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With love and thanks to Adrian, for being my biggest supporter; to my family, for being my role models; and to my friends, for making it so much fun.

Aparajita Sohoni

To Hans, Nina and Margot, with gratitude and love.

Jamie Shandro

Dedications to the brewmaster of Wasatch Brewery for malt and hop support during the editing process...

Bernhard Fassl

To my family, especially to Ana Sofia, Lucia and Manuel. You are my wisdom, light and meaning. Although this book took time away from you, it is all for you.

To my co-editors, expert reviewers, and collaborators, without whom this "good idea" would never have become a reality.

N. Ewen Amieva-Wang
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Foreword

Let's face it; it is tough evaluating and managing children in the emergency department (ED). Often the patients cannot provide a history of illness or injury, and there are potential congenital issues which can complicate evaluation and management. Also, the types of conditions they present with change with age, growth and development. Having trained as an emergency physician and seeing adult and pediatric patients over the last 27 years of my career I can say that "A Practical Guide to Pediatric Emergency Medicine" is a welcome addition to the reference texts in pediatric emergency medicine. It provides practical information that builds on what an emergency physician already knows about the care of children. The book starts out with a wonderful quick summary of many of the common pediatric specific diseases/conditions affecting children in an easy to read set of tables. Dr. Ewen Wang and colleagues then cover the breadth of pediatric emergency medicine in the book’s well illustrated 29 sections, but does so with an approach that is refreshing. The authors focus on the unique conditions that affect children and provide much needed practical advice for management in children in the ED. Expert reviews of each of the sections provide enhanced content that boosts the depth as well as the practical knowledge found in each chapter. For example – in the cardiology section, readers will learn tips and techniques in reading a pediatric ECG, learn about congenital heart disease and the complications of repairs of those lesions, and even learn about the special issues with children post heart transplant. My favorite feature is "The Tutorials" which cover much needed procedural education in diverse aspects of care, such as needle cricothyrotomy and jet ventilation, mechanical ventilation management, intraosseous and umbilical vein catheter placement, fluid and electrolyte management, eFAST and FAST for trauma, ultrasound guided procedures, pediatric radiology interpretation, and splinting to name a few; it even has a discussion on practical aspects of care of the "gizmos" such as VP-shunt (obstruction/infection), G and J-tubes (leakage, wound infection, hemorrhage, dislodgement, and obstruction), tracheostomy tubes (displacement and obstruction), and genitourinary/gastrointestinal conduits. It contains just the right amount of information to manage patients in the ED, and also provides tutorials on important aspects of outpatient care (e.g. management of outpatient asthma from the emergency department) that will assist the ED physician in bridging care of the patient to the next follow-up visit.

Cambridge University Press and Drs Wang, Shandro, Sohoni and Fassl have succeeded in producing a different kind of textbook; one that works for the practicing "ER" doctor. Bravo!

Enjoy reading and using in your practice "A Practical Guide to Pediatric Emergency Medicine".

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This manual is written for the emergency medicine practitioner who cares for children as well as adults. It is not designed to replace any of the many definitive references in emergency medicine or pediatric emergency medicine but rather to fit a special niche focusing on those who juggle the balance of caring for children alongside adults.

For the physician who takes care of adults and children simultaneously in an emergency department (ED) setting, it can be challenging to change medical perspective as one switches patient rooms. For example, the differential diagnosis and workup for a neonate with a seizure is very different to that for a 40 year old with the same chief complaint. Additionally, there are unusual but pediatric specific conditions, such as Kawasaki disease and Henoch–Schönlein purpura, whose constellation of symptoms may elude the emergency medicine provider. This can result in a diagnosis being missed. Given the range of ages, developmental stages, sizes, and vital signs included in the pediatric realm of emergency medicine, it might be handy to have a reference that can remind the physician of age-based differential diagnoses and specifically highlights differences between children and adults.

In this age of medical and technological advancements, children are also surviving previously lethal congenital anomalies and inherited conditions. Populations of “children with special health care needs” have distinct medical issues and technological needs, which are constantly evolving. The emergency provider must be trained and equipped to recognize urgent and emergent medical problems in children with inborn errors of metabolism, congenital heart disease repair, or other chronic illnesses. Similarly, children who are recipients of advances in technology, be it tracheostomies, home ventilators, or gastrostomy tubes, may come in with equipment problems or malfunctions that must be identified and treated.

