CLINICAL PATHWAY:

Suspected Neurosurgical Shunt Malfunction

THIS PATHWAY SERVES AS A GUIDE AND DOES NOT REPLACE CLINICAL JUDGMENT.

Inclusion Criteria: A child that presents with a pre-existing shunt (VP/VA/Vpleural) AND has symptoms associated with malfunction (see below)

- Infants: Enlargement of head, full and tense fontanelle while positioned upright and calm, prominent scalp veins, swelling along the shunt tract, vomiting, irritability, sleepiness, downward deviation of the eyes
- Toddlers: enlargement of head, vomiting, headache, irritability, sleepiness, loss of previous abilities (sensory or motor function)
- <u>Children and adults</u>: vomiting, headache, vision problems, photophobia, irritability, sleepiness, personality change, difficulty in waking up or staying awake

Exclusion Criteria: Concern for neurosurgical shunt infection (see Suspected Neurosurgical Shunt Infection Clinical Pathway), identification of alternate source for symptoms, or symptoms not related to shunt malfunction as defined

ED Evaluation

Triage:

- Vitals: BP, HR, O2 sat, RR, temperature
- Weigh
- Head circumference (if age <2 years)
- Pain score
- Place on continuous cardiac and respiratory monitoring
- Notify Neurosurgery attending immediately if bradycardia, hypertension, depressed level of consciousness (LOC)

Initial evaluation:

Obtain a detailed history and initial exam (see Appendix A)

Initial Management

Labs:

- CBC, CRP, BMP
- Shunt tap by Neurosurgery (at the discretion of Neurosurgery attending)
 - o If tapped, send STAT cerebrospinal fluid culture and gram stain

Imaging:

- Head ultra sound if fontanelle is open or
- Reduced shunt protocol MRI brain without contrast is preferred imaging modality if can confirm patient
 has a non-programmable shunt (if not documented in chart, may confirm via skull x-ray; Appendix B:
 Radiographic Appearance of Shunt Valves)
 - If programmable shunt is present: prior to ordering MRI, please ensure a Neurosurgery provider is able to reprogram the shunt within 24 hours of imaging. Make MRI aware that patient has a programmable shunt.
 - o If MRI not available: CT head without contrast
- Abdominal ultrasound if abdominal symptoms are present
- Order VP Shunt series at the discretion of the neurosurgery attending

FEN/GI:

- NPC
- IVF D5 NS with 20 mEq KCI/L at maintenance rate

Medications

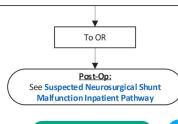
- Ondansetron 0.1 mg/kg/dose q8hr PRN nausea (max 4 mg/dose)
- Acetaminophen 15 mg/kg/dose q6hr PRN pain/headache (max 75 mg/kg/day or 4,000 mg/day)

Notify Neurosurgery attending via Intellides k

Pre-Op:

Admit to Neurosurgery service on the floor if stable, or to the PICU if unstable

- OR case request for shunt revision to be completed by Neurosurgery attending or APP
- Continuous CR monitoring (close monitoring for bradycardia)
- NPO and IVF at maintenance
- Neurosurgery to consent to OR



NEXT PAGE



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Inclusion Criteria: post-operative care for any patient diagnosed by Neurosurgery to have shunt malfunction requiring surgical correction Exclusion Criteria: none Post-operative Care: Transfer to Med/Surg floor if stable Transfer to PICU if unstable Fluids, Electrolytes, Antibiotics **Pain Control Nursing & Monitoring** Activity Nutrition Antibiotics to be given for only 24 If acute kidney injury1: Avoid NSAIDs hours post-operatively unless Monitoring: Fluids: or discuss with Nephrology for Head of bed at 30 otherwise indicated. Cardiopulmonary D5 NS with 20 mEq approval. degrees monitoring and pulse KCI/L at maintenance 24 hours post-op: OT, Cefazolin IV 100 mg/kg/day div q8hr oximetry x 24 hours or rate; wean as PO Toradol IV 0.5 mg/kg/dose PT consults (max 2000 mg/dose) for the duration of improves q6hr x 6 doses (max 30 mg/ POD 3: may shower narcotic therapy dose) Temperature, HR, RR, Diet: 6 hours after toradol Nafcillin IV 200 mg/kg/day div q6hr and BP q4hr x 24hrs. Clear liquid diet. dose, start ibuprofen PO (max 12 g/day); adult dose 2g q6hr then a8hr advance as tolerated 10 mg/kg/dose q6hr PRN when recovered from (max 40 mg/kg/day or Incision Care: anesthesia per PACU 2,400 mg/day, whichever If 6-Lactam alleray: Telfa and tegaderm to is less) Vancomycin IV: abdominal incision Bowel regimen: Acetaminophen IV 15 mg/kg/ <52 weeks PMA[‡]/about <3 mo Bacitracin to scalp Polyethylene glycol dose q6hr around the clock for old: 15 mg/kg q8hr or as incision x 48hrs 17 g daily or BID PRN 24 hours (max 1000 mg/dose) determined by pharmacy constipation After 24 hours of IV based on estimated AUC Other: Docusate 50-100 mg aceta minophen, switch ≥52 weeks PMA[‡]/about ≥3 Incentive spirometer or PRN constipation to acetaminophen PO: months old - 11 years old: 70 bubbles 4-10x/hr while 15 mg/kg/dose q6hr PRN mg/kg/day div q6hr Anti-emetics: pain (max 75 mg/kg/day ≥12 yrs old: 60 mg/kg/day div Sequential Ondansetron IV 0.1 or 4,000 mg/day) for compression device mg/kg/dose q8hr (max mild/moderate pain; may

