R. should be under the supervision of the anesthesiologist. Systems to ensure that all of these things – dose, timing, dosing by multiple clinicians, age and other relevant parameters – are identified and considered can reduce errors and improve safety, especially for our smallest and most vulnerable patients.

References:

1. Horsky J, Kuperman GJ, Patel VL. Comprehensive analysis of a medication dosing error related to CPOE [published online March 31, 2005]. *J Am Med Inform Assoc*. 2005;12(4):377-382.
2. Campbell EM, Sittig DF, Guappone KP, Dykstra RH, Ash JS. Overdependence on technology: an unintended adverse consequence of computerized provider order entry. *AMIA Annu Symp Proc*. 2007;2007:94-98.
3. Koppel R, Metlay JP, Cohen A, et al. Role of computerized physician order entry systems in facilitating medication errors. *JAMA*. 2005;293(10):1197-1203.
4. Mulroy MF, Weller RS, Liguori GA. A checklist for performing regional nerve blocks. *Reg Anesth Pain Med*. 2014;39(3):195-199.
5. Clebone A, Burian BK, Polaner DM. A time-out checklist for pediatric regional anesthetics. *Reg Anesth Pain Med*. 2017;42(1):105-108.
6. Rosenberg PH, Veering BT, Urmey WF. Maximum recommended doses of local anesthetics: a multifactorial concept. *Reg Anesth Pain Med*. 2004;29(6):564-575.
7. Luz G, Wieser C, Innerhofer P, Frischhut B, Ulmer H, Benzer A. Free and total bupivacaine plasma concentrations after continuous epidural anaesthesia in infants and children. *Paediatr Anaesth*. 1998;8(6):473-478.
8. Booker PD, Taylor C, Saba G. Perioperative changes in alpha 1-acid glycoprotein concentrations in infants undergoing major surgery. *Br J Anaesth*. 1996;76(3):365-368.