

*Essentials of*

**Anesthesia  
for  
Neurotrauma**

Edited by  
**Hemanshu Prabhakar  
Charu Mahajan  
Indu Kapoor**

*Essentials of*  
Anesthesia  
for  
Neurotrauma



# Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

*Essentials of*  
**Anesthesia**  
**for**  
**Neurotrauma**

Edited by  
Hemanshu Prabhakar  
Charu Mahajan  
Indu Kapoor



**CRC Press**

Taylor & Francis Group

Boca Raton London New York

---

CRC Press is an imprint of the  
Taylor & Francis Group, an **informa** business

CRC Press  
Taylor & Francis Group  
6000 Broken Sound Parkway NW, Suite 300  
Boca Raton, FL 33487-2742

© 2018 by Taylor & Francis Group, LLC  
CRC Press is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works

Printed on acid-free paper

International Standard Book Number-13: 978-1-138-89507-2 (Hardback)

This book contains information obtained from authentic and highly regarded sources. While all reasonable efforts have been made to publish reliable data and information, neither the author[s] nor the publisher can accept any legal responsibility or liability for any errors or omissions that may be made. The publishers wish to make clear that any views or opinions expressed in this book by individual editors, authors or contributors are personal to them and do not necessarily reflect the views/opinions of the publishers. The information or guidance contained in this book is intended for use by medical, scientific or health-care professionals and is provided strictly as a supplement to the medical or other professional's own judgement, their knowledge of the patient's medical history, relevant manufacturer's instructions and the appropriate best practice guidelines. Because of the rapid advances in medical science, any information or advice on dosages, procedures or diagnoses should be independently verified. The reader is strongly urged to consult the relevant national drug formulary and the drug companies' and device or material manufacturers' printed instructions, and their websites, before administering or utilizing any of the drugs, devices or materials mentioned in this book. This book does not indicate whether a particular treatment is appropriate or suitable for a particular individual. Ultimately it is the sole responsibility of the medical professional to make his or her own professional judgements, so as to advise and treat patients appropriately. The authors and publishers have also attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access [www.copyright.com](http://www.copyright.com) (<http://www.copyright.com/>) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

**Trademark Notice:** Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

---

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

---

Names: Prabhakar, Hemanshu, editor. | Mahajan, Charu, editor. | Kapoor, Indu, editor.  
Title: Essentials of anesthesia for neurotrauma / [edited by] Hemanshu Prabhakar, Charu Mahajan and Indu Kapoor.  
Description: Boca Raton : Taylor & Francis, 2018. | Includes bibliographical references and index.  
Identifiers: LCCN 2017053033 | ISBN 9781138895072 (hardback : alk. paper) | ISBN 9781315166742 (ebook)  
Subjects: | MESH: Trauma, Nervous System--surgery | Anesthesia--methods  
Classification: LCC RD81 | NLM WL 140 | DDC 617.9/6--dc23  
LC record available at <https://lccn.loc.gov/2017053033>

---

Visit the Taylor & Francis website at  
<http://www.taylorandfrancis.com>

and the CRC Press website at  
<http://www.crcpress.com>

*To our parents, teachers, and the greatest gifts my parents gave to me, with whom I share my childhood memories, Kavita and Hemant.*

**Hemanshu Prbhakar**

*To our parents, teachers, and the greatest gifts my parents gave to me, with whom I share my childhood memories, Shelly, Shruti, and Aman.*

**Charu Mahajan**

*To our parents, teachers, and the greatest gifts my parents gave to me, with whom I share my childhood memories, Sunita, Poonam, and Tanzin.*

**Indu Kapoor**



# Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

# Contents

---

<b>Foreword</b>	<b>xi</b>
<b>Preface</b>	<b>xiii</b>
<b>Acknowledgments</b>	<b>xv</b>
<b>Editors</b>	<b>xvii</b>
<b>Contributors</b>	<b>xix</b>
 <b>PART I INTRODUCTION TO NEUROTRAUMA</b>	
<hr/>	
1 Introduction	3
<i>Indu Kapoor, Charu Mahajan, and Hemanshu Prabhakar</i>	
 <b>PART II NEUROANATOMY</b>	
<hr/>	
2 Anatomy of neurotrauma	9
<i>Vasudha Singhal and Sarabpreet Singh</i>	
 <b>PART III NEUROPHYSIOLOGY</b>	
<hr/>	
3 Neurophysiology in neurotrauma	31
<i>Dinu Chandran and Manpreet Kaur</i>	
 <b>PART IV PREANESTHETIC EVALUATION</b>	
<hr/>	
4 Prehospital care	57
<i>Maria J. Colomina, Maylin Koo, and José María Soto-Ejarque</i>	
5 Preanesthetic evaluation	67
<i>Julia Martínez Ocón, Ana Ruiz Pardos, and Ricard Valero</i>	
6 Emergency room resuscitation	75
<i>Marta Magaldi, Luis Reyes, Marina Vendrell, and Ricard Valero</i>	



