Patients’ Plastic Pieces
Common Technology in Children with Medical Complexity
PHM 2016

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Disclosures

- We have no financial relationships or commercial interests to disclose.
- We have received no financial incentives from any corporations involved in the manufacture or development of products employed in this presentation.
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Learning Objectives

1. Manipulate and learn the basics of common medical technology including:
   - Ventricular shunts
   - Tracheostomies
   - Chest tubes
   - Long term central venous access
   - Enteral tubes

2. Learn to troubleshoot common problems and concerns related to the above technology

3. Explore ways to lead discussions with families about the above procedures and subsequent care, including the more philosophical challenges of caring for a technology-dependent children
Introduction

• Nationwide, children with medical complexity account for 0.5% of the population, yet 25% of healthcare costs.

• Hospitalists are involved in critically important episodes during these patients’ lives, and we are often asked to assist in decisions involving the placement and subsequent care of medical technology.

• We are expected to be familiar with our patients’ medical technology, empathize with the day-to-day challenges these patients and their families face, and troubleshoot and advise on problems that inevitably arise.

• This workshop is designed to suit the more advanced understanding of the target PHM audience, and it will include thought- and discussion-provoking topics relevant to the care of medically complex and technology dependent children across the continuum.
Workshop Design

• Large group discussion: Intro

• Concurrent small groups:
  A: Ventricular shunts
  B: Enteral tubes
  C: Tracheostomies and chest tubes
  D: Long-term central venous access
    – Explore physical items and electronic visual aids
    – Discuss aspects of care pertinent to each piece of technology including: patient/family education regarding the surgical procedure, as well as expectations of care and troubleshooting problems in the immediate post-operative, subacute, and long-term periods.

• Reconvene large group:
  – Closing discussion of the more philosophical topics surrounding this patient population, touching briefly on advance directives and goals of care discussions.
Ventricular Shunts

By

Sam Flores, MD
Most common shunt placement

V-P Shunt

V-A Shunt
CODMAN CERTAS® Plus Programmable Valve Components

- Reservoir
- Right Hand Side (RHS) Marker
- Valve Construct
- Outlet
- Suture Holes (4x)
- Direction of flow indicator
- New ruby bushing
- SIPHONGUARD® Anti-Siphon Device (Optional)
Medtronic Strata® II Valve View on X-ray

Medtronic Shunt Valves
http://www.medtronic.com/neurosurgery/shunts.html

Medtronic Strata II Valve (a programmable valve, different settings are depicted; “P/L” stands for Performance Level; see Medtronic website for pressure/flow information)
CODMAN CERTAS® Plus Valve
View on X-Ray

The valve setting is determined by the Setting Indicator ☐, relative to the Right Hand Side X-ray Marker ○.
Medtronic Strata® Valve Reprogrammer
CODMAN CERTAS® Tool Kit

Low Profile Locator Tool

Adjustable Height Locator Tool

Indicator Tool

Adjustment Tool

X-Ray Overlay Tool
Adjustment with CODMAN CERTAS® Toolkit

- Things to learn with adjustment....
  - Alignment is critical
  - Height is critical- need to use the Adjustable Height Locator Tool appropriately
  - Horizontal use (like a compass)
  - The indicator tool: if you drop it, request a replacement.
CODMAN CERTAS® Tool Kit

Indicator Tool

- The position of the number in the window helps confirm that the tools are properly aligned with the valve
Important Questions/Resident Teaching Points

• When shunt placed?
• Type of shunt (e.g. VP vs VA) and is it programmable?
• Do you have a pocket or wallet card that goes with your device?
• What was the most recent shunt setting?
• Date of last revision and reason for revision?
• Any history of infections?
Common Scenario

• 3 yr old male with Codman programmable VPS shunt placed in 2013 for hydrocephalus (status post revision 6 months ago) presents with a 1 day history of headache and vomiting.
  – X-ray Shunt series: intact shunt tubing
  – 1-bang MRI brain (or CT hydro): no increased intracranial pressure, ventricle size stable
  – Neurosurgery consult: Admit and observe overnight
For the Hospitalist

– Check valve type and setting on Xray and ask NSGY if it needs to be re-programmed
  • Could (should) hospitalists have access to these tools to reprogram shunts themselves?

