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Handbook

HB

# Handbook of Neuroanesthesia

Fifth Edition

Philippa Newfield

James E. Cottrell



Wolters Kluwer  
Health

Lippincott  
Williams & Wilkins

**FIFTH EDITION**

# Handbook of Neuroanesthesia

**Editors**

**Philippa Newfield, MD**

Attending Anesthesiologist  
Department of Anesthesiology  
California Pacific Medical Center  
San Francisco, California

**James E. Cottrell, MD**

Professor and Chairman  
Department of Anesthesiology  
SUNY Downstate Medical Center  
Brooklyn, New York

**Foreword by**

**Steven Giannotta, MD**

Professor and Chairman  
Department of Neurological Surgery  
LAC/USC Medical Center  
Los Angeles, California



**Wolters Kluwer | Lippincott Williams & Wilkins**  
Health

Philadelphia • Baltimore • New York • London  
Buenos Aires • Hong Kong • Sydney • Tokyo

*Acquisitions Editor:* Brian Brown  
*Product Manager:* Maria McAvey  
*Vendor Manager:* Bridgett Dougherty  
*Senior Manufacturing Manager:* Benjamin Rivera  
*Design Coordinator:* Joan Wendt  
*Production Service:* SPi Global

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2nd edition, © 1991 by Little Brown  
Two Commerce Square  
2001 Market Street  
Philadelphia, PA 19103 USA

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Printed in China

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#### **Library of Congress Cataloging-in-Publication Data**

Handbook of neuroanesthesia / editors, Philippa Newfield, James Cottrell ; foreword by Steven Giannotta. — 5th ed.

p. ; cm.

Includes bibliographical references and index.

ISBN 978-1-60547-965-1 (pbk.)

I. Newfield, Philippa. II. Cottrell, James E.

[DNLM: 1. Anesthesia—Handbooks. 2. Neurosurgical Procedures—Handbooks. WO 231]

617.9'6748—dc23

2011044474

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By Frank D. Fasano, MAMS, BFA

Artistic rendition of neuronal apoptosis in brain hippocampus

**FIFTH EDITION**

# Handbook of Neuroanesthesia



## CONTRIBUTORS

### **Eugenia Ayrian, MD**

Assistant Professor of Clinical  
Anesthesiology and Director of  
Neuroanesthesia  
University of Southern California  
Los Angeles, California

### **John A. Barwise, MD**

Assistant Professor of Clinical  
Anesthesiology and  
Neurosurgery  
Vanderbilt University Medical  
Center  
Nashville, Tennessee

### **Audrée A. Bendo, MD**

Professor of Anesthesiology  
Executive Vice-Chairman and  
Director of Neuroanesthesia  
SUNY Downstate Medical Center  
Brooklyn, New York

### **Federico Bilotta, MD, PhD**

Attending Anesthesiologist  
"Sapienza" University of Rome  
Rome, Italy  
Professor of Clinical Anesthesiology  
Albert Einstein College of Medicine  
Bronx, New York

### **Nicolas J. Bruder, MD**

Professor  
Coordonnateur du Pôle Anesthésie-  
Réanimation  
Centre Hospitalier Universitaire  
Timone  
Marseille, France

### **Jean G. Charchafliéh, MD, DrPH**

Associate Professor  
Department of Anesthesiology  
Yale University School of Medicine  
New Haven, Connecticut

### **Daniel J. Cole, MD**

Professor and Chairman  
Department of Anesthesiology  
Mayo Clinic College of Medicine  
Phoenix, Arizona

### **James E. Cottrell, MD**

Professor and Chairman  
Department of Anesthesiology  
SUNY Downstate Medical Center  
Brooklyn, New York

### **Timothy R. Deer, MD**

Clinical Professor of  
Anesthesiology  
West Virginia University School of  
Medicine  
President and CEO of the Center  
for Pain Relief  
Charleston, West Virginia

### **Karen B. Domino, MD, MPH**

Professor  
Department of Anesthesiology and  
Pain Medicine  
University of Washington School of  
Medicine  
Seattle, Washington

**Kristin Engelhard, MD, PhD**

Professor  
Department of Anesthesiology  
Medical Center of the Johannes  
Gutenberg University  
Mainz, Germany