---

**PART V NEUROSURGERY**

---

7	Extradural hematoma	89
	<i>Emma Temple and Asha Nandakumar</i>	
8	Subdural hematoma	97
	<i>Shanali Thirunavukkarasu and Morfaizan Ahmad</i>	
9	Subarachnoid hemorrhage	107
	<i>Emily G.Y. Koo, Mandy H.M. Chu, Patricia K.Y. Kan, Eunice Y.L. Dai, and Matthew T.V. Chan</i>	
10	Diffuse axonal injury	117
	<i>Marco Echeverria</i>	
11	Cervical spine injury	131
	<i>Ferenc Rabai and Lauren Berkow</i>	
12	Thoracolumbar spine injury	147
	<i>Monica S. Tandon and Priyanka Khurana</i>	

---

**PART VI NEUROMONITORING**

---

13	Monitoring in neurotrauma	185
	<i>Frederick A. Zeiler and Marek Czosnyka</i>	

---

**PART VII NEURORADIOLOGY**

---

14	Neuroradiology in neurotrauma	215
	<i>Zakir Hajat</i>	

---

**PART VIII NEUROINTENSIVE CARE**

---

15	Sedation and analgesia	223
	<i>Paola Cristina Volpi, Barbara Cambiaghi, and Giuseppe Citerio</i>	
16	Nutrition and metabolic care	235
	<i>Swagata Tripathy</i>	
17	Role of antibiotics	243
	<i>Martina Ornaghi, Valentina Ormas, and Daniela Ferlicca</i>	
18	Mechanical ventilation and respiratory care	255
	<i>Bastia Luca, Magni Federico, Pozzi Matteo, and Giuseppe Citerio</i>	
19	Cardiovascular care	267
	<i>Jovany Cruz Navarro, Vibha Mahendra, and Andrew W. Kofke</i>	
20	Neurologic care	285
	<i>Maria Chiara Casadio, Paola Cristina Volpi, and Giuseppe Citerio</i>	
21	Electrolyte disturbances and endocrinal care	295
	<i>Raffaele Di Fenza and Giuseppe Citerio</i>	
22	Neuromuscular care	317
	<i>Ankur Khandelwal and Hemanshu Prabhakar</i>	
23	Systemic care—Renal, hematologic, gastrointestinal	325
	<i>Panumart Manatpon and Andrew W. Kofke</i>	
24	Post-traumatic cognitive dysfunction	341
	<i>Ashima Nehra, Manju Mohanty, and Shivani Sharma</i>	
25	Psychological care	349
	<i>Sara Laxe and Neus Fàbregas</i>	

---

**PART IX SPECIAL CONSIDERATIONS**

---

- 26 Pediatric neurotrauma 363  
*Ankur Khandelwal and Hemanshu Prabhakar*
- 27 Geriatric neurotrauma 379  
*Hossam El Beheiry*
- 28 Pregnancy and neurotrauma 387  
*Alexandra Kisilevsky and Alana M. Flexman*
- 29 Polytrauma 399  
*Mohamed Samy Abdel Raheem*

---

**PART X FLUIDS**

---

- 30 Fluid management 421  
*Shumaila Hasan and Matthew A. Kirkman*
- 31 Coagulopathy and blood transfusions 433  
*Lamia Nayeb and Matthew A. Kirkman*

---

**PART XI PAIN MANAGEMENT**

---

- 32 Pain management 447  
*Athir Morad and Salia Farrokh*

---

**PART XII PALLIATIVE CARE**

---

- 33 Health-related quality of life and palliative care issues in neurotrauma 463  
*Suparna Bharadwaj and Lashmi Venkatraghavan*

