PEDIATRIC SURGERY

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CHILDREN ARE DIFFERENT!

Key differences:
Larger surface area to mass ratio
Less SQ fat
More body water
Higher metabolic rate
FLUID BALANCE

Maintenance Fluid Requirement:
0 – 10 Kg ---> 4 ml/Kg/hr
10 – 20 Kg ---> 2 ml/Kg/hr + 40 ml
20+ Kg ---> 1 ml/Kg/hr + 60 ml

Adequate urine output:
1 – 2 mls/Kg/hour

Weight estimate:
8 + (age X 2)

Circulating volume:
85 ml/kg
FLUID RESCUSITATION

Account for:

- Deficit
- Maintenance
- Ongoing losses

- Deficit: replace ½ in 1st 8 hrs and ½ in next 16 hrs
- Shock = 20 ml/kg bolus
Abdominal Pain Assessment:

- **History**
  - Nausea/vomiting/diarrhea
    - aches/pains
  - nature of the abdominal pain
    - crampy vs steady
    - worse with movement: walking, car ride
  - urinary symptoms
  - LMP, sexually active
Abdominal Pain Assessment:

- **Physical**
  - Vitals, % Dehydration, position of child
  - Throat, Chest assessment
  - Abdomen
    - distended
    - tenderness, rebound
    - guarding - voluntary vs involuntary
    - ‘local findings’
  - Inguinoscrotal exam

***Slow repeated assessments if necessary***
Abdominal Pain Assessment:

- Lab Data
  - CBC
  - Urine
- Abdominal X-ray
  - AXR
  - CXR
  - Selected contrast studies
- Ultrasound
- CT scan
Working diagnosis by site of pain:

- Cholelithiasis
- Gallbladder dyskinesia
- Appendicitis
- Mesenteric adenitis
- Meckel diverticulitis
- Ovarian torsion
- Inguinal-scrotal mass
- GER
- Gastritis
- PUD
- Pancreatitis
- Henoch-Schönlein Obstruction
- Constipation
- UTI
- Ovarian torsion
# Abdominal Pain: Child

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>DIAGNOSIS</th>
<th>FINDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constipation</td>
<td>Hx, PE</td>
<td>Impacted</td>
</tr>
<tr>
<td>Acute appendicitis</td>
<td>Hx, PE</td>
<td>RLQ pain, leukocytosis, fecalith</td>
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<tr>
<td>Bowel Obstruction</td>
<td>Hx, PE, AXRs</td>
<td></td>
</tr>
<tr>
<td>Torsion of intra-abd structure</td>
<td>CBC, KUB, US, US/CT Scan</td>
<td>Cyst, tumor, omental, adnexal</td>
</tr>
<tr>
<td>Inguinoscrotal mass</td>
<td>PE</td>
<td>Bulging</td>
</tr>
<tr>
<td>Henoch-Schönlein Purpura</td>
<td>Hx, PE, AXR, US</td>
<td>Intussusception, rectal bleeding, vasculitis</td>
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<tr>
<td>Mesenteric adenitis</td>
<td>US</td>
<td>Adenopathy</td>
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## Abdominal Pain: Adolescent

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<tbody>
<tr>
<td>Acute appendicitis</td>
<td>Phys Exam, CBC, KUB</td>
<td>RLQ pain, leukocytosis, fecalith</td>
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<tr>
<td>Meckel diverticulitis</td>
<td>Intra-OR</td>
<td>Meckel’s</td>
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<tr>
<td>Pancreatitis</td>
<td>Hx, Phys Exam, US Lipase, amylase</td>
<td>GB stones, elevated enzymes, edema, pseudocyst</td>
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<tr>
<td>GB stones/dyskinesia</td>
<td>Hx, Phys Exam, US HIDA-CCK</td>
<td>Gallstones &lt; 30% ejection</td>
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<tr>
<td>Torsion of intra-abd structs</td>
<td>Phys Exam, US, CT Scan</td>
<td>cyst, tumor, adnexal, omental</td>
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</table>
BOWEL OBSTRUCTION: Key Features

