

Strange and Schafermeyer's

# PEDIATRIC EMERGENCY MEDICINE

FIFTH EDITION

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# **Strange and Schafermeyer's Pediatric Emergency Medicine**

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# Strange and Schafermeyer's Pediatric Emergency Medicine

## Fifth Edition

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*My love affair with pediatric emergency medicine has spanned four decades. I began as one of the first practitioners learning along the way—from continuous forays into the literature, from subspecialty colleagues and from invaluable interactions with many North American colleagues. The endless unanswered questions seduced me into a fulfilling career of clinical research. I am very grateful to the countless scores of patients who have taught me so much and to the many trainees and colleagues that keep me current and invigorated. The opportunity to edit this tome is a natural and treasured progression. The romance continues . . .*

**Milton Tenenbein, MD, FRCPC, FAAP, FAACT, FACMT**

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**Charles G. Macias MD, MPH, FAAP, FACEP**

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**Ghazala Sharieff, MD, MBA**

*To the clinical and administrative staff of the emergency department at Kapiolani Medical Center For Women & Children: While we are a relatively small department, we have grown substantially and have been at the forefront of pediatric emergency care in areas such as electronic health records, medical error reduction, diagnostic imaging, pharmaceuticals, and the patient experience. Thank you for all my training and clinical experience at this one facility. Thank you to my many teachers and colleagues for all that I have learned. Thank you to Dr. Robert Wiebe and Dr. Marian Melish, as my #1 and #2 mentors during my training and junior faculty years. Thank you to my parents Eugene and Jean, my wife Patricia, and my children Julianne, Joelle, and Brennan for providing me with encouragement, support, and a wonderful family life.*

**Loren G. Yamamoto, MD, MPH, MBA, FAAP, FACEP**

*It was an honor to work on all of the editions of this textbook. To all the editors and authors with whom I worked, thank you for your excellent work. To my residents and faculty, I wish you long and successful careers. To An Ping, my wife of 45 years, I love you and thank you for your love and support. To my children and grandchildren, be wise, be strong, and help children whenever you get the chance.*

**Robert Schafermeyer, MD, FACEP, FIFEM, FAAP**

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# Contents

<i>Preface</i> .....	<i>xi</i>	<b>SECTION 4</b> Resuscitation.....	91
<i>Contributors</i> .....	<i>xiii</i>	18 <b>Airway Management</b> .....	91
<b>SECTION 1</b> Cardinal Presentations.....	1	Loren G. Yamamoto	
1 <b>Approach to the Child in the Emergency Department</b> .....	1	19 <b>Respiratory Failure</b> .....	100
Valerie McDougall Kestner		Loren G. Yamamoto	
2 <b>The Febrile or Septic-Appearing Neonate</b> .....	4	20 <b>Shock</b> .....	104
Daniel M. Fein, Jeffrey R. Avner		Tiffany T. Coleman-Satterfield	
3 <b>The Febrile- or Septic-Appearing Infant or Child</b> .....	7	21 <b>Cardiopulmonary Resuscitation</b> .....	110
Jeffrey R. Avner		Alson S. Inaba	
4 <b>Brief Resolved Unexplained Events</b> .....	13	22 <b>Neonatal Resuscitation</b> .....	117
Jonathan Rhine, Robert Sapien, Joel S. Tieder		Paul J. Eakin	
5 <b>Respiratory Distress</b> .....	16	<b>SECTION 5</b> Trauma.....	125
Joanna S. Cohen, Kathleen M. Brown		23 <b>Evaluation and Management of the Multiple Trauma Patient</b> .....	125
6 <b>Altered Mental Status and Coma</b> .....	19	Anna Suessman, Erin E. Endom	
Susan Fuchs		24 <b>Head Trauma</b> .....	139
7 <b>Chest Pain</b> .....	23	Melissa S. Puffenbarger, Kimberly S. Quayle	
Wendy C. Matsuno		25 <b>Cervical Spine Injury</b> .....	146
8 <b>Crying Infant</b> .....	27	Julie Catherine Leonard, Jeffrey Russell Leonard	
Joan M. Mavrinac		26 <b>Thoracic Trauma</b> .....	158
9 <b>Minor Head Trauma</b> .....	31	Karen O'Connell	
Prashant Mahajan		27 <b>Abdominal Trauma</b> .....	169
10 <b>Approach to the Patient with Rash</b> .....	37	Shireen M. Atabaki, Katie Donnelly	
Gregory Garra		28 <b>Genitourinary Trauma</b> .....	176
11 <b>Neck Masses</b> .....	42	Joyce C. Arpilleda	
Jeffrey F. Linzer Sr.		29 <b>Maxillofacial Trauma</b> .....	183
12 <b>Foreign Bodies</b> .....	47	Stacy Reynolds, JoAnna York, Stephen A. Colucciello	
Milton Tenenbein		30 <b>Orthopedic Injuries</b> .....	190
<b>SECTION 2</b> Sedation, Analgesia, and Imaging.....	55	Greg Canty, Laura Nilan	
13 <b>Procedural Sedation and Analgesia</b> .....	55	31 <b>Injuries of the Upper Extremities</b> .....	197
Joe E. Wathen, Alexandria J. Wiersma		Michael J. Stoner, Ann M. Dietrich	
14 <b>Pain Management</b> .....	65	32 <b>Injuries of the Pelvis and Lower Extremities</b> .....	209
Corrie E. Chumpitazi, Daniel S. Tsze, Amy L. Baxter		Greg Canty, Laura Nilan	
<b>SECTION 3</b> Imaging .....	73	33 <b>Soft-Tissue Injury and Wound Repair</b> .....	217
15 <b>Imaging</b> .....	73	Brittany L. Murray	
Wendy C. Matsuno		<b>SECTION 6</b> Respiratory Emergencies.....	231
16 <b>Pediatric Point-of-Care Ultrasound (P-POCUS)</b> .....	77	34 <b>Upper Airway Emergencies</b> .....	231
Alexander Sasha Dubrovsky, Jade Seguin		Linnea Wittick Roy	
17 <b>Magnetic Resonance Imaging in the Pediatric</b>		35 <b>Asthma</b> .....	237
<b>Emergency Department</b> .....	86	Ronan O'Sullivan, Darren McLoughlin	
Loren G. Yamamoto		36 <b>Bronchiolitis</b> .....	248
		Maneesha Agarwal	

