



Anesthesiology



The Journal of the American Society of Anesthesiologists, Inc.

American Society of Critical Care Anesthesiologists

Society for Obstetric Anesthesia and Perinatology



CONTENTS

- ◇ **THIS MONTH IN ANESTHESIOLOGY** **5A**
- Effects of Remifentanyl Studied in Critically Ill Patients Implanted with an Artificial Heart
- Influence of Phenytoin Use on Pharmacokinetics, Pharmacodynamics of Vecuronium Studied
- Two Closed-loop Anesthesia Delivery Systems Compared
- Tsui Test for Epidural Catheter Placement *via* Caudal Route in Pediatric Patients
- ◆ **EDITORIAL VIEWS**
- **Special Issue on Preconditioning: Work Presented at the October 2003 Journal Symposium** **469**
- Michael M. Todd*
- Anesthetic Effects on Glutamatergic Neurotransmission: Lessons Learned from a Large Synapse** **470**
- Misha Perouansky, Hugh C. Hemmings, and Robert A. Pearce*
- One Thing Leads to Another** **472**
- Timothy J. Ness*

- ◇ Refers to This Month in Anesthesiology
- ◆ Refers to Editorial Views
- See Web Site enhancement



CONTENTS

■ 2003 JOURNAL SYMPOSIUM PRECONDITIONING AGAINST ISCHEMIC INJURY

Trigger-dependent Gene Expression Profiles in Cardiac Preconditioning: Evidence for Distinct Genetic Programs in Ischemic and Anesthetic Preconditioning

474

Pavel Sergeev, Rafaela da Silva, Eliana Lucchinetti, Kathrin Zaugg, Thomas Pasch, Marcus C. Schaub, and Michael Zaugg

Trigger-dependent transcriptome variability was evaluated in isolated rat hearts exposed to ischemic and anesthetic preconditioning using Affymetrix gene chip technology. Ischemic and anesthetic preconditioning exhibited a high number of commonly up-/down-regulated genes. However, important differences in gene expression exist with respect to both protective and antiprotective gene products.

Isoflurane and Sevoflurane Precondition against Neutrophil-induced Contractile Dysfunction in Isolated Rat Hearts

489

Guochang Hu, M. Ramez Salem, and George J. Crystal

Isoflurane and sevoflurane preconditioned the heart against neutrophil-induced contractile dysfunction. This action was associated with an inhibition to neutrophil adherence and likely involved an increased resistance of the myocardium to oxidant-induced injury; the adenosine triphosphate-sensitive potassium channels played no apparent role.

Attenuation of Mitochondrial Respiration by Sevoflurane in Isolated Cardiac Mitochondria Is Mediated in Part by Reactive Oxygen Species

498

Matthias L. Riess, Janis T. Eells, Leo G. Kevin, Amadou K. S. Camara, Michele M. Henry, and David F. Stowe

Sevoflurane attenuates mitochondrial respiration in isolated cardiac mitochondria independent of adenosine triphosphate-sensitive K^+ channel opening. Reversal by scavengers of reactive oxygen species suggests that reactive oxygen species mediate attenuated respiration at complex 1 of the electron transport chain.

Reactive Oxygen Species Precede Protein Kinase C- δ Activation Independent of Adenosine Triphosphate-sensitive Mitochondrial Channel Opening in Sevoflurane-induced Cardioprotection

506

R. Arthur Bouwman, René J. P. Musters, Brechje J. van Beek-Harmsen, Jaap J. de Lange, and Christa Boer

Sevoflurane-induced cardioprotection is mediated *via* protein kinase C- δ activation downstream of reactive oxygen species.



CONTENTS

Adenosine and a Nitric Oxide Donor Enhances Cardioprotection by Preconditioning with Isoflurane through Mitochondrial Adenosine Triphosphate-sensitive K^+ Channel-dependent and -independent Mechanisms 515

Mayu Wakeno-Takahashi, Hajime Otani, Shinichi Nakao, Yuka Uchiyama, Hiroji Imamura, and Koh Shingu

Correlation between mitochondrial adenosine triphosphate-sensitive K^+ (mito K_{ATP}) channel activation and cardioprotection by preconditioning with isoflurane was investigated. Although isoflurane confers cardioprotection through mito K_{ATP} channel activation, enhanced cardioprotection can be achieved by combined preconditioning with adenosine and S-nitroso-*N*-acetylpenicillamine, which promotes both mito K_{ATP} channel-dependent and -independent mechanisms.

