Chapter 33

Pediatric Care

Introduction

The military surgeon needs to be familiar with the unique challenges the pediatric population presents, not only in war, but also in military-operations-other-than-war scenarios. This includes proper diagnostic evaluation and resuscitation, and the necessary equipment to ensure success. For US Army medical units, the humanitarian augmentation medical equipment set (MES), requested by the hospital commander through command channels, provides medical supplies and equipment for a population of 10,000 people. Additionally, the special care augmentation team can be requested for this mission.

Anatomic and Physiologic Considerations

- Fluid, electrolyte, and nutrition.
  - o Normal fluid requirements in children are estimated via a weight-based method (Table 33-1).

Table 33-1

Weight (kg)	Volume
0–10	120 mL/kg/d (after the first week of life)
11–20	1,000 mL + 50 mL/kg over 10 kg
over 20	1,500 mL + 20 mL/kg over 20 kg

  - o Maintenance IV fluid replacement is $D_5$1/2NS + 20 mEq/dL KCl for children over 3 months or D_{10}1/2NS + 20 mEq/dl KCl for children under 3 months.
  - o Fluid resuscitation is best performed with isotonic fluids at 20 cc/kg boluses. (See Evaluation and Diagnosis below.)
  - o Total fluid requirement should be adjusted for a goal urine output of 1–2 cc/kg/h.

- Daily sodium requirements are 2–3 mEq/kg/d and daily potassium requirements are 1–2 mEq/kg/d.
- Daily caloric and protein requirements are estimated by weight and age as follows (Table 33-2):

Table 33-2

Age (y)	kcal/kg body weight	Protein (g/kg body weight)
0–1	90–120	2.0–3.5
1–7	75–90	2.0–2.5
7–12	60–75	2.0
12–18	30–60	1.5
> 18	25–30	1.0

- Breast milk is always the first choice when initiating oral intake in infants. Alternatively, infant formulas contain 20 kcal/oz. An estimate of the amount of formula needed to provide 120 kcal/kg/d is

Infant's wt (kg) • 22 = Amt (in cc) of formula needed q 4 h.

- **Pulmonary.**
  - Newborns tend to be obligate nasal breathers, thus nasal airways should be avoided if possible.
  - The child's larynx is positioned more anterior in the neck, thus making it more difficult to visualize during intubation, and necessitating a more forward position of the head.
  - The acceptable range of PaO_2 (60–90 mm Hg) correlates to oxygen saturations of 92%–97%. A premature infant's oxygenation saturation should never exceed 94% to avoid retinopathy of the premature.
  - Infants breathe mostly with their diaphragm, thus increases in intraabdominal pressure or other problems that limit diaphragmatic movement can significantly inhibit respiration.
- **Cardiovascular.**
  - Vital signs by age group (Table 33-3).

Table 33-3

Age	Weight (kg)	Resp. Rate	Pulse	BP (systolic)
Premie	< 3	40–60	130–150	42±10
Term	3	40	120–140	60±10
1–5 yr	~10–20	20–30	100–130	95±30
6 –10 yr	20–32	12–25	75–100	100±15
Adolescent	50	12–18	70	120±20

- Cardiac stroke volume in children is relatively fixed. Therefore, bradycardia or relative bradycardia can significantly decrease cardiac output. Stimulation and oxygen therapy are corrective for over 90% of significant bradycardias in infants.

Limit peripheral IV access attempts to 2 within 60 seconds for the child in shock, then immediately proceed to saphenous vein cutdown or intraosseous (IO) infusion (see Chapter 8, Vascular Access).

- Burns.
  - An infant or child's head tends to encompass more of the BSA, with the lower extremities being a smaller percentage. The palm of the child's hand can be used to estimate 1% of total BSA for burn calculations (Fig. 33-1).
- Gastrointestinal.
  - Reflux is a common finding, especially in the newborn period. This predisposes some children to difficulty with digestion and frequent emesis.
  - Children are predisposed to hypoglycemia due to low glycogen storage capacity of their liver. Full-term infants will tolerate NPO status for approximately 5 days (with an appropriate D_{10} solution). Premature infants will tolerate only 3 days of NPO status prior to the initiation of TPN.