(SCD)/stockings while

Discharge Criteria

use PR acetaminophen

for infants.

- Baseline neurological examination
- Pain well-controlled on oral medication
- Afebrile x 24 hours

[‡]PMA (Post-Menstrual Age) =

gestationalage + postnatalage

- Bowel movement
- Taking adequate fluid and nutrition orally
- Clea re d by PT & OT

Discharge Medications:

- Ibuprofen PO 10 mg/kg/dose q6hr PRN (max 40 mg/kg/day or 2,400 mg/day, whichever is less) for mild/moderate pain
- Acetaminophen PO: 15 mg/kg/dose q6hr PRN pain (max 75 mg/kg/day or 4,000 mg/day) for mild/moderate pain
- Polyethylene glycol PO and/or Docusate to prevent constipation

Discharge Instructions:

Call Neurosurgery for fever >101.5, vomiting >3x in 12 hr period, excessive irritability or sleepiness, severe headache

Follow up outpatient 2-3 weeks after discharge

Consider Acute Kidney Injury (AKI) based on the following criteria:

4 mg/dose) PRN

nausea/vomiting

- Increase in serum creatinine by 1.5-1.9 times baseline within the prior seven days, or
- Increase in serum creatinine by ≥0.3 mg/dL from baseline (≥26.5 mcmol/L) within 48 hours, or
- For those with unknown creatinine, an eGFR <90 ml/ min/1.73m²



RETURN TO THE BEGINNING





Important factors to include:

- Shunt history, including:
 - Location of shunt (ventricular-atrial shunt, ventricular-pleural shunt, ventricular-peritoneal shunt)
 - Date of shunt placement
 - Date of last shunt revision
 - o Signs/symptoms present at presentation/last revision
- · Headache history, including:
 - Quality
 - Duration
 - Location
 - Past treatment
- Vomiting history, including:
 - Timing
 - Any precipitating events
- Neurological symptoms, including:
 - Change in LOC
 - Increased irritability
 - Weakness
 - Seizures
 - Upward or downward gaze
 - Increased lethargy
- Abdominal symptoms, including:
 - Significant increase in abdominal girth
 - o Pain
 - Tenderness
 - Mass
- Trauma history
- Physical exam findings:
 - o Fontanels
 - Head circumference
 - o Decreased breath sounds for pleural shunt









CLINICAL PATHWAY:

Suspected Neurosurgical Shunt Malfunction Appendix B: Radiographic Appearance of Shunt Valves

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When evaluating the radiographic markings of any implanted device, it is important to recognize that the veracity of your interpretation depends on the quality of the radiographic images. For the best results, x-rays should be taken orthogonally to the plane of the shunt valve. The positioning of the valve relative to the skull base may also obscure the valve markings, as overlapping radiodensities along the skull base can blur valve markings. In more difficult cases, fluoroscopy or 3D CT reconstruction may be used to properly identify the radio-opaque markings on a shunt valve.

It is important to realize that an exhaustive list of all shunt valve radiographic markings is beyond the scope of this appendix. For additional information regarding common shunt valve markings found in North American neurosurgical patients, you may also reference the ISPN's website on the same topic.

