

◇ This Month in

ANESTHESIOLOGY

■ CT Used to Evaluate Catheter Tip Site and Injectate Spread Patterns in Epidural Anesthesia. Hogan. (page 964)

Nonuniform distribution of injectate in those receiving epidural anesthesia is common, and unilateral block occurs in up to 21% of patients according to several studies. In 20 women scheduled for brachytherapy to treat cervical cancer, Hogan used computed tomography (CT) to identify placement of the catheter tip and pattern of contrast spread after 4-ml and 10-ml injections.

Catheter placement was performed by several members of the anesthesia department. Tuohy needles were inserted into the epidural space using loss of resistance to air injection to confirm entry. An 18-gauge radiopaque polyamide catheter was used in 17 of the women, whereas in the other 3 patients a 19-gauge soft-tip, spring-wound catheter was used. The intended vertebral level of insertion was identified by palpation of the iliac crest and duly noted. Unless laparoscopy was being performed, epidural anesthesia was used alone. Infusion rate and bupivacaine concentration were adjusted to produce suitable analgesia throughout the course of brachytherapy.

Computed tomography was performed within 4 h of surgery, timed to coincide with radiation therapists' needs to guide exact placement of radiation sources to create optimal geometry of radiation distribution. A series of images at 5-mm intervals were obtained after injection of 0.4 ml nonionic radiographic contrast material to aid in identifying the catheters. Additional images at 3-mm intervals were obtained as necessary to identify the tip. In 15 of the women, 4 ml of solution was then injected. (One woman was allergic to iodinated contrast material and was not injected.) In 19 of the non-allergic women, an additional 10 ml of the contrast solution was injected and additional CT images were obtained.

The CT images were later evaluated by an investigator blinded to anesthetic effect. Catheter tips were placed in the intended interspace in 8 women and at a higher space in the other 11. In one woman, the catheter was seen to pass through the posterior epidural fat. In all other patients, the fat was pushed aside. Spread of injectate through the intervertebral foramina was seen in all the women, but the pattern of spread was highly variable. Asymmetry in anesthetic effect was mostly attributable to catheter position, and accumulation became more symmetric with increasing injectate volume. The far lateral catheter position, Hogan concludes, is a more common cause of asymmetric block than anatomic barriers to solution spread.

■ Preoperative Fasting Guidelines in Pediatric Hospitals Surveyed. Ferrari *et al.* (page 978)

Current controversy regarding pediatric preoperative fasting guidelines, as well as the variety of fasting recommendations already in use, prompted Ferrari *et al.* to conduct a survey of such guidelines at 51 institutions listed in the Directory of Pediatric Anesthesiology Fellowship Programs. Of the 51 programs surveyed, 47 (86%) responded.

In 64% of the surveyed institutions, ingestion of clear fluids by children aged less than 6 months was permitted up to 2 h before induction of anesthesia. In 48% of institutions, children aged 6 months or older were also allowed to ingest clear liquids up to 2 h before induction. There was some variability in the categorization of breast milk and formula. For example, ingestion of breast milk was restricted to 4 h before anesthesia for all age groups in the majority of institutions, but was restricted by the same criteria as clear fluids in 23%, as formula in 7%, and as solid food in 34% of institutions. Infant formula was considered equivalent to a solid food in 43% of institutions. Opinions of respondents differed regarding the preference of a 6-h fast for solid food or fasting after midnight in the 6- to 36-month-old patient population. Half of all institutions agreed that solids should be restricted after midnight in children aged more than 3 yr.

The variation in fasting guidelines revealed by this study contributes to the difficulty in developing practice guidelines. The authors propose further discussion of the "2-4-6-8 Rule," *i.e.*, restricting clear fluids for 2 h before induction, breast milk for 4 h, formula for 6 h, and solid food for 8 h, as a possible rule of thumb.