37	<b>Pneumonia</b> .....	253			
	Sharon E. Mace				
38	<b>Pertussis</b> .....	268			
	Sharon E. Mace				
39	<b>Cystic Fibrosis</b> .....	274			
	Sabah F. Iqbal, Dinesh Pillai, Kathleen M. Brown, Bruce L. Klein				
	<b>SECTION 7 Cardiovascular Emergencies</b> .....	279			
40	<b>Congenital Heart Disease</b> .....	279			
	Lacey King, Kelly D. Young				
41	<b>Heart Failure in Infants and Children</b> .....	297			
	Mindy Fein, Aaron Dewitt, Donna M. Moro-Sutherland				
42	<b>Inflammatory and Infectious Heart Disease</b> .....	307			
	Andrew D. DePiero				
43	<b>Dysrhythmias</b> .....	312			
	Stephanie J. Doniger				
44	<b>Pediatric Hypertension</b> .....	320			
	Thomas M. Kennedy, Steven M. Selbst				
45	<b>Thromboembolic Disease</b> .....	328			
	Lee S. Benjamin				
	<b>SECTION 8 Nontraumatic Surgical Emergencies</b> .....	337			
46	<b>Late-Presenting Neonatal Surgical Emergencies</b> .....	337			
	Curt Stankovic, Prashant Mahajan				
47	<b>Pyloric Stenosis</b> .....	341			
	Danielle M. Graff, Ronald I. Paul				
48	<b>Inguinal Hernia</b> .....	344			
	Jeffrey F. Linzer Sr.				
49	<b>Intussusception</b> .....	346			
	Jay Pershad, Eunice Y. Huang				
50	<b>Meckel's Diverticulum</b> .....	349			
	Jay Pershad, Eunice Y. Huang				
51	<b>Appendicitis</b> .....	350			
	Lalit Bajaj				
	<b>SECTION 9 Neurologic Emergencies</b> .....	355			
52	<b>Syncope</b> .....	355			
	George T. Koburov				
53	<b>Seizures</b> .....	361			
	George T. Koburov				
54	<b>Ataxia</b> .....	366			
	Susan Fuchs				
55	<b>Weakness</b> .....	370			
	Susan Fuchs				
56	<b>Headache</b> .....	375			
	Susan Fuchs				
57	<b>Hydrocephalus</b> .....	380			
	Susan Fuchs				
58	<b>Cerebrovascular Syndromes</b> .....	382			
	Susan Fuchs				
	<b>SECTION 10 Infectious Emergencies</b> .....	389			
59	<b>Meningitis and Other Central Nervous System Infections</b> .....	389			
	Lise E. Nigrovic				
60	<b>Evaluation and Management of the Immunocompromised Patient</b> .....	392			
	Andrea T. Cruz				
61	<b>Toxic Shock Syndrome</b> .....	398			
	Bolanle Akinsola, Shabnam Jain				
62	<b>Soft Tissue Infections</b> .....	402			
	Coburn H. Allen, Sujit S. Iyer, Donna M. Moro-Sutherland				
63	<b>Kawasaki Disease</b> .....	409			
	Anthony Cooley				
64	<b>Influenza</b> .....	413			
	Whitney W. Irwin, Coburn H. Allen, Matthew H. Wilkinson				
65	<b>Tick-Borne Infections</b> .....	416			
	Andrea T. Cruz				
66	<b>Common Parasitic Infestations</b> .....	422			
	Emily Obringer, Alisa McQueen				
67	<b>Travel-Related Infections</b> .....	428			
	Andrea T. Cruz				
	<b>SECTION 11 Immunologic Emergencies</b> .....	439			
68	<b>Common Allergic Presentations</b> .....	439			
	Paul J. Eakin				
69	<b>Anaphylaxis</b> .....	443			
	Shana E.N. Ross, David C. Snow, E. Bradshaw Bunney				
	<b>SECTION 12 Gastrointestinal Emergencies</b> .....	447			
70	<b>Abdominal Pain</b> .....	447			
	Ghazala Q. Sharieff				
71	<b>Vomiting, Diarrhea, and Gastroenteritis</b> .....	451			
	Simon J. Lucio				
72	<b>Gastrointestinal Bleeding</b> .....	457			
	Le N. Lu				
73	<b>Gastroesophageal Reflux</b> .....	463			
	Marla J. Friedman, Doreen Benary				
74	<b>Liver Disease and Gallbladder</b> .....	467			
	Madhu D. Hardasmalani				
75	<b>Pancreatitis</b> .....	473			
	Javaid A. Shad				
76	<b>Inflammatory Bowel Disease</b> .....	477			
	Emily Rose, Ilene Claudius				
	<b>SECTION 13 Endocrine Emergencies</b> .....	485			
77	<b>Diabetes Mellitus and Hypoglycemia</b> .....	485			
	Loren G. Yamamoto				
78	<b>Adrenal Insufficiency</b> .....	492			
	Nicholas Furtado				
79	<b>Thyroid Disorders</b> .....	496			
	Nicholas Furtado				
80	<b>Inborn Errors of Metabolism</b> .....	499			
	George E. Hoganson				

