Treatment-Related Stroke

Including Iatrogenic and In-hospital Strokes
Treatment-Related Stroke

Including Iatrogenic and In-Hospital Strokes

Edited by

Alexander Tsiskaridze
Professor, Department of Neurology, Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia

Arne Lindgren
Professor of Neurology, Department of Clinical Sciences, Lund University, Sweden; Senior Consultant, Department of Neurology and Rehabilitation Medicine, Skåne University Hospital, Lund, Sweden

Adnan I. Qureshi
Executive Director, Zeenat Qureshi Stroke Institute, St Cloud, MN; Professor of Neurology, Neurosurgery, and Radiology, University of Minnesota, Minneapolis, MN, USA
To our families and mentors.
Contents

List of contributors ix
Preface xi

Section I–iatrogenic ischemic strokes: peri- and postoperative strokes

1 Stroke after general surgery 1
Magdy Selim and Arne Lindgren

2 Stroke after open arterial surgery 12
David Bergqvist and Björn Kragsterman

3 Postoperative stroke in neurosurgery 23
Federico Landriel, Pablo Ajler and Claudio Yampolsky

4 Vasospasm and delayed cerebral ischemia in aneurysmal subarachnoid hemorrhage 33
Fernando D. Goldenberg, Mario D. Terán and Federico Landriel

5 Stroke occurring on medical wards 47
David J. Blacker

6 Stroke in trauma patients 58
David J. Blacker

Section II–iatrogenic ischemic strokes: stroke after endovascular procedures

7 Stroke associated with endovascular procedures 63
Nabeel A. Herial, Mushtaq H. Qureshi and Adnan I. Qureshi

8 Stroke after diagnostic endovascular procedures 89
Anastasiis Mpotsaris and Tommy Andersson

9 Stroke after endovascular cardiac procedures and cardiothoracic surgery 97
Christian Weimar and Stephan C. Knipp

10 Stroke after carotid revascularization procedure 106
Andrei V. Alexandrov, Kristian Barlinn and Robert Mikulik

Section III–iatrogenic ischemic strokes: other causes

11 Radiation therapy and stroke 113
Jelle Demeestere and Vincent Thijs

12 Stroke after chiropractic manipulations 123
Lars Neeb and Uwe Reuter

13 Stroke due to air and fat embolism 130
Fernando de M. Cardoso and Gabriel R. de Freitas

14 Stroke after discontinuation of preventive medications 144
Jelle Demeestere and Vincent Thijs

Section IV–iatrogenic hemorrhagic strokes: thrombolysis-related hemorrhagic strokes

15 Intracranial hemorrhage: complication of endovascular therapy for acute stroke 155
Muhib Alam Khan and Rushna Ali

16 Intracranial hemorrhage: complication of intravenous thrombolysis 162
Norbert Nighoghossian
Contents

Section V–Iatrogenic hemorrhagic strokes: intracranial bleeding
17 Intracranial hemorrhages secondary to antiplatelet treatment 169 Shraddha Mainali

Section VI–Iatrogenic hemorrhagic strokes: anticoagulation-related intracranial hemorrhage
18 Intracranial–extracerebral hemorrhage: complication of anticoagulation 185 Muhib Alam Khan
19 Iatrogenic intracerebral hemorrhage due to oral anticoagulation therapy: risk factors and diagnosis 189 Alexander Tsiskaridze

Section VII–Other uncommon causes of iatrogenic stroke
20 Stroke during pregnancy and the puerperium 203 Elisabetta Del Zotto and Alessandro Pezzini

Section VIII–Cerebral venous thrombosis
23 Cerebral venous thrombosis 241 José M. Ferro and Patrícia Canhão

Section IX–Medication reversal and restarting in patients with iatrogenic strokes
24 Treatment of oral anticoagulant related intracranial hemorrhages 255 Mushtaq H. Qureshi, J. Alfredo Caceres and Adnan I. Qureshi

Index 265
Contributors

Pablo Ajler, MD, PhD
Assistant Professor and Neurosurgeon,
Hospital Italiano de Buenos Aires, Buenos Aires, Argentina

Andrei V. Alexandrov, MD
Semmes-Murphey Professor and Chairman,
Department of Neurology, The University of Tennessee Health Science Center, Memphis, TN, USA

Rushna Ali, MD
Resident, Department of Neurosurgery, Henry Ford Hospital, Detroit, MI, USA