■ In-depth Analysis of Cases of Intraoperative Awareness. Domino *et al.* (page 1053)

Up to 70% of patients who experience intraoperative awareness have unpleasant aftereffects, including sleep disturbances, flashbacks, and episodes of anxiety. Increased public concern about awareness during anesthesia may contribute to liability risks, but the medicolegal consequences of intraoperative awareness remain unclear. To identify patient and anesthetic factors associated with intraoperative awareness and to explore its contribution to professional liability in anesthesia, Domino *et al.* reviewed the database of the American Society

of Anesthesiologists Closed Claims Project, which comprises the closed claim files of 35 US liability insurers.

For purposes of the present study, awareness claims were reviewed. These were divided into two categories: awake paralysis, *e.g.*, inadvertent paralysis of an awake patient; or recall during general anesthesia, *e.g.*, a patient recalling events during general anesthesia. Each claim file was examined for anesthetic agent used, patient characteristics, and quality of care associated with intraoperative awareness, which accounted for 79 of 4,183 claims (1.9%). Compared with other claims, intraoperative awareness more often involved female patients (77%); patients younger than 60 yr (89%), and patients undergoing elective procedures (87%). The severity of injury, as rated by a 10-point insurance industry scale, was typically lower for intraoperative awareness than other claims involving a temporary injury. Most claims for awake paralysis were related to intravenous infusion errors or syringe swaps. Although the paralysis was promptly recognized and appropriately managed, most reviewers considered the cases to result from substandard care. Claims payments for awake paralysis were lower than for all other claims.

The highest frequency of recall during general anesthesia was during the maintenance phase (49 of 61 recall claims). Thirty percent of these patients described recalling conversations and sounds in the operating room; others recalled feeling surgery without pain, paralysis, endotracheal intubation, and severe panic. Fifty-one of the 61 patients (84%) sustained temporary emotional distress, and 6% developed post-traumatic stress disorder. The classic cues for light anesthesia (hypertension and tachycardia) were absent in most of these patients, and 82% resulted in a lawsuit. Five factors were significantly associated with claims for recall during general anesthesia: no volatile anesthetic agent, female gender, obstetric or gynecologic procedure, intraoperative opioid, and intraoperative muscle relaxant. However, as with claims for awake paralysis, compensation to plaintiffs was relatively low, consistent with the low severity of injury.

■ Patterns of Nerve Injury Associated with Anesthesia Dissected in Review of Closed Claims. Cheney *et al.* (page 1062)

To discern any possible patterns of nerve injury associated with anesthesia, Cheney *et al.* analyzed claims for nerve injury included in the American Society of Anesthesiologists Closed Claims Project database, which comprises closed claims files from 35 US professional liability

insurance companies. For purposes of their review, the team used the term "nerve damage" to describe injuries in which there were clinical, anatomic, or laboratory findings consistent with damage to discrete elements of the spinal cord or peripheral nervous system. They also examined patterns of injury and liability within the most common nerve injury groups—ulnar nerve, brachial plexus, lumbosacral nerve root, and spinal cord—as well as liability trends in claims for nerve injury compared with all other claims in the database.

After deaths, which accounted for 32% of the major injuries of the 4,183 claims reviewed, the 670 claims for nerve damage comprised the next most common major injury (16%). Ulnar nerve injury, which accounted for 28% of nerve injury cases, was more common in men than women (75% of men) and was associated predominantly with general anesthesia. Ulnar nerve injuries, which comprised 37% of all nerve injury claims in a previous review of an earlier period, decreased to 17% in the 1990s, whereas spinal cord injury cases increased from 7% of cases to 27% during the same period.

Except for spinal cord injury, the mechanism of injury in most of these patients was not apparent in the claims records and was stated explicitly in only 10 (9%) of 113 ulnar nerve injuries. Only 8 of 83 (10%) brachial plexus injuries were clearly related to patient position. Mechanism of injury was noted in 48% of the spinal cord injuries, and the most common causes were epidural hematoma, chemical injury, anterior spinal artery syndrome, and meningitis. In 67 lumbosacral nerve root injuries, 93% were associated with administration of spinal or epidural anesthesia. Injury to sciatic nerves, radial nerves, and median nerves were least common. Without data on mechanisms of injury, clear recommendations for avoiding them cannot be extrapolated. In the current review, the exceptions were 13 claims in which epidural hematoma occurred in anticoagulated patients who had had neuraxial blocks. In 12 of those 13 claims, the care was judged as substandard, pointing to a need for careful monitoring of such patients for any unexpected motor or sensory changes indicating epidural hematoma.