– When is it necessary to “tap the shunt”?

– Observe for Increased ICP
  • Cushing Triad: Hypertension, bradycardia, and abnormal breathing

– What to do next if patient decompensates?
  • Transfer to ICU
  • Hyperventilate
  • Consider Hypertonic saline vs mannitol
Resources

• Hydrocephalus Association
  http://www.hydroassoc.org/docs/FactSheets/FactsheetShuntSystems.pdf

• Codman Neuro:
  http://www.depuysynthes.com/hcp/codman-neuro

• Medtronic:
Tracheostomy Tubes

Chest Tubes

by

Wendy Arafiles, MD
Tracheostomy Tubes
Anatomy of a Trach

Shiley™
Neonatal Tracheostomy Tube Cuffless
4.0 NEO
Ø 4.0 mm I.D.
Ø 5.9 mm O.D.

This diagram illustrates how the proximal, radial and distal measurements are determined for proper sizing.
Trachs: Cuffed and Uncuffed

**Obturator:** facilitates trach replacement (like a stylet)

**Pilot balloon:** indicates cuff inflation, can palpate cuff tension

**Cuff:** facilitates air leak management
Trachs: Shiley™

Cuffed and Uncuffed, Neonatal and Pediatric sizes, firmer plastic material
Bivona® Flextend™ Tight-to-Shaft (TTS)™

- Extended length proximal shaft is flexible and allows for more neck soft tissue, providing more distance between the patient and connected devices (e.g. ventilator)
- Wire embedded in tube maintains tube integrity despite the extended length and is non-ferrous (less distortion on XR imaging and MR-conditional)
- Deflated cuff rests “Tight-to-Shaft”
Trachs: Other

Fenestrated:
Allows air to escape through vocal cords = vocalization

Inner cannula:
• Outer cannula stays in place up to 30 days, inner cannula removed and cleaned daily.
• Fenestrated and non-fenestrated
Trachs: Accessories

**PMV:** Passy-Muir® Valve
- Allows inspiration but blocks expiration = forces air up through vocal cords
- aka “speaking valve”

**HME:** Heat Moisture Exchanger
- Single or Double barrel
- aka “nose”

**Cap:** Blocks all air passage (for weaning)

**Ties:**
- Foam with velcro
- Metal chain

**Phoenix Children’s Hospital**
Trach Placement

- Placed in OR with ENT or general surgeon
- New trach anchored in place by sutures
- 5-7 day postoperative stay in ICU – allow new trach stoma to heal before 1st trach change
- 1st trach change performed by surgeon due to risk of false-tracking upon replacement and need for advanced airway support during procedure
- Ideally, after ICU stay, patient will be cared for on a specialized airway unit for trach-specific caregiver education and discharge planning
Life after the Trach

• Notify local power company if patient has a ventilator
• Notify local Fire Station/EMS of patient with a trach (+/- ventilator)
• Leaving the house becomes much more complicated!
  – Trip reduction
• Access to emergency services
• Access to home health nursing and DME services
Chest Tubes
Chest tubes: Pigtaiil catheter

- Placed in IR under fluoroscopy (or ED, ICU)
- Smaller caliber than surgical chest tubes therefore less painful
- BUT easily becomes clogged with purulent or fibrinous material
- TPA is safe and oftentimes effective (but not always)
- 3-way stopcock facilitates delivery of TPA doses (up to 3 doses, 24 hours apart)
- Removal at bedside – remember to release the locking mechanism that keeps the proximal end curled
Chest tubes: Drainage system

To help remove air from the pleural space, but not to exceed -20 cm suction, attached to Wall Suction:

Filtered room air is drawn into the Suction Control Chamber to ensure that the amount of suction does not exceed.

