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### Special Articles

- **Elastomeric Respirators for COVID-19 and the Next Respiratory Virus Pandemic: Essential Design Elements**

Respirators provide reliable protection from airborne respiratory pathogens. Reusable elastometric respirators offer potential advantages compared to disposable filtering facepiece respirators. Development of improved elastomeric respirators should be an international public health priority.

### Perioperative Medicine

- **Carbon Footprint of General, Regional, and Combined Anesthesia for Total Knee Replacements**
  F. McGain, N. Sheridan, K. Wickramarachchi, S. Yates, B. Chan, S. McAlister ......................................................... 976

The carbon footprint in carbon dioxide equivalent emissions associated with general anesthesia (n = 9), spinal anesthesia (n = 10), and combined (general and spinal) anesthesia (n = 10) for total knee replacement surgery in Melbourne, Australia, were similar. Single-use equipment, electricity for the patient air warmer, and pharmaceuticals were major sources of carbon dioxide equivalent emissions across all anesthetics. Sevoflurane was a significant source of the carbon dioxide equivalent emissions of both general anesthesia and combined anesthesia. Washing and sterilizing reusable items contributed substantially to the carbon dioxide equivalent emissions of both spinal and combined anesthesia. Oxygen use was an important contributor to the carbon footprint of spinal anesthesia.

### ON THE COVER:

- Health care itself contributes to climate change. Anesthesia is a “carbon hotspot,” yet few data exist to compare anesthetic choices. In this issue of Anesthesiology, McGain *et al.* examined the carbon dioxide equivalent emissions associated with general anesthesia, spinal anesthesia, and combined (general and spinal anesthesia) during a total knee replacement. In an accompanying editorial, Struys and Eckelman discuss how practicing anesthesiologists can lower the environmental footprint of anesthesia. Cover Design: A. Johnson, Vivo Visuals Studio. Cover Image: “This is the waste of one operation... my operation” by Dutch special artist Maria Kojick, created with waste generated during her own surgery. Cover Photograph: Eva Glasbeck, published with permission from the artist.
  - McGain *et al.*: Carbon Footprint of General, Regional, and Combined Anesthesia for Total Knee Replacements, p. 976
  - Struys and Eckelman: Environmental Footprint of Anesthesia: More than Inhaled Anesthetics! p. 937
Utilization:

A retrospective cohort study was conducted to determine whether these findings can be replicated at other centers and whether the results differ by cognitive status. **SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT**

Pressure Support versus Spontaneous Ventilation during Anesthetic Emergence—Effect on Postoperative Atelectasis: A Randomized Controlled Trial


This prospective single-center trial randomized patients undergoing spine surgery to spinal anesthesia with targeted sedation to Bispectral Index greater than 60 to 70 versus general anesthesia without Bispectral Index guidance. There was no difference in the incidence of postoperative delirium between randomized groups in the trial. Future studies are needed to determine whether these findings can be replicated at other centers and whether the results differ by cognitive status. **SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT**

Preoperative Opioid Utilization Patterns and Postoperative Opioid Utilization: A Retrospective Cohort Study

C. A. Rishel, M. S. Angst, E. C. Sun ............................................ 1015

In a national claims database of 57,000 chronic opioid users undergoing common surgical procedures, 41, 22, and 37%, respectively, had stable, decreasing, or increasing preoperative opioid utilization (more than 20% change). After adjustment for potential confounders, 96, 89, and 94% of patients with stable, decreasing, or increasing preoperative opioid use utilized opioids (prescriptions filled) between postoperative days 91 and 365. All three groups had similar average daily oral morphine milligram equivalent utilization. Changes in preoperative opioid utilization were not associated with clinically significant differences in postoperative opioid utilization. **SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT**

BASIC SCIENCE

Arterial and Mixed Venous Kinetics of Desflurane and Sevoflurane, Administered Simultaneously, at Three Different Global Ventilation to Perfusion Ratios in Piglets with Normal Lungs

M. Kretzschmar, J. E. Baumgardner, A. Kozian, T. Hachenberg, T. Schilling, G. Hedenstierna, A. Larsson ......................................................... 1027