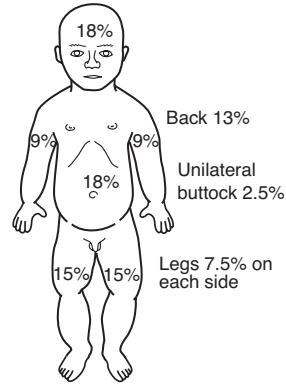

Fig. 33-1. BSA percentages for infants and children.

- A child's GI tract is very sensitive to most insults, including electrolyte abnormalities and systemic illnesses. This can result in an ileus and manifest as feeding intolerance, and may precipitate necrotizing enterocolitis (NEC).
- Gastroenteritis with diarrhea, often associated with fevers, is also a very common cause of severe dehydration.

- Hematology and blood volume.
  - Infants have a physiologic anemia during the first 3–5 months with a hematocrit of 30%–33%.
  - Estimates of blood volume are as follows:

Age	Volume (cc/kg)
Premature	85–100
Term	~80
1–3 mo	75–80
> 3 mo	~70

- Renal.
  - Infants and young children have a limited ability to concentrate urine (max 400–600 mOsm/L) and a fixed ability to excrete sodium, causing an inability to handle excess sodium, resulting in hypernatremia if they receive too much sodium. Premature infants are salt wasters and full-term infants are salt retainers. It takes 6 years to achieve normal tubular concentrating ability.
  - Infants can excrete water just like an adult. At 2 weeks of age the glomerular filtration rate (GFR) is 75% of the eventual adult rate and reaches maximum capacity at 2 years.
  - Total body water is 80% at 32 weeks, 75% at term, 60% beyond 1 year.
- Thermoregulation.
  - Infants and young children are predisposed to heat loss and they poorly compensate for wide fluctuations in ambient temperatures. Children have a higher ratio of body surface area to mass, and therefore are likely to become dehydrated earlier than adults when febrile.
  - Reduce exposure and keep infants and children in a regulated warm environment.
- Immune system.

- Premature infants have incomplete development of their immune system, causing a 60-fold increased risk of sepsis. All elective surgery in infants under 30 days of age requires 48 hours of prophylactic antibiotics (with anaerobic coverage added when appropriate) after the first week of life.
- Early signs of sepsis can include lethargy, intolerance to feedings, fever, hypothermia, tachycardia, and irritability before a rise in the white blood cell count.

Evaluation and Diagnosis

- History.
  - Duration/location of pain is important in injury diagnosis. Over one third of pediatric patients evaluated for abdominal pain lasting more than a few hours will have an underlying pathologic condition.
  - Any bilious emesis, especially in the newborn period, may be a sign of intestinal obstruction, and mandates further workup.
  - GI bleeding requires immediate attention. The character (bright red vs melena), quantity, and associated stool history (ie, diarrhea with infectious source or currant-jelly–like with intussusception) may provide clues as to the underlying disorder.
- Physical examination.
  - Basic ATLS guidelines should direct the initial assessment and evaluation for all children involved in traumas. It is essential to keep the patient warm because children are much more prone to heat loss than adults.
    - Modified GCS for children < 4 years old:

Verbal Response	V-Score
Appropriate words/social smile/fixes/follows	5
Cries, but consolable	4
Persistently irritable	3
Restless, agitated	2
None	1

- Radiological studies.

- All bilious vomiting in infants and children should be evaluated with contrast radiographic imaging. As a general rule contrast enemas are safer as an initial approach.
  - Ultrasound is an excellent screening test for the identification of free abdominal fluid and is also used in cases of abdominal pain to evaluate appendicitis (noncompressible appendix with fecolith) and intussusception (target sign), and others.
  - Constipation is a common complaint in children that can be readily diagnosed with plain radiographs and by history.

Treatment

- The treatment algorithm shown below provides the proper sequence for the rapid sequence intubation (RSI) of the pediatric patient (Fig. 33-2).