---

**PART XIII BRAIN DEATH AND ETHICAL ISSUES**

---

- 34 Brain death and ethical issues 473  
*Chiara Robba and Basil Matta*

---

**PART XIV RECENT ADVANCES**

---

- 35 Recent advances in anesthesia for neurotrauma 489  
*Haley Reis, Onat Akyol, Vadim Gospodarev, Cesar Reis, Gocke Yilmaz, Richard Applegate II, Sheng Chen, and John Zhang*

---

**PART XV CLINICAL PROCEDURES**

---

- 36 Fiber-optic intubation 503  
*Prasanna Udupi Bidkar and K. Narmadhalakshmi*
- 37 Chest drain insertion 517  
*Richa Aggarwal*
- 38 Bronchoalveolar lavage 527  
*Mohan Gurjar*

39	External ventricular drainage <i>Vasudha Singhal</i>	531
40	Lumbar drain <i>Kiran Jangra</i>	539
41	Cranial burr hole <i>Srilata Moningi</i>	553
42	Percutaneous tracheostomy <i>Ankur Luthra</i>	563
43	Immobilization of spine <i>Rajeeb K. Mishra</i>	573
44	Nasogastric tube insertion <i>Zulfiqar Ali</i>	577
45	Intraparenchymal ICP catheter insertion <i>Nidhi Gupta</i>	581

## **PART XVI WEBLIOGRAPHY**

---

46	Summary of Brain Trauma Foundation guidelines (2016) and scales and scores <i>Ankur Khandelwal</i>	593
<b>Index</b>		601

# Foreword

---

## ESSENTIALS OF ANESTHESIA FOR NEUROTRAUMA

---

Globally, neurotrauma represents one of the most important causes of neurodisability. Despite the likely increase in neurodegenerative and cerebrovascular disease over the decades to come, the World Health Organization (WHO) estimates that traumatic brain injury (TBI) and spinal cord injury (SCI) will continue to be important drivers of disability and, hence, will represent important public health targets. This is particularly the case in low- and middle-income countries, where motor vehicle use is increasing at a rate far greater than the population's rate, with a consequent escalation in the burden of death and disability caused by neurotrauma.

Optimization of outcome from neurotrauma not only depends on definitive neurosurgical interventions but also requires skillful and well-informed anesthetic and critical care practice. Such practice can facilitate surgery when required and optimize the physiologic context for recovery from injury.

However, none of the interventions that we use in this context are risk free, and both knowledge and procedural expertise are required to ensure the best balance between the benefits and risks of individual interventions. Furthermore, these interventions need to be embedded in a clinical framework that delivers appropriate and timely care.

Given this context, this textbook, edited by a clinician with substantial expertise and experience in this area, is a welcome development. The contents of this textbook, which represent the output of an expert group of international authors, will help both trainees and specialists to make judgments that maximize benefit and minimize risk, with the result that we not only increase survival from neurotrauma but also improve the quality of this survival.

David K. Menon  
Cambridge, UK



# Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

# Preface

---

Neurotrauma is a preventable public health issue, yet it can have devastating consequences amounting to huge community and economic losses. The timely, proficient anesthetic and surgical management is impetus for improving the outcomes. Yet, there has never been a dedicated book covering all of the aspects of neurotrauma along with the various complications in the past. This book is simple to read and understand and highlights all of the practical aspects of anesthesia for patients with neurotrauma. This book aims to provide an overview of the basics of anesthesia for neurotrauma. Its target audience are trainees and fellows in neuroanesthesia and anesthesia, including physicians associated with neurosurgical and allied branches, such as neurology and neuroradiology. It will be very helpful, especially to those medical practitioners who are providing anesthesia for neurotrauma cases but who have not been formally trained in the subject.

The purpose of this book is to provide basic information on anesthesia for neurotrauma and to explain how the management of different neurotrauma cases may differ, especially those involving the head, spine, and/or polytrauma.

Straightforward issues, such as neurologic examination of such patients and understanding their CT and MRI scans, have been discussed in a simple, easy-to-understand manner. Starting with the prehospital management and resuscitation of these patients, the book covers perioperative management in great detail, including their care. Special considerations, such as pediatric, obstetric, and geriatric patients suffering neurotrauma have been dealt with separately. The less-often discussed issues, such as palliative care and rehabilitation, have also been included to make the readers aware of their importance and necessity. Another highlight is the clinical procedures section, which provides quick and easy access and can be quite helpful for all practical purposes. Thus, this book provides insight into all possible aspects of the anesthetic management of neurotrauma patients. The authors of this book are experts in their fields and we are grateful to all of the contributors who have made this work possible.

