Understanding Epilepsy
Understanding Epilepsy

A Study Guide for the Boards

Edited by

Vibhangini S. Wasade, MD
Senior Staff Neurologist Henry Ford Medical Group – HFHS
Detroit, MI, USA
Clinical Associate Professor,
Wayne State University
MI, USA

Marianna V. Spanaki, MD, PhD, MBA
Senior Staff Neurologist Henry Ford Medical Group – HFHS
Detroit, MI, USA
Clinical Associate Professor,
Wayne State University
MI, USA
Vibhangini S. Wasade
To my parents, Kamal and Murlidhar Bobde, who instilled curiosity for knowledge in me from a very young age, and encouraged intellectual and educational development, with their everlasting affection.

To my husband Sanjay and son Vedant, for their infinite love, inexhaustible patience, understanding and support, who make things seem simpler and easier.

To my sisters, Mrinal and Charu, for their genuine caring, motivation, with whom I have shared my life’s great experiences and learned.

Marianna V. Spanaki
To my father who taught me how far kindness, resilience, empathy, and love for people can take us in life.
Contents

List of Contributors  ix
Preface  xiii

1. Pathophysiology of Epilepsy  1
   Kenneth Jenrow and Kost Elisevich

2. Physiologic Basis of Epileptic EEG Patterns  19
   L. John Greenfield Jr. and Sang-Hun Lee

3. Pathology of the Epilepsies  39
   Kamal Shouman and William J. Kupsky

4. Classifications of Seizures and Epilepsies  58
   Anthony L. Fine, Elaine C. Wirrell, and Katherine C. Nickels

5. Electro-clinical Syndromes and Epilepsies in the Neonatal Period, Infancy, and Childhood  77
   Jules E. C. Constantinou

6. Familial Electro-clinical Syndromes and Epilepsies in Adolescence to Adulthood  110
   Elie Abdelnour, Monisha Sachdev, and Mohamad Mikati

7. Distinctive Constellations and Other Epilepsies  127
   Ashley E. Thomas, Wolfgang G. Muhlhöfer, and Jerzy P. Szafarski

8. Seizures Not Diagnosed as Epilepsy  165
   Michael DiSano, Elia Pestana-Knight, and Ajay Gupta

9. Nonepileptic Spells  176
   Tasleema Khan and Selim Benbadis

10. Status Epilepticus  189
    Chandan B. Mehta, Paul Brady, and Shailaja Gaddam

11. EEG Instrumentation and Basics  203
    Amit Ray and Naoum P. Issa

12. Interpreting the Normal Electroencephalogram of an Adult  223
    Vibhangini S. Wasade

13. Ictal and Interictal Epileptiform Electroencephalogram Patterns  239
    Alma Yum and Vladimir Shvarts

14. Neonatal and Pediatric Electroencephalogram  251
    Basanagoud Mudigoudar, Stephen Fulton, Sarah Weatherspoon, and James W. Wheless

15. Scalp Video-EEG Monitoring  290
    Maria Stefanidou

16. Intracranial EEG Monitoring  304
    Marc R. Nuwer, Dawn Eliashiv, and John Stern

17. Neuroimaging in Epilepsy  326
    Andrew Zillgitt

18. The Role of Neuropsychology in Epilepsy Surgery  346
    Brent A. Funk and Dana R. Connor

19. Principles of Antiseizure Drug Management  357
    Georgia Montouris
## Contents

20. **Gender Issues in Epilepsy**  368  
   Patricia E. Penovich

21. **Antiseizure Drugs**  386  
   Sidrah Mahmud and Richard H. Mattson

22. **Surgical Therapies for Epilepsy**  417  
   Rushna Ali and Ellen L. Air

23. **Stimulation Therapies for Epilepsy**  432  
   David King-Stephens and Peter Weber

24. **Practical and Psychosocial Considerations in Epilepsy Management**  442  
   Russell A. Derry

25. **Comorbidities with Epilepsy**  450  
   Ramon Edmund D. Bautista, Shannon M. LaBoy, Imran Farooqui, and Samuel S. Giles