**Alana M. Flexman, MD**

Clinical Assistant Professor  
Department of Anesthesiology,  
Pharmacology, and Therapeutics  
University of British Columbia  
Vancouver, British Columbia,  
Canada

**Elie Fried, MD**

Clinical Associate Professor  
Department of Anesthesiology  
SUNY Downstate Medical Center  
Brooklyn, New York

**Adrian W. Gelb, MD**

Professor and Vice-Chairman  
Department of Anesthesia and  
Perioperative Care  
University of California San Francisco  
San Francisco, California

**Steven L. Giannotta, MD**

Professor and Chairman  
Department of Neurological  
Surgery  
University of Southern California  
Los Angeles, California

**Christine Goepfert, MD**

Instructor  
Department of Anesthesiology  
Washington University School of  
Medicine  
St. Louis, Missouri

**Nadeem A. Hamid, MD**

Attending Anesthesiologist  
Department of Anesthesiology  
Cedars-Sinai Medical Center  
Los Angeles, California

**Rukaiya K. A. Hamid, MD**

Professor of Anesthesiology  
Director of Pediatric Anesthesiology  
Cedars-Sinai Medical Center  
Los Angeles, California

**Ian A. Herrick, MD, MPA**

Director, Quality and Continuing  
Medical Education  
Department of Anaesthesia and  
Perioperative Medicine  
London Health Sciences Centre  
London, Ontario, Canada

**Rosemary Hickey, MD**

Professor of Anesthesiology and  
Director of Neuroanesthesia  
University of Texas Health Science  
Center at San Antonio  
San Antonio, Texas

**Yunfang Joan Hou, MD**

Research Assistant Professor  
Department of Anesthesiology  
SUNY Downstate Medical Center  
Brooklyn, New York

**Sheena M. Howson, MD**

Resident Physician  
Division of Critical Care  
Anesthesiology  
Department of Anesthesiology  
Vanderbilt University Medical Center  
Nashville, Tennessee

**Shailendra Joshi, MD**

Assistant Professor  
Department of Anesthesiology  
Columbia University College of  
Physicians and Surgeons  
New York, New York

**Ira S. Kass, PhD**

Professor of Anesthesiology and  
Physiology and Pharmacology  
SUNY Downstate Medical Center  
Brooklyn, New York

**Saleh A. Khunein, MD**

Consultant Neuroanesthetist  
Department of Anesthesia  
Riyadh Military Hospital  
Riyadh, Saudi Arabia

**M. Sean Kincaid, MD**

Department of Anesthesiology  
and Critical Care  
University of Washington School of  
Medicine  
Seattle, Washington

**Klaus Ulrich Klein, MD**

Attending Physician  
Department of Anesthesiology,  
Intensive Care Medicine,  
and Pain Therapy  
Medical University of Vienna/  
Vienna General Hospital  
Vienna, Austria

**Georges I. Labaze, MD**

Resident Physician  
Department of Internal Medicine  
Brookdale University Hospital  
and Medical Center  
Brooklyn, New York

**Arthur M. Lam, MD**

Medical Director of  
Neuroanesthesia and  
Neurocritical Care  
Swedish Neuroscience Institute  
Seattle, Washington

**Sean D. Lavine, MD**

Assistant Professor of Neurological  
Surgery and Radiology  
Director of Endovascular  
Neurosurgery  
Department of Neurological  
Surgery  
Columbia University College of  
Physicians and Surgeons  
New York, New York

**Melissa A. Laxton, MD**

Assistant Professor  
Department of Anesthesiology  
Wake Forest University School of  
Medicine  
Winston-Salem, North Carolina

**Baiping Lei, MD, PhD**

Assistant Professor  
Department of Anesthesiology  
SUNY Downstate Medical Center  
Brooklyn, New York

**Pirjo Hellen Manninen, MD**

Associate Professor of Anaesthesia  
Director of Neuroanaesthesia  
Toronto Western Hospital  
University Health Network  
Toronto, Ontario, Canada

**Seth Manoach, MD**

Chief Fellow  
Department of Critical Care  
Medicine  
Albert Einstein College of Medicine  
Montefiore Medical Center  
Bronx, New York