This manual is not meant to be a definitive reference for pediatric emergency medicine. Rather, a basic knowledge of emergency medicine is assumed to allow emphasis on areas where children and adults differ. Each chapter emphasizes the age-based differential diagnosis and areas where treatment of a disease entity differs from an adult. There are also at the end of each chapter a list of pearls and pitfalls. The manual includes many high-quality photographs, diagrams, and figures. The dermatology and infectious disease sections, which compare common childhood rashes graphically and visually, are unique.

There are special sections on specific pediatric populations: neonates, adolescents, and children with special health care needs, including children with cerebral palsy or genetic diseases, children graduating from the neonatal intensive care unit, and technology-dependent children.

Tutorials in pediatric imaging, pediatric ECG interpretation, procedural sedation, and procedures offer in-depth study of pediatric-specific skills. We hope that this manual provides a resource for busy practitioners caring for both children and adults, reminding us of the many ways in which children are unique and the specific considerations we must have when caring for children in our EDs.

Ten ways children are different from adults.
1. Kids are smaller and they grow
2. Kids metamorphose from aquatic to terrestrial creatures in an instant (sometimes in the ED)
3. Child’s equipment is first use; congenital anomalies manifest in early childhood.
4. Kids have a different anatomy from adults
5. Kids have a different physiology than adults
6. Kids are infected by different bugs at different ages
7. Kids act like kids
8. Kids speak a different language
9. Kids usually belong to an adult
10. In general, we are kinder to children.
Acknowledgements

We would like to acknowledge the entire Emergency Medicine Division faculty at Stanford for their unwavering belief and confidence in our vision. We would particularly like to thank Drs. Robert Norris, Bernard Dannenberg (EW) and Chris Maloney (BF) for their unconditional support and encouragement. Several colleagues and friends went beyond the call of duty to offer advice; write chapters; and to locate experts, photographs, and contributors, including Drs. Paul Auerbach, Gus Carmel, Mike Gisondi, S. V. Mahadevan, and Matthew Strehlow.

We want to acknowledge our expert reviewers, including Drs. Anand Rajani and James P. Andrus (neonatal and pediatric critical care), Anne Dubin and Emily Wessler (cardiology), Su-Chieh Brian Liu (dental), Anna Messner (ENT), Darrell M. Wilson (endocrine), Steven Alexander (FEN and renal), Dorsey Bass and Claudia Mueller (gastroenterology), Janice Lowe and Arun Gupta (general pediatrics), Bertil E. Glader and Gary V. Dahl (hematology and oncology), Hayley Gans (immunology), Kathleen M. Gutierrez and Manuel Amieva (infectious disease), Andrew Man-Lap Ho (hand), Jin Hahn (neurology), Tonya Chaffee (child abuse), Shashank Joshi (psychiatry), James Holmes (trauma), Michael S. B. Edwards (neurosurgery), and William A. Kennedy II (renal, genitourinal trauma, and urology). All these subspecialists were “curb-sided” shamelessly to review each subspecialty chapter. We are grateful to all of our contributors, particularly the subspecialists and experts who do not usually write from an EM perspective.

We want to give special thanks to Dr. Marianne Gausche-Hill for writing the Preface and Raymond Johnson for reviewing the book. Manuel Amieva went out of his way to take photographs for the cover and to create its design. Others who contributed invaluable images include Drs. Hans Kersten, S. V. Mahadevan, Paul Matz, Mehran Mosley, Steven Shpall, and Anne Strehlow. Dr. Inger Olson contributed vital pediatric electrocardiographs to the text. I want to thank Logical Images and especially Heidi Halton who cheerfully and rapidly provided the last 11 images needed to complete the book. Chris Gralappe, Lynne Larson, and Chris Miles added clarity to the book with their crisp and clear illustrations. Colleen Acosta retrieved, copied and edited images.