■ Effects of pH on Severity of Acute Lung Injury after Breast Milk Aspiration in Rabbits. O'Hare *et al.* (page 1112)

Does the severity of pneumonitis after aspiration of fluids increase according to the acidity of the fluid? O'Hare *et al.* designed a controlled study to compare the lung injury in rabbits after tracheal instillation of human breast milk

(HBM) acidified with either hydrochloric acid or gastric juice with effects of instillation of 5% dextrose solution. The team induced anesthesia in 30 New Zealand white rabbits, performed tracheostomies, obtained baseline arterial blood-gas measurements, and then instilled 0.8 ml/kg of one of five study fluids into their tracheas through the tracheotomy tubes: HBM acidified to pH 1.8 or 3.0 with gastric juice (obtained from children in their institution's critical care unit), HBM acidified to pH 1.8 with hydrochloric acid, HBM at native pH (7.0), or 5% dextrose acidified to pH 1.8 with gastric juice.

Blood-gas analysis, peak inspiratory pressure, and lung volumes were recorded hourly until 4 h after instillation. Changes in the oxidant activity of circulating phagocytes before and after tracheal instillation were quantified using whole blood chemoluminescence. Baseline alveolar to arterial oxygen tension gradients (AaDO₂) were similar in all groups. The AaDO₂ increased and dynamic compliance decreased in all groups receiving HBM, regardless of the pH values. Severity of lung injury after instillation of HBM was also similar at all pH values, whether acidified with hydrochloric acid or gastric juice. The circulating neutrophil count increased steadily for 4 h after instillation of HBM, whereas the spontaneous phagocyte oxidant burst activity peaked 1 h after instillation and returned to baseline 4 h afterward. The source of the acid does not seem to affect severity of lung injury after tracheal instillation of HBM, and whether acid and particulate aspiration synergistically induce lung injury remains to be determined. These findings support the belief that aspiration of breast milk, regardless of pH, may result in serious lung injury.

■ Is Feedback an Effective Intervention for Changing Anesthesiologists' Drug Utilization? Body *et al.* (page 1171)

To evaluate the effectiveness of a combined education-individual feedback program on volatile agent

use and drug choice, Body *et al.* first analyzed volatile agent use and fresh gas flow rate (FGFR) for all surgeries during a preintervention period at their institution. A few months later, anesthesiology staff and residents each received a letter from the department chair advising them of their individual mean FGFR, estimated volatile agent cost, and their relationship to their peer group mean. During the study period, staff and residents were provided with education regarding the suitability and economics of low-flow anesthesia and advised to reduce FGFR to less than 1 l/min for isoflurane and desflurane and to 2 l/min for sevoflurane. The use of isoflurane was also advised. No other practice guidelines were given, and company representatives were not permitted direct contact with staff or residents during the study period. Anesthesia records were then examined for 2 months after intervention and then for 2 months during a delayed follow-up period.

Data were available on 6,329 patients administered anesthesia by 76 staff anesthesiologists. For all patients, mean FGFR decreased after the intervention by 26% but increased again by 5% in the delayed follow-up period. Inexplicably the use of more expensive volatile agents increased throughout the study period. Analysis of a subgroup of anesthesiologists who had had more than five cases during the study period revealed that 42 of 44 had decreased their mean FGFR after intervention; at delayed follow-up evaluation, 30 had increased their FGFR above the postintervention flows. Although effectiveness of the intervention decreased on its withdrawal, the initial education and feedback resulted in an overall 19% reduction in FGFR when compared with the preintervention period.

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