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# ANESTHESIOLOGY

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This practice advisory updates the “Practice Advisory for the Perioperative Management of Patients with Cardiac Implantable Electronic Devices: Pacemakers and Implantable Cardioverter–Defibrillators: An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Cardiac Implantable Electronic Devices,” adopted by the American Society of Anesthesiologists in 2010 and published in 2011. This updated advisory is intended for use by anesthesiologists and all other individuals who deliver or who are responsible for anesthesia care. The update may also serve as a resource for other physicians and healthcare professionals who manage patients with cardiac implantable electronic devices. *SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT*

**Perioperative Medicine**


**CLINICAL SCIENCE**

◆ **Anesthetic Management Using Multiple Closed-loop Systems and Delayed Neurocognitive Recovery: A Randomized Controlled Trial**  
 *A. Joosten, J. Rinehart, A. Bardaji, P. Van der Linden, V. Jame, L. Van Obbergh, B. Alexander, M. Cannesson, S. Vacas, N. Liu, H. Slama, L. Barvais* .....253

Closed-loop, automated management of anesthetic, analgesic, fluid, and ventilation parameters was superior to manual control and might influence postoperative outcomes. *SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT*

◆ **Timing of  $\beta$ -Blocker Reintroduction and the Occurrence of Postoperative Atrial Fibrillation after Cardiac Surgery: A Prospective Cohort Study**  
 *C. Couffignal, J. Amour, N. Ait-Hamou, B. Cholley, J.-L. Fellahi, X. Duval, Y. Costa De Beauregard, P. Nataf, M.-P. Dilly, S. Provenchère, P. Montravers, F. Mentré, D. Longrois* .....267


There was little advantage to reintroducing  $\beta$ -blockers within 48 h. The odds of atrial fibrillation were significantly reduced by restarting  $\beta$ -blockers between 72 and 96 h after surgery. *SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT*

◆ **Correlation of Thromboelastography with Apparent Rivaroxaban Concentration: Has Point-of-Care Testing Improved?**  
 *S. P. Myers, M. R. Dyer, A. Hassouna, J. B. Brown, J. L. Sperry, M. P. Meyer, M. R. Rosengart, M. D. Neal* .....280

The use of a modified thromboelastography assay demonstrated significant correlations with rivaroxaban concentrations but values were within normal ranges, and therefore clinical utility is limited. As a result, other methods to assay rivaroxaban and other Xa inhibitor concentrations are needed to determine the anticoagulant effects of these agents when needed. *SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT*

◇ Refers to This Month in ANESTHESIOLOGY

◆ Refers to Editorial Views

 This article has an Audio Podcast

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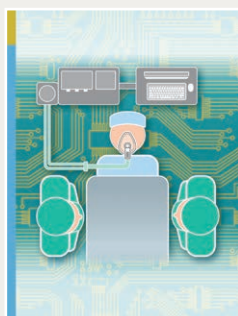
 CME Article

 This article has a Video Abstract

 Part of the Letheron writing competition

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 Readers' Toolbox



**ON THE COVER:** Automated management of anesthetic depth is now entirely feasible. In this issue of ANESTHESIOLOGY, Joosten *et al.* demonstrated that closed-loop, automated management of anesthetic, analgesic, fluid, and ventilation parameters was superior to manual control and might influence postoperative outcomes. In an accompanying Editorial, Hemmerling tell us that robotic anesthesia will soon be available and offer some ideas about how the anesthesiologist-of-the-future might interface with automated systems. Cover Illustration: S. M. Jarret, M.F.A., C.M.I.

- Joosten *et al.*: Anesthetic Management Using Multiple Closed-loop Systems and Delayed Neurocognitive Recovery: A Randomized Controlled Trial, p. 253
- Hemmerling: Robots Will Perform Anesthesia in the Near Future, p. 219



  **Associations of Intraoperative Radial Arterial Systolic, Diastolic, Mean, and Pulse Pressures with Myocardial and Acute Kidney Injury after Noncardiac Surgery: A Retrospective Cohort Analysis**

S. Ahuja, E. J. Mascha, D. Yang, K. Maheshwari, B. Cohen, A. K. Khanna, K. Ruetzler, A. Turan, D. I. Sessler .....291

For each blood pressure component, the authors report significant and clinically meaningful associations between the lowest pressure sustained for 5 min and myocardial and kidney injury. Absolute population risk thresholds were similar for myocardial and kidney injury, being roughly 90 mmHg for systolic, 65 mmHg for mean, 50 mmHg for diastolic, and 35 mmHg for pulse pressures. The odds for myocardial and kidney injury progressively increased with duration and severity of hypotension below each threshold, even after adjusting for potential baseline confounding factors. *SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT*

