Transport of Surgical Neonates

Don Moores, MD

Overview

- **General Comments**
- Rationale for transport of surgical neonates
- A bit of history
- General principles
- Mode of transport
- Effect of altitude
- A few comments about tubes

- **Specific Surgical Diagnoses**
- EATEF
- CDH
- Gastroschisis
- Omphalocele
- NEC
- Intestinal atresia
- Malrotation / Volvulus

Surgical Neonates

- Considerably less common than medical
- Pediatric Surgeons – limited resource, usually based at specialty centers
- Transport to regional centers – established practice
- Ensures that patients benefit from the most expert care available
- Prenatal diagnosis of surgical conditions allows “fetal transport” in-utero
- Still a need for post-natal transport

“Transportation”

- Word dates back to 6th century BC
- From Latin
  - “portare” (to carry)
  - “trans-” (across)
- In context of patient care
  - “to carry the patient to a nursing entity”

First Reported Neonatal Transportation

- In Greek Mythology
- Dionysus (ie Bacchus)
  - God of the grape harvest, winemaking and wine, ritual madness, fertility, theatre and religious ecstasy
- Born prematurely at 8 mo
- Needed special care

First Reported Neonatal Transportation

- Mercury (Hermes) carried Dionysus to Mount Nyssa
- Cared for by Nymphs
- Placed in a cave (incubator)
- Entrance covered by a dense ivy curtain (cover from air currents)
- ….and pines (air filter)
- Dome covered w/ vine branches (maintaining stable environmental temperature)

Dionysus

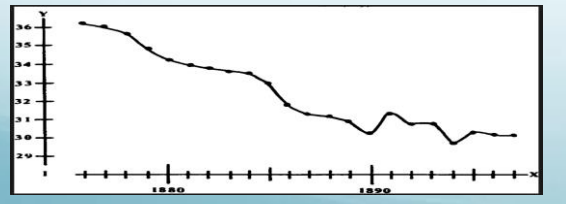
History

- Hippocrates – 5th century BC recognized the special needs of neonates
- Prior to late 1880's there was no special care for neonates
- Home delivery was standard
- Preterm or sick neonates often died (or worse)
- Orphanages were only institutions for neonatal care (mortality 85-95%)

BURYING BABIES IN CHINA.

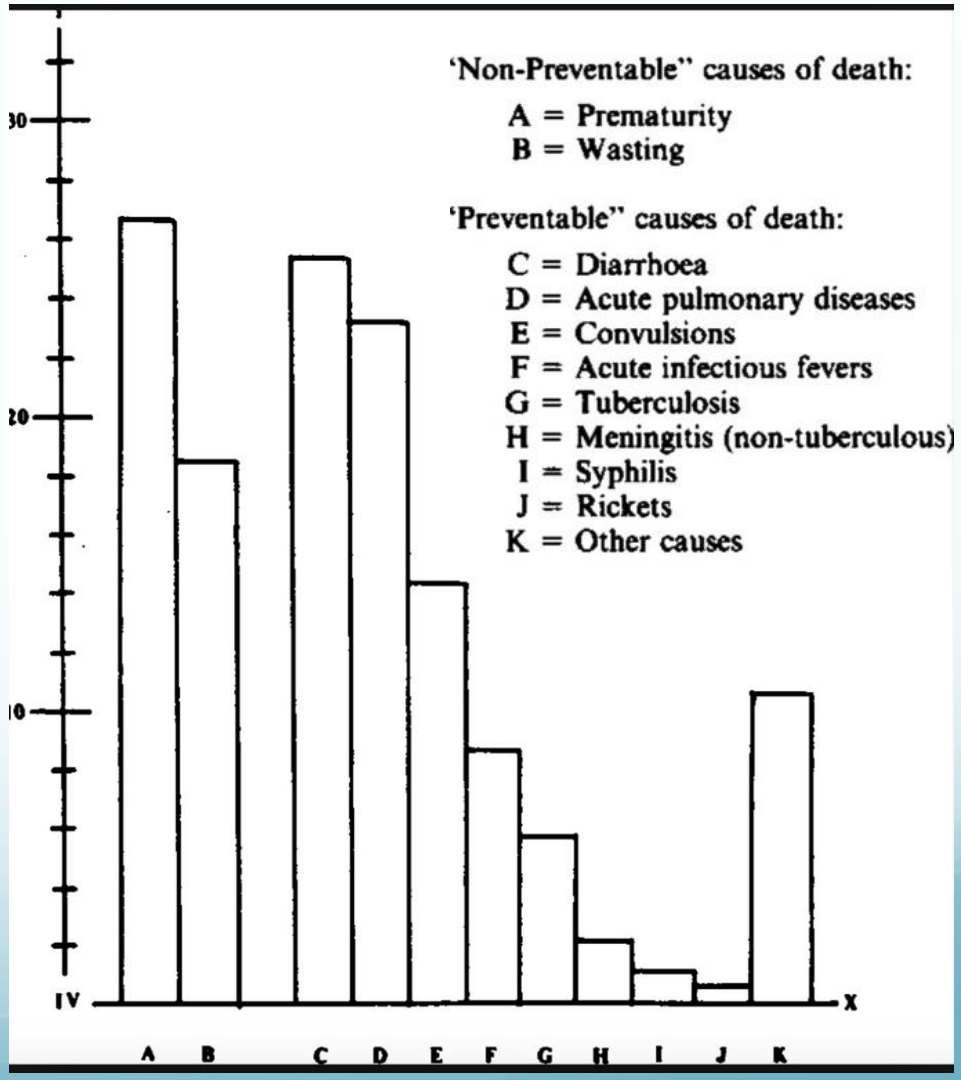
History

- Industrial revolution 1790-1840's
- More women working
- More use of "formula"
- Mortality rates ↑ up to 23%
- ↓ Birth rates
- Founding of Infant Welfare Movement (IWM)



Birth rates

Causes of Death



History

- 1834 – first neonatal endotracheal intubation
- 1853 – establishment of children's hosp's London, NY and Philadelphia
- 1878 – invention of the incubator – (Taurnier - France) - decreased mortality rate by 42% for infants <2000 gm
- 1891 – first use of supplemental oxygen for neonates

History

- 1903 – Dr. Joseph DeLee, Chicago - First portable transportation incubator (Chicago World's Fair)
- "Smallest Ambulance in the World" (aka "hand ambulance")
- Temperature controlled (cans of hot water)
- Battery powered light – illuminated patient and thermometer

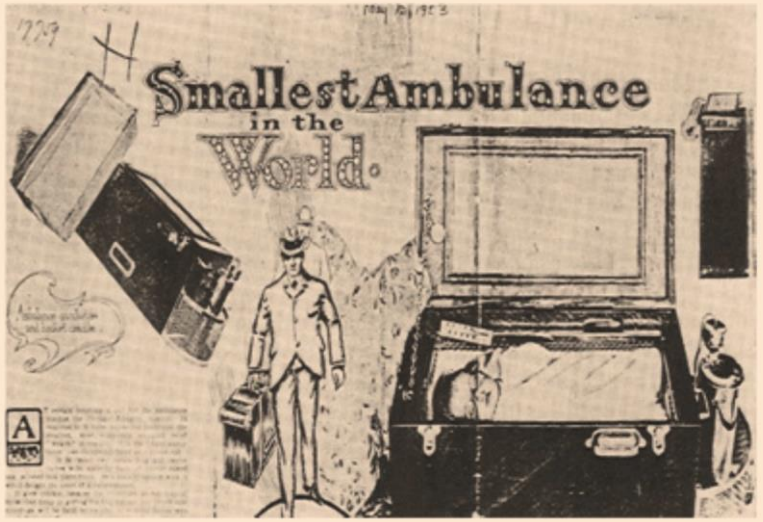


Figure 4: The Smallest Ambulance in the World (From the Neoplasm, 1903). Available at: The Pediatric Clinics of North America/Transport Medicine/April 1993.

History

- Dr. John Hess – 1914 designed a simple portable incubator that was commercially available and made transportation practical
- 24x15x17inch box w/ access ports for oxygen and a window for ventilation

History

Taxi used as ambulance w/ public health nurse, c1920

Neonate being carried to the hospital, Chicago, c1920”s

We've come a long way, eh?

General Principles

- Initial Referral of Surgical Neonate
  - Collect information (age, gestation, birthweight, suspected surgical condition, resp status, fluid management, medications)
  - Ascertain urgency of transport request
- At the referring hospital
  - Confirm history and any changes in condition
  - Confirm stability - (BP, temp, glucose, CXR)
  - Ensure reliable IV access
  - Secure airway if any resp issues or potential issues
  - Functioning NG or OG tube
  - Collect all Xray’s

Modes of Transport

- Ground ambulance
  - Most common, good for short distances
  - Come w/ power and oxygen supplies
- Fixed wing
  - Preferable for long distances
  - Requires transfer to and from airport
    - Adds time and number of transfers
  - May not have built in oxygen supply
- Helicopter
  - Can transport directly to/from hospital
  - Noisy, can be cramped

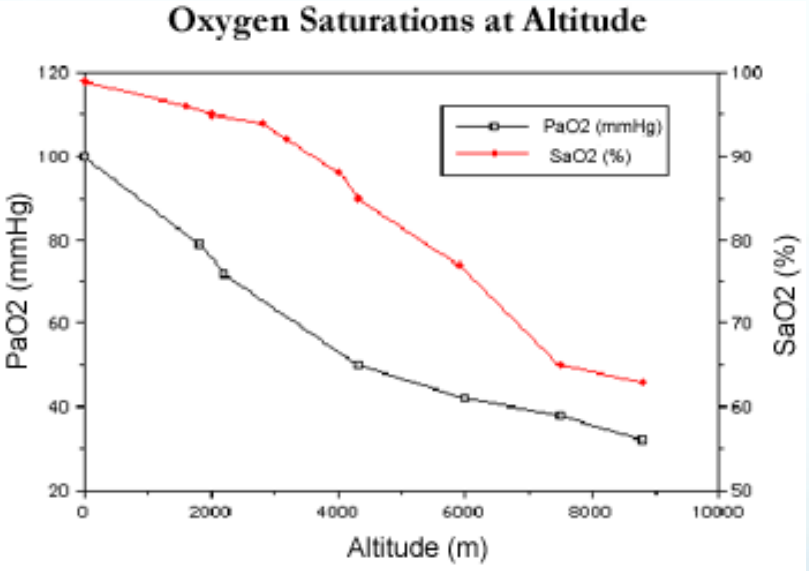
Effect of Altitude

- Pressure and volume of a gas are inversely proportional
- ↑ Elevation
- ↓ Atmospheric pressure
- ↑ Expansion of gas
- ↓ Ambient oxygen tension

$$P \propto \frac{1}{V}$$

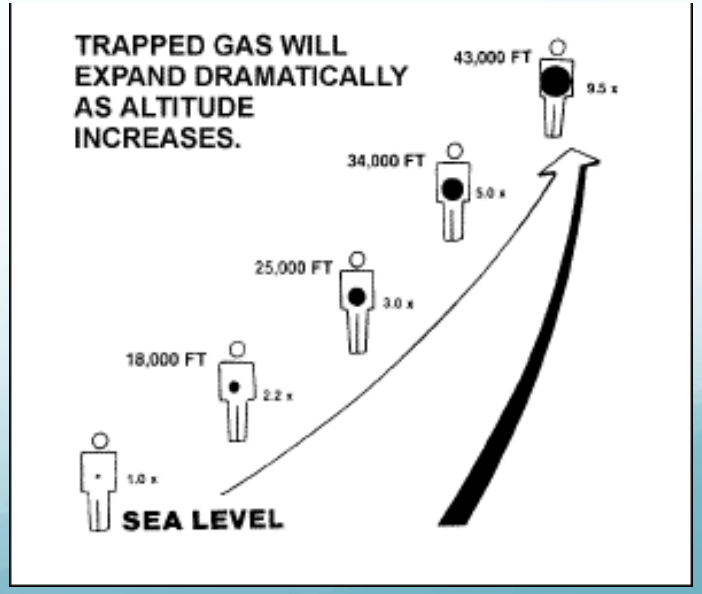
Effect of Altitude – O2

- Sea Level
  - Elevation 0’, 760 mmHg
  - Oxygen 156 mmHg
- Big Bear, CA
  - Elevation 6752’, 600 mmHg
  - Oxygen 126 mmHg
  - (79% of available oxygen at sea level)
- May have to increase supplemental O2 to maintain saturations

