◇ This Month in

ANESTHESIOLOGY

■ Does Acute Normovolemic Hemodilution Decrease Transfusion Requirements during Cardiac Surgery? Hohn *et al.* (page 276)

Using strict transfusion criteria, Hohn *et al.* conducted a prospective randomized trial to test the efficacy of acute normovolemic hemodilution (ANH) during cardiac surgery. Eighty adult patients scheduled for elective cardiac surgery with use of moderate hypothermic cardiopulmonary bypass (CPB) were enrolled in the study. Patients in the control group underwent cardiac surgery with the customary blood-saving techniques used at the investigators' institution: filling of the extracorporeal circuit with saline isotonic fluid; intraoperative blood salvage; reinfusion of shed mediastinal blood; administration of intravenous aprotinin; and external heating at the end of CPB. In the treatment group, ANH was added to the above procedures.

Complete white blood cell counts, coagulation profiles, serum creatinine, and hepatic enzyme levels were obtained the day before surgery. Hematocrit, thrombocyte count, prothrombin time, and partial thromboplastin time were repeated the day of surgery (just before CPB), after surgery, postoperatively on days 1, 2, 5, and at discharge. Intraoperative monitoring included continuous blood pressure, oxygen saturation, and transesophageal echocardiography. The investigators used the same transfusion criteria in both control and treatment groups: before CPB if hematocrit (Hct) was $<28\%$, during CPB if Hct was $<17\%$, and after CPB if Hct was $<25\%$. When needed, both patient groups received first autologous blood salvaged intraoperatively. Acute normovolemic hemodilution patients then received their blood removed by ANH and, if necessary, additional allogeneic packed red cells.

The amount of whole blood collected during ANH ranged from 10–40% of the patients' estimated blood volume. Intraoperative and postoperative blood losses did not differ between control and ANH groups. Allogeneic blood was given to 29% of control group patients and to 33% of ANH group patients. Platelet count, prothrombin time, and partial thromboplastin time were similar in both groups, both intraoperatively and postoperatively. At discharge, control group and ANH group patients also had similar Hct values. The authors concede that the transfusion trigger chosen for their study probably contributed to a lower transfusion rate in both groups of patients. In addition, the ANH group patients received more diuretics than did patients in the control group. These and other factors may explain why there was no benefit demonstrated for adding ANH to the existent CPB regimen of intravenous aprotinin, intraoperative cell saving, and external heating. It may be that ANH would be more effective in patients excluded from this study, *i.e.,* those with combined coronary and valvular surgery, emergency surgery, or those with known coagulopathy risk.

■ Electroacupuncture Assessed as Possible Preventative of Postoperative Nausea and Vomiting in Pediatric Patients. Rusy *et al.* (page 300)

Electrical stimulation of acupuncture site P6, located two Chinese inches proximal to the distal skin crease of the wrist, has been effective in adult chemotherapy patients to help curb nausea and vomiting. Rusy *et al.* designed a trial to compare electroacupuncture to sham acupuncture and no acupuncture in pediatric patients who had undergone tonsillectomy with or without adenoidectomy.

Of the 122 patients approached for the study, 120 were enrolled. All patients were between the ages of 4 and 18. The patients were randomly assigned to one of three groups. Acupuncture needles were placed at P6 and at a neutral point (for the acupuncture group) or at two positions further up the arm (sham acupuncture group) while patients were still anesthetized. Their arms were then wrapped to disguise needle placement, thus diminishing the patients' fear of needles while accomplishing observer blinding to technique. Stimulation of the needles at a low frequency of 4 Hz was begun as the patient awakened and continued for 20 min. In the control group patients, insulated wires were attached to the insides of the arm covers, and a box with sham indicator lights was also used to maintain blinded study conditions. Experienced recovery room nurses blinded to group assignment recorded episodes of nausea and vomiting in the postoperative patients. If nausea persisted for 15 min, or if two or more episodes of vomiting occurred, rescue treatment with ondansetron was instituted. Parents of the patients were given questionnaires for reporting of nausea and vomiting episodes within the first 24h of returning home.

In patients receiving electroacupuncture, the incidence of nausea was 60%, compared with 85% and 93% in the sham acupuncture and control groups respec-

tively. However, the incidence of vomiting was not significantly different between the three study groups. P6 acupuncture did not reduce the incidence of rescue treatment for postoperative nausea and vomiting, which was nevertheless the highest in the sham acupuncture group (58% in P6; 83% in the sham group). Patients in the sham acupuncture group also vomited much earlier than those in the other two groups. So while P6 electroacupuncture reduced the feeling of nausea in the study participants, this effect may not be powerful enough to reduce the incidence of vomiting after tonsillectomy, commonly an emetogenic procedure. With significantly higher and earlier incidence of vomiting in the sham acupuncture group, the study does point to the potentially harmful effect of improper acupuncture technique.