<b>SECTION 14</b> Fluid, Electrolyte, and Acid–Base Abnormalities . . .	503	102	<b>Dysmenorrhea and Abnormal Uterine Bleeding</b> . . . . .	632
81 <b>Fluid and Electrolyte Disorders</b> . . . . .	503		Lori Pandya, Pamela J. Okada	
Susan A. Kecskes		103	<b>Vaginitis</b> . . . . .	639
82 <b>Hypo- and Hyponatremia Abnormalities</b> . . . . .	506		Oluyemisi A. Adeyemi-Fowode	
Susan A. Kecskes		<b>SECTION 20</b> Hematologic and Oncologic . . . . .	643	
83 <b>Hypo- and Hyperkalemia Abnormalities</b> . . . . .	510	104	<b>Anemia</b> . . . . .	643
Susan A. Kecskes			Loren G. Yamamoto	
84 <b>Hypo- and Hypercalcemia Abnormalities</b> . . . . .	513	105	<b>Sickle Cell Disease</b> . . . . .	647
Susan A. Kecskes			Loren G. Yamamoto	
85 <b>Acid–Base Disturbances in Children</b> . . . . .	516	106	<b>Bleeding Disorders</b> . . . . .	652
Farhan Bhanji			Loren G. Yamamoto	
<b>SECTION 15</b> Genitourinary . . . . .	519	107	<b>Blood Component Therapy</b> . . . . .	656
86 <b>Male Genitourinary Problems</b> . . . . .	519		Randal K. Wada	
Annalise Sorrentino		108	<b>Oncologic Emergencies</b> . . . . .	659
87 <b>Urinary Tract Diseases</b> . . . . .	526		Jonathan E. Wickiser	
Geoffrey W. Jara-Almonte, Stephanie J. Doniger		<b>SECTION 21</b> Nontraumatic Bone and Joint . . . . .	667	
88 <b>Specific Renal Syndromes</b> . . . . .	535	109	<b>The Limping Child</b> . . . . .	667
Roger M. Barkin			Rohit Sheno	
89 <b>Sexually Transmitted Diseases</b> . . . . .	540	110	<b>Slipped Capital Femoral Epiphysis</b> . . . . .	674
George T. Koburov			Andrew J. Kienstra, Charles G. Macias, Guyon J. Hill	
<b>SECTION 16</b> Dermatologic . . . . .	549	111	<b>Inflammatory Musculoskeletal Disorders</b> . . . . .	678
90 <b>Petechiae and Purpura</b> . . . . .	549		Kemedy K. McQuillen, Victoria S. Gregg	
Marla J. Friedman, Carolina Mendoza		112	<b>Tumors of Bone</b> . . . . .	685
91 <b>Superficial Bacterial, Fungal, and Parasitic Infections</b> . . . . .	553		Kemedy K. McQuillen	
David Nelson		<b>SECTION 22</b> Toxicologic Emergencies . . . . .	691	
92 <b>Viral Exanthems</b> . . . . .	559	113	<b>General Approach to the Poisoned Patient</b> . . . . .	691
Annalise Sorrentino			Timothy J. Meehan, Timothy B. Erickson	
93 <b>Newborn and Infant Rashes</b> . . . . .	569	114	<b>Acetaminophen</b> . . . . .	696
Nadeemuddin Qureshi, Irene A. Oriaifo			Marco L. A. Sivilotti	
94 <b>Dermatitis</b> . . . . .	573	115	<b>Aspirin</b> . . . . .	699
Solomon Behar			Marco L. A. Sivilotti	
95 <b>Skin Signs of Systemic Disease</b> . . . . .	582	116	<b>Nonsteroidal Anti-Inflammatory Drugs</b> . . . . .	701
Ara Festekjian			Jennifer A. Lowry	
<b>SECTION 17</b> Otolaryngologic . . . . .	591	117	<b>Opioids</b> . . . . .	704
96 <b>Ear and Nose Emergencies</b> . . . . .	591		Trevonne M. Thompson, Timothy B. Erickson	
Hannah Smitherman		118	<b>Sedative Hypnotics and Anticonvulsants</b> . . . . .	707
97 <b>Emergencies of the Oral Cavity and Neck</b> . . . . .	597		Suzan S. Mazor	
Joseph Y. Allen, Anriada Nassif		119	<b>Cardiovascular Drugs</b> . . . . .	710
<b>SECTION 18</b> Ophthalmologic Emergencies . . . . .	603		Scott M. Leikin, Jerrold B. Leikin	
98 <b>Traumatic Eye Emergencies</b> . . . . .	603	120	<b>Psychotherapeutic Drugs</b> . . . . .	716
Jeremiah J. Johnson, Nurani Kester, Brett Davies			Henry D. Swoboda, Timothy J. Meehan	
99 <b>Non-Traumatic Eye Emergencies</b> . . . . .	610	121	<b>Iron Poisoning</b> . . . . .	722
Weena Joshi, Katherine M. Konzen			Steven E. Aks	
<b>SECTION 19</b> Gynecologic . . . . .	621	122	<b>Oral Anti-Diabetic Agents</b> . . . . .	724
100 <b>Gynecologic Disorders of Infancy, Childhood, and Adolescence</b> . . . . .	621		Donna Seger	
Lisa M. Moon, Gisselle Perez-Milicua, Jennifer E. Dietrich		123	<b>Thyroid Hormones</b> . . . . .	727
101 <b>The Adolescent Pregnant Patient</b> . . . . .	628		Alfred Aleguas, William J. Lewander	
Jennifer L. Bercaw-Pratt, Pamela J. Okada		124	<b>Isoniazid</b> . . . . .	729
			Jenny J. Lu	

