Learning From Others:

A Case Report From the Anesthesia Incident Reporting System

Anesthesia Quality Institute
ANESTHESIA INCIDENT REPORTING SYSTEM (AIRS)

Detailed review of unusual cases is a cornerstone of anesthesiology education. Each month, the AQI-AIRS Steering Committee will abstract a case and provide a detailed discussion based on a submission to the national Anesthesia Incident Reporting System. Feedback regarding this item can be sent by email to ***r.dutton@asahq.org****. Report incidents to* ***www.aqiairs.org****.*

Case 2012-3 – Get Ahead of Bleeding!

A 1-year old, ASA Physical Status I girl underwent elective neurosurgery for craniosynostosis repair. The anesthesiologist was working without assistance and was convinced by the surgeon that bleeding would be minimal. During the operation, the child sustained severe blood loss, requiring transfusion with two units of red blood cells. During skin closure, she developed hypocapnea, hypoxemia and severe hypotension.

Background and Differential Diagnosis: Craniosynostosis is a condition of premature fusion of the cranial sutures that may cause skull deformity and increased intracranial pressure. Because a large scalp incision and significant bone manipulation may be required, the patient can lose substantial amounts of blood. Surgical entry into the sagittal sinus can precipitate torrential hemorrhage. The patient has a small vascular volume to begin with (800ml in this 10 kg child), and in combination these factors can lead to rapidly progressive hemodynamic instability. Air embolus is also a possibility, especially if the head is elevated, although hemodynamic consequences are reportedly rare. Hypothermia, hyperkalemia, hypocalcemia and sensitivity to anesthetic agents can all contribute to hemodynamic instability.

Preparation and Clinical Response: Children presenting for craniosynostosis repair require excellent vascular access and close monitoring to allow the anesthesiologist to respond promptly to blood loss. Arterial monitoring may not be required for some single suture or endoscopic repairs but is highly advisable for larger or more complex procedures or for conventional sagittal suture surgery, which is associated with greater blood loss. Two I.V.s are usually placed. Central venous access is reserved for cases where larger bore secure peripheral venous access cannot be achieved. Although central venous pressures provide a rough guide to volume requirements, dynamic measurements such as systolic pressure variation or pulse variability index more accurately identify volume responsiveness, particularly when the patient is hypovolemic. Hypothermia can develop quickly, so multiple modalities for warming should be employed (e.g., fluid warmer, forced hot air blanket, warm room).

Adequate quantities of blood should be available in the operating room at the time of incision. Children coming for operation who are 3-4 months old are at the nadir of their physiologic anemia and might require early transfusion. Erythropoetin treatment for six weeks prior to surgery has been reported to reduce the need for transfusion. There have been two recent randomized, placebo-controlled trials of tranexemic acid (TXA) in craniosynostosis surgery, both of which showed a decrease in intraoperative and postoperative blood loss and need for transfusion. Coagulopathy should be anticipated if hemorrhage will exceed 50 percent of the estimated blood volume. Although prospective data are lacking, dynamic bedside tests of coagulation function (e.g., thromboelastography) may provide a better real-time guide to resuscitation than conventional laboratory tests with a longer turnaround. No test of coagulation is definitive; one interesting finding in both TXA studies was the dramatic reduction of blood loss even in the absence of clinical evidence of fibrinolysis.

Hyperkalemia from red cell transfusion is more likely to occur following transfusion of older units or units that have been irradiated, and hyperkalemic cardiac arrest has been reported during craniosynostosis surgery. Hypocalcemia from citrate intoxication occurs commonly in infants who are rapidly transfused and can precipitate profound hypotension. Metabolic

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acidosis, which can result from hypotension and hypoperfusion as well as from the administration of large volumes of normal saline, will exacerbate both coagulopathy and hemodynamic instability.

Clinical Follow-Up: Pressors and rapid transfusion of further red blood cells transiently restored the patient's vital signs, but coagulation status was not addressed. Further hemodynamic instability developed within an hour of arrival in the pediatric intensive care unit, associated with significant output from the surgical drains. Transfusion of plasma, platelets and further red cells was accompanied by aggressive use of pressors, but the patient ultimately expired.

Systems Analysis: As this unfortunate case demonstrates, persistent perioperative bleeding can be fatal. Hemorrhage leads to consumption of clotting factors, acidosis and hypothermia, while aggressive unbalanced volume replacement may cause rupture of existing clots, dilution of factors and further hypothermia. The end result is the "bloody vicious cycle" well known to trauma anesthesiologists as the final common pathway of death from exsanguination. Resolution requires early suspicion, activation of the necessary resources and a multifactorial response.

This case illustrates several instructive principles:

Preoperative preparation is critical, and this includes good communication between surgeon and anesthesiologist, as well as communication with anesthesia colleagues about what to expect with a particular operation and surgeon. It is useful to make fellow clinicians aware of the potential need for extra hands when a difficult case is anticipated.

Prevention of coagulopathy in the face of hemorrhage is much easier than recovery later. Early use of plasma and platelets ("1:1:1 resuscitation") may help when empiric decisions must be made in the absence of laboratory data or surgical predictability.

It is better to err on the side of caution with monitoring and vascular access. If there is a potential for blood loss in a small child, an arterial line provides not only a means of monitoring the dynamics of volume status, but also a means of measuring critical values such as pH, hemoglobin, potassium, ionized calcium and coagulation.

Dynamic indices of intravascular volume and volume responsiveness can provide real-time guidance for fluid replacement needs.

Bedside thromboelastic testing may be preferable to "conventional" indices of coagulation. Correction of coagulopathy is critical both to achieve intraoperative hemostasis and to limit postoperative bleeding. The use of the freshest red blood cells is indicated in small children to avoid iatrogenic hyperkalemia.

There is emerging evidence that the use of TXA may reduce intraoperative blood loss in both trauma cases and large elective surgeries.

A final comment on this tragedy is the toll it will take on the providers. The death of a child during elective surgery should be an extremely rare event. Critical incident stress debriefing is recommended for the surgical, anesthesia and nursing caregivers in the O.R. and ICU. The case should be discussed in detail in a multidisciplinary conference, with attention to improvements in recognition, treatment and system function that might have prevented a bad outcome. The institution's employee assistance or wellness program should be engaged and supportive resources made available on an individual basis to those providers most in need.

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