The washin and washout kinetics of simultaneously administered desflurane and sevoflurane were assessed in seven piglets by measuring $P_{aw}$ and $P_{aw}$ during uptake and elimination under normal, low, and high ventilation/perfusion ratio ($V_{A}/Q_{l}$) conditions. Faster arterial kinetics for desflurane were generally maintained for both washin and washout under all $V_{A}/Q_{l}$ conditions. The low $V_{A}/Q_{l}$ condition decreased the differences in scaled $P_{aw}$ between 0 and 5 min; the high $V_{A}/Q_{l}$ condition increased these differences from the low $V_{A}/Q_{l}$ value to a value approaching or exceeding the value for normal $V_{A}/Q_{l}$. Mixed venous kinetics were slower than arterial kinetics for washin and washout and were less influenced by $V_{A}/Q_{l}$.

Effect of Global Ventilation to Perfusion Ratio, for Normal Lungs, on Desflurane and Sevoflurane Elimination Kinetics

J. E. Baumgardner, M. Kretzschmar, A. Kozian, T. Hachenberg, T. Schilling, A. Larsson, G. Hedenstierna ......................................................... 1042

A mathematical model of inhaled anesthetic elimination was developed in a post hoc analysis of anesthetic partial pressures measured in mixed venous and arterial blood samples after simultaneous administration of desflurane and sevoflurane to seven piglets under normal, low, and high ventilation/perfusion ratio conditions. After a brief and rapid decline in alveolar anesthetic partial pressure, the fractional clearance of anesthetic became constant, and incomplete clearance from the lungs slowed tissue washout. Slowing of tissue elimination by incomplete lung clearance became more pronounced at low ventilation/ perfusion ratios, and was predicted to become more pronounced as blood/gas solubility increases.

Intubation Biomechanics: Clinical Implications of Computational Modeling of Intervertebral Motion and Spinal Cord Strain during Tracheal Intubation in an Intact Cervical Spine

B. C. Gadomski, B. J. Hindman, M. I. Page, F. Dexter, C. M. Puttlitz .......................................................... 1055

On the basis of simulation of an adult cervical spine, pathologic motion does not occur even with intubation force up to twice that commonly encountered during routine tracheal intubation. However, in patients who have increased susceptibility to strain-related cord injury, potentially injurious cord strain may occur during routine tracheal intubation conditions. **SUPPLEMENTAL DIGITAL CONTENT IS AVAILABLE IN THE TEXT**
Pain Medicine

CLINICAL SCIENCE

Postoperative Pain and Age: A Retrospective Cohort Association Study


Data from the PAIN OUT registry involving more than 11,000 patients undergoing spinal surgery, joint replacement, and laparoscopic cholecystectomy were used in a retrospective cohort analysis. Pain reported postoperative day 1 declined slightly with age. Severe postoperative pain was prevalent regardless of age or surgical type.

Education

IMAGES IN ANESTHESIOLOGY

Systemic Air Embolism during Percutaneous Transthoracic Lung Biopsy

V. Arora, G. Burks

Tracheal Varicose Veins Associated with Klippel–Trenaunay Syndrome

K. Mukaihara, K. Godai, T. Moriyama

CLINICAL FOCUS REVIEW

Prevention of Healthcare-associated Infections in Intensive Care Unit Patients

M. Mazzeffi, S. Galvagno, C. Rock

Healthcare-associated infections contribute to morbidity, mortality, and increased cost in intensive care unit patients. Understanding evidence-based prevention strategies can help to optimize patient outcomes.

REVIEW ARTICLE

Sleep, Pain, and Cognition: Modifiable Targets for Optimal Perioperative Brain Health

B. P. O’Gara, L. Gao, E. R. Marcantonio, B. Subramaniam

Multicomponent interventions are effective in preventing postoperative delirium, and work is ongoing to determine whether they can be effective in preventing other postoperative neurocognitive disorders. Interventions optimizing sleep, pain, and cognition are essential components for clinicians to include in strategies to maximize the recovery of body and mind of vulnerable patients.

MIND TO MIND

Counterintuitive Gerunds

K. E. McGoldrick

Anesthesia Reunion in Hospice

E. R. Basile

Correspondence

Burnout in Anesthesiologists: Comment

A. E. Abouleish

Burnout in Anesthesiologists: Reply

A. E. Vinson, A. M. Afonso
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