**Yvette Marquez, MD**

Resident Physician  
Department of Neurological Surgery  
University of Southern California  
Los Angeles, California

**Mary K. McHugh, MD**

Assistant Professor  
Department of Anesthesiology  
University of Maryland School of  
Medicine  
Baltimore, Maryland

**Cynthia M. Monsey, MD**

Neuroanesthesiology Fellow  
Washington University School of  
Medicine  
St. Louis, Missouri

**Philippa Newfield, MD**

Attending Anesthesiologist  
Department of Anesthesiology  
California Pacific Medical Center  
San Francisco, California

**Clifford Lee Parmley, MD, JD**

Professor of Anesthesiology  
Director, Division of Critical Care  
Department of Anesthesiology  
Vanderbilt University Medical Center  
Nashville, Tennessee

**Deborah S. Pederson, MD**

Instructor  
Department of Anesthesia, Critical  
Care, and Pain Medicine  
Massachusetts General Hospital  
Boston, Massachusetts

**Robert A. Peterfreund, MD, PhD**

Associate Professor of  
Anesthesiology  
Harvard Medical School  
Boston, Massachusetts

**Patricia Harper Petrozza, MD**

Professor  
Department of Anesthesiology  
Wake Forest University School of  
Medicine  
Winston Salem, North Carolina

**Valentina Picozzi, DDS**

Department of Oral Surgery and  
Orthodontics  
University of Milano School of  
Dentistry  
Milano, Italy

**Jason E. Pope, MD**

Napa Pain Institute  
Assistant Professor of  
Anesthesiology  
Vanderbilt University Medical  
Center  
Nashville, Tennessee

**Patrick A. Ravussin, MD**

Professor and Head  
Department d'anesthesiologie et de  
reanimation  
CHCVs Sion Hospital  
Sion, Switzerland

**Irene Rozet, MD**

Associate Professor  
Department of Anesthesiology and  
Pain Medicine  
University of Washington School of  
Medicine  
Veterans Affairs Puget Sound  
Health Care System  
Seattle, Washington

**Takefumi Sakabe, MD**

Professor Emeritus  
Yamaguchi University Graduate  
School of Medicine  
Director of Yamaguchi Rousal  
Hospital  
Yamaguchi, Japan

**David L. Schreiber, MD**

Assistant Professor of  
Anesthesiology  
Director of NeuroCare ICU and  
Intraoperative and  
Neurophysiologic Monitoring  
University of Maryland School of  
Medicine  
Baltimore, Maryland

**Jee Jian See, MD**

Senior Consultant  
Department of Anaesthesiology,  
Intensive Care, and Pain  
Medicine  
Yong Loo Lin School of Medicine  
National University of Singapore  
Singapore



**Gary R. Stier, MD, MBA**

Associate Professor  
Department of Anesthesiology and  
Critical Care  
Loma Linda University Medical  
Center  
Loma Linda, California

**Pekka O. Talke, MD**

Professor and Director of  
Neuroanesthesia  
Department of Anesthesia and  
Perioperative Care  
University of California  
San Francisco  
San Francisco, California

**John M. Taylor, MD**

Assistant Clinical Professor  
Medical Director, Post Anesthesia  
Care Unit and Operating Room  
Support Services  
Department of Anesthesia and  
Perioperative Care  
University of California  
San Francisco  
San Francisco, California

**René Tempelhoff, MD**

Professor of Anesthesiology and  
Neurological Surgery  
Washington University School of  
Medicine  
Chief of Anesthesiology  
Barnes-Jewish Hospital, South  
Campus  
St. Louis, Missouri

**Kishore Tolani, MD**

Anesthesiology Critical Care  
Fellow  
Department of Anesthesiology  
SUNY Downstate Medical  
Center  
Brooklyn, New York

**Concezione Tommasino, MD**

Associate Professor  
Director of Anesthesia for Dental  
Surgery  
Department of Anesthesiology and  
Intensive Care  
University of Milano  
Milano, Italy

**Chelsia L. Varner, MD**

Assistant Professor of Clinical  
Anesthesiology  
University of Southern California  
Los Angeles, California

**Ivan Velickovic, MD**

Assistant Professor  
Director of Obstetrical  
Anesthesiology  
Department of Anesthesiology  
SUNY Downstate Medical  
Center  
Brooklyn, New York

