Lines/Devices

Weird, Wild, and Wacky

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Disclosures

• No pertinent financial disclosures
• I am a new father of twins and do accept donations.
Objectives

- Describe the “normal” lines in the pediatric chest
- Discuss what can go wrong in positioning with these “normal” lines
- Briefly describe “rarer” lines and tubes
- Describe “advanced” cardiac devices
Lines
Ordinary Lines and Tubes

- Endotracheal Tube
- Enteric Tubes
- Central Venous Lines
- Umbilical Arterial Catheters
- Umbilical Venous Catheters
Correct Position?

- Varies by Institution
- Varies from physician to physician
- What is considered safe changes frequently.
- What is considered overtly unsafe is pretty stable.
- The following are general suggestions and not absolutes.
Endotracheal Tube

• Most (at least at MUSC) are cuffless
• Goal of tip is somewhere between the thoracic inlet and carina
  • What is the thoracic inlet?
  • Plane from the T1 vertebral body to the medial end of the clavicles
• Neonate head position can move the tube up to the length of the thoracic trachea
  • Head flexed – tube tip should be slightly above the carina
  • Head extended – tip should be slightly below the thoracic inlet
• Using vertebral body level is less accurate due to differences in x-ray projection
“Correctly” Positioned ETT
Malpositioned ETT
Enteric Tubes

- Obviously, the tip should be in the stomach
- Depending on patient size and tube length, the side-hole may by necessity be in the distal thoracic esophagus
- Examples of Replogle, NG, and feeding tubes
Malpositioned Enteric Tubes
Central Venous Lines

• The correct position is very controversial
• Experts even argue whether right atrial positioning is safe
  • Cases where the catheters have eroded through the endothelium
• Generally, we wish for PICCs to be in the SVC
• On a well positioned frontal projection, the SVC/RA junction is two vertebral bodies (±0.4) inferior to the carina
• Inferior approach PICCs should terminate near the IVC/RA junction
Well Positioned Central Venous Cath
Malpositioned CVS
Malpositioned PICC
**Umbilical Arterial Catheters**

- Positioning is intended to minimize thromboembolism into the main aortic branches
- **Line position relative to the spine is reliable given aortic position**
- **Note:**
  - Ductus arteriosus joins the aorta at about \( T_4 \)
  - Abdominal aortic branching is two vertebral bodies higher in neonates
    - Celiac axis arises at ~ \( T_{10}-T_{11} \)
    - SMA ~ \( T_{11} \)
    - Renal Arteries ~ \( T_{12}-L_{1} \)
    - IMA ~ \( L_{1} \)
    - Iliac Bifurcation ~ \( L_{3} \)

- **Two Position Goals:**
  - **High line position** — goal between the ductus arteriosus and celiac axis
    - Between \( T_6-T_9 \)
  - **Low line position** — Below \( L_3 \)
“Correctly” Placed UACs
Malplaced UAC
Umbilical Venous Catheters

• Contrary to UACs, UVC tip position relative to the spine is unreliable
  • Venous anatomy is not adjacent to the spine
  • Variability in patient position and radiographic angle will alter tip projection

• Reference should be to venous anatomy
• Could simply state, below, within, or above the liver
• Preferred position is at the inferior cavoatrial junction
• If superior to the IVC/RA junction, should state where it is
  • Right atrium, right ventricle, through a foramen ovale, up the SVC etc.
Malpositioned UVC
Other “less common” Lines/Tubes

- Chest tubes
- Epicardial Pacer Wires
- Intracardiac Catheters
- Mediastinal and Pericardial Drains
- ECMO Cannulae
- Esophageal Impedance Probes
- Esophageal Temperature Probes
- Intrathecal Catheters
- Vagal Nerve Stimulators
- Many, Many, More
Advanced Devices

Cardiac Assist Devices
Device Positioning

• Left Ventricular Assist Device:
  • Inflow Cannula positioning
    • Just superior to the cardiac apex
    • Points posteriorly towards the mitral valve
    • Parallel to the inter-ventricular septum
  • Outflow Cannula – right lateral ascending aorta

• Right Ventricular Assist Device
  • Inflow Cannula – right atrial or right ventricular position
  • Outflow Cannula – main pulmonary artery
Berlin Heart EXCOR

- Composed of a pulsatile pump and silicone cannulae
- May enable stable cardiovascular support for up to 2 years
- 5 different sizes
- Can be used from newborn to adolescents
Berlin Heart BIVAD

- Necessary in the setting of:
  - Biventricular Failure
  - Prolonged resuscitation
  - Increased pulmonary vascular resistance
CentriMag

- Centrifugal, continuous flow pump
- Used for short to intermediate length cardiac support
- Contains a bearingless magnetically levitated impeller
- Can support patients up to 20 kg
PediMag

- Centrifugal, continuous flow pump
- Used for short to intermediate length cardiac support
- Supports patients up to 10 kg
HeartWare HVAD

• Axial, continuous flow device with an implantable pump
• Flow cannula inserts directly into the left ventricular apex
• Used for long-term support in older children and adults
Impella

- Miniaturized left ventricular assist device
- Basically a self-contained pump within a catheter
- Inserted percutaneously during cardiac catheterization
- Passed from the femoral artery, through the ascending aorta, across the mitral valve and into the LV

- Used for:
  - Cardiogenic shock
  - Advanced Heart Failure
Thank You!

Questions?