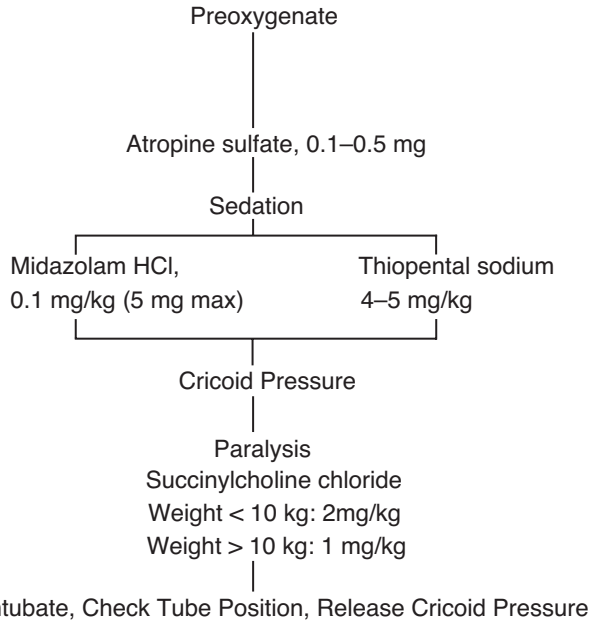

Fig. 33-2. Rapid sequence intubation for the pediatric patient.

Equipment and Supplies

- Accessory pediatric medical/surgical equipment arranged according to age and weight (Table 33-4).

Table 33-4

AGE, WEIGHT kg)	AIRWAY/BREATHING							CIRCULATION		SUPPLEMENTAL EQUIPMENT			
	O_2 Mask	Oral Airway	Bag-valve	Laryngo-scope	ET Tube	Stylet	Suction	BP Cuff	IV Cath	NG Tube	Chest Tube	Urinary Cath	C-collar
Premie 3 kg	Premie Newborn	Infant	Infant	0 Straight	2.5–3.0 No Cuff	6 F	6–8 F	Premie Newborn	24-gauge	12 F	10–14 F	5 F Feeding	—
0–6 mo 3.5 kg	Newborn	Infant Small	Infant	1 Straight	3.0–3.5 No Cuff	6 F	8 F	Newborn Infant	22-gauge	12 F	12–18 F	5–8 F Feeding	— —
6–12 mo 7 kg	Pediatric	Small	Pediatric	1 Straight	3.5–4.0 No Cuff	6 F	8–10 F	Infant Child	22-gauge	12 F	14–20 F	8 F	Small
1–3 y 10–12 kg	Pediatric	Small	Pediatric	1 Straight	4.0–4.5 No Cuff	6 F	10 F	Child	20–22-gauge	12 F	14–24 F	10 F	Small
4–7 y 16–18 kg	Pediatric	Medium	Pediatric	2 Straight or Curved	5.0–5.5 No Cuff	14 F	14 F	Child	20-gauge	12 F	20–32 F	10–12 F	Small
8–10 y 24–30 kg	Adult	Medium Large	Pediatric Adult	2–3 Straight or Curved	5.5–6.5 Cuffed	14 F	14 F	Child Adult	18–20-gauge	12 F	28–38 F	12F	Medium

- Surgical instruments.
  - o If a pediatric surgical set is not immediately available, a peripheral vascular set will usually contain instruments delicate enough to accomplish most tasks in newborns.

Commonly Used Drugs and Dosages

- Phenobarbital 2–3 mg/kg IV.
- Diazepam 0.25 mg/kg IV
- Midazolam HCl 0.1 mg/kg IV (max 5 mg).
- Atropine 0.1–0.5 mg IV.
- Phenytoin 15–20 mg/kg, administered at 0.5 to 1.5 ml/kg/min as a loading dose, then 4–7 mg/kg/d for maintenance.
- Mannitol 0.5–1.0 g/kg IV.
- Succinylcholine chloride 2 mg/kg IV for < 10 kg, and 1 mg/kg IV for > 10 kg.
- Ampicillin 25–50 mg/kg IV q8h (q12–18h in newborns).
- Gentamicin 2.5 mg/kg IV q8h (q12–18h in newborns).
- Metronidazole 10 mg/kg IV.
- Acetaminophen 15 mg/kg po.

Surgical Management

- Basics.
  - As a general guideline, transverse incisions should be used in infants. This minimizes the risk of postoperative dehiscence, while still allowing adequate exposure.
  - Absorbable suture such as Vicryl or PDS (2-0) should be used to close the rectus fascia, regardless of the incision. The skin can then be closed using staples or absorbable monofilament suture (eg, Monocryl 4-0).
  - When placing retention sutures for severe malnutrition, permanent sutures such as Prolene or nylon can be used as a full thickness through the rectus muscle and skin. Care should be taken to avoid the epigastric vessels. The sutures can be passed through small pieces of a 14F red rubber catheter prior to tying to avoid excess pressure on the skin.
  - Personnel: Remember that if obstetrics is part of the mission, pediatric support will be required!