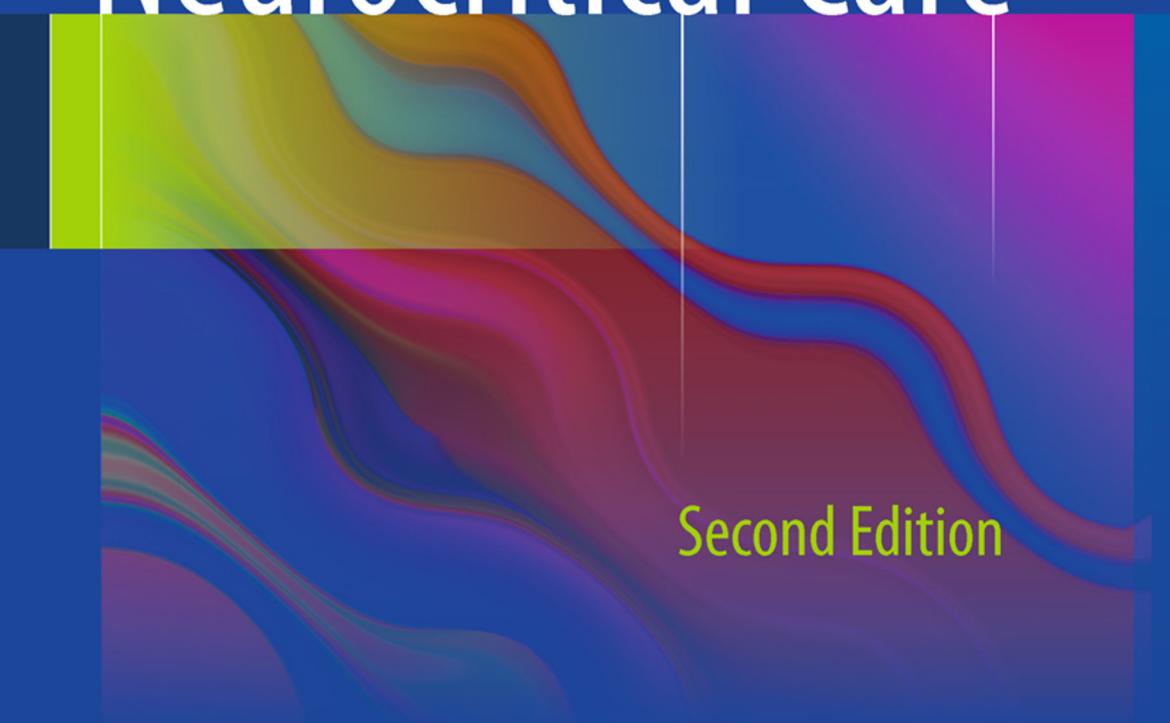
Anish Bhardwaj · Marek A. Mirski *Editors*

Handbook of Neurocritical Care



Second Edition

Springer

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Foreword

Neurocritical Care is a multi-specialty multi-disciplinary field dedicated to improving the care and outcomes of critically ill patients with neurological conditions. It has moved the central nervous system from being an innocent bystander in the management of critically ill patients to a major player. No longer is brain function all but ignored in managing critically ill patients, but rather critical care management is focused on optimizing brain function. This shift in focus has been driven as much by advances in medical knowledge and techniques as by the vision of its practitioners such as the editors and contributors to this second edition of *Handbook of Neurocritical Care*.

Over the past 20 years I have watched the field grow in terms of perceived need, knowledge, and acceptance across a growing number of medical specialties and disciplines. This is clearly evident in this text with contributors from the specialties of neurology, vascular neurology, neurosurgery, interventional neuroradiology, anesthesiology, and medical critical care and the disciplines of nutrition and advanced practice nursing. By bringing together this breadth of expertise to update this concise focused handbook the editors have created a tool useful to practitioners from a wide range of specialties and disciplines who care for critically ill patients.

The format of this handbook lends itself to being easy to use, concise, and to the point. While it is not meant to be comprehensive, it captures the most important key points that are necessary for thoughtful clinical decision making. The tables and figures provide easy to use tools that facilitate rapid evaluation and decision making both for trainees in neurocritical care as well as for experienced practitioners in related fields. This text provides concise practical review of the current state of this rapidly emerging field.

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Preface

In the preface to the first edition of *Handbook of Neurocritical Care*, we commented that neurocritical care as a subspecialty has grown rapidly over the last two decades and has reached a level of maturity with the advent of newer monitoring, diagnostic, and therapeutic modalities in a variety of brain and spinal cord injury paradigms. This growth and maturation are clearly exhibited by the emerging fellowship training programs at various facilities, the recently instituted subspecialty certification examination by the United Council for Neurologic Subspecialties, and the increasing number of critical care units around the world. These major strides in the subspecialty that are commensurate with the goals of "decade of the brain," coupled with the emerging data from clinical series and translational research, occasions another edition of this handbook.