125	<b>Alcohols</b> . . . . .	731	142	<b>Dysbaric Injuries</b> . . . . .	816
	Michael E. Nelson, Timothy B. Erickson			Ira J. Blumen, Colton A. Clay	
126	<b>Alkalis and Acids</b> . . . . .	736	143	<b>Radiation Emergencies</b> . . . . .	822
	William J. Lewander, Alfred Aleguas			Ira J. Blumen, Christine A. Babcock	
127	<b>Hydrocarbons</b> . . . . .	738	<b>SECTION 24</b>	<b>Psychosocial Emergencies</b> . . . . .	835
	Trevonne M. Thompson				
128	<b>Carbon Monoxide, Cyanide, and Smoke Inhalation</b> . . . . .	740	144	<b>Sexual Abuse</b> . . . . .	835
	David Juurlink			Robert H. Pantell	
129	<b>Methemoglobinemia</b> . . . . .	745	145	<b>Abuse and Neglect</b> . . . . .	841
	Wesley Palatnick			Cynthia Tinsley	
130	<b>Plants and Mushrooms</b> . . . . .	748	146	<b>Psychiatric Emergencies</b> . . . . .	847
	Edward P. Krenzelok			Catherine Porter Moore	
131	<b>Recreational Substances</b> . . . . .	752	147	<b>Death of a Child in the Emergency Department</b> . . . . .	851
	Jason Devgun, Navneet Cheema			Celeste A. Tarantino	
132	<b>Organophosphates and Carbamates</b> . . . . .	756	<b>SECTION 25</b>	<b>EMS and Mass Casualty</b> . . . . .	855
	Leon Gussow				
<b>SECTION 23</b>	<b>Environmental</b> . . . . .	759	148	<b>Prehospital Care</b> . . . . .	855
133	<b>Human and Animal Bites</b> . . . . .	759		Saranya Srinivasan, Manish I. Shah	
	Dale Birenbaum, Jessica Fides Aun		149	<b>Interfacility Transport</b> . . . . .	861
134	<b>Snake Envenomations</b> . . . . .	761		Maeve Sheehan, Craig J. Huang	
	Neeraj Chhabra, Patrick M. Lank, Timothy B. Erickson		150	<b>Disaster Preparedness</b> . . . . .	867
135	<b>Spider and Arthropod Bites</b> . . . . .	766		Sarita Chung, Elizabeth K. Hewett, Terry Adirim	
	Navneet Cheema, Timothy B. Erickson		<b>SECTION 26</b>	<b>Administrative Issues</b> . . . . .	873
136	<b>Marine Envenomations</b> . . . . .	773			
	Timothy B. Erickson, Armando Márquez		151	<b>Medicolegal Considerations</b> . . . . .	873
137	<b>Drowning</b> . . . . .	780		Steven M. Selbst	
	Nadeemuddin Qureshi, Andrea Rivera-Sepulveda		152	<b>Ethical Considerations</b> . . . . .	878
138	<b>Pediatric Burns</b> . . . . .	785		Alan Johnson	
	Jennifer N. Fische, Phyllis L. Hendry		153	<b>Procedural Competency and Simulation</b> . . . . .	882
139	<b>Lightning and Electrical Injuries</b> . . . . .	790		Adam Cheng, Marc Auerbach	
	Norberto Navarrete		154	<b>Electronic Health Records</b> . . . . .	887
140	<b>Heat and Cold Illness</b> . . . . .	798		Abu N.G.A. Khan	
	Adetunbi T. Ayeni, Christopher Kelly		155	<b>Patient Safety</b> . . . . .	894
141	<b>High-Altitude Illness</b> . . . . .	809		Karen Frush	
	Ira J. Blumen, James Ahn		<b>Index</b> . . . . .		899

# Preface

There once was a time when there were no emergency physicians and no pediatric emergency physicians. Gradually, this changed. First, there were practitioners, educators, and researchers who focused on the needs of children for emergency medical and trauma care. Journal articles, textbooks, and evidence-based medicine helped push the field forward. Eventually the American Board of Emergency Medicine and the American Board of Pediatrics jointly formed the subspecialty. Children greatly benefited from this progress. But the journey is not over. All of us want children to receive excellent, timely, high-quality emergency care.

One of the many efforts to improve pediatric emergency care was the McGraw-Hill *Pediatric Emergency Medicine: A Comprehensive Study Guide* textbook, published in 1996, now in its fifth edition. The initial impetus for the development of this work was the 1993 report of the Institute of Medicine on Emergency Medical Services for Children citing insufficient attention to the recognition and management of emergencies in children. It was approximately one year after the first subspecialty exam in Pediatric Emergency Medicine (PEM). Dr. Gary Strange invited several of us to help him edit this new textbook. He wanted a very readable and rapidly accessible clinical reference for clinicians. The first edition of this book, published in 1996, was developed as a resource for practitioners as well as a review book. The second edition, published in 2002, further refined the excellent trauma section and increased the depth of discussion regarding pediatric heart disease. Chapters were also added for procedural sedation and pain control, which were becoming more important topics in the practice of PEM. It remained as a clinical reference intended for topic review.

The subspecialty continued to mature and significant research was completed. Newer pharmaceuticals and new technologies also enhanced the practice of PEM. A decision was made that this would be a formal textbook *Pediatric Emergency Medicine*, with a significant update to many chapters. Chapters on cardinal presentations were added to help the clinicians with common symptoms. Fever and sepsis was divided into

two chapters, one for neonates and the other for children. Transplants were more common in children and so a chapter regarding transplant emergencies was added. It also became apparent that clinicians needed to understand bioterrorism and chemical terrorism as well as mass casualty management. Many photographs, figures, diagrams, and algorithms were added, and the third edition of the book was published in color.

