

THE NEW YORK SCHOOL OF REGIONAL ANESTHESIA

**Hadzic's** TEXTBOOK OF  
**Regional Anesthesia**  
AND ACUTE PAIN MANAGEMENT

Second Edition



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**Admir Hadzic**

The New York School of Regional Anesthesia

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REGIONAL ANESTHESIA AND  
ACUTE PAIN MANAGEMENT**

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The New York School of Regional Anesthesia

# HADZIC'S TEXTBOOK OF REGIONAL ANESTHESIA AND ACUTE PAIN MANAGEMENT

**SECOND EDITION**

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*This book is dedicated to Dr. Steven Dewaele (1974–2016), for he, the Ironman and essential marine of NYSORA's team, has inspired many by his zeal for life and the dedication with which he pursued everything he aimed at.*



"The most dangerous risk of all is the risk of spending your life not doing what you want on the bet that you can buy yourself the freedom to do it later."

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# PREFACE

The first edition of *NYSORA's Textbook of Regional Anesthesia and Acute Pain Management* (McGraw-Hill, 2007) was a compendium of knowledge in regional anesthesia and acute pain medicine that quickly became a gold standard for students, practitioners, and test-takers alike. Yet, clinical practice marches on, and over 200 key opinion leaders and the worldwide community of NYSORA's educators worked diligently over the past 4 years to update the first edition. It is now my privilege to present the second edition of the textbook.

The material in this edition has been organized into thematic sections. Writings on history of local and regional anesthesia is often unjustly limited to its very beginnings in the late 1800s and early 1900s. However, a great deal of innovative and pioneering work has taken place in more recent history, that is now featured in the current edition. We have added numerous new anatomical dissections, diagrams, and functional anatomy illustrations developed by the NYSORA team for practitioners of regional anesthesia and pain medicine. NYSORA's teaching of these techniques is based on the principles of injecting local anesthetics within connective tissue sheaths; consequently, significant effort was invested in functional regional anesthesia anatomy and in illustrations that demonstrate the importance of this concept. Sections on connective tissues and the ultrastructural anatomy of the neuraxial meninges were contributed by a group of Spanish collaborators, led by Dr Miguel Angel Reina. Their sections represent a collection of uniquely educational electron microscopic images that offer insights into the mechanisms of neural blockade, causes of failures and the anatomical basis for vulnerability of neural structures to anesthesiology interventions. I believe that these sections and their timeless images will remain relevant for generations of students to come.

The section on pharmacology features exciting information that is emerging on controlled-release local anesthetics that extend the analgesic benefits of neural blockade. New knowledge on this topic is being published as this textbook is being printed; the reader is suggested to check the latest relevant literature to complement the information that was available at the time of publication.

The section on equipment for peripheral nerve blocks features an expanded chapter on new equipment, such as the development of needles and catheters and novel equipment for needle-nerve and injection monitoring. For instance, Chapter 14 gives an overview of the role of peripheral nerve stimulation in modern practice of ultrasound-guided peripheral nerve blocks and step-by-step algorithms to facilitate understanding of this often-confusing topic.

New to the second edition is an entire section on patient management considerations and regional anesthesia pathways. In Chapter 15, Dr Barrington's team contributes a didactic

outline of the steps and processes toward evidence-based clinical pathways that incorporate big data, such as building pathways for specific surgical populations. The section also features two chapters on the effect of local anesthetics and regional anesthesia on cancer recurrence. The immune system and how it can be influenced by surgery and anesthesia are evaluated for possible mechanisms by which regional anesthesia could confer benefits in patients with cancer in Chapters 17 and 18.

Part 3B discusses the clinical practice of regional anesthesia, starting with local and infiltration anesthesia. Dr Raeder's team describes the use of local anesthetics for intra-articular and periarticular infiltration (Chapter 19), and Dr Imran Ahmad shares a wealth of clinical and teaching experience on the use of local anesthetics and ultrasound technology for airway management (Chapter 20).

Intravenous regional (Bier) blocks are still practiced worldwide. A revised chapter on intravenous regional anesthesia for upper and lower extremity surgery was contributed by Dr Alon Winnie and his former students. The chapter features an updated reference list and step-by-step guidance for clinical practice.

In Part 3C, the chapters on neuraxial and epidural anesthesia have been thoroughly updated and feature a wealth of anatomical, practical, and clinical considerations, including complications and their management. A new chapter on the etiology and management of failed spinal anesthesia is highly practical and will be of interest to both students and practitioners of anesthesiology (Chapter 23A). The chapter on epidural anesthesia contributed by Drs Toledano and Van de Velde features vast amount of physiologic, pharmacologic, and practical management information, and it is a good example of the efforts invested in making this edition of the textbook up-to-date.

Chapter 27 on postdural puncture headache now includes a number of electron microscopic images that facilitate understanding of the underlying pathophysiology and instructional diagrams that guide treatment.