The overarching goal of the handbook remains the same. The operative tenet continues to be that "time is brain," and rapid diagnosis and therapeutic interventions in these challenging patients cannot be overemphasized. The care provided to this subset of critically ill neurologic and neurosurgical patients continues to be interdisciplinary and includes care rendered by colleagues in emergency medical services and emergency medicine, neurologists, neurosurgeons, anesthesiologists, critical care physicians, critical care nurses, nurse practitioners, and physician assistants. The onus lies heavily on first-line physicians and other healthcare providers for early recognition, timely therapeutic interventions, and proper referrals in patients experiencing acute neurologic deterioration. This handbook is not meant to substitute for a full-length text, rather it is intended to serve as a quick-reference guide for those involved in the care of critically ill neurologic and neurosurgical patients. In response to feedback from the readership and colleagues regarding the previous edition, the first section of this edition, which covers general principles, logically progresses into a section regarding specific problems encountered in neurocritical care. We have focused further on management algorithms for making and confirming the clinical diagnosis with appropriate ancillary radiologic and laboratory tests and algorithms for managing acute neurologic diseases. Tables and illustrations provide quick and easy bedside reference. At the end of each chapter, key points and references highlight essential elements and should serve as quick summaries of salient features. We hope that this second edition of the handbook

continues to provide a succinct and practical approach to the management of the critically ill patient population that we serve.

We are indebted to the authors for their valuable contributions and thank Tzipora Sofare, MA, for lending her exceptional editorial skills. We would also like to particularly express our thanks to the Johns Hopkins Clinician Scientist Program, the American Heart Association, the National Stroke Association, and the National Institutes of Health extramural programs; their support has helped to advance our investigative work, aided in the establishment of fellowship training programs in neurosciences critical care, and augmented the much needed advancement of this field.

Anish Bhardwaj, MD, FAHA, FCCM, FAAN
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Special Introduction

This second edition of the *Handbook of Neurocritical Care* is a major revision of the first edition that appeared in 2004. As pointed out by the editors, since that time this field has grown and matured to include many more training fellowships as well as recent sub-specialty certification by the United Council for Neurologic Subspecialties. This handbook has also progressed forward: an expanded yet handy and easy to use reference manual for the management of patients with life threatening neurologic and neurosurgical illnesses. As in the first edition, all of the chapters are made up of bulleted teaching points followed by a list of Key Points and important references allowing for the rapid access to vital information critical for rapid and timely decision making. A major addition to the volume is the first section which covers a myriad of important general principles such as electrolyte derangements, fever and infection, cerebral blood flow, cerebral edema, brain and cardiovascular monitoring, ventilatory management, and sedation and analgesia to mention only a few. The second section covers the major diagnostic categories of neurocritical care with several new topics including neuroleptic malignant syndrome and malignant hyperthermia, meningitis and encephalitis, and intraventricular hemorrhage. Useful algorithms, tables, and illustrations throughout the book assist the decision making process. Whereas most of the contributors to the first edition were colleagues of the editors at the Johns Hopkins Hospitals, an impressive array of new authors has been added from all over the country reflecting the broad scope of this subspecialty. This handbook covers the current state of the art concisely and completely and should find itself into critical care units everywhere. It serves as a useful complement to other monographs in the Humana Press Current Clinical Neurology series such as Critical Care Neurology and Neurosurgery by Jose Suarez, Seizures in Critical Care by Panayiotis Varelas, and Status Epilepticus by Frank Drislane. This second edition is published by Springer, the new parent company of Humana Press. All books in the series can be found at www.springer.com.

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Part I
General Principles of Neurocritical Care

Chapter 1
Establishing and Organizing a Neuroscience Critical Care Unit

Marek A. Mirski

- Goals and benefits for subspecialty neuroscience critical care unit (NCCU)
  - Focused specialty care for unique ICU population
  - Special expertise required by professionals in NCCU – neuroscience background
  - Greater case efficiency of neurosurgical and neurointerventional cases
  - Efficient ICU management
  - Hub of clinical neuroscience communication
  - Academic clinical neuroscience concentration
  - Hospital hub for stroke, acute brain, and spinal cord injury centers
  - Neurocritical-trained nursing
  - Cohesive and comprehensive rounds
  - Neurologic monitoring – capable and savvy
  - Sensitive neurologic evaluations
  - Precisely match therapeutics to neurologic pathophysiology
  - Shorter lengths of stay (LOS) for patient in both the ICU and hospital
  - Improved patient outcomes
  - Increased regional referral network
  - Enhanced marketing strategy
- NCCU requires consensus-driven support from medical center
  - Medical center administration
  - Neurology
  - Neurosurgery
  - Radiology
  - Anesthesiology

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- Probable conflicts must be defined and respected; strategies to overcome conflicts must be defined
  - Administrative and political goals of medical center
  - Other ICU environments – patient selection processes
  - Territorial issues within medical center
  - Potential increase in cost of care per patient
  - Sacrifice in overall ICU bed efficiency
  - Dilution of ICU intensivist coverage pool; more resources are required by medical center
- Physician argument for an NCCU
  - Lines of evidence for improvement in patient outcomes
    - Several published reports in neurologic and neurosurgical ICU patient populations
    - Neurology – for intracranial hemorrhage (ICH), data has been published that compared general ICU care versus NCCU; Cumulative survival enhanced in NCCU (Fig. 1.1)
    - Patients with ischemic stroke – data demonstrates reduced ICU and hospital LOS and improved the disposition of patients
    - Patients with ICH, improvement in outcome as defined by percent of mortality, percent to home, and rehabilitation versus nursing home, despite lower Glasgow Coma Scale score in comparative grouping in NCCU versus general ICU (Fig. 1.2)