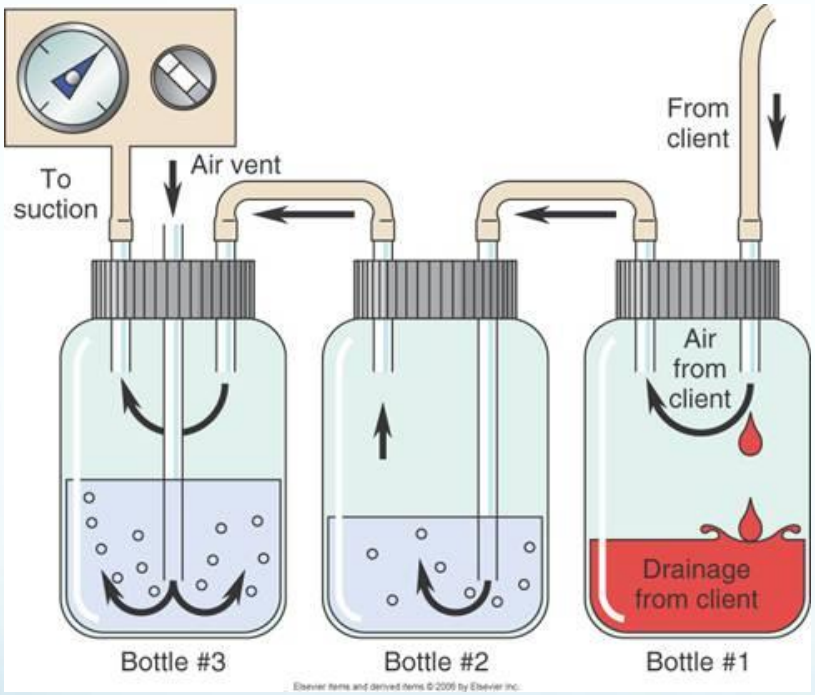


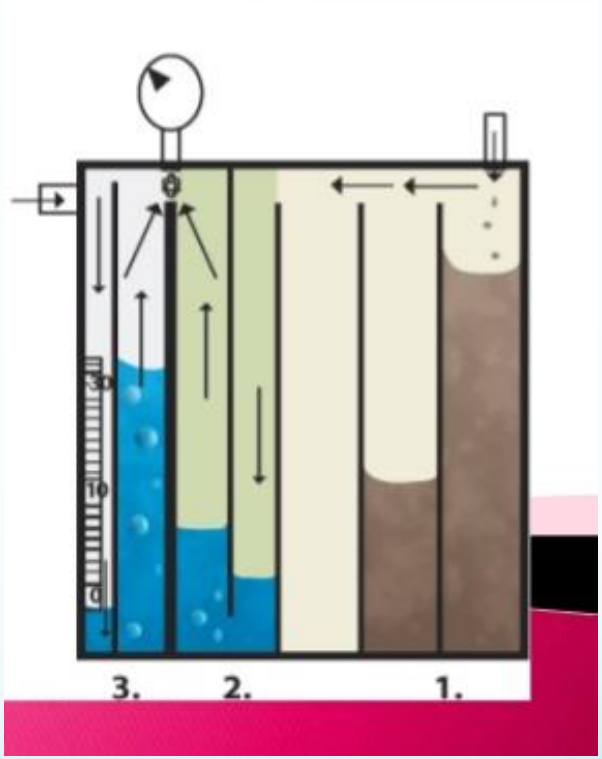
Effect of Altitude – Volume

- Gas within body compartments will expand
- Pneumothorax
  - Need functioning chest tube
- Bowel gas
  - Importance of good NG decompression
  - Large bore NG
  - Free drainage (not clamped)
  - Frequent aspiration
  - Particularly important in CDH patients



Chest Tubes and Pleurovacs



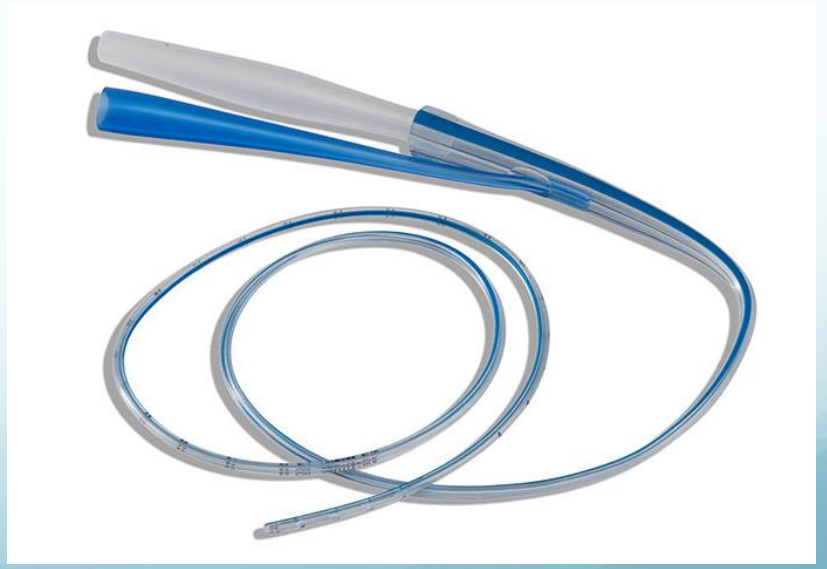


Chest Tubes and Pleurovacs

- NEVER clamp the chest tube – PLEASE!!
  - Puts patient at risk for tension pneumothorax
- Watch for fluctuation of water level with breathing
- Watch for bubbles
- Keep the pleurovac vertical

Replogle / Salem Sump

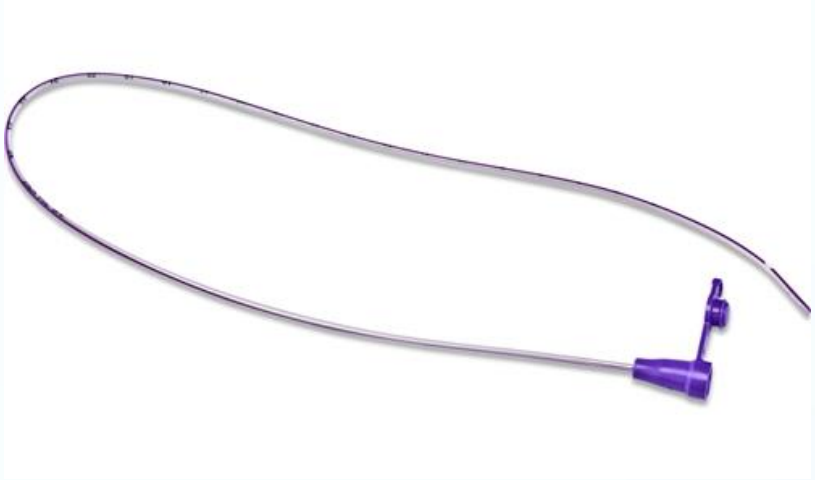
- Intended for decompression
- Double lumen tube
- Multiple distal holes
- Larger lumen → suction
- Smaller lumen → air vent
- Usually connected to continuous suction
- May require irrigation to keep clear



Blue Port / Antireflux Valve

- Blue port is intended as an air vent
- Needs to be kept free of moisture
- Flush blue port with air instead of saline
- Antireflux Valve → Good Idea? or Device of the Devil?
- Prevents decompression if the larger lumen becomes occluded

Feeding Tubes NOT Good for Decompression



Surgical Conditions

- Esophageal Atresia (with or without TEF)
- Congenital Diaphragmatic Hernia
- Gastroschisis
- Omphalocele
- Necrotizing Enterocolitis
- Bowel Atresia
- Intestinal Malrotation & Volvulus

Esophageal Atresia

- Upper esophagus ends in a blind-ending pouch rather than connect to the stomach
- Defect begins about 4th week of gestation
- Associated with polyhydramnios in 3rd trimester
- Associated with multiple other anomalies (VACTERL)
  - (Vertebral, Ano-rectal, Cardiac, TEF, Renal, Limb)
  - Cardiac anomalies are common

Esophageal Atresia

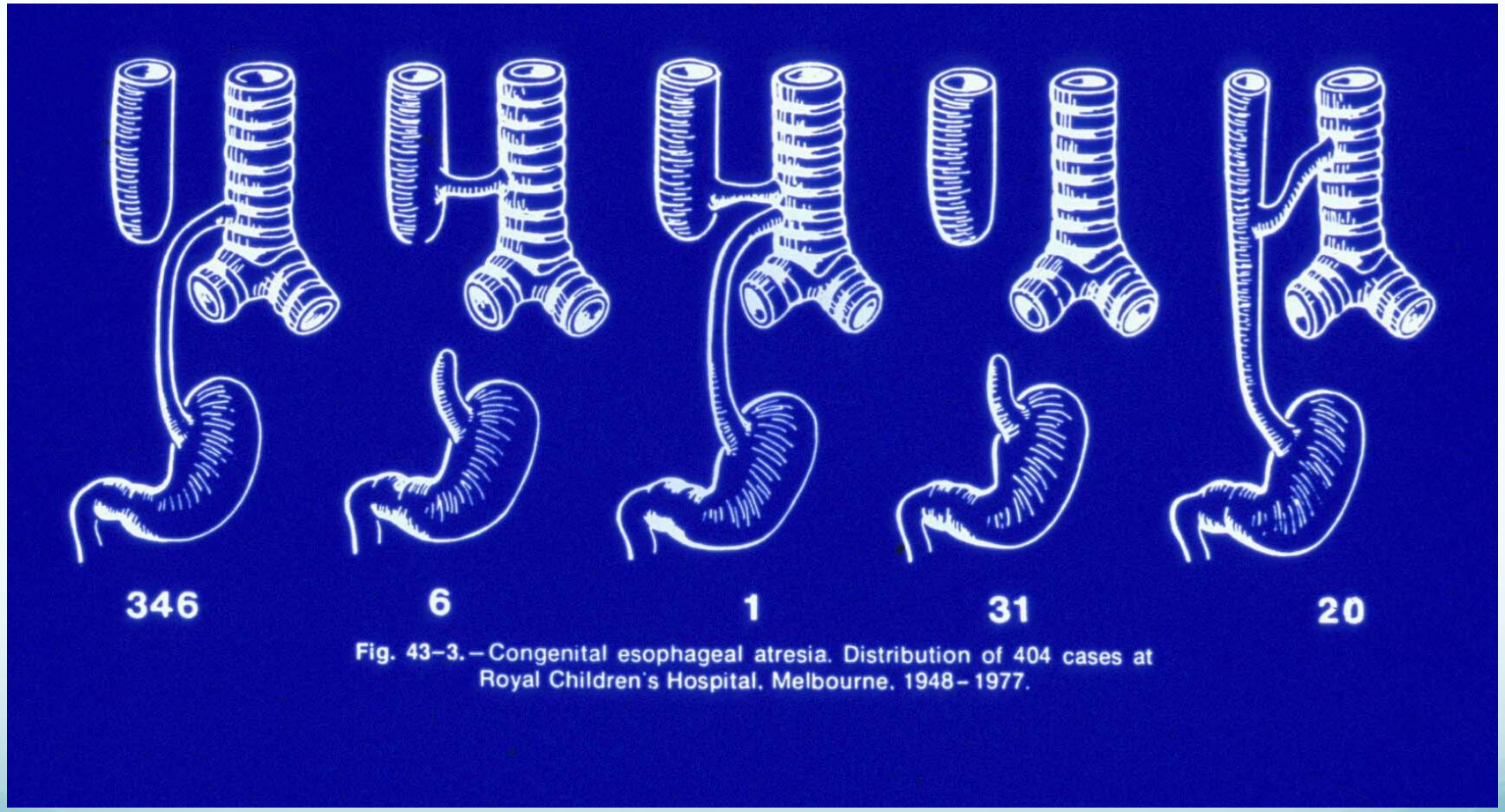
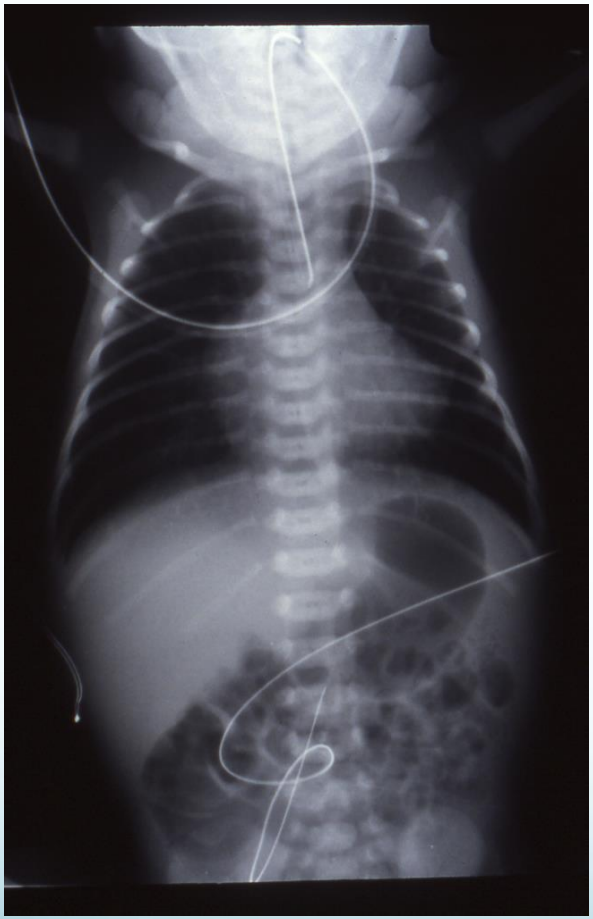
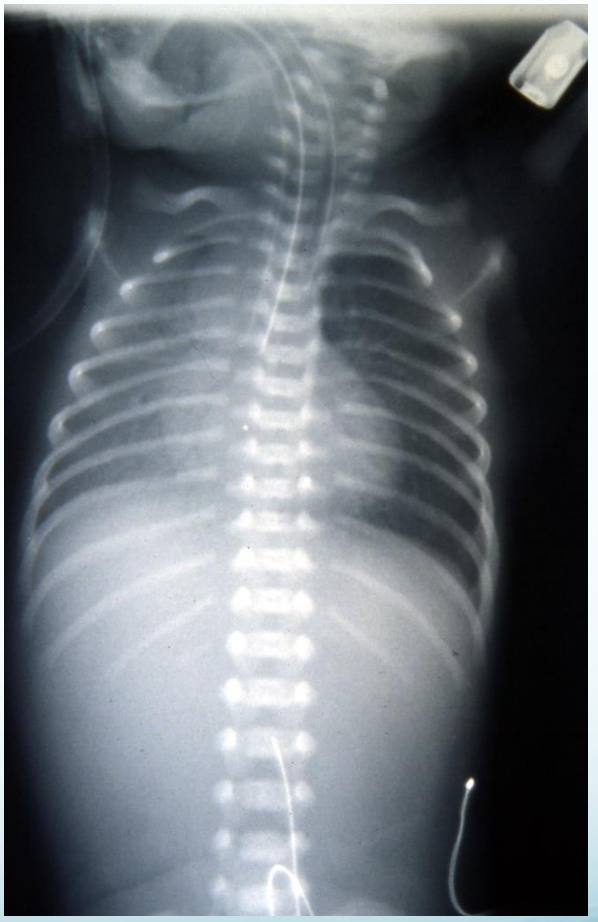