Evidence-based medicine became a cornerstone of practice and of textbooks. Research had progressed in many areas including trauma, respiratory illnesses, infectious diseases, and neurologic diseases in children. The fourth edition, published in 2015, updated the evidence and supporting references to include many of the recent guidelines, and most chapters were extensively revised. Other changes included adding chapters on ultrasound, since it was playing a much greater role in the care of children. Dr. Tenenbein added a section on abdominal surgical emergencies and extensively revised the toxicology section. He also added a freestanding chapter on foreign bodies, whether inhaled, ingested, or inserted. The book was now available online.

I feel honored and privileged to have been a part of the first four additions and to have served as senior editor for the fourth edition. My hope was that we would enhance the knowledge and expertise of clinicians so that children would receive excellent emergency care. I was also privileged to help in the planning and as a consultant for this fifth edition. Dr. Tenenbein took the baton from me for this edition. He is a skilled clinician and researcher and an excellent editor. I know that this edition will achieve the goal of having very readable and easily accessible evidence-based information to provide high-quality care to our young patients.

Even though the subspecialty is quite young, the pioneering clinicians and educators are reaching retirement and they look to the current and future pediatric emergency medicine specialists to continue the quest of quality emergency medical care for children.

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## Cardinal Presentations

## CHAPTER

## 1

## Approach to the Child in the Emergency Department

Valerie McDougall Kestner

### HIGH-YIELD FACTS

- The emergency physician must have a reasonable knowledge of the developmental stages to identify abnormal or delayed development.
- Observation of the young child during history taking provides much insight regarding the severity of the child's condition.
- Often, the best examination occurs while the parent is holding the child in her lap or arms.
- Good history taking can minimize the need for blood work.
- Minimizing radiation exposure, the "as low as reasonably achievable" (ALARA) principle is particularly important in children.

The approach to children in the emergency department (ED) is completely different than for the adult. The physician gets one attempt to engage the patient, greet the parent, perform the examination, and formulate a treatment plan. This chapter focuses on deconstructing the visit and empowering the emergency physician to be comfortable with and competently treat the child.

Knowledge of age-specific biologic variables is required to identify abnormalities. **Tables 1-1 to 1-3**<sup>1-3</sup> provide quick reference for normal pediatric respiratory rate, heart rate, and blood pressure.

The ED must be prepared for the pediatric patient.<sup>4</sup> The American Academy of Pediatrics and the American College of Emergency Physicians have established a list of recommended pediatric resuscitation equipment and emergency medications.<sup>5</sup> Dosing medication for children is challenging, especially in a dire situation. Several tools are available to help providers with weight-based dosing. These include the length-based Broselow tape and chart with corresponding colors for dosing, the Best Guess and APLS methods, which involve calculations based on age, computer support programs such as the PEMSOFT calculator software package with dosing calculators and algorithms, and Pediatric Advanced

**TABLE 1-1** Normal Respiratory Rates for Children

Age (y)	Respiratory Rate (breaths/min)
<1	24–38
1–3	22–30
4–6	20–24
7–9	18–24
10–14	16–22
15–18	14–20

Reproduced with permission from Bardella JJ. Pediatric advanced life support: a review of the AHA recommendations. *American Heart Association, Am Fam Physician.* 1999 Oct 15;60(6):1743–1750.

**TABLE 1-2** Normal Heart Rates for Children

Age (y)	Heart Rate (beats/min)
<1	100–160
1–10	70–120
>10	60–100

Data from A.D.A.M., Inc. Medical Encyclopedia of MedlinePlus 2007. <http://www.nlm.nih.gov/medlineplus/ency/article/003399.htm>.

Life Support (PALS) or regional children's hospital code cards. Having a pharmacist present at pediatric codes is invaluable.

### PREPARING FOR THE EXAMINATION

Consider a visit by first-time parents with their sick infant. They have had little sleep; their baby has been crying for 2 hours and has fed poorly today. They are referred to the ED by their pediatrician. They repeated their story to the triage nurse. Once back in the waiting room, they wait for the nurse, then the physician, and then repeat their story another time. The repetition and waiting game can turn into fear and anger. Consideration of in-room triage is a nice option in pediatrics, thus getting the child into an available room and out of the waiting room sooner.

After ensuring that the child does not have an impending emergency that requires immediate intervention, conduct a quick chart review. It is crucial to know if there is a chronic illness or a rare or genetic syndrome. Use and review of a critical information note from a patient's subspecialist can aid the emergency provider in proper management for that patient's specific condition. A basic text review or Internet search can prepare the physician for what may be normal for the child or what special problems the child may have. Remember, to the parents, syndrome *X* is their life and they may know more on the topic than the physician. Listen to the parents, as the child likely has had a similar presentation in the past, and obtain their history of prior management for this problem.

Is the required equipment available in the room? There is nothing worse than a child having a sore throat, and no light source or throat swab in the room. Children have high anxiety, and when the physician leaves the room, the child thinks the anxiety-provoking things are going to be done. When that turns out not to be true, the child may be more uncooperative.

