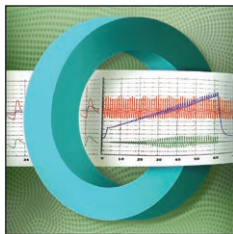


# THIS MONTH IN ANESTHESIOLOGY



## 997 Clinical Evaluation of a High-fidelity Upper Arm Cuff to Measure Arterial Blood Pressure during Noncardiac Surgery

Normotensive blood pressure can be monitored accurately with an oscillometric upper arm cuff, but this method can overestimate blood pressure during hypotension. Arterial lines enable continuous blood pressure monitoring but are associated with complications. An upper arm cuff incorporating a hydraulic sensor pad was developed to produce a high-fidelity tissue pressure pulse contour with characteristics of an arterial pulse contour. The hypothesis that this high-fidelity upper arm cuff could offer good accuracy and precision was tested by comparing blood pressure measurements done with the new cuff and reference femoral artery catheter measurements in 110 patients having noncardiac surgery. Five measurements per patient were selected for comparison, with minimum, maximum, and

intermediate values to cover the measured arterial pressure range. The average bias of mean arterial blood pressure measurements was 0 mmHg and the precision was 3 mmHg. The Pearson correlation coefficient was 0.96 and the percentage error was 9%. The high-fidelity cuff method detected mean arterial pressure values less than 65 mmHg with a sensitivity of 84% and a specificity of 97%. *See the accompanying Editorial on page 964.* (Summary: M. J. Avram. Image: A. Johnson, Vivo Visuals.)



## 1007 Early Childhood General Anesthesia and Neurodevelopmental Outcomes in the Avon Longitudinal Study of Parents and Children Birth Cohort

The hypothesis that single or multiple exposure to general anesthesia and surgery before 4 yr of age would be associated with adverse neurodevelopmental outcomes at 7 to 16 yr of age was tested in a large, population-based, representative United Kingdom birth cohort that contains a rich description of confounding factors and detailed, prospective assessment of multiple neurodevelopmental domains into adolescence. Hypothesis testing was performed on 46 neurodevelopmental outcomes. Of the 13,433 children in the sample, 1,322 were exposed to general anesthesia and surgery by 4 yr of age; 1,110 were exposed once and 212 were exposed multiple times. After adjustment for confounders, general anesthesia and surgery were not associated with

clinically and statistically significant neurodevelopmental impairments in general cognitive ability, attention, sociocognitive function, working memory, reading and spelling performance, phonologic awareness, verbal comprehension or expression, behavioral difficulties, or national assessments of English, mathematics, and science ability at ages 7 to 11 and 11 to 14 yr. There was, however, some evidence of impairments in a few specific neurodevelopmental subdomains. *See the accompanying Editorial on page 967.* (Summary: M. J. Avram. Image: C. Brodoway, A. I. duPont Hospital for Children.)



## 1021 Dissociative and Analgesic Properties of Ketamine Are Independent

Ketamine produces analgesia and dissociative symptoms at low doses. Its dissociative symptoms, which have limited the widespread use of ketamine as an analgesic, are characterized by distortion of visual and auditory stimuli and feelings of detachment from the environment and self. Ketamine-induced dissociative symptoms can be treated by administration of benzodiazepines. The hypothesis that the dissociative and analgesic properties of ketamine are independent was tested in 15 healthy subjects administered 2 mg/kg ketamine to whom 2 mg of midazolam was later administered to facilitate disentangling analgesic and dissociative drug properties. The intensity and quality of precalibrated pneumatic cuff pain was assessed longitudinally using Patient-Reported Outcomes Measurement Information System questionnaires. Dissociation was assessed using the Clinician Administered Dissociative States Scale, which measures

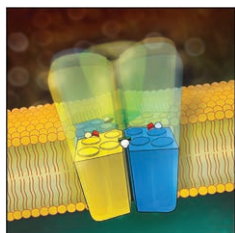
perceptual, behavioral, and attentional alterations during dissociative experiences. Ketamine produced both analgesia and dissociation and midazolam attenuated ketamine-induced dissociation in all subjects. Ketamine-induced analgesia had no strong inherent relationship with ketamine-induced dissociation beyond both being independently modulated by ketamine. *See the accompanying Editorial on page 970.* (Summary: M. J. Avram. Image: A. Johnson, Vivo Visuals.)



## 1029 Perioperative Open-lung Approach, Regional Ventilation, and Lung Injury in Cardiac Surgery: A PROVECS Trial Substudy

The PROtective VEntilation in Cardiac Surgery (PROVECS) trial found that a perioperative multimodal open-lung ventilation strategy including a moderate positive end-expiratory pressure (PEEP; 8 cm H<sub>2</sub>O), recruitment maneuvers, and mechanical ventilation during cardiopulmonary bypass did not improve clinical outcomes after on-pump cardiac surgery compared to a strategy of low PEEP (2 cm H<sub>2</sub>O) and no recruitment maneuvers. The hypothesis that open-lung ventilation homogenizes the regional distribution of ventilation and attenuates lung injury during and after on-pump cardiac surgery was tested in 86 patients undergoing elective on-pump cardiac surgery in a physiologic substudy of the PROVECS trial. Open-lung ventilation produced larger dorsal tidal ventilation before median

sternotomy than that achieved with a low-PEEP strategy, but that benefit to regional ventilation distribution did not persist to the end of surgery or 2 days later. Open-lung ventilation was associated with higher intraoperative pulmonary venous plasma sRAGE (soluble form of the receptor for advanced glycation end-products) concentrations, raising concerns about epithelial lung injury induced by the intervention, but it had no effect on plasma angiotensin-2 concentrations, implying lower likelihood of endothelial lung injury. *See the accompanying Editorial on page 982.* (Summary: M. J. Avram. Image: J. P. Rathmell.)