Isoflurane Produces Delayed Preconditioning against Myocardial Ischemia and Reperfusion Injury: Role of Cyclooxygenase-2 525

Katsuya Tanaka, Lynda M. Ludwig, John G. Krolkowski, Dunbar Alcindor, Phillip F. Pratt, Judy R. Kersten, Paul S. Pagel, and David C. Warltier

Administration of isoflurane 24 h before prolonged coronary artery occlusion and reperfusion reduced myocardial infarct size in rabbits. This delayed cardioprotection was abolished by the selective cyclooxygenase-2 inhibitor celecoxib when administered after, but not before, exposure to isoflurane. The results indicate that isoflurane-induced delayed preconditioning is mediated but not triggered by cyclooxygenase-2.

Protein Kinase C Translocation and Src Protein Tyrosine Kinase Activation Mediate Isoflurane-induced Preconditioning *In Vivo*: Potential Downstream Targets of Mitochondrial Adenosine Triphosphate-sensitive Potassium Channels and Reactive Oxygen Species 532

Lynda M. Ludwig, Dorothee Weihrauch, Judy R. Kersten, Paul S. Pagel, and David C. Warltier

Selective antagonists of protein kinase C- δ and - ϵ and Src tyrosine kinases inhibited isoflurane-induced preconditioning in rats. Isoflurane stimulated protein kinase C- δ and - ϵ translocation to sarcolemma and mitochondria, respectively, in rat myocardium that was abolished by the mitochondrial adenosine triphosphate-sensitive potassium channel antagonist 5-hydroxydecanoate and the reactive oxygen species scavenger *N*-acetylcysteine.

CONTENTS



Nuclear Factor κ B and Anesthetic Preconditioning during Myocardial Ischemia-Reperfusion 540

Caiyun Zhong, Yamei Zhou, and Hong Liu

Attenuation of nuclear factor κ B activation and subsequent down-regulation of nuclear factor κ B-dependent inflammatory gene expression plays an important role in the protective mechanism of volatile anesthetic preconditioning against myocardial ischemia-reperfusion injury.

Cyclooxygenase-2 Mediates Ischemic, Anesthetic, and Pharmacologic Preconditioning *In Vivo* 547

Dunbar Alcindor, John G. Krolikowski, Paul S. Pagel, David C. Wartier, and Judy R. Kersten

Cyclooxygenase-2 mediates protection against myocardial infarction during ischemic, anesthetic, and pharmacologic preconditioning in dogs.

Role of Tyrosine Kinase in Desflurane-induced Preconditioning 555

Dirk Ebel, Jost Müllenheim, Hendrik Südkamp, Thomas Bohlen, Jan Ferrari, Ragnar Huhn, Benedikt Preckel, and Wolfgang Schlack

To determine whether activation of tyrosine kinase is involved in desflurane-induced cardioprotection, the authors investigated whether the two structurally different tyrosine kinase blocking agents genistein and lavendustin A can block desflurane-induced preconditioning in the rabbit heart *in vivo*. Desflurane-induced preconditioning does not depend on tyrosine kinase activation.

Morphine Preconditions Purkinje Cells against Cell Death under *In Vitro* Simulated Ischemia-Reperfusion Conditions 562

Young Jin Lim, Shuqiu Zheng, and Zhiyi Zuo

Preconditioning rat cerebellar brain slices with morphine significantly increased the survival rate of Purkinje cells after an episode of simulated ischemia-reperfusion *in vitro*. This morphine preconditioning-induced neuroprotection may be δ_1 -opioid receptor dependent.

Dual Exposure to Sevoflurane Improves Anesthetic Preconditioning in Intact Hearts 569

Matthias L. Riess, Leo G. Kevin, Amadou K. S. Camara, James S. Heisner, and David F. Stowe

Repeated anesthetic exposure seems to be important in initiating cardiac anesthetic preconditioning at clinically relevant concentrations. This may improve outcome but may also limit the clinical applicability of anesthetic preconditioning.