Talk with the parents and determine their main concern. Outline the expectations of the family early in the visit. Discuss what issues you are going to address in the ED and what you will leave for the primary care physician. One must also expect to patiently relay information to

**TABLE 1-3** Normal Blood Pressure for Children

Age	Systolic BP (mm Hg)
0–28 d (full term)	>60
1–12 mo	>70
1–10 y	>70 + 2 × age in y
>10 y	>90

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Age	Gross Motor	Visual-Motor/Problem Solving	Language	Social/Adaptive
1 mo	Raises head from prone position	<i>Birth:</i> Visually fixes <i>1 mo:</i> Has tight grasp, follows to midline	Alerts to sound	Regards face
2 mo	Holds head in midline, lifts chest off table	No longer clenches fists tightly, follows object past midline	Smiles socially (after being stroked or talked to)	Recognizes parent
3 mo	Supports on forearms in prone position, holds head up steadily	Holds hands open at rest, follows in circular fashion, responds to visual threat	Coos (produces long vowel sounds in musical fashion)	Reaches for familiar people or objects, anticipates feeding
4 mo	Rolls over, supports on wrists, and shifts weight	Reaches with arms in unison, brings hands to midline	Laughs, orients to voice	Enjoys looking around
6 mo	Sits unsupported, puts feed in mouth in supine position	Unilateral reach, uses raking grasp, transfers objects	Babbles, ah-goo, razz, lateral orientation to bell	Recognizes that someone is a stranger
9 mo	Pivots when sitting, crawls well, pulls to stand, cruises	Uses immature pincer grasp, probes with forefinger, holds bottle, throws objects	Says “mama, dad” indiscriminately, gestures, waves bye-bye, understands “no”	Starts exploring environment, plays gesture games (e.g., pat-a-cake)
12 mo	Walks alone	Uses mature pincer grasp, can make a crayon mark, releases voluntarily	Uses two words other than mama/dad or proper nouns, jargoning (runs several unintelligible words together with tone or inflection), one-step command with gesture	Imitates actions, comes when called, cooperates with dressing
15 mo	Creeps up stairs, walks backward independently	Scribbles in imitation, builds tower of two blocks in imitation	Uses four to six words, follows one-step command without gesture	15–18 mo: Uses spoon and cup
18 mo	Runs, throws objects from standing without falling	Scribbles spontaneously, builds tower of three blocks, turns two to three pages at a time	Mature jargoning (includes intelligible words), 7–10 word vocabulary, knows five body parts	Copies parents in tasks (sweeping, dusting), plays in company of other children
24 mo	Walks up and down steps without help	Imitates stroke with pencil, builds tower of seven blocks, turns pages one at a time, removes shoes, pants, etc.	Uses pronouns (I, you, me) inappropriately, follows two-step commands, has a 50-word vocabulary, uses two-word sentences	Parallel play
3 y	Can alternate feet when going up steps, pedals tricycle	Copies a circle, undresses completely, dresses partially, dries hands if reminded, unbuttons	Uses a minimum of 250 words, three-word sentences, uses plurals, knows all pronouns, repeats two digits	Group play, shares toys, takes turns, plays well with others, knows full name, age, gender
4 y	Hops, skips, alternates feet going down steps	Copies a square, buttons clothing, dresses self completely, catches ball	Knows colors, says song or poem from memory, asks questions	Tells “tall tales,” plays cooperatively with a group of children
5 y	Skips alternating feet, jumps over low obstacles	Copies triangle, ties shoes, spreads with knife	Prints first name, asks what a word means	Plays competitive games, abides by rules, likes to help in household tasks

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multiple concerned parties. For example, the physician talks to the father and is then handed the cell phone to repeat the same information to the mother.

The emergency physician should consider what the young patient’s role should be during the history taking and physical examination. Knowledge of developmental stages is paramount for this decision. Several charts and tables are available delineating month-by-month development of children.<sup>5,6</sup> **Table 1-4**<sup>7</sup> is included for reference of developmental milestones.

## THE HISTORY AND PHYSICAL EXAMINATION

There are several qualities that can enhance the assessment of children in the ED. Flexibility is important. Interview the parent while the child plays. Concomitant observation provides insight regarding the severity of the child’s condition. Often, the best examination occurs while the parent is holding the child.

If the child has a respiratory or cardiac complaint, examine the lungs and heart before the history taking. If the child is screaming, it is difficult to hear heart murmurs or crackles. If the child is very resistant to the

examination, showing him the process on a parent, sibling, or stuffed animal can decrease anxiety. Let the child know what to expect during the examination: scratch his hand with the ear curette or let him hold the stethoscope so that he is less surprised during the examination.

It is best to examine the painful or injured part last. Crying may occur during the entire examination. In these cases, the examiner has to rely on differential crying, or comparing crying when touching different locations. Also, if the child cries for the abdominal exam, instructing the parent on palpating the four quadrants can guide your decision-making. This is extremely important in toddlers.

Dedicated child life personnel can be invaluable, particularly during procedures. They bring their arsenal of iPads, DVDs, spinning toys, and a calming third-party presence to the room. Their distraction techniques can minimize the need for sedation in many patients.

Communication is very important in pediatrics, and there is a delicate balance of enough information with too much information. The setting of laceration repair illustrates this dilemma. Show the child the saline, let the child feel it, and show the child how the irrigation works. Telling the child “OK, now a big bee sting” is counterproductive. The child knows that they hurt. A better choice is to tell the child: “Some kids think the

medicine feels hot and some think it feels cold, what do you think it feels like?” With many older children, it works to simply let them know that the pain with numbing will take X amount of seconds, and then there will be no pain at all. Talk to the child during the procedure—about school, siblings, pets, anything but the pain.

The emergency physician has to gauge the parents’ attitude. Will the parent be a help or a hindrance? The parent can be the best ally, explaining the process and steps to the child. However, the parent can also be an obstacle. An example is in the setting of laceration repair—if the parent is in tears and visibly upset, the child will be more distressed. This parent can be coached, however, outside of the room, as to the counterproductive nature of their behavior—often being able to return to the room or send another family member in for the procedure. Also, limit the number of family members allowed to stay in the room for a procedure.

