

## ANESTHESIOLOGY

### ■ Bypassing Postanesthesia Care Unit Used as Outcomes Measure for Revising Care Processes. Apfelbaum *et al.* (page 66)

Following a two-tier screening process, five ambulatory surgical centers were selected by Apfelbaum *et al.* for an open-label, prospective, nonrandomized outcomes study on patterns of anesthesia care. The goal of the 3-month-long study was to assess whether evaluating recovery criteria in same-day surgery patients at an earlier time point after surgery would result in safely bypassing the postanesthesia care unit (PACU). The researchers first recorded outcome data for 2,508 surgical patients for 1 month at the participating study sites. During the second month, physicians, nurses, support staff, and administration at each facility were educated about the new process of care. Implementation of the new care processes also began during the second month. The impact of the intervention on recovery times, adverse events, and bypass of the PACU was monitored for a 1-month follow-up period for another 2,354 surgical patients.

Anesthesia providers were free to choose the anesthetic regimen most appropriate for the patient, with no restrictions on whether or not a short acting anesthetic was used. Decision to bypass the PACU based on meeting recovery criteria was also left to the individual provider. Teleconferences and site visits were used by the research team to improve compliance with data capture, and to advise study sites on physical alterations to expedite moving patients' beds to the on-site recovery area. Comprehensive reports summarizing patient and procedure demographics, use of anesthetics, types of procedures, and postoperative events were furnished on a regular basis to each site.

A total of 2,508 patients were observed during the baseline period, and 2,354 ambulatory surgical patients were assessed for eligibility to bypass the PACU during the follow-up period. Three of the surgical centers were community-based hospitals, while two were freestanding ambulatory surgical centers. The most common types of procedures were orthopedic; ophthalmologic; gynecologic; ear, nose, and throat; and nonintraabdominal. The PACU bypass rate increased from 15.9% during the baseline month to 58.9% during the follow-up month. Patients given a short-acting anesthetic and undergoing either gynecologic or ophthalmologic procedures were more likely to bypass the PACU. Patients undergoing an ear, nose, or throat procedure or laparos-

copy were less likely to bypass the PACU. The average duration from surgical closure to arrival in the recovery unit was similar for PACU bypass and PACU stay patients. Patients who bypassed the PACU spent an average of 85 min in on-site recovery *versus* 175 min for those not bypassing the PACU. Patients who received only short-acting anesthetics were 78% more likely to bypass the PACU. The study did not measure patient satisfaction as an outcome of the change in process of care, and results may have been confounded by the learning taking place at each site due to feedback reports from study authors. However, the latter limitation also serves to illustrate the educational value in changing a care paradigm using feedback to providers, a useful tool when designing other cost-saving care processes.

### ■ Genesis of Stretch-induced Perioperative Neuropathies Explored in Healthy Volunteers. Coppieters *et al.* (page 75)

In an effort to better understand potentially harmful positioning associated with stretch-induced neuropathies in anesthetic practice, Coppieters *et al.* administered the brachial plexus tension test in 25 healthy male volunteers aged 20–32 yr. The test involves several maneuvers that have also been associated with perioperative neuropathies: shoulder girdle depression, abduction above 90°, lateral rotation of the arm, lateral flexion of the patient's head to the contralateral side, full elbow extension, and forearm supination.

Four variations of the brachial plexus tension test were done in randomized order: elbow extension (1) with the wrist and cervical spine in neutral position; (2) with wrist extension; (3) with cervical contralateral lateral flexion; and (4) with both wrist extension and cervical contralateral lateral flexion. All four variations were performed in three different shoulder positions: (1) with abduction and lateral rotation of the arm while the shoulder girdle was fixed in its neutral position; (2) with abduction of the arm and fixation of the shoulder girdle; and (3) with abduction only. The principal measure during the tests was the available range of elbow extension. The extension maneuver was stopped when subjects reported either substantial discomfort (rated on a 0–10 scale) or when full extension was reached. An electrogoniometer was used to measure elbow extension, and those administering the tests were blinded as to the goniometer readings.

Results revealed that cervical contralateral lateral flexion, depression of the shoulder girdle and lateral rotation of the shoulder, in combination with shoulder abduction, and wrist extension all had a significant effect on the available range of elbow extension. Elbow extension also challenged the nervous system, as subjects reported substantial discomfort during this maneuver as well. The authors observed a cumulative effect when different components were added at the same time. A neutralizing effect was noted when an adjacent region allowed for an unloading of the nervous system. Variability between subjects increased as more components were added, demonstrating that different people respond differently to nerve bedding elongation. Further adding to the possibility of nerve injury during perioperative positioning is that the anesthetized and sedated patient has none of his or her withdrawal reflexes that would normally protect against larger elongation of the nerve bedding. Based on these and other results, the authors recommend that perioperative shoulder abduction and lateral rotation be kept to a minimum and not be combined with the use of shoulder braces. Elbow and wrist extension should also be avoided whenever possible.