Continued on page 16A



CONTENTS

Contribution of Reactive Oxygen Species to Isoflurane-induced Sensitization of Cardiac Sarcolemmal Adenosine Triphosphate-sensitive Potassium Channel to Pinacidil 575

Jianzhong An, Anna Stadnicka, Wai-Meng Kwok, and Zeljko J. Bosnjak

In single guinea pig ventricular myocytes, the scavengers of reactive oxygen species *N*-acetyl-L-cysteine, carnosine, superoxide dismutase, and catalase attenuated or abolished isoflurane-induced facilitation of cardiac sarcolemmal adenosine triphosphate-sensitive potassium channel opening by pinacidil, suggesting that reactive oxygen species may mediate the actions of isoflurane on this channel.

Desflurane-induced Preconditioning Alters Calcium-induced Mitochondrial Permeability Transition 581

Vincent Piriou, Pascal Chiari, Odile Gateau-Roesch, Laurent Argaud, Danina Muntean, Delphine Salles, Joseph Loufouat, Pierre-Yves Gueugniaud, Jean-Jacques Lehot, and Michel Ovize

The authors showed in a rabbit mitochondrial preparation that desflurane preconditioning improved the resistance of the mitochondrial transition pore to Ca^{2+} -induced opening. This effect was inhibited by 5-hydroxydecanoate, an inhibitor of mitochondrial potassium adenosine triphosphate channel.

Reduced Efficacy of Volatile Anesthetic Preconditioning with Advanced Age in Isolated Rat Myocardium 589

Roman Sniecinski and Hong Liu

Volatile anesthetic preconditioning limits intracellular Na and Ca, prevents the depletion of adenosine triphosphate, and improves function after ischemia in isolated hearts from young adult and middle-aged but not aged rats.

■ CLINICAL INVESTIGATIONS

Mandibular Advancement Improves the Laryngeal View during Direct Laryngoscopy Performed by Inexperienced Physicians 598

Miki Tamura, Teruhiko Ishikawa, Rie Kato, Shiroh Isono, and Takashi Nishino

Mandibular advancement was effective to improve the laryngeal view during direct laryngoscopy performed by inexperienced physicians. The effect was slightly smaller than that of the BURP maneuver (backward, upward, rightward pressure of the larynx); however, the authors conclude that it has clinical significance.

CONTENTS



- ◇ **Remifentanyl Induces Systemic Arterial Vasodilation in Humans with a Total Artificial Heart** 602
Alexandre Ouattara, Gilles Boccard, Uwe Köckler, Patrick Lecomte, Pascal Leprince, Philippe Léger, Bruno Riou, Akthar Rama, and Pierre Coriat
 In patients with a total artificial heart, remifentanyl decreased systemic vascular resistance without significant effect on the capacitance vessels.
- Variable Ventilation Improves Perioperative Lung Function in Patients Undergoing Abdominal Aortic Aneurysmectomy** 608
Abdulaziz Boker, M.D. M.Ed., Craig J. Haberman, Linda Girling, Randy P. Guzman, George Louridas, John R. Tanner, Mary Cheang, Bruce W. Maycher, Dean D. Bell, and Greg J. Doak
 Variable ventilation significantly improves lung function over conventional ventilation in patients undergoing abdominal aortic aneurysmectomy. The benefits to certain patients with vulnerable ventilatory status may be significant.
- Sequential Effects of Increasing Propofol Sedation on Frontal and Temporal Cortices as Indexed by Auditory Event-related Potentials** 617
Wolfgang Heinke, Ramona Kenntner, Thomas C. Gunter, Daniela Sammler, Derk Olthoff, and Stefan Koelsch
 This study suggests sequential effects of propofol on auditory function. Sedative concentrations first affect auditory change detection processes that involve frontal cortices, whereas processes merely involving the primary auditory cortex are only affected by propofol concentrations causing unconsciousness.
- ◇ **Influence of Chronic Phenytoin Administration on the Pharmacokinetics and Pharmacodynamics of Vecuronium** 626
Peter M. C. Wright, Gerald McCarthy, Janos Szenohradszky, Manohar L. Sharma, and James E. Caldwell
 This study examines the pharmacokinetics and pharmacodynamics of vecuronium in patients taking phenytoin compared with controls. Patients taking phenytoin were resistant to vecuronium because it was eliminated more rapidly and because the patient was less sensitive to vecuronium. These two factors were equally responsible for the resistance to vecuronium.