Fig. 43–3. – Congenital esophageal atresia. Distribution of 404 cases at Royal Children's Hospital, Melbourne, 1948 – 1977.

Esophageal Atresia



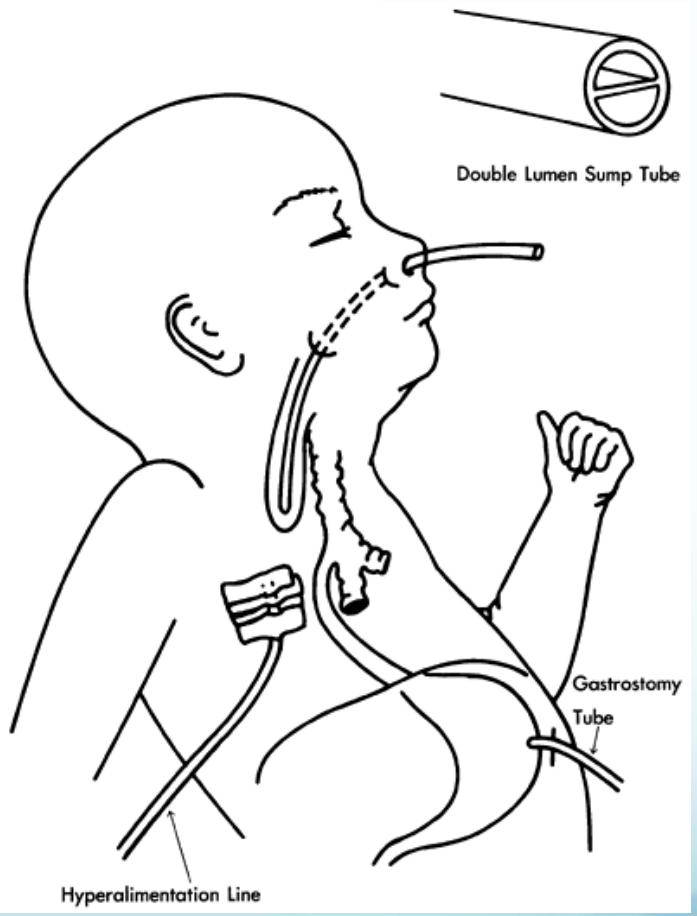
With Tracheo-Esophageal Fistula



No fistula

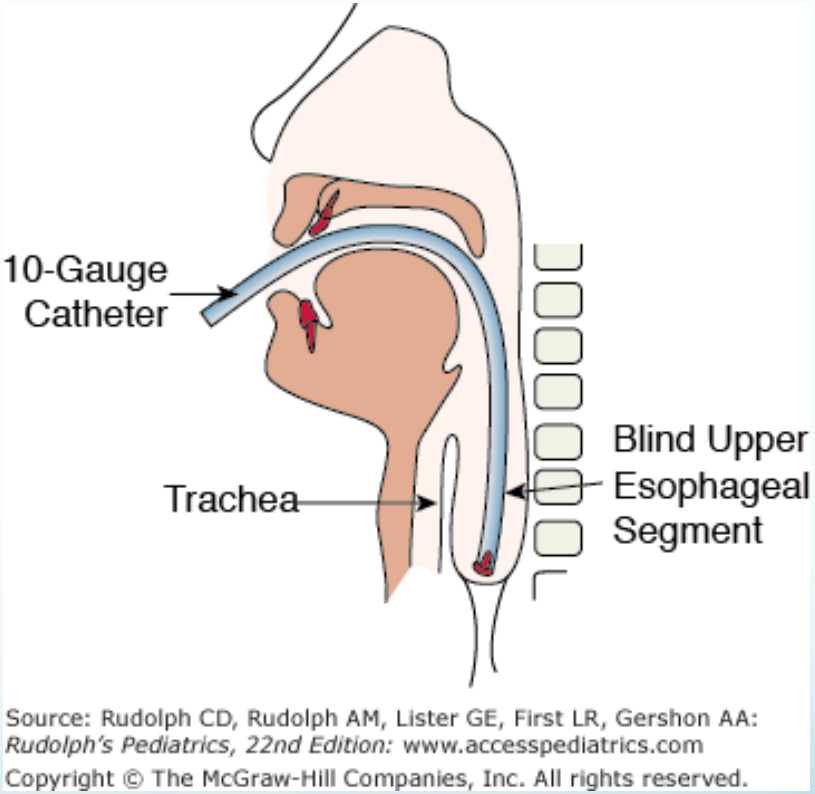
Esophageal Atresia w/ TEF

- Risk is aspiration - gastric
- Insert Replogle tube
  - Upper pouch
  - Continuous suction if possible…. Or
  - Free drainage w/ frequent aspiration during transport
- Elevate HOB 30°
- AVOID intubation and positive pressure ventilation
  - Gastric distension / reflux



Pure Esophageal Atresia

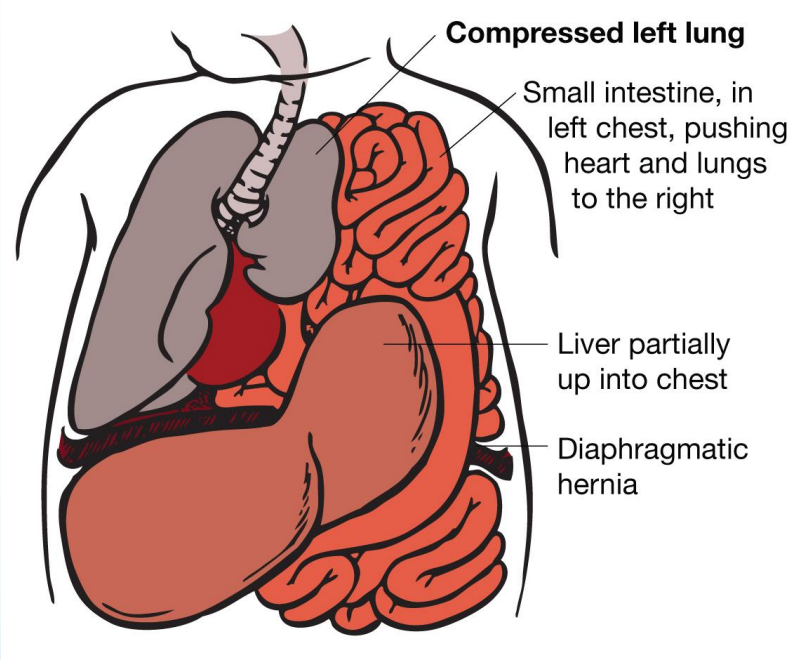
- Risk is aspiration of saliva
- Insert Replogle tube
  - Upper pouch
  - Continuous suction if possible…. Or
  - Free drainage w/ frequent aspiration during transport
- Flat or even slight head down if necessary
- Be aware of potential for cardiac conditions (cyanosis, etc)



Source: Rudolph CD, Rudolph AM, Lister GE, First LR, Gershon AA: *Rudolph's Pediatrics, 22nd Edition:* www.accesspediatrics.com

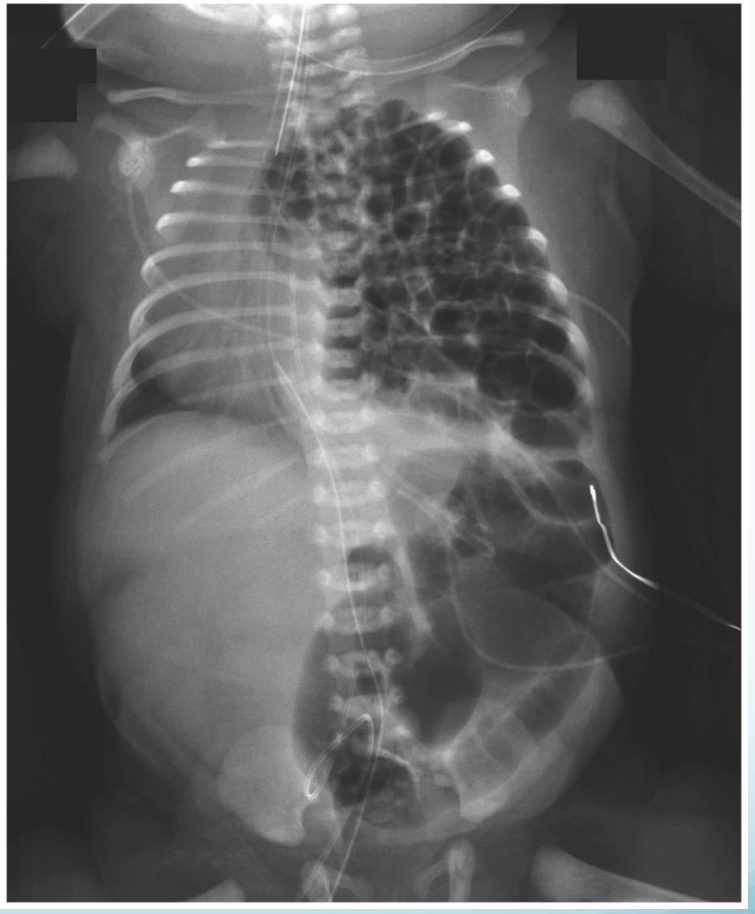
Congenital Diaphragmatic Hernia

- Potentially lethal
- Failure of diaphragm to fuse
- Usual defect is postero-lateral
- Intra-abdo organs herniate and take up space
- Resulting in….
  - Pulmonary hypoplasia (BOTH lungs)
  - Pulmonary hypertension