Tommy Andersson, MD, PhD
Neurosurgeon and Neuroradiologist. Senior Consultant, Karolinska University Hospital, Stockholm, Sweden

Kristian Barlinn, MD, MSc
Department of Neurology, Carl Gustav Carus University Hospital, Dresden, Germany

David Bergqvist, MD, PhD, FEBVS
Professor Emeritus in Vascular Surgery, University Hospital, Uppsala, Sweden

David J. Blacker, MBBS, FRACP
Neurologist and Stroke Physician, Sir Charles Gairdner Hospital; Clinical Professor of Neurology, University of Western Australia; Medical Director, Western Australian Neuroscience Research Institute, Nedlands, Australia

J. Alfredo Caceres, MD
Zeenat Qureshi Stroke Institute and CentraCare Health System, St Cloud, MN, USA

Patrícia Canhão, MD, PhD
Associate Professor of Neurology, Department of Neurosciences and Mental Health, Service of Neurology, Hospital de Santa Maria, University of Lisbon, Lisbon, Portugal

Fernando de M. Cardoso, MD, PhD
Hospital Quinta D’Or, Rio de Janeiro, Brazil

Gabriel R. de Freitas, MD, PhD
Hospital Quinta D’Or/D’Or Institute for Research and Education (IDOR), Rio de Janeiro, Brazil

Elisabetta Del Zotto, MD, PhD
Neurorehabilitation Unit, Rehabilitation Center “E. Spalenza”, Don Gnocchi Foundation, Rovato, Brescia, Italy

Jelle Demeestere
Department of Neurology, University Hospitals Leuven, Leuven, Belgium

José M. Ferro, MD, PhD
Chairman and Full Professor of Neurology, Department of Neurosciences and Mental Health, Service of Neurology, Hospital de Santa Maria, University of Lisbon, Lisbon, Portugal

Fernando D. Goldenberg, MD
Co-Director, Neuroscience ICU, The University of Chicago Medicine, Chicago, IL, USA; Director of Neurocritical Care, Hospital Italiano de Buenos Aires, Buenos Aires, Argentina

Morten L. Hansen, MD, PhD
Department of Cardiology, Gentofte Hospital, Cogenhagen, Denmark

Nabeel A. Herial, MD
Department of Neurology, UC San Diego Health System, San Diego, CA, USA

Steen Husted, MD, DMSci
Department of Medicine, Hospital Unit West, Herning, Denmark
## List of contributors