- Vomiting - Bilious vs. Non-bilious
- Proximal vs. Distal
- Previous surgery
- Age of the child
- Always look for an incarcerated inguinal hernia
BOWEL OBSTRUCTION: Imaging

- Abdominal X-rays
- Contrast studies
- Ultrasound
# Bowel Obstruction: Child

<table>
<thead>
<tr>
<th>CAUSES</th>
<th>DIAGNOSIS</th>
<th>FINDINGS</th>
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<tbody>
<tr>
<td>PREVIOUS SURGERY (ADHESIONS)</td>
<td>KUB</td>
<td>A/F levels</td>
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<td></td>
<td>UGIS</td>
<td>Pinpoint tendernessness</td>
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<tr>
<td>HERNIAS</td>
<td>Phys Exam</td>
<td>Inguinal mass</td>
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<tr>
<td>INTUSSUSCEPTION</td>
<td>Contrast enema</td>
<td>Intraluminal mass</td>
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<tr>
<td>MECKEL’S DIVERTICULUM</td>
<td>Laparoscopy</td>
<td>Meckel’s</td>
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<td>MIDGUT VOLVULUS</td>
<td>Contrast study</td>
<td>Malrotation/obstruction</td>
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<tr>
<td>HIRSCHSPRUNG’S</td>
<td>Contrast enema</td>
<td>Transitional zone</td>
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# Bowel Obstruction: ADOLESCENT

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<tr>
<th>CAUSE</th>
<th>DIAGNOSIS</th>
<th>FINDINGS</th>
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<tr>
<td>Appendicitis</td>
<td>AXR</td>
<td>A/F levels</td>
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<tr>
<td></td>
<td></td>
<td>Dilated bowel loops</td>
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<tr>
<td>Previous Surgery (Adhesions)</td>
<td>AXR UGIS?</td>
<td>A/F levels</td>
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<tr>
<td></td>
<td></td>
<td>Dilated bowel loops</td>
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<tr>
<td>Tumor</td>
<td>AXR US/CT Scan</td>
<td>Mass effect</td>
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<tr>
<td></td>
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<td>Burkitts</td>
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<tr>
<td></td>
<td></td>
<td>Non Hodgkin’s</td>
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<tr>
<td>Congenital Cause</td>
<td>AXR Laparoscopy</td>
<td>Band, internal</td>
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<tr>
<td></td>
<td></td>
<td>hernia, volvulus</td>
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</table>
Although he was openly mocked by his peers, Goldy was confident that his radical theological views would one day be accepted...
PYLORIC STENOSIS

- Male:Female  4:1
- Age 2 – 6 weeks
- Forceful nonbilious vomiting ("projectile")
- Dx: Palpation of mass
  Ultrasound,
  UGI contrast study
PYLORIC STENOSIS

Treatment:

- Correction of dehydration
- Correction of Hypochloremic metabolic alkalosis
- Ramstedt Pyloromyotomy
INTUSSUSCEPTION
INTUSSUSCEPTION

- Age 2 months to 2 years
- Usually have or had a recent viral illness
- Intermittent severe visceral pain (cramps)
- Blood PR => Currant jelly stool
- Eventually will develop a distal bowel obstruction
Red currant jelly stool
INTUSSUSCEPTION

Diagnosis:
- Palpation of mass
- LGI contrast study
  (Ultrasound)
INTUSSUSCESSION

Treatment:
Hydrostatic reduction (5%)
Surgical reduction (1%)
BEWARE THE BABY
WHO VOMITS BILE !!!!
MALROTATION / VOLVULUS

- Malrotation leads to nonfixation of the bowel, which predisposes to volvulus
- Most common malrotation is arrest of rotation after 90 degrees (270 normal)
- Most present in 1st yr of life
MALROTATION / VOLVULUS

Volvulus presents as a high intestinal Obstruction.