20 cm

Suction Control Chamber Water Seal Chamber Fluid Collection Chambers

Blood/Fluid drained from the patient’s pleural space:
Air evacuated from the patient’s pleural space:
Air drawn from room to maintain added suction at 20 cm
Sterile saline or Sterile water
Chest tubes: Atrium drainage system
Atrium drainage system

A: Suction regulator
B: Water seal chamber
C: Air leak monitor – oscillating ball and bubble window
D: Fluid collection chambers
E: Suction bellows
Home chest tube drainage systems

Passive drains

• To drain intrapleural fluid at home
• Limited volume capacity

Active drains

• To drain intrapleural fluid at home
• Larger volume capacity
• Atrium product requires suction source
Home chest tube drainage systems

Heimlich or “Flutter” Valve

- One-way valve to let intrapleural air escape the thorax
- E.g. persistent air leak in bronchopleural fistula
- Meant for very stable patients with ~90% re-expansion to use at home
Indwelling Central Venous Catheters

By

Kiran Mangat, MD
1. Internal Jugular (IJ)
2. External Jugular (EJ)
3. Peripherally Inserted Central Catheter (PICC) Closed-Ended
4. Broviac (can also access Subclavian Vein)
5. Port
6. Subclavian Line
7. Femoral Line
8. PIV
9. Power-Injectable PICC (Power PICC)
10. PICC Open-Ended
## Central Venous Catheters

<table>
<thead>
<tr>
<th></th>
<th>PICC</th>
<th>Broviac®/Hickman®</th>
<th>Port-a-Cath®/MediPort®</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Catheter</td>
<td></td>
<td>Tunneled</td>
<td>Not externally visible</td>
</tr>
<tr>
<td>Can be tunneled</td>
<td></td>
<td>Externally visible</td>
<td>Flush monthly</td>
</tr>
<tr>
<td>Power option for contrast</td>
<td></td>
<td>Cuffed to grow into skin</td>
<td>Externally accessed</td>
</tr>
<tr>
<td>Requires frequent flushing</td>
<td></td>
<td>Open ended</td>
<td>Intermittent use</td>
</tr>
<tr>
<td>Easily displaced</td>
<td></td>
<td>Daily, long term use</td>
<td>Less mechanical damage</td>
</tr>
<tr>
<td>Can be used up 6 months</td>
<td></td>
<td></td>
<td>Durable, withstands punctures best of 3</td>
</tr>
<tr>
<td>Highest risk of infection</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## CVCs: Complications

<table>
<thead>
<tr>
<th>Immediate</th>
<th>Delayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleeding</td>
<td>Infection</td>
</tr>
<tr>
<td>Arterial Puncture</td>
<td>Thrombosis</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>Catheter migration</td>
</tr>
<tr>
<td>Air embolism</td>
<td>Catheter embolization</td>
</tr>
<tr>
<td>Thoracic duct injury</td>
<td>Myocardial perforation</td>
</tr>
<tr>
<td>Catheter malposition</td>
<td>Nerve injury</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td></td>
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</tbody>
</table>

The smaller diameter catheter & fewer lumens should be used to reduce the risk of thrombosis.
CVCs: PICC

- Often placed in IR, +/- sedation
- Can be performed at bedside with sterile field, +/- anxiolysis with midazolam
- Tip placement confirmed with bedside ultrasound, by measurement and post-placement CXR, or direct image guidance
- **Upper extremity PICC:** usually inserted into the cephalic, basilic, or brachial vein, advanced to the cavoatrial junction
- **Lower extremity PICC:** usually inserted into the greater saphenous vein, advanced to the IVC

**Tunneled CVC:**

- Placed in IR under GA with fluoroscopy guidance
- Inserted peripherally, tunneled subcutaneously to vessel access point
- Usually used in patients with more difficult central access
CVCs: PICC

Groshong® catheters:
• Use of a heparin lock is not necessary
• No clamps on the external length
• Flush with NS weekly
• Less risk of air embolus
• Black tip with three-way valve formed by slit in the sidewall of the catheter tip.
  - Valve opens outward during infusion
  - Inward during blood aspiration
  - Closed when not accessed

PowerPICC®:
• Single-, Double-, or Triple-lumen
• Used for “power flush” of IV contrast for imaging
CVCs: Broviac® & Hickman®

- Placed in the OR under GA
- Proximal catheter inserted directly into a central vein
- Distal catheter is tunneled under the skin and brought out on the chest or thigh away from the site where it enters the vein
- Tunneling prevents bacteria from gaining access to the central portion of the catheter
- Single- or Double-lumen available