CONTENTS

Effect of Amino Acid Infusion on Central Thermoregulatory Control in Humans

634

Yasufumi Nakajima, Akira Takamata, Takashi Matsukawa, Daniel I. Sessler, Yoshihiro Kitamura, Hiroshi Ueno, Yoshifumi Tanaka, and Toshiki Mizobe

Infusion of amino acids increases the set point for thermoregulatory thresholds but does not alter the gain of the major thermoregulatory defenses (sweating, active precapillary vasodilation, arteriovenous shunt vasoconstriction, and thermogenesis).

◇ Performance Evaluation of Two Published Closed-loop Control Systems Using Bispectral Index Monitoring: A Simulation Study

640

Michel M. R. F. Struys, Tom De Smet, Scott Greenwald, Anthony R. Absalom, Servaas Bingé, and Eric P. Mortier

When simulating closed-loop control of the Bispectral Index using propofol anesthesia, the use of a patient-individualized, model-based adaptive closed-loop system with effect site control resulted in better control of the Bispectral Index compared with a standard proportional integral derivative controller with plasma site control.

■ LABORATORY INVESTIGATIONS

Effect of Propofol on Hypotonic Swelling-induced Membrane Depolarization in Human Coronary Artery Smooth Muscle Cells

648

Takako Masuda, Yoshinobu Tomiyama, Hiroshi Kitahata, Yasuhiro Kuroda, and Shuzo Oshita

Propofol inhibits swelling-induced membrane depolarization in human coronary artery smooth muscle cells.

Single Amino Acid Residue in the Extracellular Portion of Transmembrane Segment 2 in the Nicotinic $\alpha 7$ Acetylcholine Receptor Modulates Sensitivity to Ketamine

657

Kenny K. Ho and Pamela Flood

Ketamine inhibits nicotinic acetylcholine receptors at clinically relevant concentrations. The authors have identified a single amino acid residue that modifies ketamine sensitivity.



CONTENTS

- ◆ **Isoflurane Inhibits Transmitter Release and the Presynaptic Action Potential** 663

Xin-Sheng Wu, Jian-Yuan Sun, Alex S. Evers, Michael Crowder, and Ling-Gang Wu

Isoflurane inhibited the excitatory postsynaptic current and transmitter release to a similar degree but reduced the presynaptic action potential amplitude to a smaller degree at a rat glutamatergic calyx-type synapse. By finding that the excitatory postsynaptic current was proportional to the presynaptic action potential amplitude raised to a power of 10.2, the authors concluded that isoflurane inhibited transmitter release and thus the excitatory postsynaptic current largely by inhibition of the presynaptic action potential.

■ PAIN AND REGIONAL ANESTHESIA

- ◆ **Peripheral Nerve Injury Sensitizes the Response to Visceral Distension but Not Its Inhibition by the Antidepressant Milnacipran** 671

Sang-Wook Shin and James C. Eisenach

Spinal nerve ligation, a model of neuropathic pain in rats, also produces hypersensitivity to visceral stimulation. Intrathecal injection of the norepinephrine-serotonin reuptake inhibitor, milnacipran, reduces hypersensitivity to somatic but not visceral stimuli after nerve injury, indicating a difference in pharmacology of analgesia for somatic and visceral pain in the setting of nerve injury.

- ED₅₀ and ED₉₅ of Intrathecal Hyperbaric Bupivacaine Coadministered with Opioids for Cesarean Delivery** 676

Yehuda Ginosar, Edward Mirikatani, David R. Drover, Sheila E. Cohen, and Edward T. Riley

This study determined the success of a range of intrathecal doses of bupivacaine (6–12 mg) for cesarean delivery. Based on logistic regression, the ED₅₀ and ED₉₅ for completion of surgery were 7.6 and 11.2 mg, respectively. No significant advantage was associated with very low doses of bupivacaine.

