Morray JP, Bhananker SM: Recent Findings From the Pediatric Perioperative Cardiac Arrest (POCA) Registry. *ASA Newsletter* 69(6): 10-12, 2005.

Full Text

In 1993, the ASA Closed Claims Project published an analysis of malpractice claims that involved care of anesthetized pediatric patients.1 Included in this analysis were cardiac arrests in which etiology could not be identified, although cardiovascular depression from halothane was suspected. The following year, the Pediatric Perioperative Cardiac Arrest (POCA) Registry was formed to identify the most common causes of anesthesia-related cardiac arrest in children and to identify strategies for prevention of arrest. Institutions that provided anesthetic care for children were asked to enroll voluntarily and to designate a representative responsible for submitting demographic information, including type of institution, number and training of anesthesia providers and number and types of cases. The institutional representatives also were asked to complete and submit anonymously a standardized data form for all cases of cardiac arrest (defined as need for chest compression or as death) that occurred in children 18 years of age or younger during administration of or recovery from anesthesia.

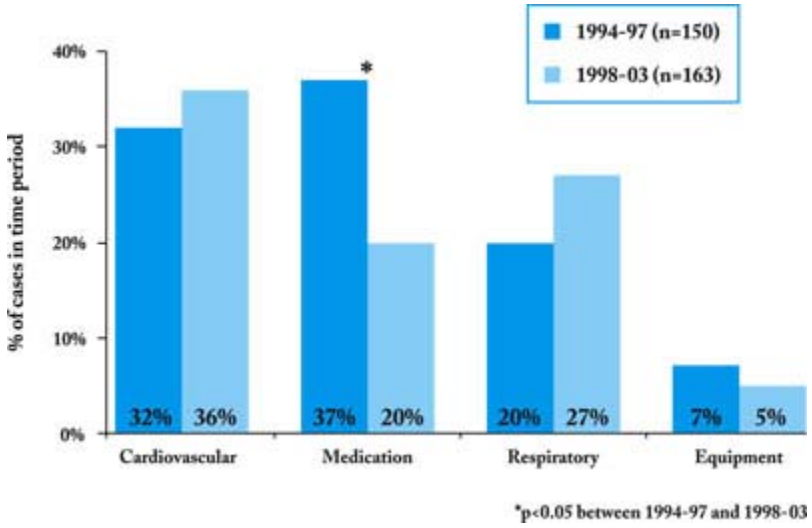
1994-97: In 2000 the POCA Registry collated and published data on 150 anesthesia-related cardiac arrests collected from 63 North American institutions for the years 1994-97.2 Infants less than one year of age accounted for 55 percent of all cardiac arrests. Medication-related problems were most frequent, accounting for 37 percent of all arrests. The predominant mechanism of arrest in this category was cardiovascular depression from the inhalation agents, usually halothane, alone or in combination with an intravenous medication. One-third of all cardiac arrests occurred in previously healthy (ASA Physical Status 1-2) children; in this group, 64 percent of arrests were medication-related.

Mortality rate following cardiac arrest was 26 percent. The only two predictors of mortality were ASA Physical Status 3-5 and emergency surgery. Age alone, when corrected for ASA Physical Status, was not predictive of mortality.

1998-03: Since the publication of the initial series of anesthesia-related cardiac arrests, more than 300 additional cases have been submitted to the POCA Registry; 163 of these arrests were related to anesthetic causes. The cause profile of anesthesia-related cardiac arrest changed from 1998 to 2003 [Figure 1]. Medication-related causes declined from 37 percent to 20 percent of the total due primarily to the decline of cases of cardiovascular depression from the inhaled agents. The proportion of cardiovascular causes of arrest increased slightly from 32 percent to 36 percent, making this category the most common. Hypovolemia (often from hemorrhage) or the metabolic consequences of massive transfusion (usually hyperkalemia) were the most frequent known causes of arrest in this category. As in the earlier series, the exact cause of arrest could not be determined in some cases in the cardiovascular category; frequently these were children with congenital heart disease and ASA Physical Status 3-5. Respiratory events increased from 20 percent to 27 percent. The most common event leading to cardiac arrest in this category was laryngospasm, followed by airway obstruction, inadequate oxygenation, inadvertent extubation, difficult intubation and bronchospasm. Most commonly arrests that related to problems with equipment (4 percent) occurred during or after placement

of central venous catheters, usually from cardiac tamponade, pneumothorax or hemothorax.