26. **System-Based Issues in Epilepsy**  463  
   Yeeck Sim and David M. Labiner

---

*Index*  468
Contributors

Elie Abdelnour, MD
Division of Pediatric Neurology
Duke Children's Hospital and Health Center
Durham, NC, USA

Ellen L. Air, MD, PhD, FAANS
Co-Director Functional Neurosurgery
Department of Neurosurgery
Henry Ford Hospital, Detroit, MI, USA

Rushna Ali, MD
Department of Neurosurgery
Spectrum Health Medical Group
Grand Rapids, MI, USA

Ramon Edmundo D. Bautista, MD, MBA
Professor and Associate Chairman of Neurology
Director, Comprehensive Epilepsy Program
University of Florida Health Sciences Center Jacksonville
Jacksonville, Florida, USA

Selim Benbadis, MD
Professor of Neurology and Director Comprehensive Epilepsy Program
University of South Florida and Tampa General Hospital
Tampa, FL, USA

Paul Brady, MD
Fellow
Neuro-Intensive Care Unit
Henry Ford Hospital
Detroit, MI, USA

Dana R. Connor, PhD
Neuropsychologist
Henry Ford Health System
Detroit, MI, USA

Jules E. C. Constantinou, MB ChB, FRACP
Division Head, Pediatric Neurology
Henry Ford Health System
Detroit, MI, USA
and
Clinical Associate Professor
Wayne State University
Detroit, MI, USA

Russell A. Derry, MPH
Director of Education
Epilepsy Foundation of Michigan
Southfield, MI, USA

Michael DiSano, MD
Fellow Pediatric Epilepsy
Cleveland Clinic
Cleveland, OH, USA

Dawn Eliashiv, MD
Professor, Department of Neurology
David Geffen School of Medicine at UCLA
Co-director, UCLA Seizure Disorder Center
UCLA Department of Neurology
Los Angeles, CA, USA

Kost Elisevich, MD, PhD
Chair
Department of Clinical Neurosciences
Spectrum Health, Grand Rapids, MI, USA
Michigan State University, MI, USA

Imran Farooqui, MD
University of Florida Health Sciences Center Jacksonville
Jacksonville, Florida, USA

Anthony L. Fine, MD
Instructor
Division of Child and Adolescent Neurology
Department of Neurology
Mayo Clinic, Rochester, MN, USA
### List of Contributors

**Stephen Fulton, MD**  
Associate Professor of Neurology and Pediatrics  
University of Tennessee Health Science Center  
Le Bonheur Comprehensive Epilepsy Program  
Le Bonheur Children's Hospital  
Memphis, TN, USA

**Brent A. Funk, PhD**  
Neuropsychologist  
Henry Ford Health System  
Detroit, MI, USA

**Shailaja Gaddam, MD**  
Senior Staff Neurologist  
Henry Ford Hospital  
Detroit, MI, USA

**Samuel S. Giles, MD**  
University of Florida Health Sciences Center Jacksonville  
Jacksonville, Florida, USA

**L. John Greenfield Jr., MD, PhD**  
Professor and Chair of Neurology  
UConn Health  
Farmington, CT, USA  
and  
Department of Neurology  
University of Arkansas for Medical Science  
Little Rock, AR, USA

**Ajay Gupta, MD**  
Associate Professor  
The Cleveland Clinic Lerner College of Medicine  
Case Western Reserve University  
and  
Section Head of Pediatric Epilepsy  
Epilepsy Center/Neurological Institute  
Cleveland, OH, USA

**Naoum P. Issa, MD, PhD**  
Department of Neurology and Adult Epilepsy Center

**University of Chicago**  
Chicago, IL, USA

**Kenneth Jenrow, PhD**  
Associate Professor of Neuroscience  
Department of Psychology  
Central Michigan University  
Mt. Pleasant, MI, USA