Part 3D focuses on the latest techniques and information pertaining to ultrasound-guided nerve blocks. Beginning with equipment and the physics behind image optimization and artifact reduction, the chapters progress to the practical aspects of ultrasound-guided techniques for peripheral nerve blocks of the upper and lower extremities (Chapters 33A–33H) and for truncal blocks (Chapters 34 and 35). The techniques of locoregional anesthesia for maxillofacial and eye surgery have also been updated with highly illustrative, all-new NYSORA illustrations that we developed over the past 3 years. Chapters 39 and 40 focus on ultrasound imaging of the paravertebral and neuraxial space.

The sections on pediatric regional anesthesia and the utility of ultrasound have been greatly expanded by some of most

respected practitioners and educators in pediatric anesthesiology and perioperative care.

Part seven features updated and much expanded chapters on the practice of regional anesthesia in patients with specific considerations and comorbidities.

The etiology of and avoiding complications of regional anesthesia are topics of great interest for practitioners of regional anesthesia. Part 9 discusses the mechanisms of and evidence-based recommendations on how to improve the management of patients with neurologic complications, including sections on advances in monitoring and medicolegal documentation.

Medical care is increasingly driven by evidence-based and cost-effectiveness considerations. Consequently, several chapters address the principles of pharmacoeconomics as they relate to regional anesthesia, rehabilitation, and postoperative outcome.

Part 12 of the book discusses the principles and practice of acute pain management, organization of the acute pain service, the role of intravenous patient-controlled analgesia and perineural catheters, and the epidemiology of pain. Special consideration was given to multimodal analgesia and pharmacologic interventions that increase patient's experience of anesthesia and surgery may have a role in preventing persistent postoperative pain (Chapter 75).

Part 13 focuses on education in regional anesthesia and the development of regional anesthesia fellowship programs in the United States.

Although the current trend toward ultrasound guidance is likely to become the most prevalent method of delivering most regional anesthesia techniques in the developed world, surface-based and electrical nerve stimulation techniques will likely continue to be practiced in many geographic areas without expertise ultrasound equipment. Because this edition was envisioned as a standardized text for global education in regional

anesthesia and acute pain medicine, for completeness we opted to include principles of peripheral nerve blockade without ultrasound guidance (Part 15). These sections have been thoroughly updated from the previous edition, many practice updates being adopted from what we have learned utilizing ultrasound guidance. These chapters also include fascinating historical perspectives on the development of peripheral nerve block techniques throughout decades passed and how advances in anatomical, pharmacologic, and equipment influenced their developments. The chapters also contain a wealth of anatomical information, teaching diagrams, and illustrations that add meaningful value to this textbook regardless of the needle guidance and techniques methods.

Finally, the book features two practical appendices. Appendix 1 contains a pragmatic guide for the use of regional anesthesia in the anticoagulated patient adopted for practices in Europe. The Appendix 2 illustrates the principles of disposition of injectates in tissue sheaths in common regional anesthesia techniques, contributed by a true pioneer in this area, Dr Philippe Gautier (BE).

No book is complete or without unavoidable errors regardless of the efforts invested. However, I believe that we have put together one of the most comprehensive texts on regional anesthesia and pain medicine to date and have spared no efforts to accomplish this. I thank and sincerely congratulate all collaborators and cordially invite readers to send along any discrepancies or suggestions to [ana.lopez.517@gmail.com](mailto:ana.lopez.517@gmail.com). As with the first edition, we will do our best to use the feedback to improve the textbook in a future edition to come a few years from now.

Respectfully,  
*Prof. Admir Hadzic*

# ACKNOWLEDGMENTS

Writing a textbook is an overwhelming endeavor; only those who have undertaken the work on a book can understand the efforts and the sacrifice that it entails. Throughout the couple of years it took to compile the new information and collaborate with such a large group of opinion leaders, researchers, and educators, a number of outstanding individuals were crucial to its successful completion.

Sincerest appreciation to my wife, life and work partner, Dr Catherine Vandepitte, without whose wisdom, advice, and esthetic guidance this book would not see the light of the day.

Huge thanks go to NYSORA's incredible illustrator, Vali Lancea. Thank you to Dr Monika Golebiewski's impeccable organizational skills, eye for detail, and beyond-describable work ethics, Monika was truly instrumental in tying the loose ends in the final push to complete this project.

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and nurses at ZOL Anesthesiology; and more. Many thanks to Dr Alex Visan for his advice on the economics of regional anesthesia as well. Thank you to all current and former NYSORA fellows who have inspired much of the work.

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Finally, thank you to the amazing managing editor, Brian Belval; your professionalism, common sense, and experience have provided the crucial guidance for this book to come together. Combined with co-managing editor Christie Naglieri, the production supervisor Catherine H. Saggese, and production manager Sonam Arora, we had the best team possible to make this book the gold standard it inspires to be.

*Prof. Admir Hadzic*

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PART 1  
**HISTORY**