- ◇ **Thoracic and Lumbar Epidural Analgesia *via* the Caudal Approach Using Electrical Stimulation Guidance in Pediatric Patients: A Review of 289 Patients** 683

Ban C. H. Tsui, Alese Wagner, Dominic Cave, and Ramona Kearney

Caudal epidural analgesia using the Tsui test may be an alternative to direct thoracic and lumbar epidural analgesia for pediatric patients.



CONTENTS

Synergistic Antinociceptive Effect of Amitriptyline and Morphine in the Rat Orofacial Formalin Test 690

Philippe Luccarini, Laurent Perrier, Céline Dégoulange, Anne-Marie Gaydier, and Radhouane Dallel

Antinociceptive effects of amitriptyline, morphine, and their interaction were studied in the orofacial formalin test in rats. Results show that amitriptyline and morphine produced a dose-related inhibition on the first and second phases of rubbing activity. Combinations of amitriptyline and morphine produced a synergistic effect to inhibit cutaneous orofacial inflammatory pain.

■ ECONOMICS

Economics of Nerve Block Pain Management after Anterior Cruciate Ligament Reconstruction: Potential Hospital Cost Savings *via* Associated Postanesthesia Care Unit Bypass and Same-day Discharge 697

Brian A. Williams, Michael L. Kentor, Molly T. Vogt, William B. Vogt, Kim C. Coley, John P. Williams, Mark S. Roberts, Jacques E. Chelly, Christopher D. Harner, and Freddie H. Fu

The use of nerve blocks for acute pain management in patients undergoing anterior cruciate ligament reconstruction is associated with recovery room bypass, reliable same-day discharge, and the potential for significant hospital cost savings.

■ REVIEW ARTICLE

Mechanisms of Cardioprotection by Volatile Anesthetics 707

Katsuya Tanaka, Lynda M. Ludwig, Judy R. Kersten, Paul S. Pagel, and David C. Warltier

Volatile anesthetics precondition myocardium against ischemic injury through a complex signal transduction mechanism in which mitochondrial adenosine triphosphate-sensitive potassium channels and reactive oxygen species play central roles.

■ CLINICAL CONCEPTS AND COMMENTARY

Current Concepts of Hemostasis: Implications for Therapy 722

Harold R. Roberts, Dougald M. Monroe, and Miguel A. Escobar

The classic cascade hypothesis of blood coagulation leading to a stable fibrin clot has been revised based on a cell-based assay using cells as a source of tissue factor and platelets as the surface against which thrombin generation occurs. The new concept of coagulation forms the basis for the use of therapeutic agents that either accelerate or retard thrombin generation.



CONTENTS

■ CASE REPORTS

- Spontaneous Occurrence of the Disposition to Malignant Hyperthermia 731

Henrik Rueffert, Derk Olthoff, and Christine Deutrich

- A Bifurcated Tracheal Tube for a Neonate with Tracheoesophageal Fistula 733

Yoshikazu Miyamoto, Keiko Kinouchi, Akihiro Taniguchi, and Seiji Kitamura

- Anesthetizing the Phantom: Peripheral Nerve Stimulation of a Nonexistent Extremity 736

Stephen M. Klein, John Eck, Karen Nielsen, and Susan M. Steele

- Dexmedetomidine and Cardiac Arrest 738

Esperanza Ingersoll-Weng, Gerard R. Manecke, Jr., and Patricia A. Thistlethwaite

■ LABORATORY REPORT

- Electrical Field Stimulation to Study Inhibitory Mechanisms in Individual Sensory Neurons in Culture 740

Frédéric Duflo, Yong Zhang, and James C. Eisenach

■ CORRESPONDENCE

- The Pain Visual Analog Scale: Linear or Nonlinear? 744

Paul S. Myles

- Analgesic Evaluation in Postoperative Patients 744

Ghassem E. Larijani and Michael E. Goldberg

- In Reply *Frédéric Aubrun and Bruno Riou* 745

- Is Overestimation of Bispectral Index in Sedated Intensive Care Unit Patients Only Related to Electromyographic Activity? 746