**Tasleema Khan, MD**  
Fellow  
Yale University  
New Haven, CT, USA

**David King-Stephens, MD**  
Medical Director  
Sutter Pacific Epilepsy Program at California Pacific Medical Center in San Francisco, CA, USA

**William J. Kupsky, MD**  
Professor of Pathology  
Wayne State University School of Medicine  
Detroit, MI, USA

**David M. Labiner**  
Professor and Head of Neurology  
Department of Neurology  
University of Arizona, Tuscon, AZ, USA

**Shannon M. LaBoy, MD, MSMS**  
University of Florida Health Sciences Center Jacksonville  
Jacksonville, Florida, USA

**Sang-Hun Lee, PhD**  
Department of Neurology  
University of Arkansas for Medical Science  
Little Rock, AR, USA

**Sidrah Mahmud, MD**  
Epilepsy and Clinical Neurophysiology Fellow  
Yale University School of Medicine  
New Haven, CT, USA

**Richard H. Mattson, MD**  
Professor Emeritus of Neurology  
Yale University School of Medicine  
New Haven, CT, USA
Chandan B. Mehta, MD
Staff Neuro-Intensivist
Henry Ford Hospital
Detroit, MI, USA

Mohamad Mikati, MD
Wilbur C. Davison Professor of Pediatrics
Professor of Neurobiology
Chief, Division of Pediatric Neurology and Developmental Medicine
Director of Pediatric Epilepsy Program
Duke University Medical Center
Durham, NC, USA

Georgia Montouris, MD
Clinical Associate Professor of Neurology
Boston University School of Medicine
Director of Epilepsy Services
Boston Medical Center
Boston, MA, USA

Basanagoud Mudigoudar, MD
Assistant Professor of Pediatric Neurology
University of Tennessee Health Science Center
Le Bonheur Comprehensive Epilepsy Program
Le Bonheur Children’s Hospital
Memphis, TN, USA

Wolfgang G. Muhlhofer, MD
Assistant Professor
UAB Epilepsy Center
Birmingham, AL, USA

Katherine C. Nickels, MD
Associate Professor
Divisions of Child and Adolescent Neurology and Epilepsy
Department of Neurology
Mayo Clinic, Rochester,
MN, USA

Marc R. Nuwer, MD, PhD
Professor and Vice Chair, Department of Neurology

Department Head, Department of Clinical Neurophysiology
Ronald Reagan UCLA Medical Center
Los Angeles, CA, USA

Patricia E. Penovich, MD
Minnesota Epilepsy Group PA
Adjunct Professor
Department of Neurology
University of Minnesota
St Paul, MN, USA

Elia Pestana-Knight, MD
Staff Pediatric Epilepsy
Cleveland Clinic
Cleveland, OH, USA

Amit Ray, MD
Director Neurology and Epilepsy Program
Aurora Healthcare
Kenosha WI, USA

Monisha Sachdev, MD
Yale University
New Haven, CT, USA

Kamal Shouman, MD
Fellow, Division of Autonomic Disorders
Department of Neurology
Mayo Clinic, Rochester
MN, USA

Vladimir Shvarts, MD
Director of Epilepsy and Clinical Neurophysiology Fellowship
Director of Intraoperative Monitoring Program
Assistant Professor of Clinical Neurology
Barrow Neurological Institute
Associate Professor of Neurology
Creighton Medical School
and
Associate Professor of Neurology
University of Arizona, Phoenix,
AZ, USA
List of Contributors

Yeeck Sim, MD
Department of Neurology
University of Arizona, Tucson, AZ, USA

Maria Stefanidou, MD, MSc
Assistant Professor of Neurology
Boston University School of Medicine
Boston, MA, USA

John Stern, MD
Professor, Department of Neurology
David Geffen School of Medicine at UCLA
Co-director, UCLA Seizure Disorder Center
UCLA Department of Neurology
Los Angeles, CA, USA

Jerzy P. Szaflarski, MD
Professor of Neurology and Neurobiology and Director
UAB Epilepsy Center
Birmingham, AL, USA