Contain a "cuff" of Dacron material which is buried under the skin
  - Within a month, subQ fat tissue grows into this "cuff"
  - Stabilizes the catheter in the skin
  - Acts as a barrier to infection

*This is essentially what differentiates a Broviac from a tunneled PICC*
CVCs: Port-a-Cath® or MediPort®

- Placed in the OR under GA
- Embedded under the skin and catheter is tunneled subcutaneously then inserted into a central vein
- Port is the size of a nickel or quarter, circular (or oblong or triangle) in shape, palpable under the skin
- Port has a raised septum of self-sealing rubber material in the center through which the access needle is inserted
- Meant for long-term intermittent access (septum has a limited lifespan = # of “pokes”)
- Less risk of complication when not accessed compared to Broviac®
- Requires heparin flush every month
CVCs: Dressings

Broviac® dressing

Accessed Portacath®
CVCs: Dressings

**Biopatch®**
Chlorhexidine impregnated sponge with 360 degree contact around the catheter at skin insertion site

**StatLock®**
Locking device that adheres to skin and holds distal portion of the catheter in place to minimize movement at skin entry point

**Tegaderm™, Sorbaview®**
Clear adhesive layer that covers entire apparatus optimizing visibility at insertion site
Removing a PICC

1. CLEAN PROCEDURE = wear mask, gown, gloves; tie hair back
2. Note the length of indwelling catheter from insertion records
3. Using non-sterile gloves: place a glob of vaseline on middle 1/3 of one edge of a 4x4 gauze – set aside; loosen all peripheral tape and dressings beforehand, but keep Tegaderm™ and Biopatch® securely in place directly over skin insertion site
4. Using a sterile glove, keep a finger over the catheter at insertion site and remove Biopatch® and remainder of dressing (prevent catheter from receding further into vessel)
5. Use Chloraprep® stick to brush off sand (if present) and clean insertion site, immediate surrounding area, and adjacent catheter
6. Place gauze with vaseline directly under catheter where it enters the skin, loosely fold two sides over the catheter
7. Holding slight pressure over the vaseline/gauze over catheter, slowly and steadily slide the catheter out through the vaseline/gauze
8. Once entire catheter is removed, keep holding the gauze over the insertion site and inspect the tip and length of catheter removed – ensure catheter is intact
9. Once inspection is complete, without removing vaseline gauze from insertion site, fold distal portion of gauze up to create a small pressure dressing – cover securely with Telfa™ dressing
CVCs: General troubleshooting

- Fibrin sheaths or thrombosis can develop
- Difficulty with draw but not flush = fibrin sheath
- Difficulty with both draw and flush = thrombosis
- Do not flush through it as the pressure can cause a break in lumen leading to a leak
- Usually try Alteplase for 30 minutes in catheter. If not improved, then try 2 hours. May require second dose.
- Alteplase will not work if crystallization has occurred due to incompatibility of infusions.
Tunneled CVCs: Pinch off syndrome

- Tunneled catheter passing through tissue of the space outside the vessel lumen becomes compressed between the clavicle and rib.
- Intermittent pain and occlusion.
- Occurs with subclavian vessel placement.
- As the patient raises and lowers the shoulder, repeated compression and shearing forces put pressure on the catheter.
- Repositioning helps but if recurs, line needs to be replaced.
PICC and Tunneled CVC: Troubleshooting

**PICC**
- Risk of phlebitis:
  - Chemical
  - Mechanical: due to presence of foreign body or wire irritation on lumen.
- Kinked dressing can occlude line
- Trial warm pack and range of motion q 2 hours to help
- If not flushing, change end cap or dressing.

**Port**
- Check position with X-ray, PA and Lateral
- Sometimes needle is not accessing due to short length
- If there is a leak, skin may develop swelling.
- Redness or blistering can occur if infusion is a vesicant.
- During a prolonged infusion, check needle position as it can be displaced.