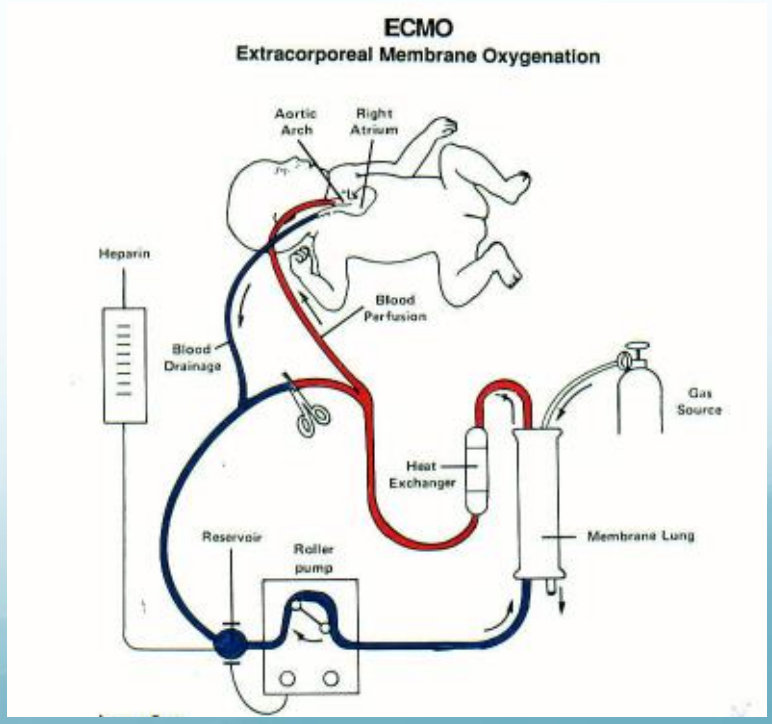
Congenital Diaphragmatic Hernia

- Intrathoracic portion of bowel rapidly becomes aerated and expands
- NG tube is essential
  - Decompression and aspiration of gastric contents and air



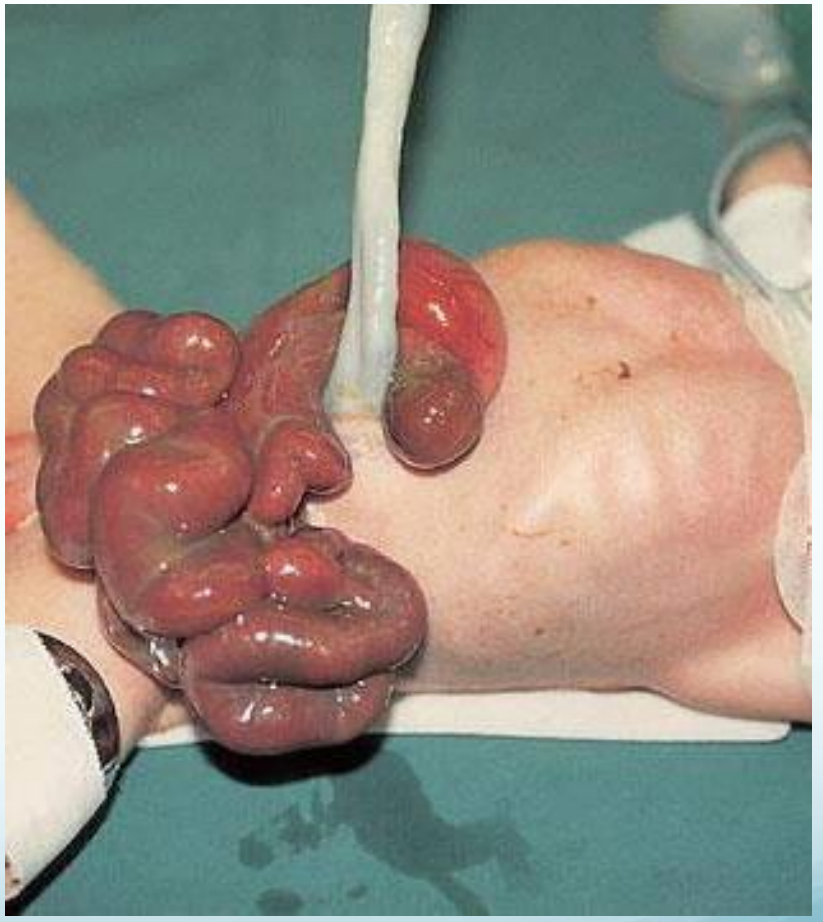
Congenital Diaphragmatic Hernia

- Most patients will require intubation / vent support
- Frequent ABG's / monitoring
- Easily desaturate with cares → hypoxia
- Frequently require…
  - Paralytics / Sedation
  - Inotropes
  - Pulm vasodilators
- +/- ECMO (eg time is of essence)



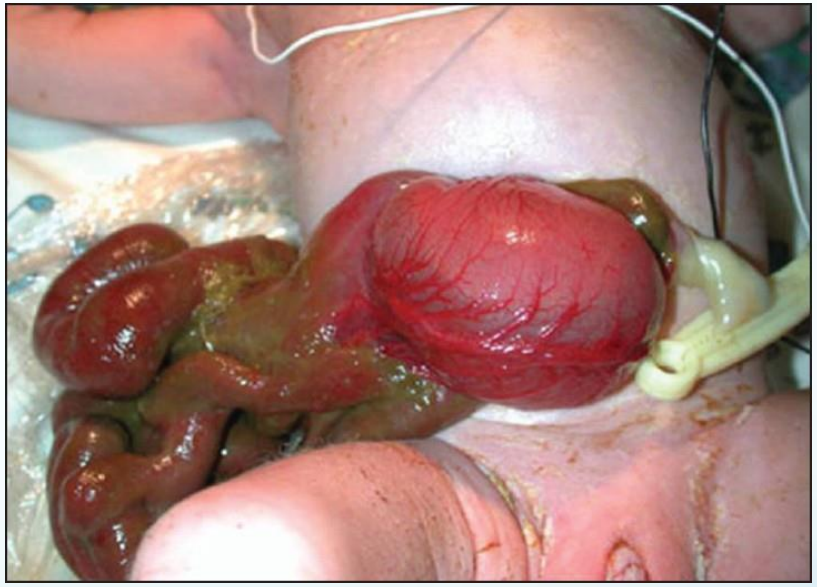
Gastroschisis

- Abdominal wall defect to right of umbilicus
- No sac covering viscera
- Bowel edematous
- Associated w/ prematurity (60%) and IUGR
- 10-15% bowel atresia
- Other anomalies rare
- Young mothers
- Fluid losses a major issue



Gastroschisis

- Priorities at birth are…
- Protection of the bowel
  - Contamination
  - Evaporative fluid loses
  - Protection of vascular inflow
- Gastric decompression
  - Large bore OG tube
  - Contents will be thick



Gastroschisis

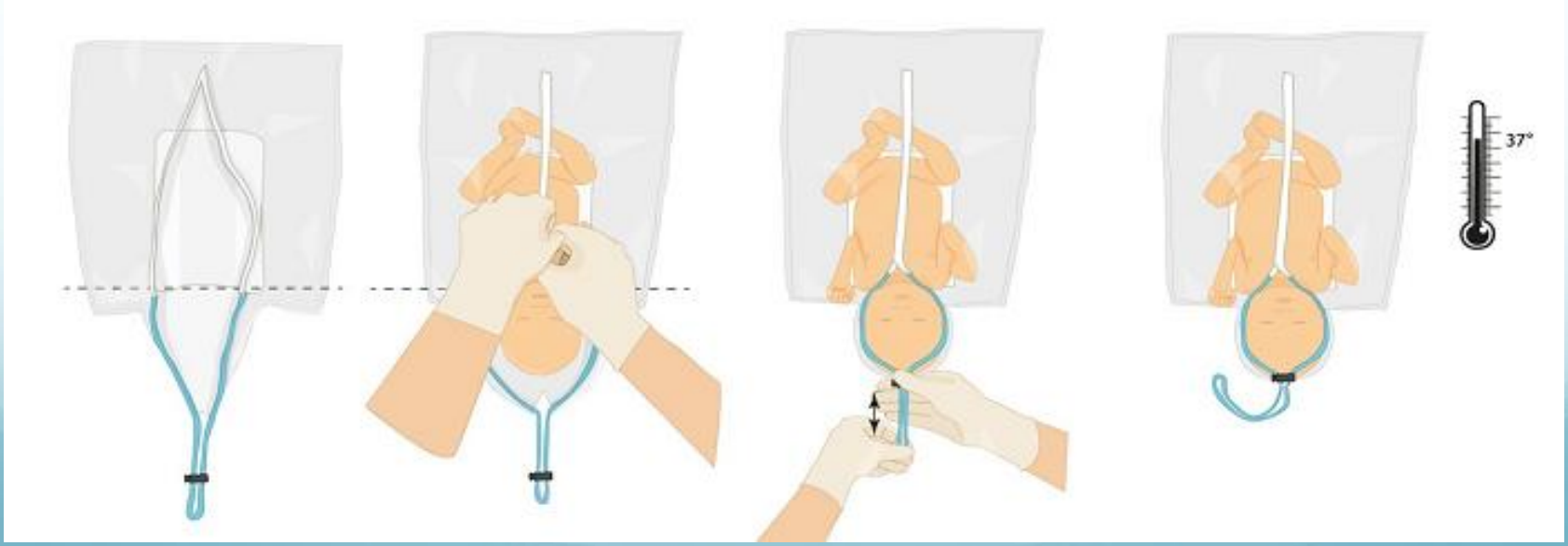
- Bowel bag

Gastroschisis

- Saran wrap (ie cling wrap)

Gastroschisis

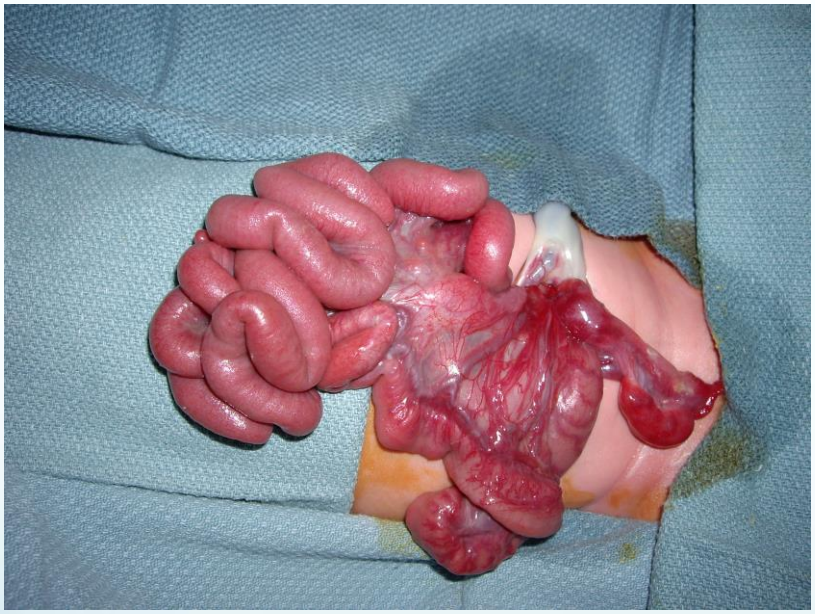
- **NeoHelp**
- Velcro closure in front
- Drawstring around head/face



Gastroschisis

- Priorities for transport…
- Protection / support of the exposed viscera
  - Lay on RIGHT side with bowel in front… or
  - Support bowel on front of supine abdomen
  - Maintain sterility
  - Avoid kinking of the bowel
- Gastric decompression – frequent suctioning
- IV access for fluid resuscitation

Gastroschisis – Primary Closure



Gastroschisis - Silo

Omphalocele

- Central abdominal wall defect
- Membrane covers herniated viscera (usually liver and bowel)
- Umbilical cord inserts directly into the sac
- Associated anomalies >50%
  - GI, GU, CNS, Cardiac, Skel
  - Chromosomal
- Mortality 30-60%

Omphalocele

Large

Small

Omphalocele

- Large moist surface → evaporative heat loss
- If sac intact, contamination not an issue
- Transport priorities…
  - IV Access / fluids
  - NG decompression
  - Coverage of sac to prevent heat loss & desiccation
    - Xeroform / gauze
    - Moist saline / Saran wrap
  - Avoid pressure on sac

Omphalocele

- Timing of repair depends on size of the omphalocele
- Small → primary repair
- Large → topical mgmt till skin covered w/ delayed repair months to years later

