

## 1.1 What is Pediatric Surgery?

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The easiest answer to this question is the semantic interpretation of the words pediatric and surgery, meaning surgery on a child. Is pediatric surgery, however, the transposition of surgical procedures to a smaller human being? The main difference between an adult and a child is the fact that the child is growing and throughout the time between its birth and entrance to adulthood – about 18 years – this child never stays the same. Considering this fact, the surgical procedure in pediatric surgery has to be adapted to the child's age, something with which an adult surgeon is not confronted. This philosophy was best expressed in the nineteenth century by the British novelist Charles Dickens who wrote the following statement:

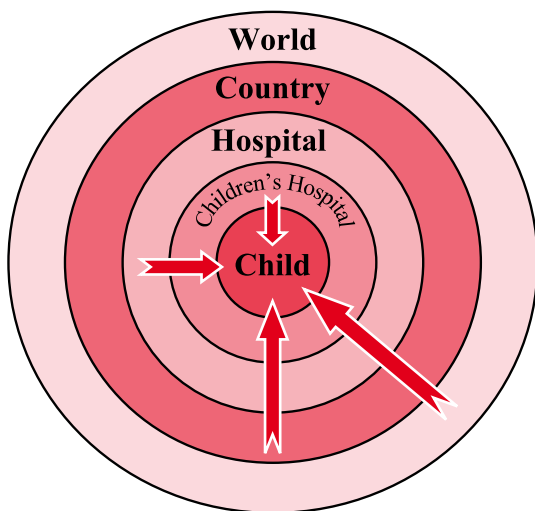
*“It is not enough, that a wise physician, who succeeds in curing an adult with a medicine, reduces this prescription in order to treat a child. Some diseases occur only in children and some others, that afflict adults also, develop in other forms in children that diverge from each other as a child and an adult. Children are not miniature adults.”*

This visionary statement reflects the quintessence of pediatric surgery. Malformations of the gastrointestinal tract for instance are only found in children. Then again, acute appendicitis takes a very different course in children compared to adults, with perforation occurring much earlier. Bone fracture treatment is the best example showing that any therapy applied to a growing organism has to consider the child's growth potential.

Pediatric surgery is not the mere application of surgical procedures to a child but requires special knowledge about embryology, pediatrics, growth

pathophysiology, and specific therapy principles. Pediatric surgery is a specialization on the growing organism.

Medical knowledge has grown enormously in recent decades. This fact has led to the subspecialization of medicine on the basis of organs. Pediatric surgeons are perhaps the only remaining physicians who treat the whole organism and not simply an individual organ. This task is very difficult, as it is impossible to be the best in all fields. The pediatric surgeon is, in my opinion, the “manager” of the surgically ill child. Indeed, pediatric surgery offers the infrastructure in which the medical specialist can come to the child, in a child- and family-friendly environment, to offer her/his great expertise. The pediatric surgeon puts the child in the center and cares for them with the best possible treatment. If this treatment is not offered by pediatric surgery, then, according to the local setting, adult surgeons from the institution, from elsewhere in the country or from other parts of the world may provide the solution. The pediatric surgical “bull’s eye” (Fig. 1.1) illustrates the solution providing optimal treatment.



**Fig. 1.1** Pediatric Surgical “Bulls eye”

## 1.2 Timing of Operations in Pediatric Surgical Patients

### General

The following considerations are necessary before the indication for operation is set (see Table 1.1 for proposed ideal age for elective operations):

- Is the patient compromised due to the disease? (i.e., intrauterine bowel perforation)
- What risks for the patient could occur due to the operation? (i.e., premature newborn)
- Is the operation at this point technically possible? (i.e., hand malformations)
- Is a spontaneous healing possible? (i.e., umbilical hernia or hydrocele in the newborn)
- What are the psychosocial aspects of the therapy and the hospitalization? (i.e., intersex)

**Table 1.1** Proposed ideal age for elective operations in pediatric surgery

Malformation	Age	Hospitalization
Craniosynostosis	1st to 3rd month	2 weeks
Meningocele	3rd to 6th month	2 weeks
Lip, cleft	3rd to 9th month	1 week
Palate, cleft	18th to 36th month	1 week
Prominent ears	5th to 6th year	Day surgery
Thyroglossal fistula, cyst	As from the 3rd month	5 days
Torticollis	6th to 12th month	4 days
Inguinal hernia	After diagnosis	3 days
Umbilical hernia	After the 12th month	Day surgery
Testicular position anomalies	18th to 24th month	4 days
Varicocele	Grade III and according to signs	2 days
Phimosis (medical indication)	3rd to 5th year	Day surgery
Hypospadias	6th to 12th month	4–14 days