**Binbin Wang, MD**

Attending Anesthesiologist  
Department of Anesthesiology and  
Perioperative Care  
Kaiser Permanente, San Francisco  
San Francisco, California

**Lela D. Weems, MD**

Clinical Assistant Professor  
Department of Anesthesiology  
SUNY Downstate Medical  
Center  
Brooklyn, New York

**Deborah M. Whelan, MD**

Associate Professor  
Department of Anesthesiology  
Wake Forest University School of  
Medicine  
Winston-Salem, North Carolina

**David J. Wlody, MD**

Professor of Clinical

Anesthesiology

Department of Anesthesiology

SUNY Downstate Medical Center

Chief of Anesthesiology Service

SUNY Long Island College Hospital

Brooklyn, New York

**Samrat H. Worah, MD**

Assistant Professor and Director of

Critical Care Anesthesiology

Department of Anesthesiology

SUNY Downstate Medical Center

Brooklyn, New York

**William L. Young, MD**

Professor and Vice-Chairman

Director, UCSF Center for

Cerebrovascular Research

Department of Anesthesia and

Perioperative Care

Professor of Neurological Surgery

and Neurology

University of California

San Francisco

San Francisco, California

The inexorable march of technologic advance in both the clinical neurosciences and anesthesia makes the publication of successive editions of this handbook imperative. From the time of the first edition, dramatic innovations in CNS imaging, minimally invasive therapeutic interventions, and the pharmacology of anesthesia have increased the complexity of neurosurgical care. The reader's attention should be drawn to chapters on deep brain stimulation, awake craniotomy, intraoperative MRI imaging, and anesthesia for interventional radiologic techniques. These cutting-edge treatment paradigms cannot advance without the partnership between neuroanesthesia and neurosurgery.

Along with our ability to develop and implement technical advancements, we must seamlessly integrate initiatives that improve patient safety. Facilitating communication among all members of the OR team assumes primacy in this endeavor. The aviation industry has served as a model to be emulated. The surgical time-out evolved from the checklist methodology, which mandates information transfer among cabin crew. Although the isolated OR time-out serves an important purpose, a neurosurgical procedure can easily take longer than many airline flights. Information transfer remains integral to all phases of the flight/case. We may want to look at the principles of cockpit resource management for inspiration. These include, but are not limited to, team management, situational awareness, assertion and advocacy, stress and fatigue management, error reduction, and leadership strategies.

We remain indebted to Drs. Cottrell and Newfield for their continued efforts at advancing our interrelated disciplines.

**Steven Giannotta, MD**

## PREFACE

It is in the true spirit of cooperation, consultation, and collaboration among neuroanesthesiologists, neurosurgeons, neurointensivists, neurointerventionalists, neuropathologists, neuroradiologists, and neurologists that this fifth edition of the *Handbook of Neuroanesthesia* is offered as a concise and easily accessible compendium of neuroanesthesia and neurocritical care.

The chapters in this Fifth Edition have not only been updated but now most feature clinically relevant illustrative cases along with summaries and chapter highlights. Several new chapters have been added including one on information technology that serves as a reader's guide to online medical resources and search modalities. Other additions include such topics as Parkinson's disease and deep brain stimulation, intraoperative imaging modalities, and the prevention of postoperative neuropathies and visual loss.

The advances in neuroanesthesia and neurocritical care over the past few years can be attributed to the intellectual curiosity, creativity, energy, and determination of the physicians who have worked tirelessly to improve the care of neurosurgical patients. We acknowledge the anesthesiologists who have devoted their careers to advancing the safe and enlightened practice of neuroanesthesia through teaching, research, and clinical care, especially those who have so generously contributed to this volume.

In the midst of our preparation of the Fifth Edition of the *Handbook of Neuroanesthesia*, we were greatly saddened by the passing of Anne Minaidis who had shepherded the first four editions to completion with us. Our gratitude to Christine Waters is boundless for the way in which she stepped right into a foreign landscape, quickly familiarized herself with what had been done thus far, and then worked with the authors, editors, and publisher to see the process of writing and editing through to its conclusion. No detail escaped her notice, no e-mail went unanswered, and no author went uncontacted. We are in her debt for the thorough, professional, and good-humored way in which she approached the work.