Omphalocele

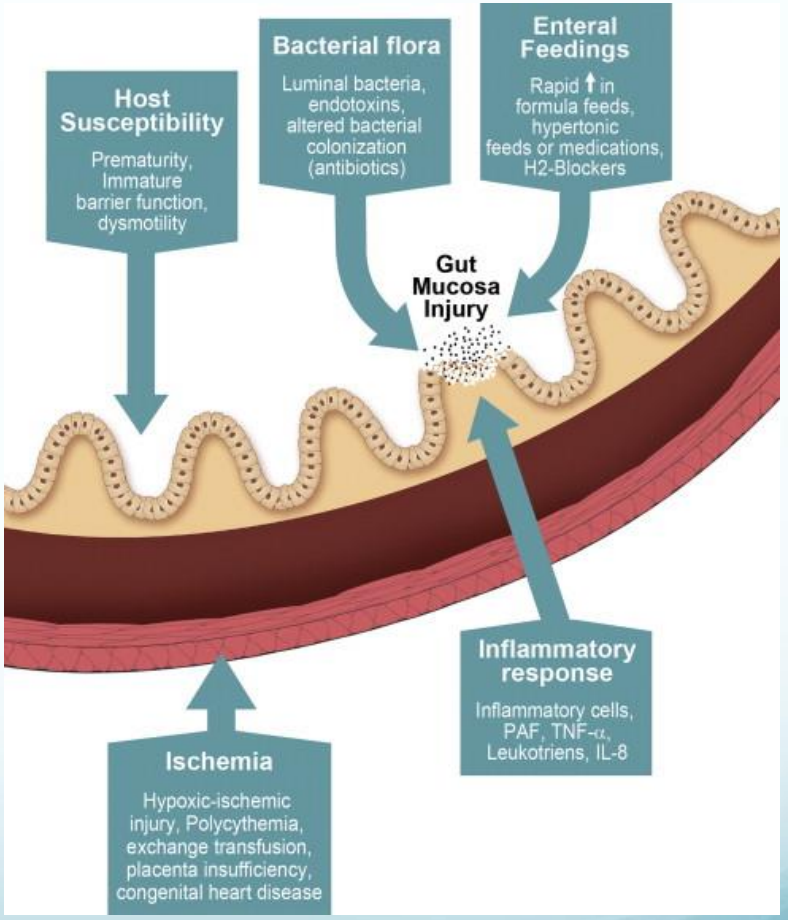
- If sac is ruptured → coverage with biologic mesh
- Prolonged topical care
- Supportive care w/ TPN often required
- Eventual repair months to years later

Necrotizing Enterocolitis

- Necrotizing infection of the bowel wall (SB or colon)
- Typically in premature infants (>90% of cases)
- Reported 7-20% of premature infants will get NEC – (25% mortality)
- Other risk factors include…
  - Congenital heart disease
  - Birth asphyxia
  - Exchange transfusion
  - Prolonged rupture of membranes

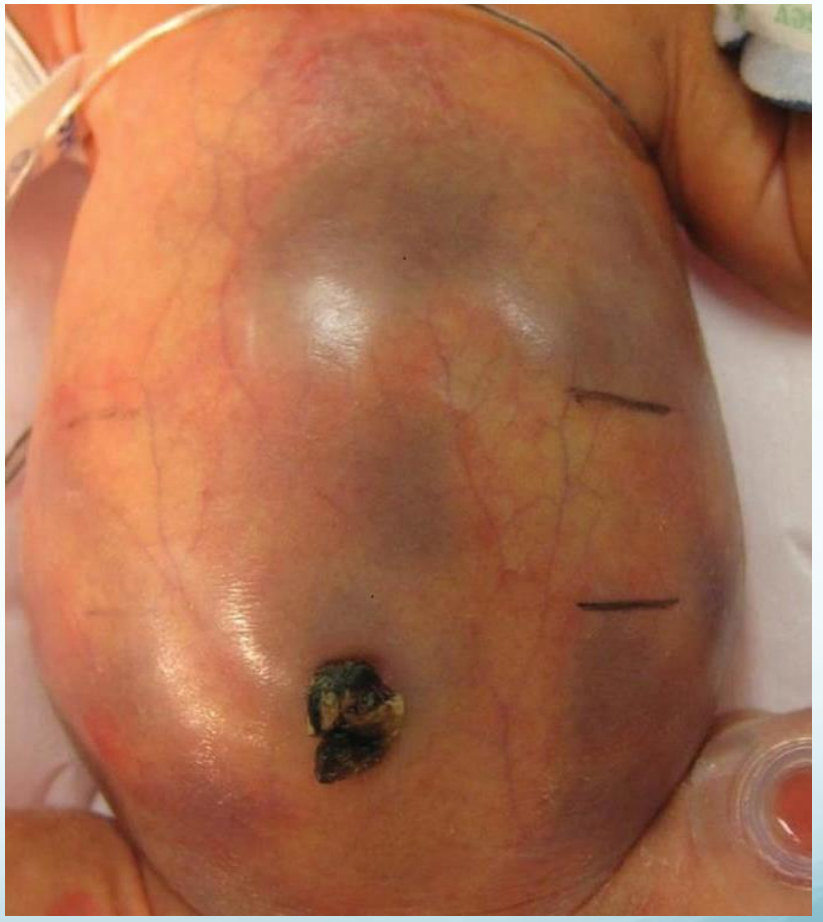
Necrotizing Enterocolitis

- Etiology not entirely clear
  - Mucosal damage, feeding?
  - Poor blood flow
  - Translocation of bacteria
- Progression of disease
  - Mucosal inflammation
  - Hemorrhagic/coagulative necrosis
  - Loss of mucosal integrity
  - Transmural necrosis
  - Perforation



Necrotizing Enterocolitis

- Symptoms can include…
  - Feeding intolerance
  - Bilious emesis/NG output
  - Bloody stool
  - Distension
  - Abdominal discoloration
  - Respiratory distress
  - Acidosis
  - Sepsis
  - Pneumatosis on KUB



Pneumatosis

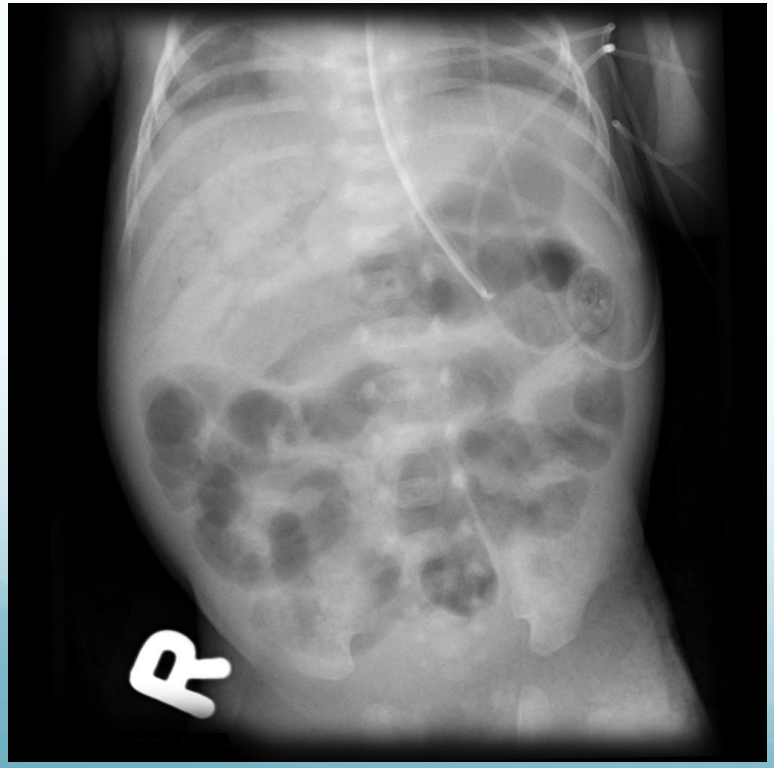
- Bubbles or linear lucencies due to intramural air in wall of bowel
- Gas forming organisms

Necrotizing Enterocolitis

- Treatment..
  - NPO, Bowel rest
  - Broad Spectrum IV antibiotics
  - NG tube
  - IV fluids
  - Serial exams and xrays

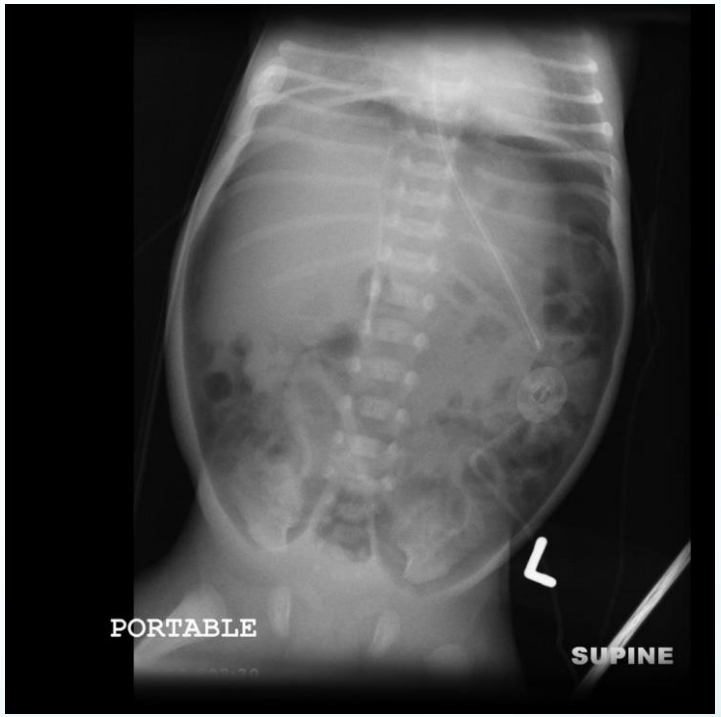
Portal Vein Gas

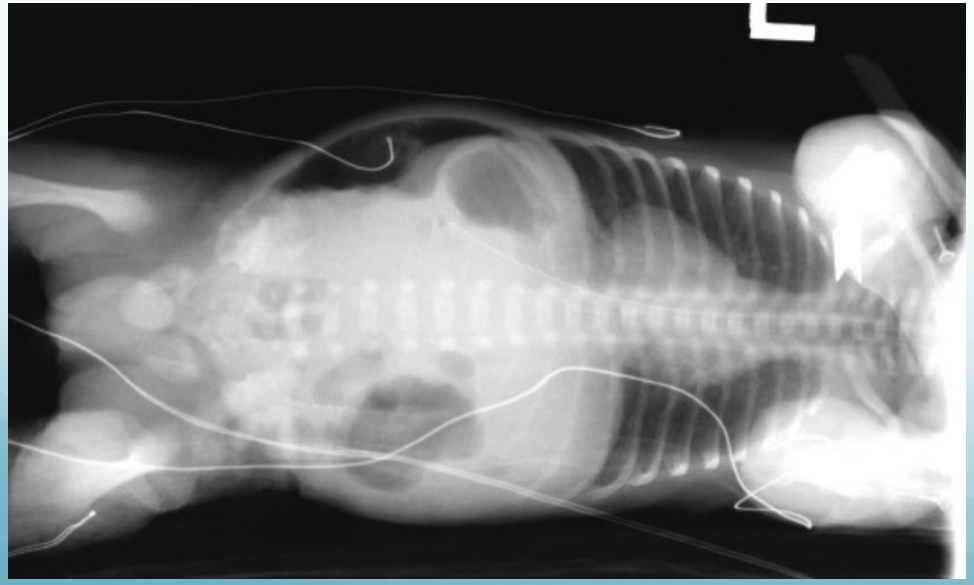
- Sign of severe disease
- Relative (not absolute) indication for surgery

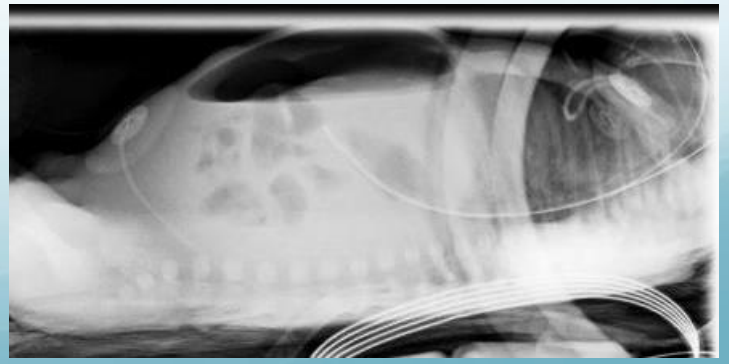


Pneumoperitoneum

- May require lateral view to be seen
- Absolute indication for operative intervention