**Table 1.1** (*continued*) Proposed ideal age for elective operations in pediatric surgery

Malformation	Age	Hospitalization
Bladder exstrophy		
▪ Turn-in	Newborn period	2–3 weeks
▪ Epispadia repair	3rd year	2–3 weeks
▪ Continence repair	4th to 5th year	2–3 weeks
Kidney and descending urinary tract	3rd month	2–3 weeks
▪ Ureteropelvic- junction obstruction		
▪ Vesicoureteral reflux		
Hirschsprung's disease (definitive)	3rd to 6th month	3 weeks
Anorectal anomalies	3rd to 12th month	1–3 weeks
Hexadactyly	3rd to 6th month	1–2 weeks
Syndactyly	6th to 24th month	1–2 weeks
Funnel chest	8th to 10th year	2 weeks
Exostosis	With hitting puberty	3–7 days
Bone cysts	As from the 5th year	3–7 days
Hemangioma	According to signs, 6th to 18th month	2 days/day surgery
Ambiguous genitalia	As soon as possible –18th month	3 weeks

### 1.3 Preoperative Management

#### Medical history

- Pre-, peri- and postnatal anamnesis
- History of the surgical disease
- Anamnesis of pediatric diseases
- Risk factors (diabetes, hemophilia, asthma, heart malformations, etc.)
- Time of last food ingestion

**Clinical status**

- General status
- Surgical local finding
- Inspection (scars), palpation, auscultation
- Anthropometric measurements (weight, height, head circumference)
- Rectal examination (especially in abdominal diseases)

**Laboratory examinations**

- Full blood analysis (including serum glucose)
- Differential blood count with thrombocytes
- Electrolytes
- Coagulation status
- Urine analysis
- Laboratory examinations can be omitted in cases where the child is over 1 year old, has never been seriously ill, and is undergoing a routine operation

**Additional diagnostic measures**

- Chest X-ray (as indicated by the history)
- Electrocardiogram (ECG; as indicated by the history)
- Ultrasonography (appendicitis, hypertrophic pylorus, blunt abdominal trauma, etc.)
- C-reactive protein (CRP) and blood culture (sepsis, infections)

**Special diagnostic measures**

- Liver enzymes
- Liquor puncture
- Head CT/MRI
- Electroencephalography (EEG)
- 24-h creatinine clearance

**Contraindications for elective surgical procedures**

- Infections of the upper respiratory system with fever and leukocytosis
- Children who have teething problems

- Those who have received vaccinations in the previous 4 weeks (especially live vaccines)
- Those who have chronic disease (diabetes, asthma, etc.) and whose treatment is not optimally adjusted

### **Emergency measures**

- Respiratory distress (see Chap. 3): mechanical ventilation if
  - Breathing rate is 50% lower than age norm
  - The patient's general condition is getting worse in light of the  $\text{PaCO}_2$  (normal range 4.7–6 kPa)
- Cardiac decompensation: catecholamines (see Sect. 3.5)
- Anemia: transfusion when Hb under  $7 \text{ g} \cdot \text{dl}^{-1}$
- Dehydration: fluid and electrolyte substitution and treat the acidosis
- Convulsion attack: substitution in case of metabolic cause, lower the temperature if there is fever, lumbar puncture

### **Transportation of high-risk pediatric surgical patients**

- Transport in an incubator accompanied by a neonatal specialist
- Vascular access
- Stomach drainage
- Sterile dressing of open wounds
- Respiratory support if necessary; intubation before transport
- Vitamin K prophylaxis in newborns

## **1.4 The Newborn as a Pediatric Surgical Patient**

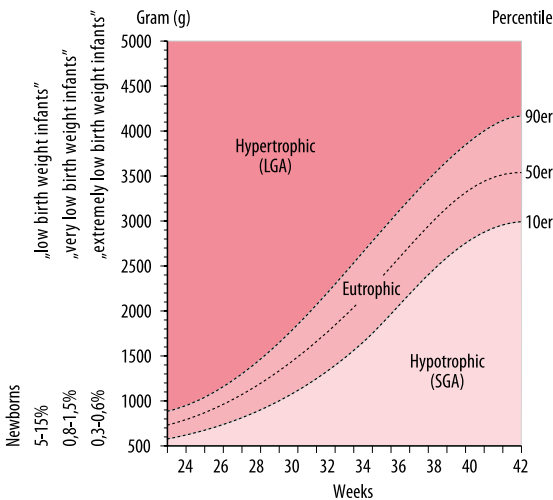
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### **Definition of the newborn period**

- The first 3 days (short sense), the first 28 days (broad sense)

### Classification according to birth weight (Fig. 1.2)

- Normal: between the 10th and 90th percentiles for the gestational age
- Small for gestational age: under the 10th percentile for the gestational age
- Large for gestational age: over the 90th percentile for the gestational age
- Low birth weight infant: less than 2500 g independent of gestational age
- Very low birth weight infant: less than 1500 g
- Extremely low birth weight infant: less than 1000 g