Vincenzo Fodale and Letterio B. Santamaria

- In Reply *Benoît Vivien and Bruno Riou* 746



CONTENTS

Management of Patient Body Temperature Is Challenging	747
<i>Ram Y. Sharon</i>	
In Reply <i>Bhargavi Gali, James Y. Findlay, and David J. Plevak</i>	747
 The Perioperative Use of Cyclooxygenase-2 Selective Nonsteroidal Antiinflammatory Drugs May Offer a Safer Alternative	 748
<i>Scott S. Reuben and Neil R. Connelly</i>	
 Effects of Postoperative Nonsteroidal Antiinflammatory Drugs on Bleeding Risk after Tonsillectomy	 748
<i>Alfred P. J. Lake and Magdi Khater</i>	
 Nonsteroidal Antiinflammatory Drugs and Hemorrhage following Tonsillectomy: Do We Have the Data?	 749
<i>Richard Dsida and Charles J. Coté</i>	
In Reply <i>Emmanuel Marret and Francis Bonnet</i>	751
 Carotid Sinus Mechanical Properties	 752
<i>Roger J. Bagshaw</i>	
 Unusual Case of Breathing Circuit Obstruction: Plastic Packaging Revisited	 753
<i>Andrew C. Chacon, Krzysztof M. Kuczkowski, and Ramon A. Sanchez</i>	
 Revenue Gain for Academic Anesthesiology Departments if the Centers for Medicare and Medicaid Services Provide Full Reimbursement to Teaching Physicians	 754
<i>Amr E. Abouleish, Donald S. Prough, Lydia A. Conlay, and Charles W. Whitten</i>	
 Deviation of the Cauda Equina by Changing Position	 754
<i>Tetsuo Takiguchi, Shigeki Yamaguchi, Yasuhisa Okuda, and Toshimitsu Kitajima</i>	

Continued on page 30A



CONTENTS

Novel Breathing Circuit Architecture: New Consequences of Old Problems	755
<i>Warren S. Sandberg and Sheila Kaiser</i>	
In Reply <i>Jeffrey M. Feldman</i>	756
■ REVIEWS OF EDUCATIONAL MATERIAL	757
■ ANNOUNCEMENTS	759

INSTRUCTIONS FOR AUTHORS

The most recently updated version of the Instructions for Authors is available at www.anesthesiology.org. Please refer to the Instructions for the preparation of any material for submission to ANESTHESIOLOGY.

WEB SITE ANNOUNCEMENT

Full-text articles are now available on-line at www.anesthesiology.org

ANESAV is a code word ("coden") used by the Chemical Abstract Service to identify the journal.

Manuscripts submitted for consideration for publication must be submitted in electronic format. The preferred method is via the Journal's Web site (<http://www.anesthesiology.org>). Manuscripts may also be submitted via computer disk and mailed to the Editorial Office or via e-mail (anesthesiology@uiowa.edu). Detailed directions for submissions and the most recent version of the Instructions for Authors can be found on the Web site (<http://www.anesthesiology.org>). A print version of the Instruction for Authors appears in the January and July issues. Books and educational materials should be mailed to David O. Warner, M.D., Department of Anesthesia, Mayo Clinic, 200 First Street SW, Rochester, MN 55905. Requests for permission to duplicate materials published in ANESTHESIOLOGY should be submitted in electronic format, to the Editorial Office (anesthesiology@uiowa.edu). All articles accepted for publication are done so with the understanding that they are contributed exclusively to this Journal and become the property of the American Society of Anesthesiologists, Inc. Statements or opinions expressed in the Journal reflect the views of the author(s) and do not represent official policy of the American Society of Anesthesiologists unless so stated. Advertising and related correspondence should be addressed to Advertising Manager, ANESTHESIOLOGY, Lippincott Williams & Wilkins, 530 Walnut Street, Philadelphia, Pennsylvania 19106 (Web site: <http://www.lww.com/advertisingratecards/>). Publication of an advertisement in ANESTHESIOLOGY does not constitute endorsement by the Society or Lippincott Williams & Wilkins, Inc. of the product or service described therein or of any representations made by the advertiser with respect to the product or service.