Hemanshu Prabhakar  
Charu Mahajan  
Indu Kapoor



# Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

# Acknowledgments

---

We wish to acknowledge the support of the administration of the All India Institute of Medical Sciences (AIIMS), New Delhi, India, for allowing us to conduct this academic task.

We thank the faculty and staff of the Department of Neuroanesthesiology and Critical Care at AIIMS for their support.

Special thanks are due to the production team at CRC Press/Taylor & Francis: Shivangi, Mouli, Ritesh, Rajani, and Sunaina.





# Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

# Editors

---

**Hemanshu Prabhakar** is a Professor in the Department of Neuroanesthesiology and Critical Care at All India Institute of Medical Sciences (AIIMS), New Delhi, India. He received his training in neuroanesthesia at the same institute. Recently, he completed a PhD and now has the honor of being the first PhD (in neuroanesthesia) in India. He is the recipient of the AIIMS Excellence Award for notable contributions in academics. He has more than 250 publications to his credit. He is a reviewer for various national and international journals. He is also a review author for the Cochrane Collaboration and has a special interest in evidence-based practice in neuroanesthesia. Dr. Prabhakar is a member of various neuroanesthesia societies and is a past secretary of the Indian Society of Neuroanesthesia and Critical Care. He is an invited faculty member of numerous conferences, is on the editorial board of the *Indian Journal of Palliative Care*, and is the executive editor of the *Journal of Neuroanaesthesiology and Critical Care*. Dr. Prabhakar has written many book chapters in his area of expertise. He is the editor of *Complications in Neuroanesthesia* (2016) and *Essentials of Neuroanesthesia* (2017), which were published by Elsevier. He is also the editor of the *Manual of Neuroanesthesia* (2017), which has been published by CRC Press/Taylor & Francis.

**Charu Mahajan** is an Assistant Professor in the Department of Neuroanesthesiology and Critical Care at AIIMS, New Delhi, India. After completing a MD in anesthesia, she was awarded a DM

in neuroanesthesia at AIIMS and later joined as a faculty member. She has authored over 60 publications in various national and international journals. She is a reviewer for the Cochrane Collaboration. She also co-edited the book, *Manual of Neuroanaesthesia* (2017), which has been published by CRC Press/Taylor & Francis. She has authored chapters in many books and has received numerous awards for scientific presentations. Dr. Mahajan is a member of various scientific societies and is a reviewer for several reputable scientific journals.

**Indu Kapoor** is an Assistant Professor in the Department of Neuroanesthesiology and Critical Care at AIIMS, New Delhi, India. She received her training in neuroanesthesia at the same institute. She is the recipient of the Dr. T N JHA Memorial Award in 2009, which was awarded by the Indian Society of Anesthesiologists (ISA) in Chennai. She has also received the SMT Chandra and SH Narayan Wadhvani Memorial Award for best outgoing postgraduate in anesthesia at the University College of Medical Sciences, Delhi, in 2010. She has over 35 publications in national and international journals to her credit. She is also a reviewer of national journals and a review author for the Cochrane Collaboration. Dr. Kapoor has a special interest in evidence-based practice in neuroanesthesia. Additionally, she is a member of various national societies and has been an invited faculty member at various national conferences. Dr. Kapoor has written numerous chapters for various national and international books.



# Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

# Contributors

---

**Mohamed Samy Abdel Raheem**

Department of Anesthesiology and Intensive Care  
Asyut University Hospitals  
Asyut University School of Medicine  
Asyut, Egypt

**Richa Aggarwal**

Division of Trauma Surgery and Critical Care  
JPNA Trauma Centre  
AIIMS  
New Delhi, India

**Morfaizan Ahmad**

Department of Anesthesia  
Sheffield Teaching Hospitals  
Sheffield, United Kingdom

**Gocke Yilmaz**

Department of Anesthesiology  
Bahcelievler State Hospital  
Istanbul, Turkey

**Onat Akyol**

Department of Anesthesiology  
University of Health Sciences,  
Istanbul Bagcilar Training and Research Hospital  
Istanbul, Turkey