**Broviac®**
- Families should keep plastic clamps handy.
- For any break, leak, or hole, clamp should be applied above damaged area and close to patient to prevent bleeding or air emboli.
Enteral Tubes

By

Sarjita Shukla, MD
Nasogastric (NG) & Nasojejunal (NJ) Tubes
Nasogastric (NG) & Nasojejunal (NJ) Tubes
NG/NJ Tube: Placement

NGT

• Determine length (distance nose to ear lobe, then to xiphoid process)

• Confirm placement with AP CXR with upper abdomen

• ND can also be placed at bedside.

NJT

• Requires fluoroscopy to place tube tip distal to ligament of Treitz
NGT/NJT: Complications

*Especially with long-term use*

- GER/Aspiration +/- pneumonia
- Pharyngitis, Esophagitis, Otitis Media, Sinusitis
- Bleed, Perforations, Mucosal tears
- Nasal ulceration or pressure necrosis
- Dislodgement
- Obstruction
  - Flush with warm H2O +/- enzymes
  - If does not work, then *carbonated diet* soda
AMT Bridle™:
NG/NJ tube securement device
NG/NJ tube Bridle™

• Secures NG/NJ tubes via umbilical tape anchor to vomer bone (nasal septum)
• Reduces risks of inadequately secured tubes (i.e. displacement and feeds aspiration, pressure necrosis, skin breakdown from adhesives)
• Reduces costs of frequent replacements (i.e. nutrition interruption, tube replacement procedures and risks therein, x-rays for confirmation of placement)
• With increased pressure on tube, tube diameter will narrow and slip through the clamp to release before damaging the vomer bone
Gastrostomy Tubes
Anatomy of a Feeding Tube

External portion visible on or outside the skin
- Traditional tube projecting out of skin
- Skin level device (button)

External bolster
- Sliding ring
- Flaps on valve (button)

Internal portion within stomach (retention tip)
- Balloon
- Mushroom/cupped
- Pigtail
Ports

- Feeding port
- +/- Side port for fluids/meds
- +/- Balloon inflation port
Long GT or PEG Tube

- **Corflo® Max PEG Tube** (Balloon tip)
- Simplified tube, easy to use, less mechanical failures.
- Protrudes from abdomen, requires securement device in active patients.
- Can be pulled into distal GI tract.

Bard long gastrostomy tube (Obturated tip)
Button GT: Measurements

French size = diameter of tube (stoma)
1 French = 1/3 mm

Length in cm = thickness of abdominal wall
Button GT: obturated

• No balloon, but obturated or mushroom-shaped tip prevents dislodgement.
• Obturated tip is firm and usually painful upon removal – usually requires sedation for planned removal.
• Extension does not lock into place – detaches often with active patients.

Bard* Button Gastrostomy Tube
Button GT: balloon

- Balloon keeps button in place
- Silicone material of the balloon can break
- Low profile – close to surface of skin
- Extensions lock into place
Gastrojejunostomy (GJ) Tubes
GJ long tube

Mic-Key GJ tube

Mini GJ tube
GJ Tubes

• Placed in IR
• Usually does not need sedation if converting from GT to GJT
• Run continuous feeds in “Jejunal” or “J” port
• Vent stomach from or give medications in “Gastric” or “G” port
• Inflate balloon via separate side port ("BAL")
• J portion of tube has radiopaque maker to allow visualization during placement in IR
• J portion of tube can clog – small diameter, tube can kink
Jejunostomy (J) Tubes

- Usually placed by surgeon in OR
- Direct stoma through skin into loop of jejunum via enterotomy
- Usually a long tube is placed first, then can be changed to button tube once stoma has epithelialized
- Increased risk of bowel obstruction and stricture, peritonitis in immediate postoperative period
- Avoids gastric outlet obstruction with tube through pylorus (as in GJT)
Enteral Tube Placement

GT:
• Percutaneous endoscopic: GI for visualization with endoscopy, surgeon for tube placement
• Interventional radiology: fluoroscopic imaging
• Surgical: Open vs. Laparoscopic

GJT:
• Most common: exchange GT for GJT in IR after GT stoma epithelializes (4-6 weeks after initial GT placement)
• Primary GJT placement by surgery (less common)

Direct JT:
• Tube primarily placed in loop of jejunum, laparoscopic vs open
GT/GJT/JT Care