Sometimes, important historical information can only be teased out by two or three different questions designed to obtain the same information. For example, not simply “Does your child have asthma?” but also “Has your child ever used albuterol?” and “Do you give breathing treatments at home?” The same is true with immunization status: not “Are immunizations up to date?” but also “Did your child get the 6-month shots yet?”

The emergency physician should attempt to obtain the child’s personal input as soon as the patient is developmentally able. Many preschoolers are capable of providing at least some historical data, and involving the child is a respectful approach. If the parent is dominating the conversation, a gentle “And what do you think about all of this?” to the patient is often helpful. A parent, especially of teenagers, doing all of the talking is a red flag. Excuse the parent from the room to conduct a sensitive and thorough interview. Having the parent leave the room can be challenging, but focusing on the patient’s right to autonomy and its impact on the care of the child is often helpful.

A unique situation in pediatrics is the presence of siblings. Approaches to facilitate examination include turning down the TV, asking one adult to step out with the other children, or giving the siblings something to do.

## ASSESSMENT AND PLAN

Good history taking can minimize the need for blood work, as the child’s age, immunization status, and past medical history all impact the need for this investigation. This is especially important in younger children, because obtaining the specimen can be challenging and the procedure provokes anxiety.

Imaging studies require special consideration because of the detrimental effect of radiation upon young children with developing brains and reproductive organs. Minimizing radiation exposure, the “as low as reasonably achievable” (ALARA) principle is particularly important in children.<sup>8</sup> One should strongly consider whether that closed head injury really merits a CT scan. Could that abdominal pain be addressed by a radiation-free modality such as ultrasound?

Consider the parents’ role in the child’s treatment. Is the treatment plan reasonable for a parent to follow or is there an easier way to achieve the same goal? The physician must listen to what the parent is saying. Is it possible to prescribe a medication once a day instead of twice a day? Is it possible to teach the parent how to use an inhaler instead of

a cumbersome nebulizer? Can the physician prescribe an epinephrine auto-injector for both mom and dad’s individual houses?

Enlisting the support of the parent in the child’s care is important for education, clear discharge instructions, and answering questions. Adult learners use several modalities to learn, so visual teaching, written instructions, and verbal review of the plan all increase the chance of compliance. The discharge instructions must be clear and written out for the parent. Leave follow-up phone numbers, names of subspecialists, if appropriate, and a time frame for follow-up. Give the parent symptoms to look for as reasons to return to the ED. Allow the parents a final chance to ask questions.

Finally, address any remaining concerns, and reward the child. It can be a material reward such as a sticker or stuffed animal, a high-five for being such a good patient, or simply a statement complimenting the child’s maturity level or behavior. The ED is a scary place for a child, and a reward lets her know that the physicians are here to help.

## SUMMARY

Children as ED patients present a wonderful, yet challenging opportunity. Break down the visit into components: consider the challenges the physician will face during preparation, history, physical examination, assessment, and management plan. Preparation for the examination of the child, enlisting the role of the parent, decreasing anxiety of all parties, and educating with clear instructions will help all to make the encounter a successful one.

## REFERENCES

1. Bardella IJ. Pediatric advanced life support: a review of the AHA recommendations. *Am Fam Physician*. 1999;60(6):1743–1750. <http://www.aafp.org/afp/991015ap/1743.html>. Accessed April 12, 2008.
2. A.D.A.M., Inc. Medical Encyclopedia of Medline Plus 2007. <http://www.nlm.nih.gov/medlineplus/ency/article/003399.html>. Accessed April 12, 2008.
3. 2015 American Heart Association Guidelines for CPR and ECC. Web-based Integrated 2010 & 2015 AHA Guidelines for CPR & ECC. 12(4.1.4):15. [eccguidelines.heart.org](http://eccguidelines.heart.org).
4. American Academy of Pediatrics, Committee on Pediatric Emergency Medicine and American College of Emergency Physicians, Pediatric Committee. Care of children in the emergency department: guidelines for preparedness. *Pediatrics*. 2001;107(4):777–781.
5. Needleman RD. Growth and development. In: Behrman RE, Kliegman RM, Jenson HB, eds. *Nelson Textbook of Pediatrics*. 17th ed. Philadelphia, PA: Saunders; 2004:23–57.
6. American Academy of Pediatrics. *Children’s Health Topics*. Elk Grove Village, IL; 2004. <http://www.aap.org/topics.html>. Accessed April 12, 2008.
7. Engorn B, Flerlage J. *The Harriet Lane Handbook*. 20th ed. Saunders; 2015:197–198 (Table 9-1).
8. Frush DP, Donnelly LF, Rosen NS. Computed tomography and radiation risks: what pediatric health care providers should know. *Pediatrics*. 2003;112(4):951–957.

# The Febrile or Septic-Appearing Neonate

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## HIGH-YIELD FACTS

- The risk of serious bacterial illness (SBI) is greatest during the neonatal period, defined as birth to 28 days of life. Some authorities recommend that a child born prematurely should have the degree of immaturity subtracted from the child's chronological age for this consideration.
- It is generally accepted that a fever is a temperature of  $\geq 38^{\circ}\text{C}$  or  $100.4^{\circ}\text{F}$  taken with a rectal thermometer.
- A neonate who had a documented fever by any method but is afebrile in the emergency department (ED) should be treated as a febrile neonate whether or not antipyretics have been given, as other methods of thermometry tend to underestimate the actual temperature.
- The most frequent bacterial pathogens in the neonatal period are group B *Streptococcus* (GBS), *Escherichia coli*, and *Listeria monocytogenes*.
- Hypothermia is a rectal temperature less than  $36^{\circ}\text{C}$  or  $96.8^{\circ}\text{F}$ , and in the neonatal period may actually be a more common presentation than elevated temperature. All neonates with hypothermia should be treated as septic.
- Causes other than SBI, especially herpes simplex virus (HSV) infection, should be considered and, if suspected, treated expectantly.
- Noninfectious problems, such as congenital heart disease (CHD), inborn errors of metabolism, and trauma, may present in a similar way and must always be included in the differential diagnosis of the septic-appearing infant.
- If the child is exhibiting signs of shock, such as tachycardia, mottling, apnea, or prolonged capillary refill time, aggressive fluid resuscitation must be immediate.
- Antibiotics should be started after cultures have been obtained.
- If the child is unstable, the lumbar puncture may need to be postponed but should not delay empiric antibiotic therapy.