Ashley E. Thomas, MD
Assistant Professor
UAB Epilepsy Center
Birmingham, AL, USA

Vibhangini S. Wasade, MD
Senior Staff Neurologist, Henry Ford Hospital
Detroit, MI, USA
Clinical Associate Professor
Wayne State University
Detroit, MI, USA

Sarah Weatherspoon, MD
Assistant Professor of Neurology and Pediatrics
University of Tennessee Health Science Center
Le Bonheur Comprehensive Epilepsy Program

Le Bonheur Children’s Hospital
Memphis, TN, USA

Peter Weber, MD
Surgical Director
Sutter Pacific Epilepsy Program at California Pacific Medical Center in San Francisco, CA, USA

James W. Wheless, MD
Professor and Chief of Pediatric Neurology
Le Bonheur Chair in Pediatric Neurology
University of Tennessee Health Science Center
Director, Le Bonheur Comprehensive Epilepsy Program and Neuroscience Institute
Le Bonheur Children’s Hospital
Memphis, TN, USA

Elaine C. Wirrell, MD
Professor
Divisions of Child and Adolescent Neurology and Epilepsy
Department of Neurology,
Mayo Clinic, Rochester, MN, USA

Alma Yum, MD
Assistant Professor
Department of Neurology
Denver Health Medical Center and The University of Colorado Denver,
CO, USA

Andrew Zillgitt, DO
Director
Adult Epilepsy Program
Associate Professor
Oakland University
Beaumont School of Medicine,
Royal Oak, MI, USA
Preface

Epilepsy is one of the oldest recognized neurological conditions dating back to 2000 BC. Historical reports have documented famous people suspected to suffer from the disease. They come from all realms of vocation, from leaders (Julius Caesar, President Roosevelt), philosophers (Socrates), authors (Fyodor Dostoevsky, Charles Dickens), poets (Lord Byron), athletes (Glover Cleveland Alexander, Florence Griffith Joyner), artists (Vincent van Gogh), actors (Richard Burton, Hugo Weaving) and singers (Susan Boyle, Lil Wayne) to name a few. Epilepsy remains one of the most common neurological conditions affecting nearly 50 million people worldwide. Development in epilepsy management started occurring 100 years ago in the diagnostic field after Hans Berger invented electroencephalography (EEG), and most remarkably after the advent of magnetic resonance imaging (MRI) and other diagnostic tests in the past few decades. Since then, plentiful medications with novel mechanisms of action and minimal side effects have been available.

The information about epilepsy is vast and easily accessible via digital media on the internet. Numerous books have been published for those interested in epilepsy, varying from reference textbooks delving deeper in the field to those with practical approaches and primers. There are books that focus on EEG and are popular EEG atlases, and other books that review technical aspects of EEG or clinical aspects of epilepsy. Being involved in the fellowship program at Henry Ford Hospital, we realized the need for a book to aid our trainees during their rotation. This book will help bridge this gap for those preparing for board certification as well as those fellows, residents, physicians, or nurse practitioners who want to learn more about epilepsy and EEG in a more methodical fashion. The topics aim to comprehensively cover the field of epilepsy so as to eliminate the necessity of surfing multiple books to grasp the subject. This book will provide a more updated, systematic, and comprehensive approach to understanding epilepsy.

This book represents the work of our authors in their field of expertise. We are deeply grateful to each one of them for their time, hard work, and commitment to our effort.

We are very thankful to Stephanie Stebens from Henry Ford library services for her invaluable viewpoints and support. We would like to acknowledge the encouragement and input we received from Anna Whiting from Cambridge University Press during critical steps in the process of this project, and the ongoing help from Emily Jones, Nigel Graves, and the entire team at Cambridge University Press. Without their support, this book would not have been brought into existence. Lastly, our husbands – Sanjay and Panayiotis – who have been forever inspiring with no limits, stepping up to support us; our children – Vedant and Eleni – with whom we couldn’t spent much time, but did marvelously in our absence and have matured beyond their years; encouraging siblings and doting parents, all comforting and positive throughout – we thank and love you all!