DAKSHESH H. PARIKH
DAVID C.G. CRABBE
ALEXANDER W. AULDIST
STEVEN S. ROTHENBERG
EDITORS

Pediatric Thoracic Surgery



Pediatric Thoracic Surgery

Dakshesh H. Parikh • David C.G. Crabbe Alexander W. Auldist • Steven S. Rothenberg Editors

Pediatric Thoracic Surgery



Editors

Dakshesh H. Parikh, MD, FRCS Department of Paediatric Surgery Birmingham Children's Hospital Birmingham United Kingdom David C.G. Crabbe, MD, FRCS Leeds General Infirmary Leeds United Kingdom

Alexander W. Auldist, BSc, BM, FRACS General Surgery Department The Royal Children's Hospital Melbourne, Victoria Australia Steven S. Rothenberg, MD The Mother and Child Hospital at Presbyterian/St. Luke's Medical Center Denver, Colorado USA

ISBN 978-1-84800-902-8 DOI 10.1007/b136543 e-ISBN 978-1-84800-903-5

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

Library of Congress Control Number: 2008944284

© Springer-Verlag London Limited 2009

Apart from any fair dealing for the purposes of research or private study, or criticism or review, as permitted under the Copyright, Designs and Patents Act 1988, this publication may only be reproduced, stored or transmitted, in any form or by any means, with the prior permission in writing of the publishers, or in the case of reprographic reproduction in accordance with the terms of licenses issued by the Copyright Licensing Agency. Enquiries concerning reproduction outside those terms should be sent to the publishers.

The use of registered names, trademarks, etc., in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant laws and regulations and therefore free for general use.

The publisher makes no representation, express or implied, with regard to the accuracy of the information contained in this book and cannot accept any legal responsibility or liability for any errors or omissions that may be made.

Product liability: The publisher can give no guarantee for information about drug dosage and application thereof contained in this book. In every individual case the respective user must check its accuracy by consulting other pharmaceutical literature.

Printed on acid-free paper

Springer Science + Business Media springer.com

Foreword

In most parts of the world the treatment of adults with surgically correctable abnormalities of the thorax and its contents is provided by specially trained thoracic surgeons. On the other hand, in children pediatric general surgeons usually take on this role because of their training in the surgical care of sick infants and children, and their experience with the management of congenital malformations. In an ideal world the treatment of surgical disorders of the thorax in children would be provided by a super specialist, but this is neither practical nor possible. This text provides information that will help bridge the gap for a group of conditions often only encountered rarely by otherwise experienced surgeons.

This book is not designed to be a textbook of operative surgery. Instead the broad scope is to provide important up to date information and reference material relating to most of the thoracic surgical conditions seen in childhood. The editors and contributors have ably met their goal to give the reader the proper medical and surgical principles needed to treat these childhood conditions.

One can't help to note the impressive array of authors from around the world. When I first started out in pediatric surgery only a few pediatric surgeons in a few centers would dare tackle some of the abnormalities noted in these chapters. Others who dared, because they had no other choice, often failed. Now it is clear that globalization has truly come to our discipline. The benefits to children in every corner of the earth cannot be overestimated.

Robert M Filler, MD FRCS(C), OOnt Professor of Surgery and Pediatrics, Emeritus University of Toronto Ontario Canada

Surgeon-in Chief Emeritus The Hospital for Sick Children Toronto, Ontario Canada

Preface

Most pediatric surgeons operate on the chest. Some operate with confidence, some with trepidation. The concept behind this project was to publish a comprehensive textbook of pediatric thoracic surgery that would assist surgeons in both groups.

The book includes forty seven chapters which provide a broad coverage of thoracic surgical problems in children including diseases of the lung and pleural space, the esophagus, mediastinum, diaphragm and chest wall. Chapters on basic science and respiratory medicine are interspersed with more exclusively surgical chapters partly to gain perspective and partly because successful management of the more complex thoracic problems in children requires close collaboration between physicians and surgeons.