<table>
<thead>
<tr>
<th>Name</th>
<th>Title and Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muhib Alam Khan, MD</td>
<td>Clinical Assistant Professor, Neuroscience Institute, Spectrum Health Michigan State University, Providence, RI, USA</td>
</tr>
<tr>
<td>Björn Kragsterman, MD, PhD</td>
<td>Department of Surgical Sciences, Section of Vascular Surgery, University Hospital, Uppsala, Sweden</td>
</tr>
<tr>
<td>Stephan C. Knipp, MD</td>
<td>Consultant in Cardiothoracic Surgery, Department of Thoracic and Cardiovascular Surgery, West German Heart and Vascular Center, University of Duisburg-Essen, Essen, Germany</td>
</tr>
<tr>
<td>Federico Landriel, MD</td>
<td>Neurosurgeon, Hospital Italiano de Buenos Aires, Buenos Aires, Argentina</td>
</tr>
<tr>
<td>Arne Lindgren, MD, PhD</td>
<td>Professor of Neurology, Department of Clinical Sciences, Lund University, Lund, Sweden, Senior Consultant in Neurology, Department of Neurology and Rehabilitation Medicine, Skåne University Hospital, Lund, Sweden</td>
</tr>
<tr>
<td>Shraddha Mainali, MD</td>
<td>Division of Vascular Neurology, Weil-Cornell Medical College, New York, NY, USA</td>
</tr>
<tr>
<td>Robert Mikulik, MD, PhD</td>
<td>Director of Stroke Program, Department of Neurology, St. Anne’s University Hospital, Brno, Czech Republic</td>
</tr>
<tr>
<td>Anastasios Mpotsaris, MD, PhD</td>
<td>Radiologist and Neuroradiologist, Acting Head, Department of Neuroradiology, University Hospital of Cologne, Cologne, Germany</td>
</tr>
<tr>
<td>Lars Neeb, MD</td>
<td>Department of Neurology, Charité Universitätsmedizin Berlin, Berlin, Germany</td>
</tr>
<tr>
<td>Norbert Nghoghossian, MD, PhD</td>
<td>Professor, Neurovascular Unit, Hopital Neurologique, Pierre Wertheimer University, Lyon, France</td>
</tr>
<tr>
<td>Alessandro Pezzini, MD</td>
<td>Associate Professor of Neurology, Department of Clinical and Experimental Sciences, Neurology Clinic, University of Brescia, Brescia, Italy</td>
</tr>
<tr>
<td>Adnan I. Qureshi, MD</td>
<td>Professor of Neurology, Department of Neurology, University of Minnesota, MN, USA</td>
</tr>
<tr>
<td>Mushtaq H. Qureshi, MD</td>
<td>Zeenat Qureshi Stroke Research Center, University of Minnesota, Minneapolis, MN, USA</td>
</tr>
<tr>
<td>Uwe Reuter, MD, PhD, MBA</td>
<td>Department of Neurology, Charité Universitätsmedizin Berlin, Berlin, Germany</td>
</tr>
<tr>
<td>Magdy Selim, MD, PhD</td>
<td>Professor of Neurology, Harvard Medical School, Boston, MA, USA; Chief, Stroke Division, Department of Neurology, Beth Israel Deaconess Medical Center, Boston, MA, USA</td>
</tr>
<tr>
<td>Fazeel M. Siddiqui, MD</td>
<td>Department of Neurology, UT Southwestern Medical Center, Dallas, TX, USA</td>
</tr>
<tr>
<td>Mario D. Terán, MD</td>
<td>Neurocritical Care Staff Physician, Hospital Italiano de Buenos Aires, Buenos Aires, Argentina</td>
</tr>
<tr>
<td>Vincent Thijs, MD</td>
<td>Department of Neurology, Austin Health, Heidelberg, Victoria, Australia Florey Institute of Neuroscience and Mental Health, University of Melbourne, Heidelberg, Australia</td>
</tr>
<tr>
<td>Alexander Tsiskaridze, MD, PhD, DSc, FESO</td>
<td>Professor of Neurology, Department of Neurology, Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia</td>
</tr>
<tr>
<td>Christian Weimar, MD</td>
<td>Department of Neurology, University Hospital Essen, Essen, Germany</td>
</tr>
<tr>
<td>Claudio Yampolsky, MD</td>
<td>Chief of Neurosurgical Department, Hospital Italiano de Buenos Aires, Buenos Aires, Argentina</td>
</tr>
</tbody>
</table>
Preface

Iatrogenic stroke is considered to be uncommon but can occur in many different settings and may have unexpected and disastrous consequences. However, until now there has been no major comprehensive book dedicated to this topic. We are therefore very grateful for the opportunity to for the first time be able to present a book with special focus on iatrogenic stroke.

Iatrogenic derives from the ancient Greek word *iatros* (physician). It means an effect induced inadvertently by a physician or surgeon or by medical treatment or diagnostic procedures in a patient.

During the last decades, there have been impressive advances in medicine, leading to better outcomes for patients afflicted with what were earlier perceived as incurable diseases. Many new drugs, surgical techniques, and medical devices have been introduced in the diagnostic and therapeutic armamentarium. Also, diagnosis and treatment are now accessible to a much larger proportion of patients worldwide. Challenging and complex interventions are increasingly performed in elderly patients and in subjects with multiple comorbidities. This is particularly true in the fields of acute stroke care, secondary stroke prevention, surgery, intensive care, and oncology.

As all medical interventions have an inherent risk, and also known as well as sometimes unexpected adverse effects, the risk of iatrogenic stroke has increased in parallel with the availability of advanced treatments and general improvement in medical care. Iatrogenesis can be reduced by improving patients’ safety and by risk reduction programs, but there is sometimes an inevitable pay-off of the diagnostic and therapeutic escalade in complex and critical patients.

Many very experienced and well known authors have contributed to the different chapters of this book. Without their help and the support from Cambridge University Press this project would not have been possible to accomplish. We hope that this book will provide a comprehensive overview of the topic and be of use for many stroke neurologists and other physicians working with stroke patients and patients with risk of stroke and thereby help reduce the risk of iatrogenic stroke.

Arne Lindgren, Adnan I. Qureshi, Alexander Tsiskaridze, José M. Ferro, and Patrícia Canhão Lund, Minneapolis, Tbilisi, and Lisbon