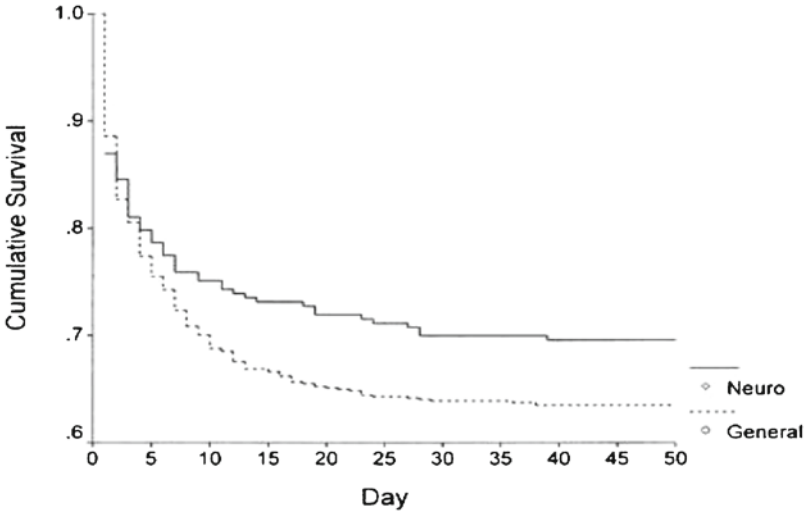

Fig. 1.1 Cumulative survival curve demonstrating a benefit in lower mortality of patients suffering from acute intracerebral hemorrhage that are admitted to and cared for in a neuroscience speciality critical care unit. There is approximately an additional 10 percent survival benefit after a 10 day ICU length of stay. Data from Diringer 2001

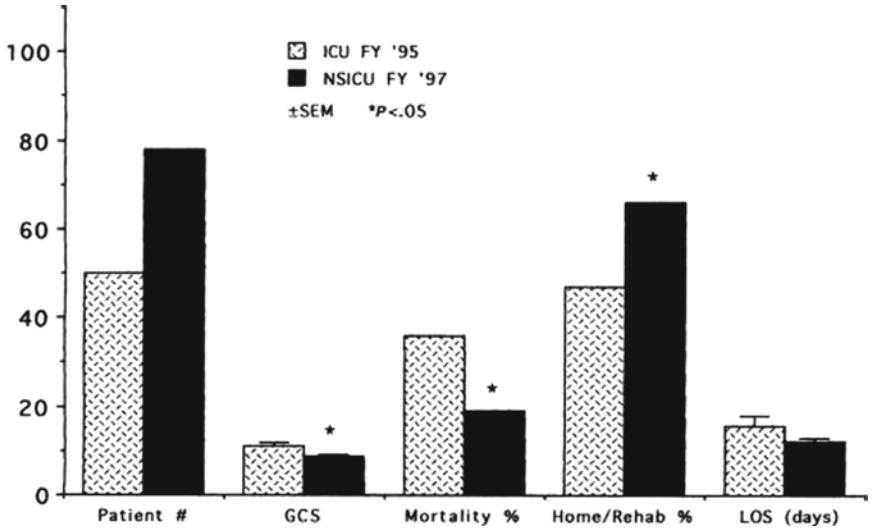

Fig. 1.2 Comparative hospital outcome data from patients with intracerebral hemorrhage (ICH) treated in general medical-surgery intensive care unit (ICU) versus a neuroscience subspecialty ICU (NSICU). GCS = Glasgow Coma Scale score; Rehab = rehabilitation; LOS = total hospital length of stay; SEM = standard error of the mean. Data from Mirski 2001

- ♦ Improvement in ICU efficiency of care and ICU LOS
  - Shorter ICULOS leads to reduction in cost and increased case-load profitability
  - For neurology patients, reduction of LOS from 4.2 ± 4.0 to 3.7 ± 3.4 following development of an NCCU; another series reports a reduction in LOS to 2.0 ± 0.9 NCCU days compared to 3.0 ± 0.2 for comparable patients in MICU
  - For neurosurgery patients, LOS post-craniotomy for tumor and traumatic brain injury reduced post-implementation of specialty NCCU compared to general surgical ICU model of care: (DRG 001-craniotomy; DRG 002-; DRG 027-; DRG 028-) (Fig. 1.3)

- ■ Hospital argument for NCCU
  - ♦ Improvement in ICU efficiency of care and cost of care
    - Subspecialty intensivist can minimize cost of services due to recognition of patient condition and diagnoses based on precise and focused examination and interpretation of findings; e.g., reduction of imaging requisitions and lower cost of pharmaceuticals can be expected with expertise at bedside (Fig. 1.4)
    - Further subdivision among costs for imaging studies, pharmacy, and laboratory testing found reduction across all aspects of clinical management