**Zulfiqar Ali**

Division of Neuroanesthesiology  
and Neurocritical Care  
Sheri Kashmir Institute of Medical Sciences Soura  
Jammu and Kashmir, India

**Richard Applegate II**

Department of Anesthesiology and Pain Medicine  
University of California  
Davis, California

**Lauren Berkow**

Department of Anesthesiology  
Division of Neuroanesthesia  
University of Florida College of Medicine  
Gainesville, Florida

**Suparna Bharadwaj**

Department of Neuroanesthesia and  
Neurocritical Care  
National Institute of Mental Health and  
Neurosciences  
Bangalore, India

**Prasanna Udupi Bidkar**

Department of Anesthesiology and Critical Care  
JIPMER  
Puducherry, India

**Barbara Cambiagli**

School of Medicine and Surgery  
University of Milan–Bicocca  
Milan, Italy

**Maria Chiara Casadio**

School of Medicine and Surgery  
University of Milan–Bicocca  
Milan, Italy

**Matthew T.V. Chan**

Department of Anesthesia and Intensive Care  
The Chinese University of Hong Kong  
Hong Kong Special Administrative Region, China

**Dinu Chandran**

Department of Physiology  
All India Institute of Medical Sciences  
New Delhi, India

**Sheng Chen**

Department of Neurosurgery  
Second Affiliated Hospital  
School of Medicine  
Zhejiang University  
Hangzhou, Zhejiang, China

**Mandy H.M. Chu**

Department of Anesthesia  
Pamela Youde Nethersole Eastern Hospital  
Chai Wan, Hong Kong Special Administrative  
Region, China

**Giuseppe Citerio**

School of Medicine and Surgery  
University of Milan–Bicocca  
Milan, Italy  
and  
Neurointensive Care  
Department of Emergency and Intensive Care  
San Gerardo Hospital  
ASST Monza, Italy

**Maria J. Colomina**

Department of Anesthesiology, Reanimation  
and Pain Clinic  
Hospital Universitari de Bellvitge–Hospitalet  
Universitat de Barcelona  
Barcelona, Spain

**Marek Czosnyka**

Section of Brain Physics  
Division of Neurosurgery  
Addenbrooke's Hospital  
University of Cambridge  
Cambridge, United Kingdom  
and  
Institute of Electronic Systems  
Warsaw University of Technology  
Warsaw, Poland

**Eunice Y.L. Dai**

Department of Imaging and Interventional  
Radiology  
Prince of Wales Hospital  
Hong Kong Special Administrative Region, China

**Raffaele Di Fenza**

School of Medicine and Surgery  
University of Milan–Bicocca  
Milan, Italy

**Marco Echeverria**

Department of Anesthesiology  
Clinical Research  
Wexner Medical Center  
Ohio State University  
Columbus, Ohio

**Hossam El Beheiry**

Department of Anesthesia  
University of Toronto  
Toronto, Ontario, Canada  
and  
Trillium Health Partners  
Mississauga Hospital  
Mississauga, Ontario, Canada

**Neus Fàbregas**

Anesthesiology Department  
Hospital Clínic de Barcelona  
University of Barcelona  
Barcelona, Spain

**Salia Farrokh**

Department of Pharmacy  
The Johns Hopkins Hospital  
Department of Anesthesiology and Critical Care  
Medicine  
The Johns Hopkins School of Medicine  
Baltimore, Maryland

**Magni Federico**

Department of Emergency and Intensive Care  
San Gerardo Hospital  
ASST Monza, Italy

**Daniela Ferlicca**

Department of Emergency and Intensive Care  
San Gerardo Hospital  
ASST Monza, Italy

**Alana M. Flexman**

Department of Anesthesiology, Pharmacology  
and Therapeutics  
University of British Columbia  
Vancouver General Hospital  
Vancouver, British Columbia, Canada

**Vadim Gospodarev**

Department of Physiology and Pharmacology  
Loma Linda University School of Medicine  
Loma Linda, California

**Nidhi Gupta**

Department of Neuroanesthesia  
Indraprastha Apollo Hospital  
New Delhi, India

**Mohan Gurjar**

Department of Critical Care Medicine  
Sanjay Gandhi Postgraduate Institute  
of Medical Sciences  
Lucknow, India