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## Abbreviations

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<th>Abbreviation</th>
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<td>AAP</td>
<td>American Academy of Pediatrics</td>
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<tr>
<td>ABC</td>
<td>airways, breathing, and circulation</td>
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<td>ACE</td>
<td>angiotensin-converting enzyme</td>
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<td>adrenocorticotropic hormone</td>
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<td>acquired immunodeficiency syndrome</td>
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<td>altered level of consciousness</td>
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<td>alanine transaminase (aminotransferase)</td>
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<tr>
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<td>aspartate transaminase (aminotransferase)</td>
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<td>BID</td>
<td>twice daily</td>
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<td>bpm</td>
<td>beats per minute</td>
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<td>blood urea nitrogen</td>
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<tr>
<td>PaCO₂</td>
<td>arterial partial pressure carbon dioxide</td>
</tr>
<tr>
<td>PaO₂</td>
<td>arterial partial pressure oxygen</td>
</tr>
<tr>
<td>PCR</td>
<td>polymerase chain reaction</td>
</tr>
<tr>
<td>PO</td>
<td>oral</td>
</tr>
<tr>
<td>PT</td>
<td>prothrombin time</td>
</tr>
<tr>
<td>PTT</td>
<td>partial thromboplastin time</td>
</tr>
<tr>
<td>q.</td>
<td>every</td>
</tr>
<tr>
<td>QID</td>
<td>four times a day</td>
</tr>
<tr>
<td>QTc</td>
<td>corrected QT interval</td>
</tr>
<tr>
<td>RLQ</td>
<td>right lower quadrant</td>
</tr>
<tr>
<td>RUQ</td>
<td>right upper quadrant</td>
</tr>
<tr>
<td>SC</td>
<td>subcutaneous (administration route)</td>
</tr>
<tr>
<td>TID</td>
<td>three times a day</td>
</tr>
<tr>
<td>ULN</td>
<td>upper limit of normal</td>
</tr>
<tr>
<td>WBC</td>
<td>white blood cell count</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
Pediatric-specific disease

N. Ewen Amieva-Wang

There is a small but important subset of disorders that are pediatric specific. The physician who cares for adults and children must keep these more unusual diagnoses within the differential when caring for children. Some of these disorders are secondary to differences in susceptibility to infection, and physiologic and anatomic development. Neonates and young children can also have congenital disease manifesting with first use of malformed anatomy (e.g., tracheoesophageal fistula), time (e.g., ductal-dependent congenital heart disease), and stress (e.g., inborn error of metabolism).

Tables 1 and 2 are not meant to be a comprehensive list of pediatric-specific disorders, more a list of the more “common” diseases, as well as the organ system they affect, the age range, and symptoms.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Neonatal disease</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disease</strong></td>
<td><strong>Organ system</strong></td>
</tr>
<tr>
<td>Choanal atresia (bilateral, p. 000)</td>
<td>Respiratory</td>
</tr>
<tr>
<td>Tracheoesophageal fistula</td>
<td>Respiratory/GI</td>
</tr>
<tr>
<td>Vascular sling/web</td>
<td>Respiratory</td>
</tr>
<tr>
<td>Congenital heart disease: ductal-dependent lesion “tet spell”</td>
<td>Circulatory</td>
</tr>
<tr>
<td>Necrotizing enterocolitis</td>
<td>GI</td>
</tr>
<tr>
<td>Pyloric stenosis</td>
<td>GI</td>
</tr>
<tr>
<td>Intestinal malrotation ± volvulus</td>
<td>GI</td>
</tr>
<tr>
<td>Intussusception</td>
<td>GI</td>
</tr>
</tbody>
</table>
## Table 1  (cont.)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Organ system</th>
<th>Age range</th>
<th>Symptoms</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonatal herpes</td>
<td>ID</td>
<td>&lt;6 weeks</td>
<td>Severe sepsis (&lt;1 week); skin and mucous membrane disease (2–4 weeks); herpes encephalitis (2–3 weeks)</td>
<td>Perinatal infection; acquired maternal infection may not be apparent. Sepsis and encephalitis can manifest without skin lesions. Skin and mucous membrane disease can be controlled with radiotherapy</td>
</tr>
<tr>
<td>Ophthalmalgia neonatorum</td>
<td>ID/eyes</td>
<td>2–4 weeks</td>
<td>Purulent conjunctivitis</td>
<td>Neisseria meningitidis ophthalmic infection can cause blindness</td>
</tr>
<tr>
<td>Congenital adrenal hyperplasia</td>
<td>Endocrine</td>
<td>2–4 weeks</td>
<td>Vomiting, dehydration, shock Virilized female genitalia</td>
<td></td>
</tr>
<tr>
<td>Kernicterus</td>
<td>Hematological/ neurological</td>
<td>Neonates</td>
<td>Untreated severe jaundice</td>
<td>Guidelines for phototherapy depend on risk factors of neonate as well as age and bilirubin level</td>
</tr>
</tbody>
</table>

Gl, gastrointestinal; ID, infectious disease.