**Critical Care Medicine**

**BASIC SCIENCE**

  **Static and Dynamic Transpulmonary Driving Pressures Affect Lung and Diaphragm Injury during Pressure-controlled *versus* Pressure-support Ventilation in Experimental Mild Lung Injury in Rats**

E. F. Pinto, R. S. Santos, M. A. Antunes, L. A. Maia, G. A. Padilha, J. de A. Machado, A. C. F. Carvalho, M. V. S. Fernandes, V. L. Capelozzi, M. Gama de Abreu, P. Pelosi, P. R. M. Rocco, P. L. Silva ..... 307

In a rat model of mild lung injury caused by intratracheal endotoxin administration, animals received both pressure-support and pressure-controlled ventilation, and effects on driving pressures were measured, along with lung inflammation and diaphragm inflammation. Pressure-support *versus* pressure-controlled ventilation was associated with higher dynamic (but not static) transpulmonary driving pressure, while markers of lung and diaphragm inflammation did not differ between ventilation modes. *SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT*

**Heart Rate Control during Experimental Sepsis in Mice: Comparison of Ivabradine and  $\beta$ -Blockers**

A. Bedet, G. Voiriot, J. Ternacle, E. Marcos, S. Adnot, G. Derumeaux, A. M. Dessap .....321

This study assesses the effects of ivabradine, atenolol, and placebo in the setting of murine peritonitis. Mice that received atenolol *versus* ivabradine both experienced a similar and significant decline in heart rate. The mice in the atenolol group also experienced a significant decrease in cardiac output, systolic blood pressure, and left ventricular systolic function that was not experienced by the mice who received ivabradine. Mice who received atenolol *versus* ivabradine *versus* placebo did not have significantly different survival 60 h after induction of sepsis. Future studies are needed to determine the value of ivabradine *versus* atenolol for heart rate control in human sepsis.

**Pain Medicine**

**CLINICAL SCIENCE**

 **Postoperative Pain and Analgesic Requirements in the First Year after Intraoperative Methadone for Complex Spine and Cardiac Surgery**

G. S. Murphy, M. J. Avram, S. B. Greenberg, T. D. Shear, M. A. Deshur, D. Dickerson, S. Billimoria, J. Benson, C. E. Maher, G. J. Trenk, K. J. Teister, J. W. Szokol .....330

Using data from two previously completed trials, it was observed that a single intraoperative dose of methadone was associated with fewer episodes of pain during the first month after cardiac surgery and the first 3 months after spinal surgery. Fewer spine surgery patients who received methadone intraoperatively were receiving opioids 3 months after surgery, suggesting a possible reduction in chronic opioid use.

**BASIC SCIENCE**

 **Oral Dimethyl Fumarate Reduces Peripheral Neuropathic Pain in Rodents *via* NFE2L2 Antioxidant Signaling**

J. Li, J. Ma, M. J. Lacagnina, S. Lorca, M. A. Odem, E. T. Walters, A. Kavelaars, P. M. Grace .....343

Using a rat model of nerve injury, both male and female animals displayed reduced mechanical and nociceptive sensitization when given dimethyl fumarate. Dimethyl fumarate administration increased superoxide dismutase activity while decreasing cytokine expression and improving mitochondrial bioenergetics. *SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT*

 **Endoplasmic Reticulum Stress Contributes to Nociception *via* Neuroinflammation in a Murine Bone Cancer Pain Model**

Y. Mao, C. Wang, X. Tian, Y. Huang, Y. Zhang, H. Wu, S. Yang, K. Xu, Y. Liu, W. Zhang, X. Gu, Z. Ma .....357

Using a murine model of bone cancer pain, it was observed that tumor growth was associated with the spinal production of inflammatory mediators and increased expression of endoplasmic reticulum stress markers. The pharmacologic inhibition of endoplasmic reticulum stress reduced pain-related behaviors and the production of inflammatory mediators in spinal tissue. *SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT*

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**REVIEW ARTICLE**

🌐 ◇ **Artificial Intelligence in Anesthesiology: Current Techniques, Clinical Applications, and Limitations**  
*D. A. Hashimoto, E. Witkowski, L. Gao, O. Meireles, G. Rosman* .....379

This scoping review of artificial intelligence in anesthesiology summarizes six areas of research: (1) depth of anesthesia monitoring, (2) control of anesthesia, (3) event/risk prediction, (4) ultrasound guidance, (5) pain management, and (6) operating room logistics. *SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT*

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