**Zakir Hajat**

Department of Anesthesia and Critical Care  
Royal Hallamshire Hospital  
Sheffield Teaching Hospitals NHS FT  
Sheffield, United Kingdom

**Shumaila Hasan**

The Royal London Hospital  
Barts Health NHS Trust  
London, United Kingdom

**Kiran Jangra**

Department of Anesthesia and Intensive Care  
Postgraduate Institute of Medical Education  
and Research  
Chandigarh, India

**Patricia K.Y. Kan**

Department of Anesthesia and Intensive Care  
Prince of Wales Hospital  
Hong Kong Special Administrative Region, China

**Indu Kapoor**

Department of Neuroanesthesiology  
and Critical Care  
Neurosciences Center  
All India Institute of Medical Sciences  
New Delhi, India

**Manpreet Kaur**

Department of Physiology  
Vardhaman Mahavir Medical College  
and Safdarjung Hospital  
New Delhi, India

**Ankur Khandelwal**

Department of Neuroanesthesiology and Critical  
Care  
Neurosciences Centre  
All India Institute of Medical Sciences  
New Delhi, India

**Priyanka Khurana**

GB Pant Institute of Post Graduate Medical  
Education and Research  
New Delhi, India

**Matthew A. Kirkman**

The National Hospital for Neurology  
and Neurosurgery  
UCL Hospitals NHS Foundation Trust  
Queen Square, London, United Kingdom

**Alexandra Kisilevsky**

Department of Anesthesiology, Pharmacology  
and Therapeutics  
University of British Columbia  
Vancouver General Hospital  
Vancouver, British Columbia, Canada

**Andrew W. Kofke**

Department of Anesthesiology and Critical Care  
and  
Department of Neurosurgery  
University of Pennsylvania  
Philadelphia, Pennsylvania

**Emily G.Y. Koo**

Department of Anesthesiology, Intensive Care  
and Pain Medicine  
Tan Tock Seng Hospital  
Singapore, Singapore

**Maylin Koo**

Department of Anesthesiology, Reanimation  
and Pain Clinic  
Hospital Universitari de Bellvitge–Hospitalet  
Universitat de Barcelona  
Barcelona, Spain

**Sara Laxe**

Brain Injury Department  
Institut Guttmann  
Hospital for Neurorehabilitation  
Barcelona, Spain

**Bastia Luca**

School of Medicine and Surgery  
University of Milan–Bicocca  
Monza, Italy

**Ankur Luthra**

Department of Anesthesia and Intensive Care  
Postgraduate Institute of Medical Education  
and Research  
Chandigarh, India

**Marta Magaldi**

Department of Anesthesiology  
Hospital Clínic de Barcelona  
University of Barcelona  
Barcelona, Spain

**Charu Mahajan**

Department of Neuroanesthesiology  
and Critical Care  
Neurosciences Center  
All India Institute of Medical Sciences  
New Delhi, India

**Vibha Mahendra**

Department of Anesthesiology  
Baylor College of Medicine  
Houston, Texas

**Panumart Manatpon**

Division of Neurocritical Care  
Department of Anesthesiology  
University of Pennsylvania  
Philadelphia, Pennsylvania

**Basil Matta**

Neurosciences Critical Care Unit  
Addenbrooke's Hospital  
University of Cambridge  
Cambridge, United Kingdom

**Pozzi Matteo**

Department of Emergency and Intensive Care  
San Gerardo Hospital  
ASST Monza, Italy

**Rajeeb K. Mishra**

Department of Neuroanesthesiology  
and Critical Care  
All India Institute of Medical Sciences  
New Delhi, India

**Manju Mohanty**

Department of Neurosurgery  
Post Graduate Institute of Medical Education  
and Research  
Chandigarh, India

**Srilata Moningi**

Department of Anesthesia and Intensive Care  
Nizam's Institute of Medical Sciences  
Hyderabad, India

**Athir Morad**

Division of Neurocritical Care  
Department of Anesthesiology  
and Critical Care Medicine  
The Johns Hopkins School of Medicine  
Baltimore, Maryland

**Asha Nandakumar**

Department of Anesthesia  
Royal Hallamshire Hospital  
Sheffield Teaching Hospitals  
NHS Foundation Trust  
Sheffield, United Kingdom