• Know type & size of tube, balloon volume
• Postoperatively:
  – 24 hours prophylactic IV cephalosporin
  – Begin early feedings, sometimes starting with Pedialyte vs straight to formula – usually continuous feeds first
  – May place G portion of GJ tube to intermittent suction for post-op gastroparesis
  – Provide Foley catheter (same F size as tube and one size smaller) to place in new stoma immediately after an accidental pull-out
• Maintenance:
  – Clean daily with soap and water, avoid hydrogen peroxide
  – Tube should be able to move up and down 1 cm and rotate 180°
  – Check balloon volume and change tube monthly (may depend on health plan and # tubes provided to patient per month)
G-Tube Dislodgement

• If within 6 weeks of initial placement:
  – Foley one size smaller, do not inflate balloon or feed
  – Fluoroscopy to replace ASAP

• If after 6 weeks:
  – Can replace at bedside
  – Foley of similar diameter, secure with tape on skin
  – Check for gastric secretions then can restart feeds

• If not noticed for several hours:
  – Place NG, intermittent suction, broad spectrum IV antibiotics
  – Can replace new GT in approx. 7-10 days
Replacing an established GT

- **Equipment:** Lubricant gel, new device, NS, 10 ml syringe

- **Prep new tube**
  - Check size and balloon integrity
  - Deflate and lubricate

- **Remove old tube**
  - Deflate balloon fully with syringe
  - Pull out firmly, usually has some resistance

- **Insert new tube into stoma**
  - Inflate balloon fully, tug to check if secure
  - Firmly pull up, push external bolster down with 2-5 mm slack

- **Confirm placement**
  - Aspirate tube for gastric contents
  - Consider GT contrast study
Discontinuing a GT

• Most fistulas spontaneously close in 48 -72 hours

• Persistent (gastric drainage > 2 months)
  – Prolonged placement (> 8-12 mo), large diameter (14 Fr)
  – Malnutrition, obesity, straining cough, debilitating dz

• Non-operative closure: 2-octylcyanoacrylate (2OC)
  – Tissue adhesive: stimulates tissue inflammation and fibrosis
  – Cost effective, non-invasive, no anesthesia, outpatient setting

• Surgical excision and closure of fistula
Clogged tube

• Prevention
  – Flush tube with water after feeds and medications
  – Use liquid form of meds
  – Consider flush volume in total daily

• Management
  – Push and pull 1-3 ml of warm H2O, carbonated soda, pancreatic enzyme, or papain
  – No stylet - breaks valves
  – Last resort is to replace tube
Cecostomy Tubes (C tubes)

Cecostomy Tube
Initial Tube

incision made to insert catheter
catheter connector
drainage bag

cecum

Chait Trapdoor
C-tube: Indications & Placement

- Chronic refractory constipation and fecal incontinence
- Placed by IR or laparoscopically by surgery
  - 2 days bowel prep
  - Perioperative IV antibiotics
  - Initial tube long, change to low-profile after 2 months
- Risks
  - Peritonitis
  - Abscess
  - Bleeding
  - Injury to other structures
C-tube: Management

- **Daily care**
  - Clean daily with soap and water
  - Keep tubing secure

- **Enema regimen (begin 1-2 weeks after initial placement)**
  - Have patient sit on toilet
  - Flush enema regimen as prescribed
  - Have activities for patient (DVD, books, etc), can take up to 1 hour to complete stooling
  - Clean site and equipment after completed

- **Tube change**
  - Every 6 to 12 months after initial long tube changed to low-profile
C-tube: Complications

- Infection
- Leakage
- Granulation tissue
- Dislodgement
  - Place foley catheter, do not inflate balloon
  - Replace in IR
References


Closing Discussion

Yes, we can...

...but *should* we?
Goals of Care

• Planning ahead
• Palliative Care
• Overall goals of care
• Advanced directives
• Medical power of attorney
• Decision-making capacity of caregivers
• Access to emergency and home care services
• Access to hospice services
• Care transitions for aging patients and caregivers
Educational Resources

- Radiopaedia.org
- http://pediatrics.ucsf.edu/blog
- http://dontforgetthebubbles.com
- http://lifeinthefastlane.com
Thank you!!!

From Wendy, Sam, Kiran, and Sarjita

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