Although we wanted to allow the contributing authors a lot of freedom to express their ideas and experience every effort has been made to achieve a uniform style for each chapter. The general organisation of text includes historical perspective, incidence, investigations, diagnosis, differential diagnosis, management and future perspectives. The chapters are well referenced and, we believe, present a balanced view of contemporary practice.

The editors are experienced paediatric thoracic surgeons from the UK, North America and Australia. The authors have all been chosen carefully for their recognised expertise and we are proud to include experts from all corners of the globe. The effort involved in making this textbook a reality has been exhausting. We hope the final result achieves the original aim.

We would like to acknowledge the thoughtful contributions to the book from all the authors with much gratitude. We also express our thanks to Melissa Morton, Senior Editor at Springer, and her editorial assistants, in particular Lauren Stoney, who provided professional support and encouragement throughout the writing of this book. Finally, we must record our sincere thanks to Sunil Padman, at SPi Technologies, without whom this book would never have reached print.

DHP DCGC SSR AWA

Contents

Cor	ntributors	xiii			
Section 1: Fundamental Considerations					
1.	Applied Anatomy	3			
2.	Developmental Biology and Embryology of the Thorax	19			
3.	Applied Physiology and Pulmonary Function Testing Caroline Beardsmore	27			
4.	Radiology of the Chest	41			
5.	Anesthesia for Thoracic Surgery	57			
6.	Thoracoscopic Surgery	75			
7.	Thoracic Incisions and Operative Approaches. Dakshesh H. Parikh and David C.G. Crabbe	81			
Section 2: Infection					
8.	Pneumonia	95			
9.	Empyema Thoracis	109			
10.	Pulmonary Tuberculosis	129			
11.	Lung Abscess	145			
12.	Pulmonary Hydatid Disease	161			
	Bronchiectasis	169			

14.	Chronic Pleuro-Pulmonary and Chest Wall Infections Devendra K. Gupta and Shilpa Sharma	179		
Sec	tion 3: Trauma			
15.	Thoracic Trauma. General Considerations	193		
16.	Blunt Thoracic Trauma	199		
17.	Penetrating Thoracic Trauma Joe Crameri and Kate Ferguson	213		
Sec	tion 4: Tumours			
18.	Anterior Mediastinal Tumors. Juan A. Tovar	225		
19.	Posterior Mediastinal Tumors	235		
20.	Lung Tumors	251		
21.	Chest Wall Tumors	261		
Sec	tion 5: Esophagus			
22.	Congenital Malformations	281		
23.	Esophageal Stricture	311		
24.	Esophageal Replacement	321		
25.	Achalasia Philip Morreau	335		
26.	Gastro-esophageal Reflux	341		
27.	Esophageal Foreign Bodies	357		
Section 6: Trachea				
28.	Foreign Bodies in the Airway David C.G. Crabbe	365		
29.	Vascular Rings	373		
30.	Foregut Duplication Cysts	383		

Section 7: Lung Disease				
31.	Cystic Adenomatoid Malformation	391		
32.	Pulmonary Sequestration	399		
33.	Congenital Lobar Emphysema. Steven S. Rothenberg	407		
34.	Respiratory Disorders of the Newborn	411		
35.	Cystic Fibrosis	427		
36.	Pulmonary Hemorrhage and Hemoptysis	445		
37.	Interstitial Diseases of the Lung. Maya Desai	455		
38.	Pneumothorax	465		
Sec	tion 8: Diaphragm			
39.	Congenital Diaphragmatic Hernia. Harriet J. Corbett and Paul D. Losty	483		
40.	Diaphragmatic Eventration and Phrenic Palsy	501		
41.	Extra-corporeal Membrane Oxygenation	509		
42.	Diaphragmatic Pacing in Children	523		
Section 9: Chest Wall Abnormalities				
43.	Pectus Excavatum	535		
44.	Thoracic Outlet Syndrome	547		
45.	Thoracopagus Conjoined Twins	557		
Section 10: Miscellaneous				
46.	Chylothorax	573		

xii	Contents
-----	----------

47.	The Thymus and Myasthenia Gravis David C.G. Crabbe and Dakshesh H. Parikh	579
48.	Hyperhidrosis and Thoracic Sympathectomy	589
Index		601