**K. Narmadhalakshmi**

Department of Anesthesiology  
and Critical Care  
JIPMER  
Puducherry, India

**Jovany Cruz Navarro**

Department of Neurology, Division of  
Neurocritical Care  
Department of Anesthesiology and Critical Care  
University of Pennsylvania  
Philadelphia, Pennsylvania

**Lamia Nayeb**

London Postgraduate Medical and Dental  
Education  
London, United Kingdom

**Ashima Nehra**

Clinical Neuropsychology at Neurosciences Centre  
and  
Division of Clinical Psychology  
Department of Psychiatry  
All India Institute of Medical Sciences  
New Delhi, India

**Julia Martínez Ocón**

Department of Anesthesiology  
Hospital Clínic de Barcelona  
University of Barcelona  
Barcelona, Spain

**Valentina Ormas**

School of Medicine and Surgery  
University of Milan–Bicocca  
Milan, Italy

**Martina Ornaghi**

School of Medicine and Surgery  
University of Milan–Bicocca  
Milan, Italy

**Ana Ruiz Pardos**

Department of Anesthesiology  
Hospital Clínic de Barcelona  
University of Barcelona  
Barcelona, Spain

**Hemanshu Prabhakar**

Department of Neuroanaesthesiology  
and Critical Care  
All India Institute of Medical Sciences  
New Delhi, India

**Ferenc Rabai**

Department of Anesthesiology  
Division of Neuroanesthesia  
University of Florida  
College of Medicine  
Gainesville, Florida

**Cesar Reis**

Department of Physiology and Pharmacology  
Loma Linda University School of Medicine  
Loma Linda, California

**Haley Reis**

Department of Physiology and Pharmacology  
Loma Linda University School of Medicine  
Loma Linda, California

**Luis Reyes**

Department of Neurosurgery  
Hospital Clínic de Barcelona  
University of Barcelona  
Barcelona, Spain

**Chiara Robba**

Neurosciences Critical Care Unit  
Addenbrooke's Hospital  
University of Cambridge  
Cambridge, United Kingdom

**Shivani Sharma**

Department of Laboratory Medicine  
Clinical Neuropsychology  
Neurosciences Centre  
All India Institute of Medical Sciences  
New Delhi, India

**Sarabpreet Singh**

Department of Anaesthesia  
Sheffield Teaching Hospitals  
Sheffield, United Kingdom

**Vasudha Singhal**

Medanta  
The Medicity  
Gurgaon, India

**José María Soto-Ejarque**

Cap Territorial RSCC  
Emergències Mèdiques–Departament de Salut  
Generalitat de Catalunya, Spain  
and  
Serveid'Anestesiologia i Medicina Crítica  
Hospital d'Igualada  
and  
University of Barcelona  
Barcelona, Spain

**Monica S. Tandon**

G.B Pant Institute of Post Graduate Medical  
Education and Research  
New Delhi, India

**Emma Temple**

Department of Anesthesia  
Royal Hallamshire Hospital  
Sheffield Teaching Hospitals  
NHS Foundation Trust  
Sheffield, United Kingdom

**Shanali Thirunavukkarasu**

Department of Anesthesia  
Sheffield Teaching Hospitals  
Sheffield, United Kingdom



**Swagata Tripathy**

Department of Anesthesia and Intensive Care  
All India Institute of Medical Sciences  
Bhubaneswar, Odisha, India

**Ricard Valero**

Department of Anesthesiology  
Hospital Clínic de Barcelona  
University of Barcelona  
Barcelona, Spain

**Marina Vendrell**

Department of Anesthesiology  
Hospital Clínic de Barcelona  
University of Barcelona  
Barcelona, Spain

**Lashmi Venkatraghavan**

University of Toronto  
and  
Department of Anesthesia and Pain Medicine  
Toronto Western Hospital  
Toronto, Ontario, Canada

**Paola Cristina Volpi**

School of Medicine and Surgery  
University of Milan–Bicocca  
Milan, Italy

**Frederick A. Zeiler**

Division of Anesthesia  
Addenbrooke's Hospital  
University of Cambridge  
Cambridge, United Kingdom  
and

Section of Neurosurgery  
Department of Surgery  
and  
Clinician Investigator Program  
University of Manitoba  
Winnipeg, Canada

**John Zhang**

Department of Physiology and Pharmacology  
and  
Department of Neurosurgery  
Loma Linda University School of Medicine  
Loma Linda, California