### ■ Perioperative Anesthetic-related Cardiac Arrests Determined from Hospital Database. Newland *et al.* (page 108)

Newland *et al.* reviewed all cardiac arrests reported during 72,959 consecutive anesthetics given to all patients at their institution (a tertiary care university hospital) from August 15, 1989 through August 14, 1999. An anesthesia database developed from a quality assessment form supplied details on perioperative adverse events, including airway, cardiovascular, respiratory, neurological, regional, and miscellaneous events. Cardiac arrest was defined as an event requiring cardiopulmonary resuscitation. The hospital's daily discharge lists were compared with the daily surgical schedules to identify all patients who died within 48 h of anesthesia and surgery. All identified cases of cardiac arrest (144 events) were reviewed by faculty anesthesiologists responsible for cases. Written summaries were provided for peer review. Patients experiencing perioperative cardiac arrest were more likely to be male; to be older; to have a greater American Society of Anesthesiologists physical status; to have had operations of longer duration; to have had emergency operations; to have had surgery later in the day; and to have undergone thoracic, cardiac, spine, or upper abdominal surgery.

Anonymous abstracts of each case were submitted to an Anesthesia Study Commission recruited for this study. The commission was comprised of three nationally recognized chairpersons of academic anesthesia departments, a chair of a department of surgery, and a senior faculty internist and pulmonologist certified in critical care medicine. During the first review of case abstracts, commission members were asked to determine whether the primary cause of cardiac arrest or death was due to anesthesia, surgery, patient disease or condition, other causes (such as catastrophic failure of equipment), or an indeterminate cause.

Cases coded as events caused primarily by anesthesia by at least one panel member were then submitted to the commission for a second review, as were cases coded by two or more members as events to which anesthesia had contributed. Members were then asked not to refer to previous notes and to determine the degree of certainty with which they felt anesthesia contributed to the event. Following the second review, five cardiac arrests were deemed attributable to anesthesia, resulting in an anesthesia-attributable cardiac arrest rate of 0.69 per 10,000 anesthetics. Four of these patients died, resulting in a risk of death from anesthesia-attributable cardiac arrest of 0.55 per 10,000 anesthetics. Anesthesia was judged to be contributory in another 10 cardiac arrests, resulting in an anesthesia-contributory rate of 1.37 per 10,000 anesthetics. Causes of the cardiac arrests associated with anesthesia included medication-related events (40%), complications associated with central venous access (20%), problems in airway management (20%), unknown or possible vagal reaction (13%), and one perioperative myocardial infarction. The medication-related events involved either relative overdoses or unusual responses to a standard dose. The authors believe the risks of cardiac arrest, as well as death after cardiac arrest, found in their study accurately reflect the real risks of perioperative anesthetic-attributable and anesthetic-contributory events.

### ■ Novel Selective Prostaglandin Receptor Subtype EP<sub>4</sub> Agonist Assessed in a Rat Monoarthritic Model. Omote *et al.* (page 170)

Omote *et al.* wanted to determine whether the selective EP<sub>4</sub> receptor agonist, 16-(m-methoxymethyl)phenyl derivative (ONO-AE1-329) would modulate pain responses in both acute and chronic phases of monoarthritis in rats. For the acute monoarthritis assessment, the team conducted baseline assessments of rats' withdrawal latencies to thermal stimulation, withdrawal thresholds to

mechanical stimulation, and volume and diameter of hind paws and ankles. In one group of rats, arthritis was induced by intracapsular injection of complete Freund's adjuvant (CFA) into the right tibiotarsal joint. Another group of rats received saline injections and served as controls. All rats were assessed for withdrawal latency, pain threshold, and paw volume and diameter 24 h after the first injection. Rats then received another intracapsular injection of either saline or three different dosages of ONO-AE1-329. The latencies, thresholds, or inflammatory responses were assessed for up to 60 min.

To test the efficacy of ONO-AE1-329 in a chronic arthritis model, the team waited 4 weeks after initial CFA injection to determine baseline pain responses and then administered either ONO-AE1-329 or saline on the same side as the CFA injection. In another experiment, the team evaluated whether ONO-AE1-329 could inhibit tumor necrosis factor  $\alpha$  (TNF- $\alpha$ )-induced hyperalgesia.

The withdrawal latencies were shortened, and withdrawal thresholds increased, 24 h after rats received

intracapsular injection of CFA. Their paw volumes and ankle diameters also increased, consistent with inflammatory changes. These changes were also observed four weeks after CFA, although the intensity of paw swelling had diminished. Intracapsular saline did not produce any significant changes. The intracapsular administration of ONO-AE1-329 24 h after CFA injection significantly prolonged the withdrawal latency to both heat and mechanical stimuli in a dose- and time-dependent manner. Peak antihyperalgesic effects were observed 30 min after administration of the drug. The study drug also decreased paw volume and ankle diameter in a dose-dependent manner at both the 24-h and 4-week time points. Concomitant administration of ONO-AE1-329 (50  $\mu$ g) with TNF- $\alpha$  (100 ng) did not produce any inhibition of TNF- $\alpha$ -induced thermal and mechanical hyperalgesia. Based on the results of this study, an EP4 agonist might represent a potential strategy for inhibiting inflammatory pain in arthritis.

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