## Table 2  Pediatric-specific disease

<table>
<thead>
<tr>
<th>Disease</th>
<th>Organ system</th>
<th>Age range</th>
<th>Symptoms</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laryngotracheal bronchitis</td>
<td>Respiratory/ID</td>
<td>3 months to 6 years</td>
<td>Inspiratory stridor/barking</td>
<td>Usually outgrown by age 5 years</td>
</tr>
<tr>
<td>Popsicle panniculitis</td>
<td>Dermatological</td>
<td>Infants/ toddlers</td>
<td>Tender plaques or nodules on cold exposed areas</td>
<td>Resolve in months; no treatment</td>
</tr>
<tr>
<td>Infant botulism</td>
<td>ID</td>
<td>&lt;1 year</td>
<td>Hypotonia, constipation, respiratory insufficiency</td>
<td>High index of suspicion necessary. Exposure usually respiratory</td>
</tr>
<tr>
<td>Kawasaki disease</td>
<td>Immune/ID</td>
<td>6 months</td>
<td>Generalized inflammation with fever, rash (non-vesicular), non-purulent conjunctivitis, mouth changes, extremity changes, lymphadenopathy</td>
<td>Atypical Kawasaki disease can occur outside typical age range. Most common form of acquired heart disease in children</td>
</tr>
<tr>
<td>Hemolytic uremic syndrome</td>
<td>Immune/renal</td>
<td>Peak incidence in children &lt;5 years</td>
<td>Microangiopathic hemolytic anemia, thrombocytopenia, and AKI</td>
<td>Similar pathophysiology to TTP in adults. Kidney disease more common in children whereas neurologic disease is more common in adults.</td>
</tr>
<tr>
<td>Henoch–Schönlein purpura</td>
<td>Immune/dermatological/ GI</td>
<td>2–6 years</td>
<td>Abdominal pain, palpable purpura, arthritis, renal involvement</td>
<td>Most common systemic vasculitis in children</td>
</tr>
<tr>
<td>Cerebral edema associated with diabetic ketoacidosis</td>
<td>Endocrine</td>
<td>&lt;18 years</td>
<td>Cerebral edema with severe diabetic ketoacidosis</td>
<td>Occurs in ~1% of diabetic ketoacidosis and causes the majority of deaths from diabetic ketoacidosis</td>
</tr>
<tr>
<td>Acute cerebellar ataxia</td>
<td>Neurological</td>
<td>Toddlers</td>
<td>Isolated ataxia after viral prodrome</td>
<td>Self-limited disease; diagnosis of exclusion</td>
</tr>
<tr>
<td>Febrile seizure</td>
<td>Neurological</td>
<td>6 months to 6 years</td>
<td>Seizure when febrile</td>
<td>Strong familial history; risk of epilepsy is &lt;5%</td>
</tr>
</tbody>
</table>
### Pediatric-specific disease

<table>
<thead>
<tr>
<th>Disease</th>
<th>Organ system</th>
<th>Age range</th>
<th>Symptoms</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torus, greenstick fractures, Salter–Harris (physeal) fractures</td>
<td>Musculoskeletal</td>
<td>Prior to closure of the physis</td>
<td>Pain and sometimes deformity</td>
<td>Usually good prognosis; can be difficult to reduce greenstick fractures</td>
</tr>
<tr>
<td>Avulsion fractures</td>
<td>Musculoskeletal</td>
<td>Adolescents</td>
<td>Severe pain with activity</td>
<td></td>
</tr>
<tr>
<td>Apophyseal injury (tibial apophysitis (Osgood–Schlatter disease), calcaneal apophysitis (Sever’s disease))</td>
<td>Musculoskeletal</td>
<td>10–15 years of age with increased activity, overuse</td>
<td>Pain with activity</td>
<td>Treated with rest and reduced activity</td>
</tr>
<tr>
<td>Physeal, epiphyseal, injury; slipped capital femoral epiphysis</td>
<td>Musculoskeletal</td>
<td>Classically large boys 10–16 years of age</td>
<td>Pain in hip or knee; onset can be insidious and chronic</td>
<td>Non-weight bearing and possible surgical fixation</td>
</tr>
<tr>
<td>“Toddlers fracture,” spiral fracture of distal tibia</td>
<td>Musculoskeletal</td>
<td>Toddler</td>
<td>Refusal to bear weight, limp</td>
<td>Manage with immobilization even if fracture not visualized</td>
</tr>
<tr>
<td>Legg–Calvé–Perthes disease (vascular necrosis of hip)</td>
<td>Musculoskeletal</td>
<td>4–12 years of age</td>
<td>Pain in hip or knee; onset can be insidious and chronic</td>
<td>Non-weight bearing and possible surgical fixation</td>
</tr>
<tr>
<td>Nursemaid’s elbow (radial head subluxation)</td>
<td>Musculoskeletal</td>
<td>&lt;6 years of age, with traction of the elbow</td>
<td>Refusal to move the forearm; no apparent pain at rest</td>
<td>Can recur with repeated traction</td>
</tr>
</tbody>
</table>

AKI, acute kidney injury; ID, infectious diseases; TTP, thrombotic thrombocytopenic purpura.