Suspected Neurosurgical Shunt Infection

THIS PATHWAY AND DOES NOT

¹Risk Factors for

Shunt Infection

Shunt surgery

within

previous 6

Clinical signs

of infection

involving

including skin erosion

cellulitis.

incisional

drainage or

abdominal

pseudocyst

Clinical signs

of meningitis

No other

obvious

source of

Previous

fever

shunt hardware

months

Inclusion Criteria: Clinical suspicion of shunt infection by Emergency Department physician based on clinical judgment and/or presence of ≥1 risk factors for shunt infection

Exclusion Criteria: alternative source for fever identified

Notify Neurosurgery (NSG) attending at first suspicion of shunt infection TRIAGE:

- Vital signs o1hr then o2hr when more stable; temperature, BP, HR, RR, O2 sat, neuro check
- Weight, head circumference (for <12 month old)
- Place on continuous CR monitoring

Notify Neurosurgery attending immediately if bradycardia, hypertension or depressed LOC is noted Obtain detailed history/initial exam: See Appendix A

INITIAL MANAGEMENT:

- CBC w diff, CRP, iStat chem 7, procalcitonin, blood culture, UA, urine culture
- Shunt tap by NSG: send STAT CSF for cell count, glucose, protein, gram stain, aerobic culture and anaerobic culture

Imaging:

- $Reduced \ shunt \ protocol \ MRI \ brain \ without \ contrast \ is \ preferred \ if \ imaging \ modality \ if \ confirmation \ patient \ has \ non-programmable$ 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.
 - If MRI not available: CT head without contrast
- If suspected abdominal pseudocyst or abdominal symptoms: limited ultrasound of abdomen
- If large or complex pseudocyst: CT of the abdomen with contrast

Antibiotics and Fluids:

- Start both empiric antibiotics after obtaining blood culture, UA/urine culture, and CSF culture, if possible (unless ill-appearing/septic):
 - Ceftazidime IV: 150 mg/kg/day divided q8hr (max 2 g/dose) AND
 - Vancomycin IV: <52 weeks PMA[‡]/about <3 mo old: 15 mg/kg q8hr or as determined by pharmacy based on estimated AUC; ≥52 weeks PMA[‡]/about ≥3 months old – 11 years old (max 3 g/day); 70 mg/kg/day div q6hr; ≥12 yrs old: 60 mg/kg/day div q8hr (max 3
- NPO and start IVF at maintenance (with 0.45 or 0.9% NaCl depending on serum Na levels)

[‡]PMA (Post-Menstrual Age) = gestational age + postnatal age

Definition of Acute Kidney Injury

<1 year of age)

At least a 50% increase in Scr above baseline* **and** new Scr ≥0.5 mg/dL OR An increase by 0.3 mg/dL from baseline*, and new Scr ≥0.5 mg/dl

*If a baseline creatinine is unknown, estimate baseline Cr using the rtz Calculation (baseline creatinine = (0.413 * height cm)/ 120 GFR). For patients with Chronic Kidney Disease (CKD), use the CKID U25 Calculato

Pre-Op: Admit to PICU on Neurosurgery service

- OR case request for externalization (Neurosurgery to obtain consent for
- Continuous CR monitoring (close monitoring for bradycardia)
- Continue NPO and IVF

Post-Op: admit back to PICU EVD/externalized shunt parameters per surgeon; follow post-op care

Antibiotics

- Consult Infectious Disease (ID)
- Continue empirio antibiotics (Vancomycin and Ceftazidime) x24 hours pending CSF culture or per ID recs
- Adjust antibiotics based on culture and ID recs If >5 day antibiotics

expected, consider long term IV access.

Labs:

CSF studies: cell count and culture to lab per Neurosurgery and/or ID

√abs/Monitoring

- If CSF culture positive, repeat in 24-36 hours to document sterilization.
- If persistently febrile or clinical deterioration: repeat CSF culture is warranted. Consider blood, urine and respiratory evaluation.

Monitoring:

- Continuous CR monitoring
- Vitals q1hr if unstable; q2hr in PICU if stable; q4hr on MS

If acute kidney injury²: Avoid NSAIDs or discuss with Nephrology for approval.