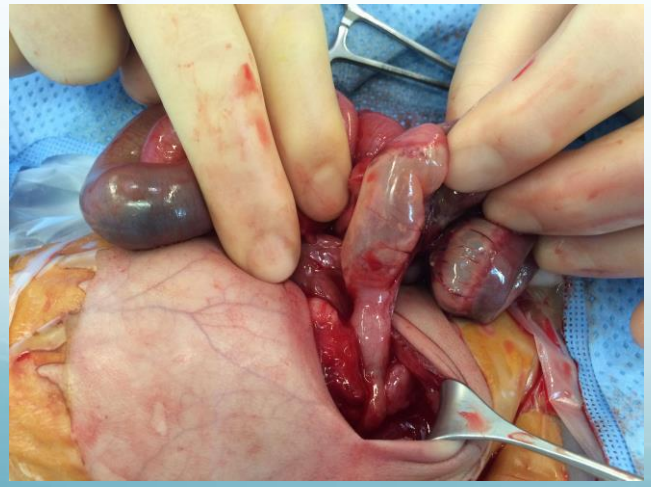






Necrotizing Enterocolitis

- Surgical intervention
  - Resection of grossly dead tissue
  - +/- stoma
  - Possible "2nd Look" in 48 to 72 hrs
  - Possible abdominal wound vac

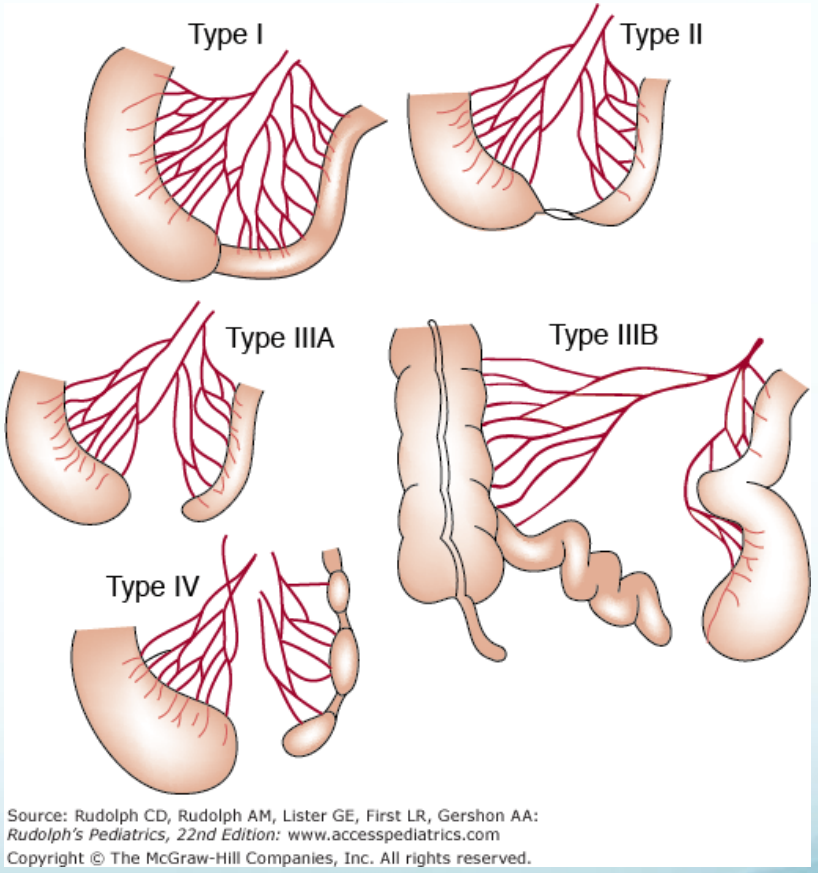


Necrotizing Enterocolitis

- These patients need to be in a center where surgery can intervene ASAP if needed
- Patients may be extremely ill
- Transportation priorities
  - IV access
  - NG decompression
  - Ventilator support if intubated
  - +/- pressors
  - Bring all xrays

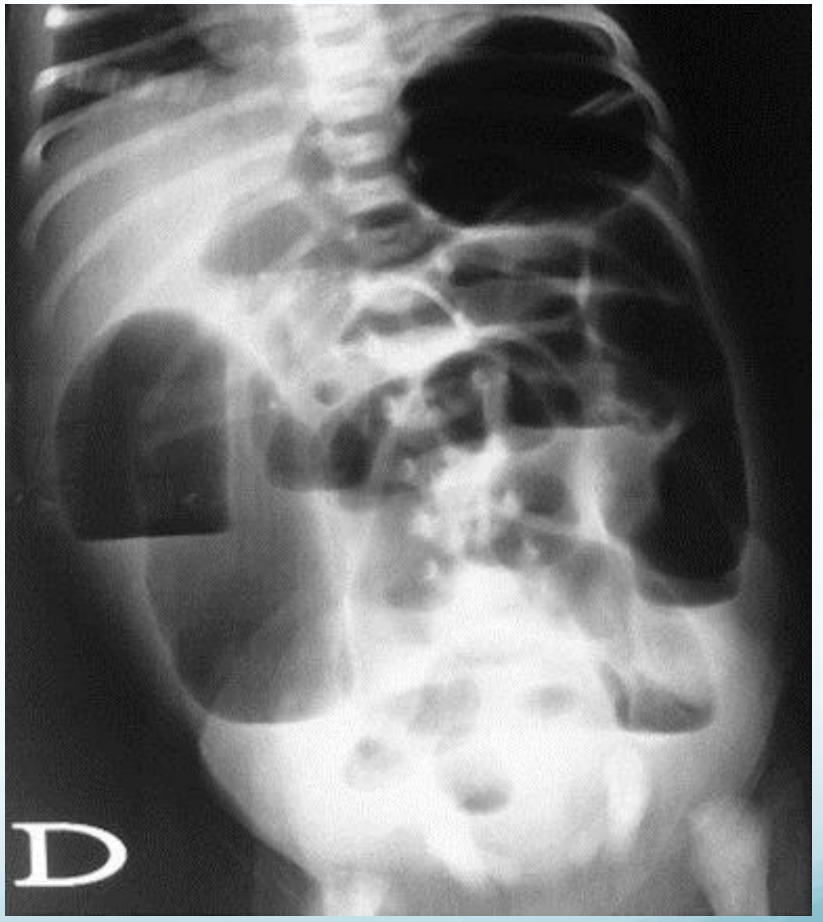
Intestinal Atresia

- Complete obstruction of intestinal lumen
- Vascular accidents in-utero
- Damaged segment shrivels and fibroses → obstruction
- Presentation…
  - Bilious emesis
  - Distension
  - Non-passage of stool



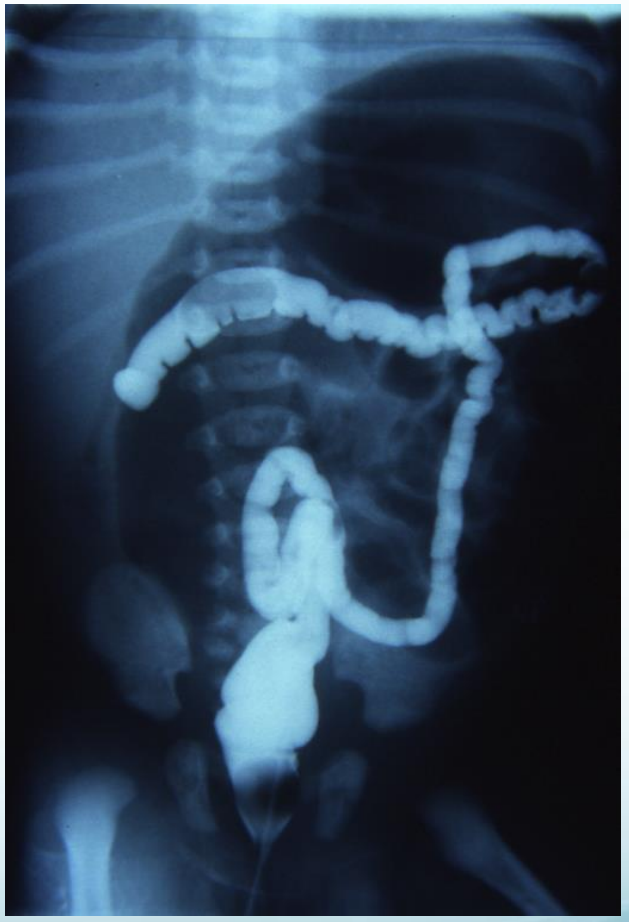
Intestinal Atresia

- Swallowed air → progressive distension
- Dilated loops on KUB
- Air/fluid levels
- Risk of aspiration



Intestinal Atresia

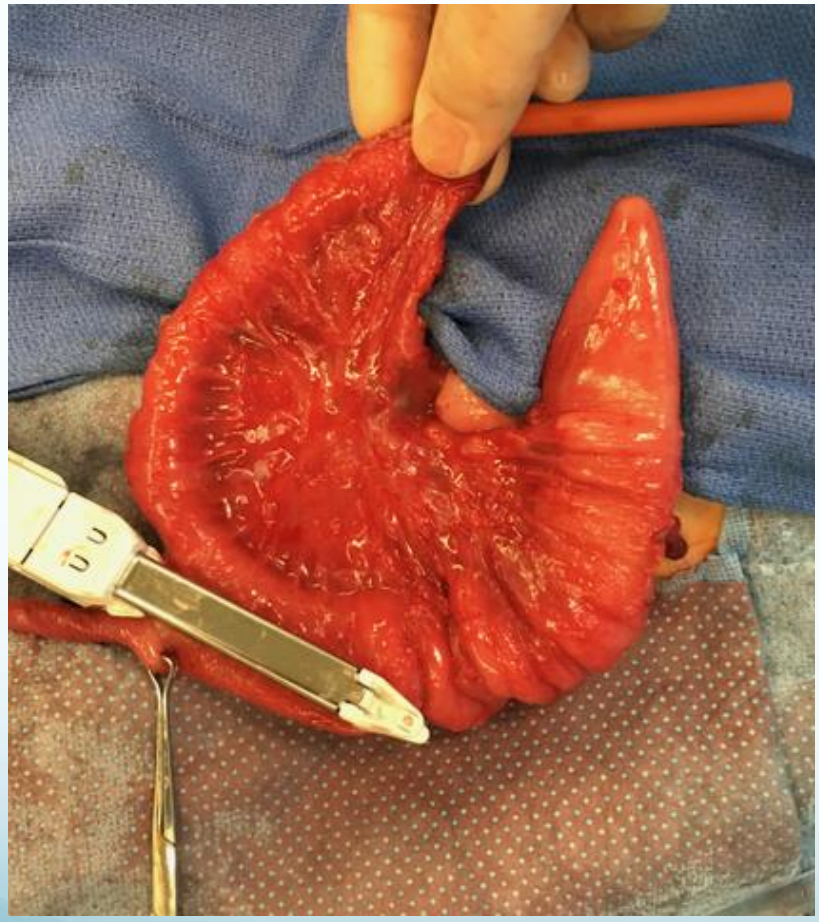
- Contrast enema → Micro-colon
- Colon growth depends on passage of enteral content
- Confirms diagnosis of intestinal obstruction that will require surgical exploration
- Exact etiology won't be clear until surgery



Intestinal Atresia

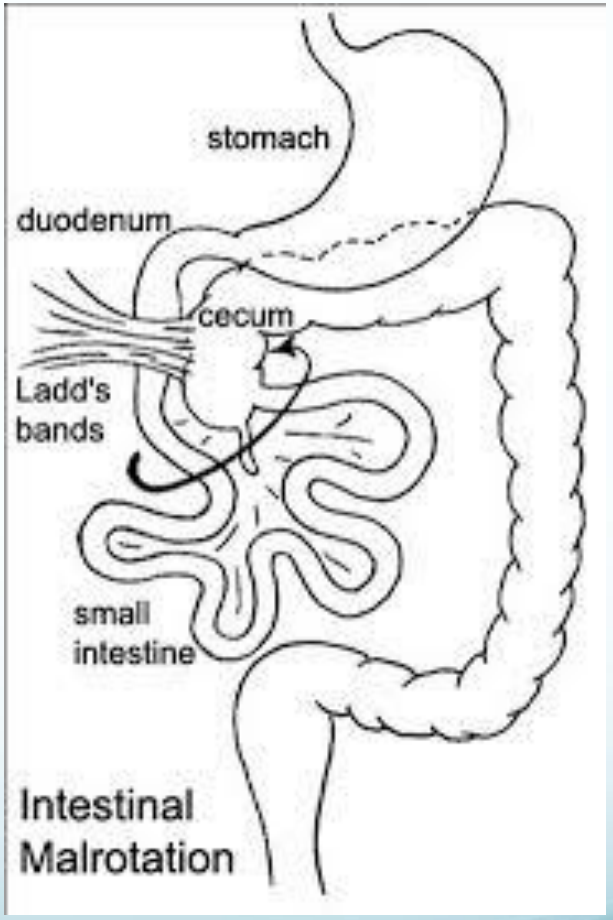
- Initial management…
- NPO
- NG decompression
- IV access
- IV fluids
- Transfer for surgical management