Fever is one of the most common presenting complaints of children evaluated in the emergency department (ED). Of particular concern to both parents and practitioners is the febrile neonate (0–28 days), since fever is often the only clinical sign of SBI in this age group. Neonates are at a particularly high risk of SBI due to a relatively immature immune system, including decreased T-helper cell activity, opsonization, antibody titers, macrophage, neutrophil, monocyte, and complement activity compared to older infants.<sup>1–3</sup> Some authorities recommend that a child born prematurely should have the degree of immaturity subtracted from the child's chronological age for this consideration. The resultant inability to adequately contain bacterial infections results in higher morbidity for neonates with SBI. In addition, due to developmental immaturity, clinical indicators of wellness are not universally present in the neonate. For example, acquisition of the social smile, one of the most commonly used signs to judge the clinical appearance of infants, generally does not develop until 4 to 8 weeks of age.

Fever is generally defined as a rectal temperature  $\geq 38.0^{\circ}\text{C}$  ( $100.4^{\circ}\text{F}$ ). Temperatures obtained by the axillary, otic, temporal artery, or noncontact mid-forehead infrared routes tend to underestimate the rectal temperature and are often unreliable.<sup>4</sup> Neonates with a documented rectal fever obtained by a reliable caretaker at home or in the office setting, who are afebrile on presentation to the ED, have the same risk of SBI

**TABLE 2-1** Non-Infectious Etiologies of the Septic-Appearing Neonate

Congenital adrenal hyperplasia (Chapter 78)
Congenital heart disease (Chapter 40)
Dysrhythmias (Chapter 43)
Electrolyte disturbances (Chapter 81)
Food protein–induced enterocolitis syndrome (FPIES)
Hypoglycemia
Inborn errors of metabolism (Chapter 80)
Nonaccidental trauma (Chapter 145)
Toxic exposure
Volvulus (Chapter 46)

as those with documented fever who present initially to the ED. Therefore, they should be managed as febrile whether or not antipyretics have been given. Mild temperature elevation can occur secondary to environmental factors such as bundling; however, in this scenario, the neonate should be unbundled and have repeated temperature measurements to determine if there is fever. Subjective (tactile) fever determination by the parent is unreliable and does not place the neonate at higher risk for SBI. Hypothermia ( $\leq 36.0^{\circ}\text{C}$  [ $96.8^{\circ}\text{F}$ ]) can also be a presenting symptom of SBI, and the evaluation should be the same as for a febrile neonate.

SBI is typically defined as the presence of a pathogenic bacterial organism in the cerebrospinal fluid (CSF), blood, urine, or stool. Many investigators consider the presence of a lobar infiltrate on chest radiograph to be indicative of bacterial pneumonia and therefore considered an SBI. The rate of SBI in the febrile neonate is  $>20\%$ .<sup>5</sup> Focal bacterial infections such as cellulitis, septic arthritis, omphalitis, and otitis media are typically managed as an SBI if the neonate is febrile.

The epidemiology of SBI has changed over the past several decades due to routine childhood immunization against two of the most previously common pathogens implicated in bacterial meningitis and bacteremia—*Haemophilus influenzae* type B (HiB) and *Streptococcus pneumoniae*. The incidence of HiB meningitis has decreased drastically since introduction of the vaccine; although *S. pneumoniae* remains one of the most common causes of bacterial meningitis, an overall decrease in the incidence of invasive pneumococcal disease reflects vaccine efficacy. Currently, GBS and *Escherichia coli* are the most common causes of bacteremia and bacterial meningitis in neonates. *E. coli* is the pathogen responsible for the majority of neonatal urinary tract infections (UTIs). *Listeria monocytogenes* is also a recognized pathogen in younger or premature neonates. Other bacterial pathogens in febrile neonates include *Staphylococcus aureus*, *Salmonella* sp., and other gram-negative organisms.

While emphasis is typically placed on identification of SBI in febrile neonates, viral infections occur more frequently than bacterial infections. While most viral infections are benign, some may result in serious illness. Neonatal herpes simplex virus (HSV) infection is rare (estimated 1500 cases/year in the United States); however, it carries risk of significant morbidity (primarily neurologic deficits) and mortality that can be reduced with appropriate antiviral therapy. Three different clinical presentations of neonatal HSV that may overlap exist: skin, eye, and mouth infection (45% of cases); central nervous system infection (30% of cases); and disseminated HSV (25% of cases).<sup>6</sup> Respiratory viruses, such as influenza and respiratory syncytial virus (RSV), are fairly common in febrile neonates, especially in the winter months.

The differential diagnosis of the septic-appearing neonate is broad. Conditions other than sepsis are listed in **Table 2-1**.

## CLINICAL PRESENTATION

Ill-appearing febrile neonates require rapid assessment of the airway, breathing, and circulation along with intravenous access, fluid resuscitation, oxygen administration, and parenteral antibiotics. If the neonate