Contributors

Rosemary J. Arthur, BSc, MBCHB, FRCR

Department of Paediatric Radiology, Leeds Teaching Hospitals NHS Trust, Leeds, West Yorkshire, United Kingdom

Gularaj S. Arul, MD, FRCS

Birmingham Children's Hospital, Birmingham, West Midlands, United Kingdom

Oliver Bagshaw, MB ChB, FRCA

Department of Anaesthesia, Birmingham Children's Hospital, Birmingham, West Midlands, United Kingdom

*Ian M. Balfour-Lynn, BSc, MD, MBBS, FRCP, FRCPCH, FRCS(Ed), DHMSA*Department of Paediatric Respiratory Medicine, Royal Brompton Hospital, London, United Kingdom

David J. Barron, MB BS, MD, MRCP(UK), FRCS(CT)

Department of Cardiac Surgery, Birmingham Children's Hospital, Birmingham, West Midlands, United Kingdom

Caroline S. Beardsmore, BSc, PhD

Department of Infection Immunity and Inflammation, University of Leicester, Leicester, East Midlands, United Kingdom

Spencer W. Beasley, MB ChB, MS, FRACS

Department of Paediatric Surgery, Christchurch Hospital, Christchurch, Canterbury, New Zealand

Russell Blakelock BHB, MBchB, FRACS

Department of Paediatric Surgery, Christchurch Hospital, Christchurch, Canterbury, New Zealand

T. J. Bradnock, MRCS(Ed)

Royal Hospital for Sick Children, Glasgow, Scotland, United Kingdom

William J. Brawn, MB BS, FRACS, FRCS

Department of Cardiac Surgery, Birmingham Children's Hospital, Birmingham, West Midlands, United Kingdom

Sarah Brown BSc, MBBS, MRCPCH

Department of Paediatrics, Royal Brompton Hospital, London, United Kingdom

Keith G. Brownlee, MB ChB, FRCPCH

Leeds Regional Paediatric Cystic Fibrosis Centre, Leeds, West Yorkshire, United Kingdom

xiv Contributors

Philip A. J. Chetcuti, DM, FRCPCH

Department of Paediatrics, Leeds General Infirmary, Leeds, West Yorkshire, United Kingdom

Thomas Clarnette MBBS, MD, SRACS

Department of General Surgery, Royal Children's Hospital, Melbourne, Victoria, Australia

Harriet J. Corbett, MB ChB (Hons), BSc (Hons), MRCS

Department of Paediatric Surgery, The Royal Liverpool Children's Hospital, Liverpool, North West England, United Kingdom

Joe Crameri MBBS, FRACS

Royal Children's Hospital, Parkville, Victoria, Australia.

Steven Cray, MBBS, FRCA

Department of Anaesthesia, Birmingham Children's Hospital, Birmingham, West Midlands United Kingdom

Carl F. Davis, FRCS

Royal Hospital for Sick Children, Glasgow, Scotland

United Kingdom

Michael G. Davis, MD, FRCPC

Montreal Children's Hospital, McGill University Health Center, Montreal, Quebec, Canada

Maya Desai, MD, MRCP, MRCPCH

Birmingham Children's Hospital, Birmingham, West Midlands, United Kingdom

Kate Ferguson BSc, MB BS

Austin Hospital, Heidelberg, Victoria, Australia

Hélène Flageole, MD, MSC, FRCPSC, FACS

Montreal Children's Hospital, McGill University Health Center, Montreal, Quebec, Canada

Devendra K. Gupta MS, M.Ch, FAMS, Hony. FAMS, FRCSG (Hony), D.Sc.