Intestinal Atresia

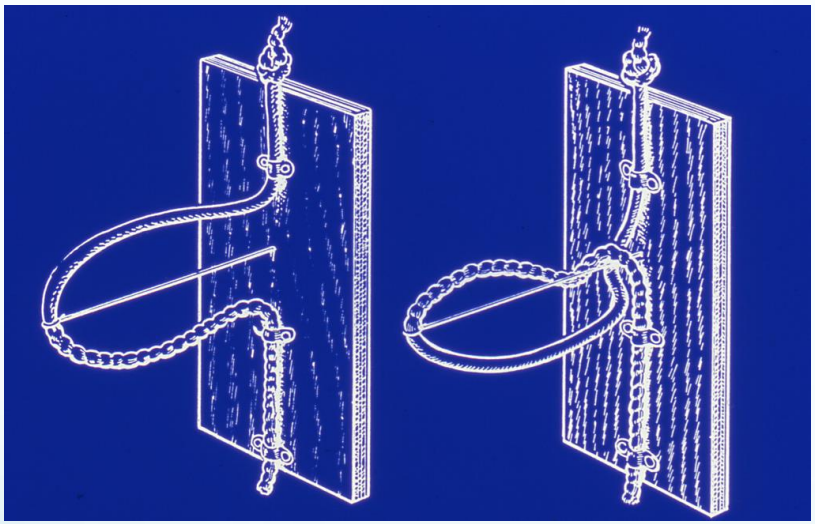


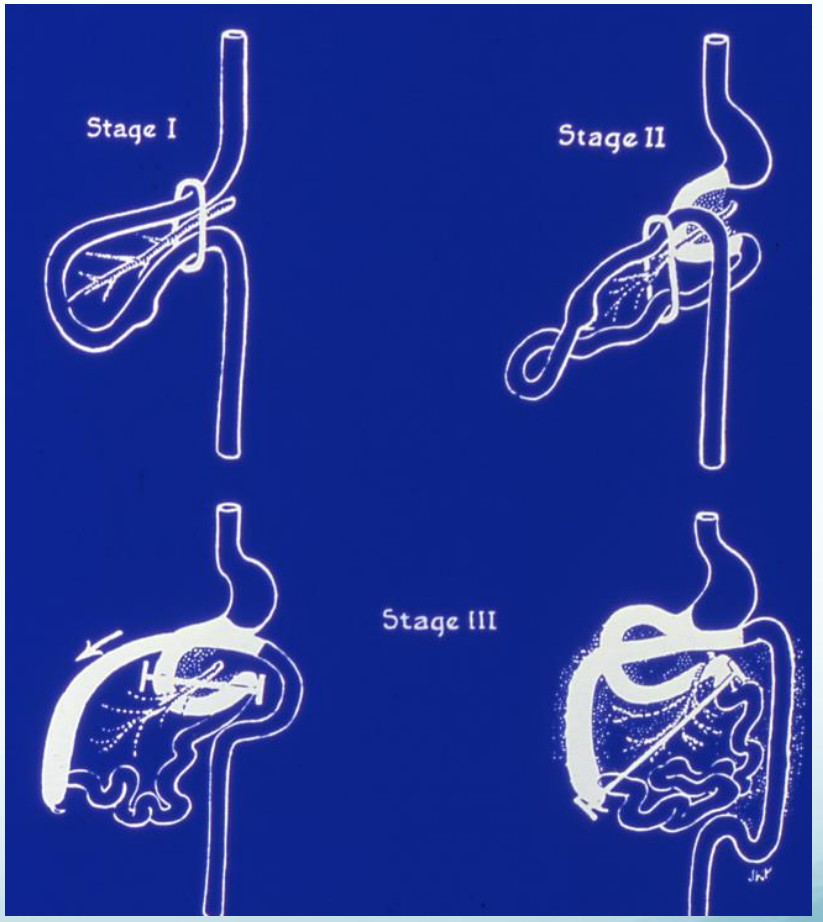
Intestinal Malrotation

- Congenital abnormality in fixation of the bowel
- Allows the bowel to twist
- Can result in acute bowel ischemia and loss of entire small bowel and 2/3's of the colon

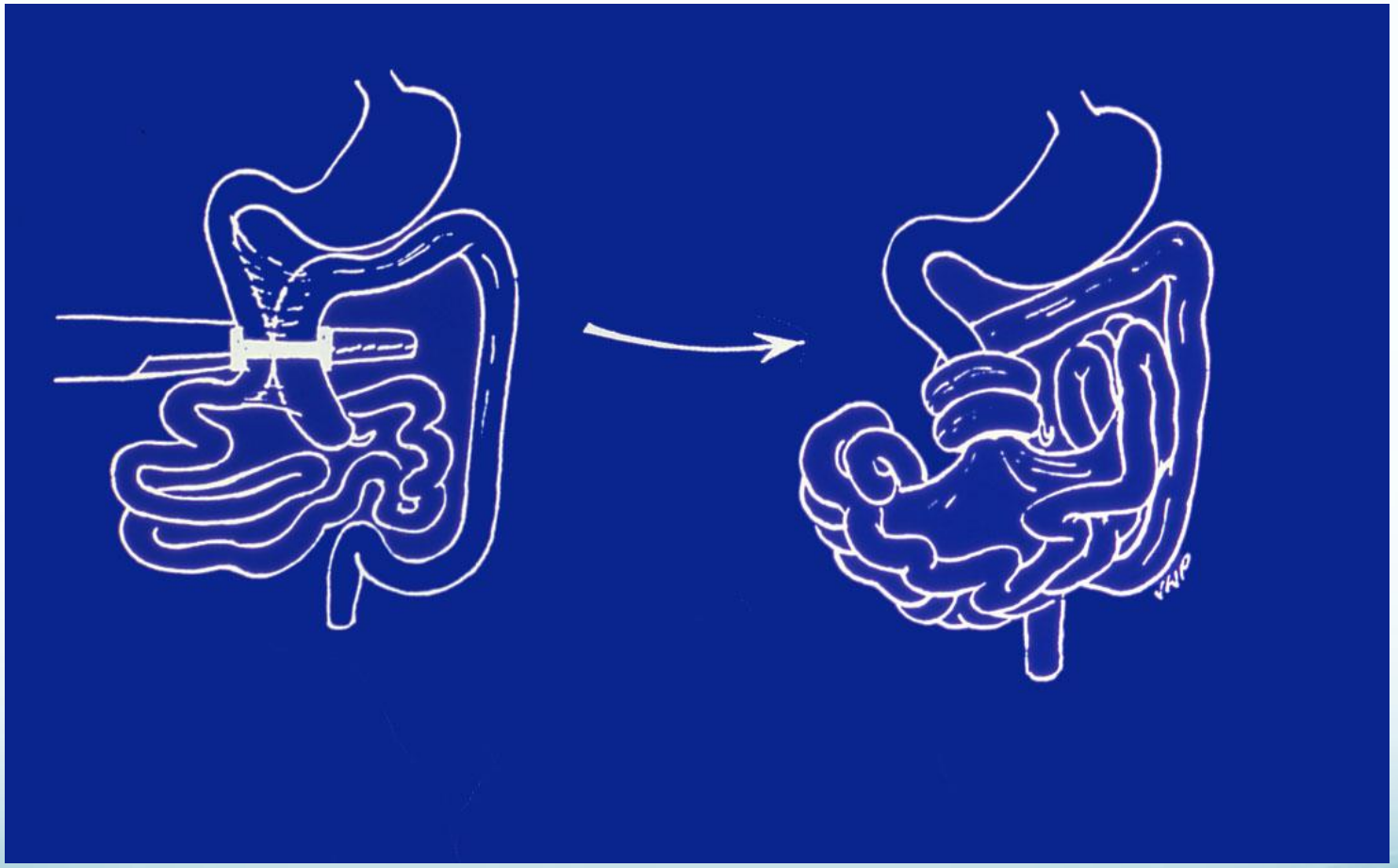


Intestinal Malrotation





Intestinal Malrotation

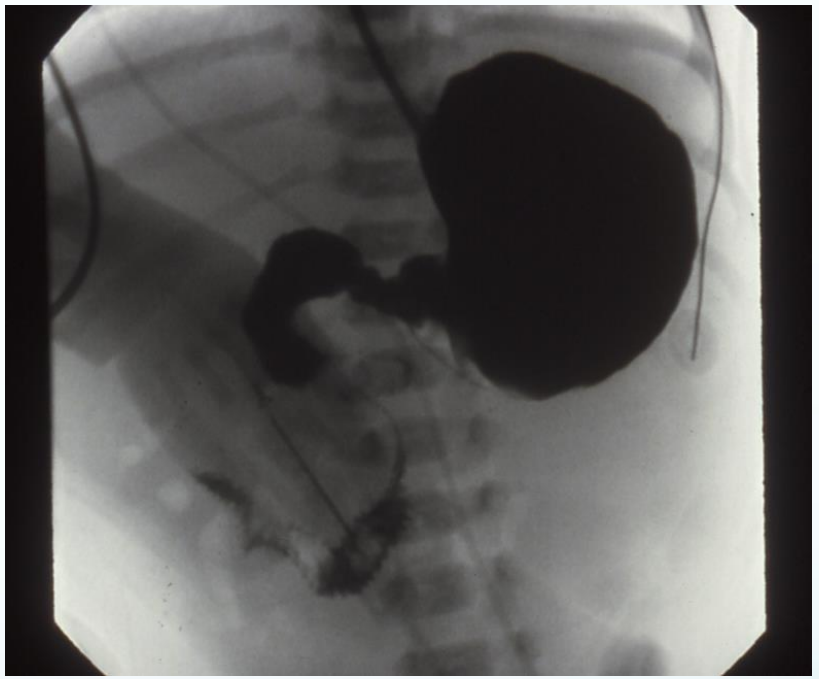


Intestinal Malrotation

- Clockwise twist → proximal obstruction
- Bilious emesis
- Restricts vascular inflow → ischemia
- +/- bloody stool
- Eventual distension / acidosis
- Cardiovascular collapse if not treated promptly

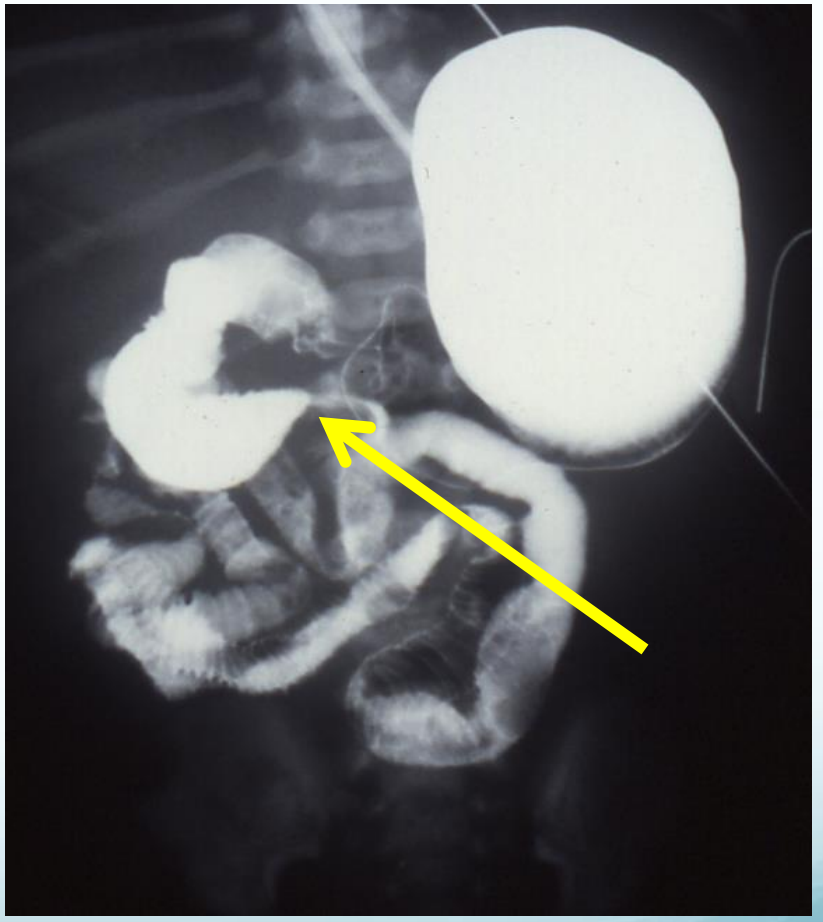
Intestinal Malrotation

- **UGI – diagnostic study of choice**
- Will show abnormal path of duodenum
- Abnormal location of Ligament of Treitz