## 1046 Competitive Interactions between Halothane and Isoflurane at the Carotid Body and TASK Channels

Hypoxic ventilatory response is mediated by the carotid bodies. Under normoxic conditions the resting membrane potential of their glomus cells is maintained negative by constitutively active potassium channels (TASK channels), which are inhibited by hypoxia and activated by volatile general anesthetics. The hypotheses that halothane and isoflurane differ in their ability to suppress hypoxic response of the cell and TASK channel activity and that the less efficacious anesthetic might antagonize the more efficacious anesthetic in a manner predicted by classical drug-receptor theory were tested by studying their effects on hypoxia-evoked rise in intracellular calcium in isolated neonatal rat glomus cells and TASK single-channel activity in native glomus cells and HEK293 cells transiently expressing TASK1.

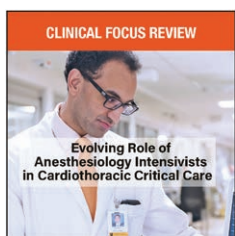
Halothane and isoflurane—both agonists—exhibit competition, with the weaker, isoflurane, antagonizing the effects of the stronger, halothane, at both whole cell (calcium signaling) and molecular level (TASK channels). The effects of combinations of isoflurane and halothane were consistent with the modeling of weak and strong agonists competing at a common receptor on the TASK channel. *See the accompanying Editorial on page 973. (Summary: M. J. Avram. Image: A. Johnson, Vivo Visuals.)*



## 1060 Lung Atelectasis Promotes Immune and Barrier Dysfunction as Revealed by Transcriptome Sequencing in Female Sheep

The hypothesis that atelectasis would produce local transcriptomic changes in lung tissue conducive to lung injury and that these changes would be exacerbated by systemic inflammation was tested in a sheep model of one-lung collapse and mechanical ventilation with global and regional physiologic properties comparable to those of humans. Twelve female sheep were included in the study, half of which received a systemic lipopolysaccharide infusion. A local differential transcriptomic response was identified that was consistent with impairment of the acute pulmonary immune function in atelectatic (vs. aerated) lung in the absence of additional inflammatory stimulus. In contrast, a distinct inflammatory pattern with augmentation of the transcriptomic immune response was present in atelectatic

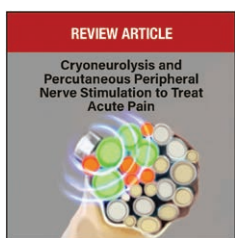
tissue exposed to systemic lipopolysaccharide. Locally increased interferon-stimulated genes were potentially associated with the atelectatic tissue response to systemic lipopolysaccharide. Dysregulation of transcriptomic responses related to alveolar-capillary barrier integrity in atelectatic tissue irrespective of systemic inflammation was likely associated with Yes-associated protein (YAP) signaling. *See the accompanying Editorial on page 976. (Summary: M. J. Avram. Image: J. P. Rathmell.)*



## 1120 Evolving Role of Anesthesiology Intensivists in Cardiothoracic Critical Care (Clinical Focus Review)

Anesthesiologists involved in cardiothoracic critical care have embraced new roles as experts in the management of cardiogenic shock and extracorporeal membrane oxygenation. Their current roles in those areas at an academic hospital in the United States are reviewed as an example of a successful multidisciplinary team that has been established in an institution with strong departmental interests. The evolution of treatments for heart failure and shock, a brief history of extracorporeal membrane oxygenation, and the current role of anesthesiology critical care specialists in both venovenous and venoarterial extracorporeal membrane oxygenation are then considered. This review emphasizes how the investigation of both cardiac and lung function in these critically ill patients now is essential. The authors next evaluate the early data regarding both venovenous and venoarterial extracorporeal membrane oxygenation in COVID-19 patients. The review concludes with speculation regarding possible future roles of cardiothoracic critical care anesthesiologists, including as remote monitors to selectively triage patients that may benefit from mechanical assist devices and as part of hospital echocardiography teams. *(Summary: M. J. Avram. Image: K. Shelton, Massachusetts General Hospital.)*

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## 1127 Cryoneurolysis and Percutaneous Peripheral Nerve Stimulation to Treat Acute Pain: A Narrative Review (Review Article)

Cryoneurolysis and percutaneous peripheral nerve stimulation are alternatives to local anesthetic-based regional analgesic techniques. Cryoneurolysis uses temperatures between  $-20$  and  $-100^{\circ}\text{C}$  to produce axon breakdown (Wallerian degeneration) distal to the lesion, resulting in inhibition of afferent and efferent signal transmission for weeks to months as the axon regenerates. Given its few contraindications, low risk profile, minimal cost, low patient burden, and extended period of action, it can be used to treat acute pain conditions when prolonged analgesia is required and an extended duration of hypesthesia, muscle weakness, and possibly decreased proprioception are acceptable. Percutaneous peripheral nerve stimulation produces analgesia by introducing electrical

current with an external pulse generator through an insulated lead lying adjacent to a peripheral nerve. Its benefits over cryoneurolysis include a lack of sensory and motor deficits, titratability, and control over treatment duration. Conversely, cryoneurolysis can be applied to multiple target nerves and may provide more potent focused analgesia at a lower cost without the risk of lead dislodgement or retained lead fragments. *(Summary: M. J. Avram. Image: From original article.)*