All India Institute of Medical Sciences, Ansari Nagar, New Delhi, India

Sundeep Harigopal, MB BS, DCH, MRCPCH

Neonatal Intensive Care Unit, Royal Victoria Infirmary, Newcastle upon Tyne, North East, United Kingdom

John P. Hewitson, MB, ChB, FCS (SA)

Department of Cardiothoracic Surgery, University of Cape Town and Red Cross Children's Hospital, Rondebosch, Cape Town, South Africa

Robert E. Kelly, Jr., MD, FACS, FAAP

Department of Surgery, Eastern Virginia Medical School, Norfolk, Virginia, USA

Jennette Kraft, FRCR

Department of Paediatric Radiology, Leeds Teaching Hospitals NHS Trust, Leeds, West Yorkshire, United Kingdom

Anthony D. Lander, PhD, FRCS(Paed) DCH

Birmingham Children's Hospital, Birmingham, West Midlands, United Kingdom

Jacob C. Langer, MD

Division of Pediatric General Surgery, Hospital for Sick Children, Toronto, Ontario, Canada

David Lasko, MD

Hospital for Sick Children, Toronto, Ontario, Canada

Tim W. R. Lee, MB ChB, BSc, MMedSc, PhD, MRCP(UK), MRCPCH

Leeds Regional Paediatric Cystic Fibrosis Centre, St James's University Hospital, Leeds, West Yorkshire, United Kingdom

Paul D. Losty, MD, FRCSI, FRCS(Eng), FRCS(Ed), FRCS(Paed)

Division of Child Health,

University of Liverpool, Liverpool, North West England, United Kingdom

Ashvini Menon, MRCS

West Midlands Deanery, Birmingham, United Kingdom

Alastair J. W. Millar MB, ChB, FRCS, FRACS, DCh

Paediatric Surgery, University of Cape Town, Rondebosch, Cape town, South Africa

Philip Morreau, MBChB, Dip Obst, FRACS, FRACS (Paeds)

Department of Paediatric Surgery, The Starship Children's Hospital, Auckland, New Zealand

Bommaya Narayanaswamy

Royal Hospital for Sick Children, Edinburgh, United Kingdom

Donald Nuss, MB ChB, FRCS(C), FACS

Eastern Virginia Medical School, Children's Hospital of The King's Daughters, Norfolk, Virginia, USA

Pankaj R. Parekh, MD DCH

Department of Paediatrics, Sir H.N. Hospital and Medical Research Center, Child Health Clinic, Mumbai, India

Juan Carlos Pattillo, MD

Seccion Cirugía Pediatrica, Division de Cirugía, Pontificia Universidad Católica de Chile, Santiago, Chile

Todd A. Ponsky, MD

Department of Surgery, School of Medicine, Case Western Reserve University, Cleveland, Ohio, USA

Heinz Rode

Department of Paediatric Surgery

University of Cape Town, Rondebosch, Cape Town, South Africa

Naeem Samnakay

Department of Paediatric Surgery, Princess Margaret Hospital, Perth, Western Australia, Australia

Khalid Sharif, MBBS, FRCS (Paeds), FCPS Paed Surg (PAK)

The Liver Unit, Birmingham Children's Hospital, Birmingham, West Midlands, United Kingdom

Shilpa Sharma

Department of Pediatric Surgery, All India Institute of Medical Sciences, Ansari Nagar, New Delhi, India

xvi Contributors

Nigel John Shaw, MB ChB, MD, MRCP, FRCPCH, MA (Clin Ed)

Neonatal intensive Care Unit, Liverpool Women's Hospital, Liverpool, North West England, United Kingdom

Malcolm Simms, FRCS,

University Hospital Birmingham NHS Foundation Trust, Birmingham, West Midlands, United Kingdom

David A. Spencer, MBBS (Hons), MD, MRCP, FRCP CH

Department of Respiratory Paediatrics, Newcastle Upon Tyne Hospitals Foundation Trust, Newcastle Upon Tyne, North East, United Kingdom

Jenny Thomas

Department of Paediatric Surgery, University of Cape Town, Rondebosch, Cape Town, South Africa

Juan A. Tovar, MD, PhD

Department of Pediatric Surgery, Hospital Universitario "La Paz", Madrid, Spain

Gregor M. Walker, MD, FRCS

Royal Hospital for Sick Children, Glasgow, Scotland, United Kingdom

Section 1 Fundamental Considerations