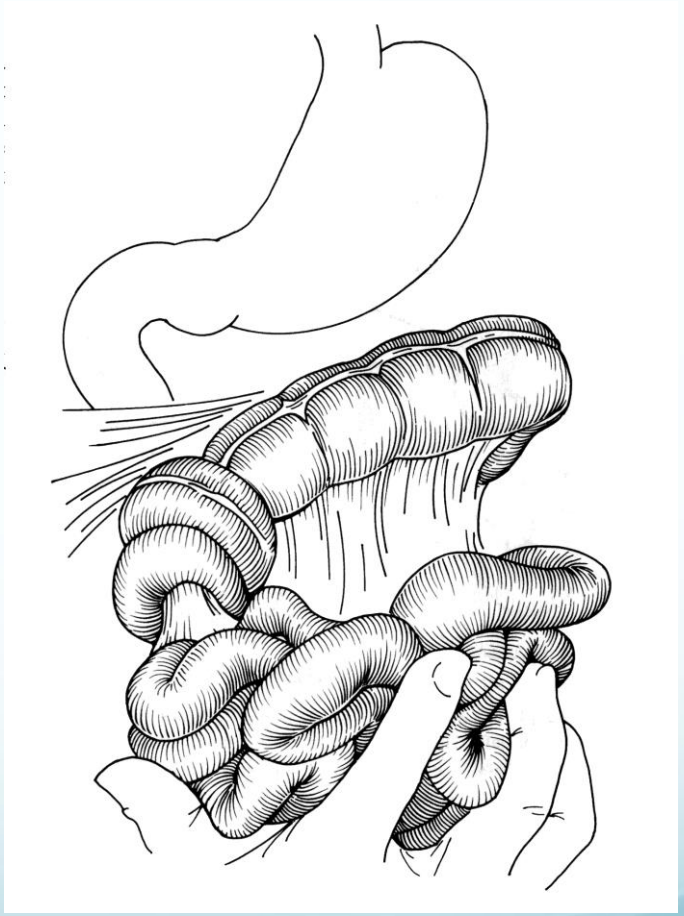
Intestinal Malrotation

- **UGI – diagnostic study of choice**
- Will show abnormal path of duodenum
- Abnormal location of Ligament of Treitz
- Bird Beak if volvulus



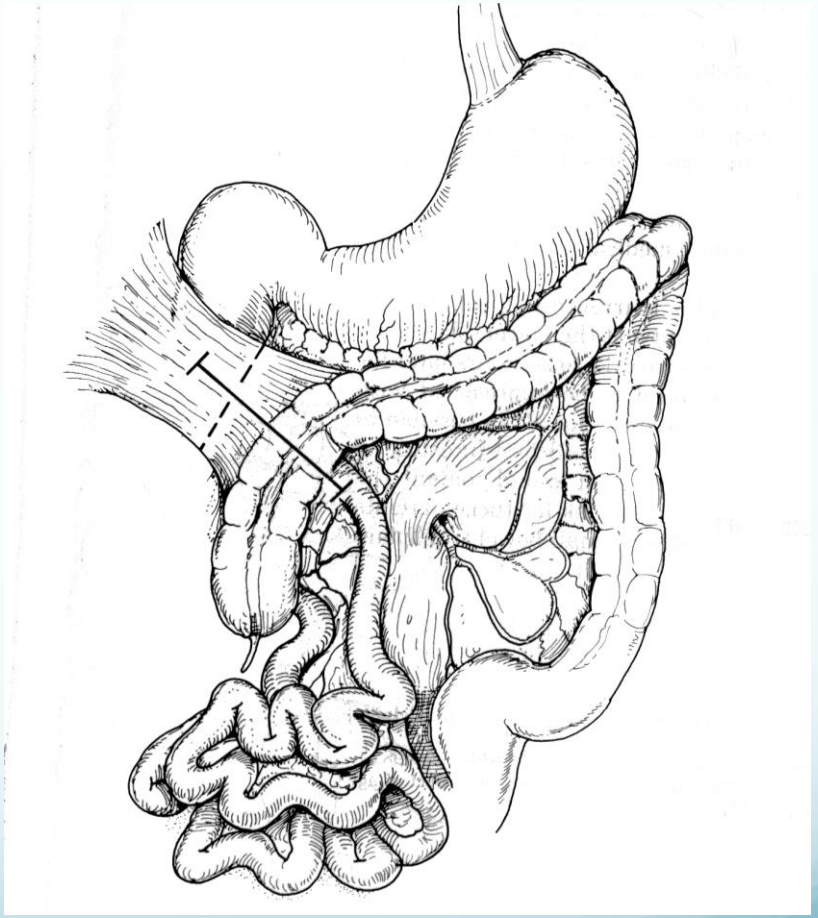
Treatment

- Emergent exploration
- Counter-clockwise untwisting of the bowel



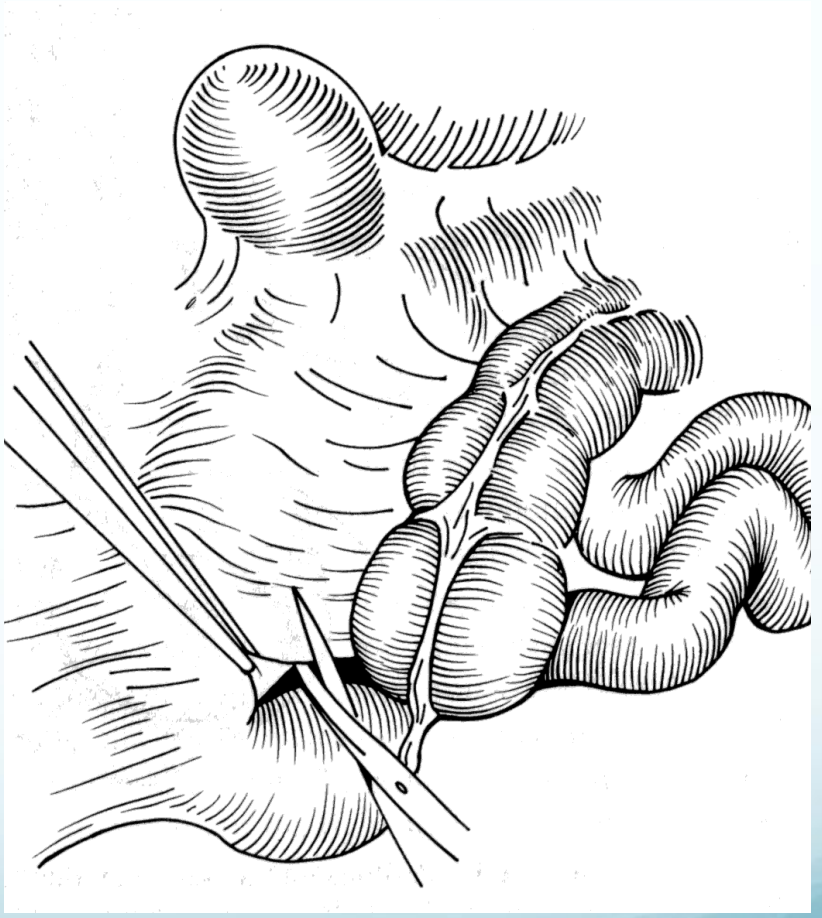
Treatment

- Emergent exploration
- Counter-clockwise untwisting of the bowel
- Division of Ladd's Bands



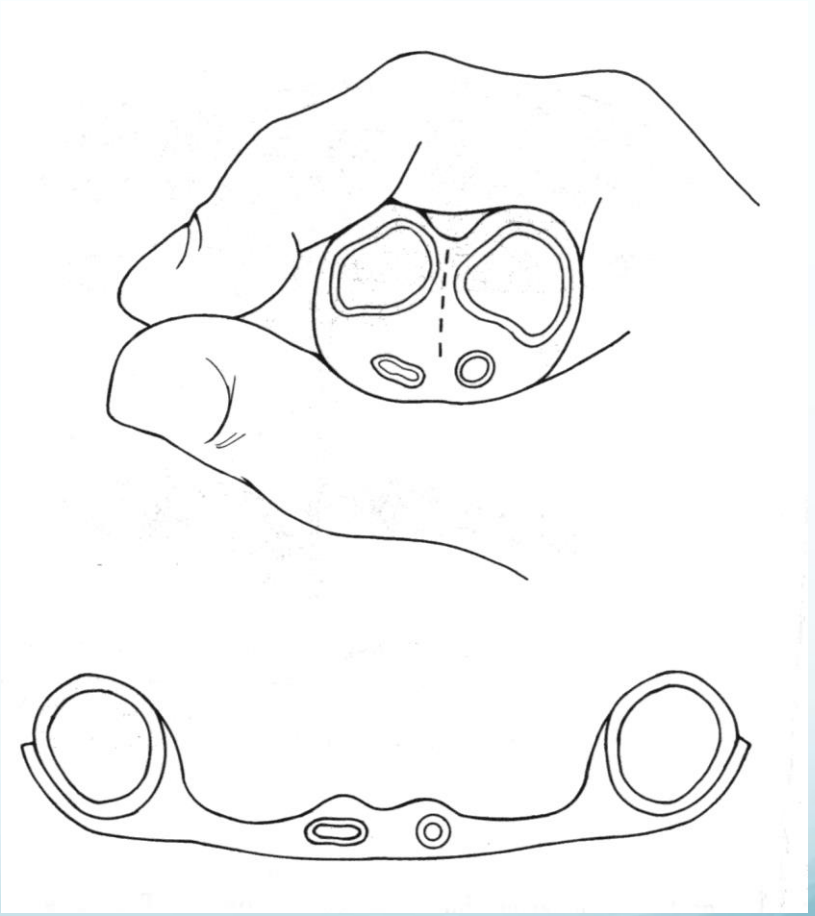
Treatment

- Emergent exploration
- Counter-clockwise untwisting of the bowel
- Division of Ladd's Bands
- Opening of the mesentery → separation of duodenum and colon



Treatment

- Emergent exploration
- Counter-clockwise untwisting of the bowel
- Division of Ladd's Bands
- Opening of the mesentery → separation of duodenum and colon
- Return the bowel in a neutral non-rotated orientation



Intestinal Malrotation

Intestinal Malrotation

Intestinal Malrotation

Intestinal Malrotation

Intestinal Malrotation

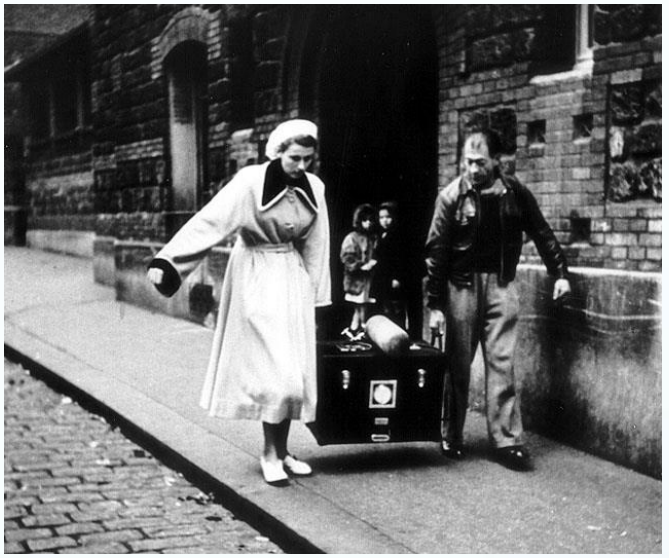
- Transport priorities in suspected malro
- NPO
- NG decompression
- IV access / fluids
- Go, Go, Go ASAP
- Time is of the essence
- Clock is ticking…!

Summary

- Surgical neonates deserve prompt transport to a center with pediatric surgeons
- Stabilization prior to transport is preferable
- Make sure patient has…
  - Good IV access
  - Secure airway if any respiratory concerns
  - Functioning NG decompression
- Protect the bowel / viscera in pts with abdo wall defects
- Be aware of the effect of altitude on gas filled spaces

Summary

- Be thankful we don't live in 1923 (This could be you)



- Most importantly....
- BE SAFE OUT THERE !!!!!

Questions?