**Fig. 1.2** Newborn classification according to gestational age and body weight

### Organ function changes after birth

- Organ function changes and adaptation processes are listed in Table 1.2 and must be considered when deciding perioperative and operative therapy
- During the newborn period a steady state should be aimed for every operation (Table 1.3)

**Table 1.2** Changes of the organ functions after birth and adaptation

Organ system	Normal values	Malfunctions
<b>Respiratory</b> <ul style="list-style-type: none"> <li>▪ Lung drainage during birth</li> <li>▪ Surfactant activation</li> <li>▪ Initial hypoxia as stimulus</li> </ul>	<ul style="list-style-type: none"> <li>▪ Breathing rate: <math>30\text{--}55 \cdot \text{min}^{-1}</math></li> <li>▪ <math>\text{PaCO}_2</math> 40–45 mmHg</li> <li>▪ <math>\text{PaO}_2</math> 75–85 mmHg</li> </ul>	Respiratory distress syndrome <ul style="list-style-type: none"> <li>▪ Tachypnea</li> <li>▪ Flaring of alae nasi</li> <li>▪ Moan</li> <li>▪ Inspiratory retraction</li> <li>▪ Cyanosis</li> </ul>
<b>Cardiovascular</b> <ul style="list-style-type: none"> <li>▪ Fetal circulation conversion</li> <li>▪ Pulmonary resistance ↓</li> <li>▪ Oval foramen/Botalli (ductus arteriosus) duct obliteration</li> </ul>	<ul style="list-style-type: none"> <li>▪ Heart rate: <math>110\text{--}140 \text{ beats} \cdot \text{min}^{-1}</math></li> <li>▪ Systolic blood pressure 45–65 mmHg</li> <li>▪ Blood volume: 8%–10% of birth weight</li> <li>▪ Hb: <math>16\text{--}22 \text{ g} \cdot \text{dl}^{-1}</math></li> <li>▪ Hct: 48–66%</li> </ul>	Heart malformations and re-establishment of the fetal circulation
<b>Metabolic</b> <ul style="list-style-type: none"> <li>▪ Hypoglycemia <math>&lt;40 \text{ mg\%}</math></li> <li>▪ Tremor</li> <li>▪ Apathy</li> <li>▪ Convulsion</li> <li>▪ Hypotension</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hypocalcemia <math>&lt;2 \text{ mmol} \cdot \text{l}^{-1}</math></li> <li>▪ Agitation</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hyperbilirubinemia <math>&gt;18\text{--}20 \text{ mg\%}</math></li> <li>▪ Rhesus incompatibility, with hemolysis</li> <li>▪ Prematurity</li> <li>▪ Biliary atresia</li> </ul>
<b>Water/electrolytes</b> <ul style="list-style-type: none"> <li>▪ Immature kidneys</li> <li>▪ Body weight water fraction: 80%</li> <li>▪ Concentration ability ↓</li> <li>▪ <math>\text{Na}^+</math> reabsorption ↓</li> </ul>	<ul style="list-style-type: none"> <li>▪ Glomerular filtration rate: <math>25 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}</math></li> <li>▪ Concentration ability: <math>600\text{--}700 \text{ mosmol} \cdot \text{l}^{-1}</math></li> </ul>	<ul style="list-style-type: none"> <li>▪ Kidney malformations</li> <li>▪ (Potter syndrome)</li> <li>▪ Obstruction/reflux urinary system</li> </ul>
<b>Thermoregulatory</b> <ul style="list-style-type: none"> <li>▪ Deficient isolation</li> <li>▪ Large body surface</li> <li>▪ Poor cutaneous vasoconstriction</li> </ul>		<ul style="list-style-type: none"> <li>▪ Hypothermia <math>&lt;36^\circ\text{C}</math></li> <li>▪ Breathing distress</li> <li>▪ Hypoglycemia</li> <li>▪ Acidosis</li> </ul>



**Table 1.3** Establishing a steady state in newborns before operation

Preoperative	Intraoperative	Postoperative
<ul style="list-style-type: none"><li>▪ Correct respiratory insufficiency</li><li>▪ Balance fluid deficiency</li><li>▪ Treat anemia</li><li>▪ Normoglycemia</li><li>▪ Compensate acidosis</li></ul>	<ul style="list-style-type: none"><li>▪ Normothermia</li><li>▪ Normoglycemia</li><li>▪ Normoxia</li><li>▪ Adequate fluid application</li></ul>	<ul style="list-style-type: none"><li>▪ Same principles as intraoperatively</li><li>▪ Wound treatment</li><li>▪ Bowel movements</li><li>▪ Pain treatment</li></ul>



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