Figure 1: Primary Cause of Arrest



The demographic profile of the cases submitted since 1998 also has changed. The percentage of ASA Physical Status 1 and 2 patients decreased from 33 percent to 27 percent, and the percentage of patients under one year of age decreased from 55 percent to 36 percent ($p<0.05$). These changes may relate to the decline in the number of arrests being reported to the POCA Registry that were caused by the inhalation agents; these arrests often occurred in ASA Physical Status 1 or 2 patients who were less than one year of age. It is interesting that despite the above-mentioned changes, the mortality rate during the two time periods (26 percent and 28 percent) has not changed.

Strategies for prevention of arrest

The cause-of-arrest profile from 1998-03 suggests clinical strategies for the reduction of risk for anesthetized children. One change already made has been the switch from halothane to sevoflurane by pediatric anesthesiologists. In a survey of attendees at the Society for Pediatric Anesthesia 2004 Spring Meeting, 5 percent still used halothane for induction, while 95 percent used sevoflurane. Sevoflurane possesses a number of attractive characteristics. Heart rate, one of the main determinants of cardiac output, is maintained under sevoflurane anesthesia and is decreased with halothane.3 Sevoflurane, when compared to halothane, is less depressant of myocardial contractility in infants4 and children.5 Based on these differences, a switch from halothane to sevoflurane by pediatric anesthesiologists would predictably result in a decline in medication-related cardiac arrests.

Another cause of medication-related arrest reported to the POCA Registry since its inception has been intravascular injection of local anesthetics, usually during caudal injection of 0.25 percent bupivacaine with epinephrine, usually after negative aspiration and test dose and usually after bolus injection of the entire dose. The toxicity of bupivacaine when inadvertently injected into the intravascular space is well recognized. Alternative agents with less potential for toxicity include ropivacaine

and the L isomer of bupivacaine. Recent reports of cardiac arrest associated with ropivacaine use during regional techniques in adults emphasize that compulsive attention to detail is required when local anesthetics of any kind are used. The risk of cardiac arrest from inadvertent intravascular injection is reduced (but not eliminated) when aspiration for blood and a test dose are negative and when incremental doses rather than full doses are injected.

Cardiac arrests from hypovolemia (usually secondary to hemorrhage) and from the consequences of massive transfusion (usually hyperkalemia) were considered to be anesthesia-related when the anesthesiologist could possibly have prevented the arrest in some manner. Failure by the anesthesiologist to secure adequate intravenous access preoperatively and failure to keep up with intraoperative blood loss were the most common reasons why such arrests are deemed, at least in part, anesthesia-related. At least some of these arrests are preventable with adequate anticipation and attention to detail.

Hyperkalemia from massive transfusion also is potentially preventable through awareness of the problem and a few simple steps to reduce the amount of potassium administered in transfused blood. As blood ages, potassium leaks from the intracellular space into the plasma. This leakage is dramatically accelerated in irradiated blood. The anticoagulant used influences how blood ages. Packed cells, because of the reduced amount of plasma, have a lower potassium load than whole blood. The amount of potassium administered, and thus the risk of a hyperkalemic cardiac arrest, is reduced by the following recommendations:

1. Use the freshest packed red blood cells available. Avoid using whole blood.
2. Do not irradiate the blood except when absolutely necessary (e.g., a premature baby or immunocompromised child). When irradiation is required, the time between irradiation and blood administration should be minimized.
3. In high-risk situations (e.g., newborn or infant requiring >1 blood volume, or with irradiated blood), measure the potassium in the blood to be transfused. If the potassium level is high, consider washing the cells in the cell saver and resuspending the cells in plasma prior to administration.

The central venous pressure (CVP) catheter-related complications in the POCA database are similar in profile to those reported from the Closed Claims Database.6 The authors of the Closed Claims study concluded that either ultrasound guidance or pressure waveform analysis would have prevented nearly 50 percent of complications related to CVP catheter placement. Doppler devices also offer an inexpensive, simple and effective alternative that can improve success rates and decrease complications of CVP catheter placement.

Since its inception, the POCA Registry has been under the combined auspices of the ASA Committee on Professional Liability and the American Academy of Pediatrics Section on Anesthesiology Quality Assurance Committee. ASA has provided annual funding for the registry. Institutional representatives interested in participating in the POCA Registry should contact Karen L. Posner, Ph.D., at (206) 616-2630 or e-mail <posner@u.washington.edu>.

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