Look for:

- Bilious vomiting
- Intermittent pain
- Blood PR (late)
MALROTATION / VOLVULUS

- Diagnosis:
  - Limited UGI Contrast study
  - Lower GI Contrast study
  - Ultrasound
MALROTATION / VOLVULUS

Treatment:
- Correct dehydration

Urgent surgery:
- Untwist bowel
- Ladd procedure
- Appendectomy
MALROTATION / VOLVULUS

Delayed diagnosis has lethal consequences

Always consider Volvulus in an infant or child with bilious vomiting who has no other apparent cause for obstruction.
MECKELS DIVERTICULUM

- Vitelline Duct Remnant
- Rule of 2s
- Present 3 ways:
  - Painless rectal bleeding
  - Perforation (diverticulitis)
  - Bowel Obstruction
MECKELS DIVERTICULUM

Diagnosis:
- Meckel’s Scan (T99)
- Small Bowel study
- Laparoscopy

Treatment:
  - Resection
Tracheoesophageal fistula and esophageal atresia (TEF)
Esophageal Atresia & TEF

Presentation:

- Inability to feed, Mucous,
- Respiratory distress, failure
to pass NG tube

Think VACTERL!
VACTERL

- V = Vertebral (hemi-vertebrae)
- A = Anal (imperforate anus)
- C = Cardiac
- T = Tracheal (TEF)
- E = Esophageal (TEF)
- R = Renal (absent kidney, etc)
- L = Limb (radial anomalies)
Repair in newborn period unless there is no fistula = “long gap”
TEF
Newborn with vomiting

“Dubble Bubble”

= Duodenal atresia
Small Bowel Atresia
Hirschsprung’s Disease

Congenital absence of Ganglion cells

In 90% of cases the transition between abnormal and normal bowel is the rectosigmoid junction

Present with failure to pass meconium and a distal bowel obstruction

Dx: Contrast study and rectal biopsy
Hirschsprung's Disease = congenital megacolon

Tx: Bring normal “ganglionated” bowel to anus
Imperforate Anus

High IA = colostomy and then definitive repair later

Low IA = anal repair shortly after birth

Look for the VACTERL associations
AGAIN, BEWARE THE BABY WHO VOMITS BILE !!!!
Gastroschisis

Herniation of the bowel out a small defect near the umbilicus. No covering sac.

Bowel can be quite damaged.

These infants usually do not have other congenital anomalies (“good baby bad bowel”).

Repair primarily or use a stage “silo” technique
Omphalocele

Central abdominal wall defect. Has a covering sac.

Associated with other congenital anomalies ("bad baby good bowel")

Repair primarily or use a staged "silo" technique
CHEST WALL DEFORMITIES

- Pectus excavatum
- Pectus carinatum
- Poland’s Syndrome
- Sternal defects
- Misc. deformities
CHEST WALL DEFORMITIES

- Pectus carinatum

Chest deformities are mostly a cosmetic problem
CHEST WALL DEFORMITIES

- Pectus carinatum

Chest deformities are mostly a cosmetic problem
Pediatric Tumors

Nephroblastoma (Wilm’s Tumor)
Hepatoblastoma
Neuroblastoma
Sarcoma
Lymphoma

Most require “triple” therapy
Chemotherapy
Radiotherapy
Surgery
"I'm afraid we left a surgical sponge behind when we sewed you up - it was one of those sponges that swells up into a little dinosaur."
Pediatric Trauma - Initial Approach - Unique Features

- Size and Shape Issues
  - more multiple injuries
- Skeleton - more pliable
- Surface Area/Body volume - hypothermia
Pediatric Trauma
Anatomic/Physiologic Issues

Airway
- Large head and tongue
- Larger U shaped epiglottis
- More cephalad larynx (glottis - C3, adult C5-6)
- Narrowest at cricoid
- < 6 months age obligate nasal breathers
- Short trachea
- C-spine - SCIWORA
**Fig. 1-A**

Adult immobilized on a standard backboard.