In addition, we owe a debt of gratitude to our neurosurgical colleague, Dr. Steven Giannota, who wrote the Foreword to the fifth edition. His recognition of the need for interdisciplinary cooperation, clearly illustrated in his chapter entitled: "Anesthesia and Neurosurgery: A Communication Paradigm," underlines the importance of good communication and teamwork in the operating room, neurointerventional suite, and neurosurgical intensive care unit.

The blending of specialties for a systems-based approach toward total patient care is a goal to which we must all aspire.

Philippa Newfield, MD  
James E. Cottrell, MD, FRCA



## ACKNOWLEDGMENT

To our neuroanesthesiology fellows, in the clinical and research areas, who have added to our knowledge that has contributed to better patient care. Also, thanks to Ira Kass, PhD, who heads our neuroscience efforts in the laboratory and patiently guides our research fellows through.

*Anthony Abadia, MD*  
*Elisabeth Abramowicz, MD*  
*David Acosta, MD*  
*Edwarda Amadeu, MD*  
*Pedro Amorim, MD*  
*Waseem Ashraf, MD*  
*Audrée A. Bendo, MD*  
*Jean Boening, MD*  
*Jean G. Charchafli, MD*  
*Lynette Charity, MD*  
*Dennis Dimaculangan, MD*  
*Elie Fried, MD*  
*Lilya Garber, MD*  
*Bhagwandas Gupta, MD*  
*Joan Hoa, MD*

*Pavel Illner, MD*  
*Michael Kittay, MD*  
*Baiping Lei, MD*  
*Brad Litwak, MD*  
*Gina Matei, MD*  
*Michael Mendeszoon, MD*  
*Myrna I. Morales, MD*  
*James K. Ohn, MD*  
*Janet Pittman, MD*  
*Lesly Pompy, MD*  
*Andrew Robustelli, MD*  
*Hector Torres, MD*  
*Ting Wang, MD*  
*Samrat Worah, MD*

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# 1

## Physiology and Metabolism of the Brain and Spinal Cord

Yunfang Joan Hou and Ira S. Kass

### Illustrative Clinical Case

Ms. Z is a 35-year-old healthy female without a history of hypertension. She was skiing and fell and bumped her head on a patch of ice. She was initially dazed but recovered quickly and felt fine; she continued skiing for an hour. When she went to the lodge for lunch, a headache developed and she took two Advil; this made her feel better. She mentioned her headache to a friend who convinced her to go to the first aid station in the lodge. Her blood pressure was elevated (180/100 mm Hg) and she complained about being tired; the nurse in the aid station recommended she be immediately transported to the hospital. In the ambulance she became increasingly confused and drowsy, her blood pressure reached 240/130 mm Hg, and her heart rate was 48 bpm. The ambulance radioed in for a neurosurgeon and anesthesiologist to be present on arrival of the patient. The patient deteriorated rapidly and was unconscious on arrival in the emergency room (ER). An immediate CT scan indicated a large epidural hematoma. The patient was sent immediately to the operating room for a craniotomy with evacuation of the hematoma.

The bleeding into the epidural space initially used up compliance and displaced volume from other compartments; thus, this increase in volume did not initially increase intracranial pressure (ICP). Once this compliance was exhausted, a small additional increase in volume caused a large increase in ICP. Since cerebral perfusion pressure (CPP) is equal to mean arterial pressure (MAP) minus ICP, blood flow to the brain is reduced. When cerebral blood flow (CBF) is reduced to ischemic levels, there is a strong sympathetic response (Cushing reflex) to increase blood pressure (with a compensatory decrease in heart rate) to maintain cerebral perfusion. This can compensate only up to a certain point beyond which CPP will fall further and lead to severe cerebral ischemia, coma, or even death if ICP is uncontrolled. The increased ICP from the expanding hematoma can also cause herniation of the brain, which can lead to rapid neurologic deterioration or death.

### Chapter Highlights

- Neurons maintain a membrane potential that is mainly influenced by the concentration difference of potassium (K) and sodium (Na) inside and outside of the neuron and the conductance of the membrane to