Please see the next several pages for examples of radiographic images of non-programmable and programmable shunts. The sources of these images are:

- http://www.kinderneurochirurgie-leipzig.de/therapeuticfocus/hydrocephalus/radiologic-identification-of-vp-shunt-valves-and-adjustment/
- https://www.ispn.guide/
- https://www.medtronic.com/us-en/index.html
- https://radiopaedia.org/

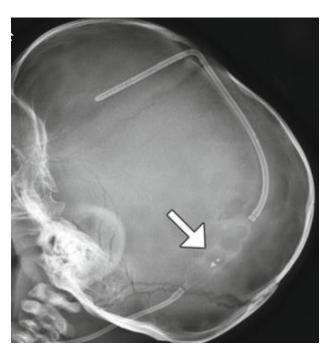








Non-Programmable Valve Examples:



Medtronic Delta Fixed Pressure Valve



Medtronic PS Medical Pressure Differential Valve (non-programmable)







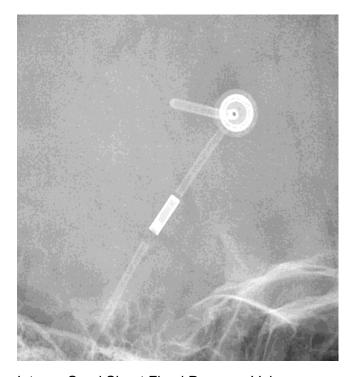


Suspected Neurosurgical Shunt Malfunction Appendix B: Radiographic Appearance of Shunt Valves

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Spitz-Holter Non-Programmable Valve



Integra Omni Shunt Fixed Pressure Valve

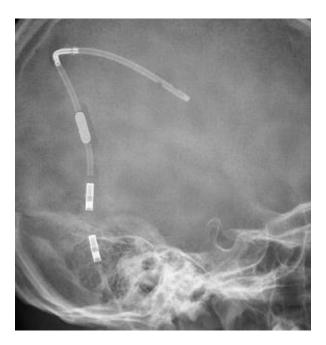






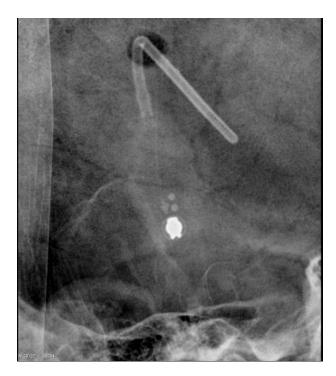






Integra DP Fixed Pressure Valve

Programmable Valve Examples:



Strata Programmable Valve







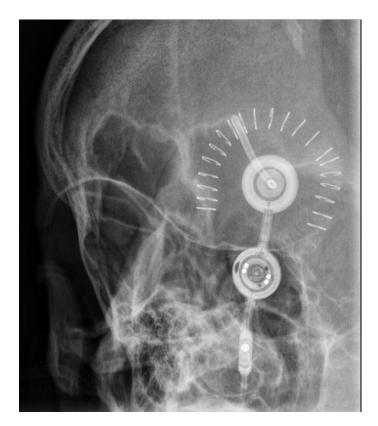


Suspected Neurosurgical Shunt Malfunction Appendix B: Radiographic Appearance of Shunt Valves

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Codman Hakim Programmable Shunt Valve



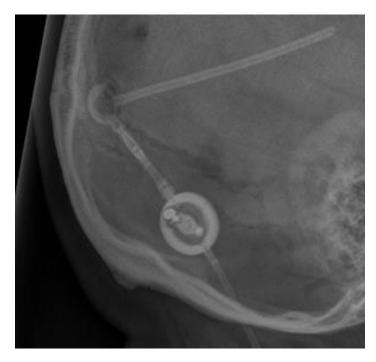
Unidentified Programmable Valve (likely Sophysa model)











ProGrav Adjustable Valve



Sophysa Programmable Valve





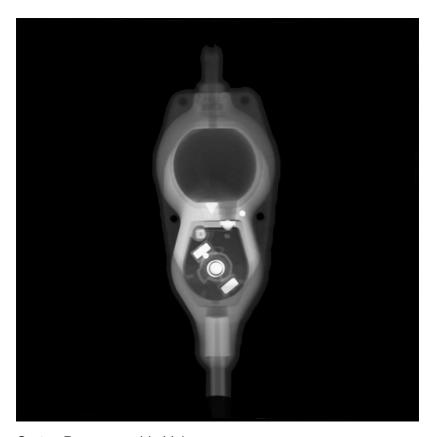




CLINICAL PATHWAY:

Suspected Neurosurgical Shunt Malfunction Appendix B: Radiographic Appearance of Shunt Valves

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Certas Programmable Valve