■ Identifying Children at Risk for Complications after Adenotonsillectomy. Wilson *et al.* (page 313)

Hypothesizing that assessment for obstructive sleep apnea (OSAS) might help predict risk for postadenotonsillectomy respiratory complications, Wilson *et al.* undertook a retrospective chart review of children referred for sleep studies at their institution. Out of 349 children referred for such studies between 1992 and 1998, 163 children had received adenotonsillectomy without concomitant procedures within 6 months of their referral. These were the patients whose medical charts were included in this study.

Authors grouped both home and laboratory polysomnography assessments under the general name of cardiorespiratory sleep study, or CRSS. Each patient's CRSS record was analyzed for several variables, and the study reports on the following four parameters: the apnea and hypoapnea index (OAH index), the oxygen saturation (SaO_2) nadir, the desaturation index, and the percent time less than 90% saturation ($T < 90\%$). The OAH index was defined as the number of respiratory events (apnea and hypoapnea) per hour of sleep. The severity of sleep-disordered breathing was classified as normal, mild, moderate, or severe depending on the number of episodes (from less than 1 to more than 5). The SaO_2 nadir was defined as the minimum oxygen saturation occurring during sleep, regardless of its duration.

Next, the investigators identified respiratory complications (such as desaturation and airway obstruction) and medical interventions (such as reintubation and positive pressure ventilation) noted in the patients' postoperative medical records. Children who required interventions were further divided into minor and major intervention groups. There were 34 children (21% of the study population) who had required a medical intervention after respiratory complications. Ten required a major intervention (reintubation, admission to the intensive care unit) and 24 required a minor intervention (such as oxygen therapy beyond the usual period). Fourteen of those requiring a minor intervention (58%) had shown a preoperative SaO_2 nadir equal to or less than 80%, while 50% of the children requiring a major intervention had shown similar SaO_2 nadir values.

The authors identified age and presence of an associated medical condition as clinical predictors of postoperative respiratory complications. An OAH index of equal to or more than 5 events per hour, and a preoperative nocturnal SaO_2 nadir of equal to or less than 80% significantly increased the incidence of respiratory complications. Mild, moderate, and severe OSAS were associated with a 6, 14, and 31% incidence of respiratory complications respectively. Determination of nocturnal oxygen saturation may prove not only a cost-effective way to diagnose severe OSAS, but also to predict postoperative risk for complications in children about to undergo adenotonsillectomy.

■ Fentanyl and Carrageenan-induced Hyperalgesia Prevented by *N*-methyl-D-aspartate Antagonist. Rivat *et al.* (page 381)

In 78 rats, the team of Rivat *et al.* assessed baseline nociceptive thresholds using the paw-pressure vocalization test on two successive days before beginning their experiments. On the study day, animals were randomly assigned to receive either a subcutaneous injection of fentanyl alternating with carrageenan in the left hind paw, or saline injections alternating with the carrageenan paw injections. Nociceptive thresholds were measured 2 and 4 h after the carrageenan and then daily. Carrageenan-induced inflammation was assessed by measuring hind paw diameters to determine the amount of swelling.

A second set of experiments involved a second carrageenan injection 7 days later in the saline-injected rats. Carrageenan injections were given in the same paw or the contralateral paw according to protocol. In another protocol, the first carrageenan injection was given to rats were administered ketamine injections either 30 min

before, 4 h and 30 min, or 9 h and 30 min after the first saline or fentanyl injection. In this group of rats, a second carrageenan injection was also given 7 days later.

The carrageenan injection produced swelling in both fentanyl- and nonfentanyl-treated rats. The injection also decreased the nociceptive threshold 2 and 4 h after administration. Fentanyl initially opposed the hyperalgesic effect of carrageenan, but this effect disappeared 4 h later. The second set of carrageenan injections induced enhanced and long-lasting hyperalgesia when performed in the same hind paw, and also decreased the nociceptive threshold for the originally injected paw when the contralateral paw was injected. Ketamine totally prevented the enhancement of long-lasting hyperalgesia resulting from the second carrageenan injection. Nonketamine-treated rats exhibited hyperalgesia for up to 7 days *versus* only 4 days in the rats treated with ketamine. The effects of ketamine were similar in the fentanyl-treated rats with hyperalgesia, with the long-lasting hyperalgesia lasting only 2 days *versus* 6 days in nonketamine treated rats.

The decrease of the nociceptive threshold shown several days after the first carrageenan injection in fentanyl-treated rats suggested that fentanyl's enhancement of pain sensitivity results from a central sensitization process. Indeed, the fentanyl-treated rats showed an exaggerated nociceptive response to the second carrageenan injection 7 days later, suggesting that the rats were rendered hypersensitive to the pain stimulus by the opioid administration. Thus opioid administration may contribute to preemptive hyperalgesia, not analgesia. *N*-methyl-D-aspartate receptor antagonist therapy may be beneficial to prevent or reduce development of pain sensitization.

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