**Fig. 1-B**

Young child on a standard backboard. The relatively large head forces the neck into a kyphotic position.
Pediatric Trauma - Airway Management

- Oral Airway
- Orotracheal Intubation
  - Rapid Sequence Intubation
  - C-spine protection
- Cricothyroidotomy
  - Surgical
  - Needle
Pediatric Trauma - Breathing - Issues and Management

- Respiratory rate varies with age
- Tidal Volume - 7-10 ml/kg
- Hypoventilation - most common cause of cardiac arrest in children
- Tube thoracostomy
Pediatric Trauma - Circulation/Shock

- ‘Shut down appearance’ indicates impending circulatory collapse
- Hypotension is late finding
- Fluid Resuscitation
  - 20 ml/kg X 3
  - then 10ml/kg PRBC typed, type specific, O neg
  - if hypotensive go straight to PRBC once available
Pediatric Trauma - Circulation/Shock

- **Venous Access**
  - peripheral IV access two attempts (5 minutes)
  - interosseous - tibia or distal femur
  - venous cutdown - saphenous at the ankle
  - percutaneous central - femoral, subclavian, jugular

- Urinary output 1 ml/kg

- Thermoregulation
Pediatric Trauma - Chest Trauma

- Rib fractures - severe force
- Compliant chest wall
- Increase mediastinal mobility
- Thoracotomy - rarely needed
Pediatric Trauma - Abdominal Trauma

- Assessment difficult
- Gastric distension - NG/OG tube
- Bladder distension - urinary catheter
- Diagnostic adjuncts - CT, Ultrasound, DPL(rare)
- Management - most non-operative but needs close observation
Pediatric Trauma - Abdominal
Trauma - Specific Injuries

- Spleen, liver, kidney injuries usually managed non-operatively
- Duodenal Hematoma
- Pancreatic Injury
- Lap Belt Injury
  - Chance Fracture (Neurologic Injury)
  - Hollow Viscus Injury
  - Seat Belt Sign
Hernia or hydrocele?

- Both due to patent processus vaginalis

- **Hydroceles:**
  - transilluminate,
  - you can palpate the cord above it,
  - but often can’t feel the testis

- **Hernias:**
  - usually can be reduced
  - are painful if incarcerated
Processus Vaginalis

Fig 78-1. Different forms of inguinal hernia and hydrocele arising from failure of the processus vaginalis to obliterate completely.
Hernia or Hydrocele?
**Hydrocele:** You can ‘roll’ the normal cord between your finger and the pubic symphisis

(vs Hernia: extends up into inguinal canal)
Hernia or hydrocele?
Fig 78–4.—Age-related incidence of incarcerated hernia in 351 infants and children. Newborn infants are at greatest risk for incarceration.
Unilateral Frog-Leg Maneuver
In a female consider the possibility of an incarcerated ovary
Umbilical Hernia

90 – 95% will resolve spontaneously

Rarely, if ever, cause symptoms

Recommend surgical repair after 3 to 5 years of age
## Neck Masses

### Congenital
- Branchial Clefts
- Pre-Auricular Cysts
- Thyroglossal Ducts
- Dermoid & Epidermoid Cysts
- Ranula
- Torticollis

### Inflammatory
- Suppurative adenitis
- Chronic adenitis
- Mycobacterial lymphadenitis
- “Cat-Scratch” disease
Neck Masses
Angular Dermoid
Torticollis

Caused by fibrosis of the SCM muscle.

Palpable mass in the muscle in 2/3s of patients (not present at birth).

Tx: Passive stretching exercises

Complications: Facial asymmetry
Torticollis
Pre-auricular skin tag
Thyroglossal Duct Cyst / Dermoid

Midline neck masses
Both require excision

TGDC can become infected (rare for Dermoids)
Branchial Cleft Fistula

Second Branchial anomaly is the most common (1 to 3).

External opening is at the anterior border of the SCM muscle (inferior 1/3).
Lymphadenitis
Lymphadenitis
Cystic Hygroma

Lymphangioma: 75% in head and neck region.
Tx: resection, sclerotherapy