Toradol IV 0.5 mg/kg/dose q6hr (max 30 mg/dose)

Pain/Fever

- 6 hours after last toradol dose, start ibuprofen PO 10 mg/kg/dose q6hr PRN (max 40 mg/kg/day or 2,400 mg/day, whichever is
- Acetaminophen IV 15 mg/kg/dose q6hr ATC for 24 hours (max 1,000 mg/dose)
 - After 24 hours of IV acetaminophen, switch to PO acetaminophen: 15 mg/kg/dose q6hr PRN pain; (max 75 mg/kg/day or 4,000 mg/ day) for mild/moderate pain; may use PR acetaminophen for infants.
- Morphine IV 0.05 0.1 mg/kg/dose IV q3hr PRN severe pain (max 5 mg/dose)

IVF:

Maintenance IVF

FEN/GI

NS 1:1 replacement with CSF output Medications:

- Ondansetron 0.1 mg/kg/dose q8hr (max 4 mg/dose) PRN nausea/ vomiting
- Polyethylene glycol 17 g daily or BID PRN constipation
- Docusate sodium 50 mg/day PRN constipation

Other OT/PT: activity to

- include OOB with EVD clamped for therapies if stable and tolerating clamping
- SCD/ compression boots for DVT ppx per hospital policy
- Incentive spirometer or hubbles for atelectasis/PNA prevention

Internalization Criteria:

If CSF culture is positive, discuss timing of shunt replacement and duration of antibiotics with NSG and ID based on clinical status, type of organism, and response to therapy. Target site for distal drainage dependent on clearance of end-organ space infections. If still present, will consider alternate site if possible.

Post-Op care:

Transfer to MS floors and resume all pre-internalization care and start: Bacitracin to scalp incision, Tegaderm/Telfa to abdominal/chest/clavicular/neck incision; may shower POD 3; no further CSF replacement or daily cultures needed unless persistently febrile >36 hours, clinically deteriorating

Discharge Criteria: stable neuro exam; pain well controlled on PO meds; afebrile x24 hrs; bowel movement; adequate PO

Discharge Instructions/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
- Follow Up: 2-3 weeks post discharge
- Call NSG if: fever >101.5°F, vomiting >3 times in a 12 hours period, excessive irritability or sleepiness, severe headache

NEXT PAGE





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Suspected Neurosurgical Shunt Infection Appendix A: Obtaining a Detailed History and Physical

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

Important factors to consider include:

Shunt Type:

- o ventricular-atrial shunt
- o ventricular-plural shunt
- o ventricular-peritoneal shunt

• Headache History:

- location
- quality
- duration
- treatment

Vomiting History:

- o timing
- o any precipitating events

• Neurological symptoms:

- o change in LOC
- ↑ irritability
- o weakness
- o seizures
- o up/downward gaze
- ↑ lethargy

Abdominal symptoms:

- significant ↑ abdominal girth
- o pain
- tenderness
- o mass

General:

- o trauma
- o fontanels
- o head circumference
- ↓ breath sounds for pleural shunts









CLINICAL PATHWAY: Suspected Neurosurgical Shunt Infection Appendix B: Radiographic Appearance of Shunt Valves

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

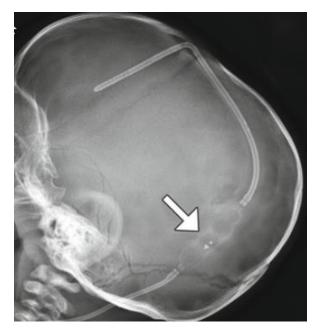
When evaluating the radiographic markings of any implanted device, it is important to recognize that the veracity of your interpretation depends on the quality of the radiographic images. For the best results, x-rays should be taken orthogonally to the plane of the shunt valve. The positioning of the 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)



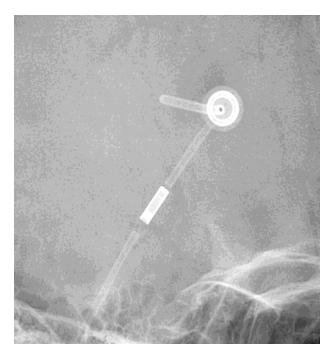
Spitz-Holter Non-Programmable Valve



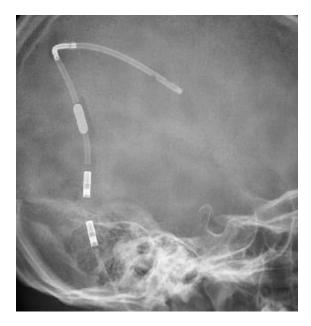








Integra Omni Shunt Fixed Pressure Valve



Integra DP Fixed Pressure Valve

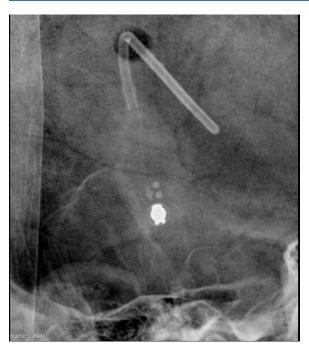








Programmable Valve Examples:



Strata Programmable Valve



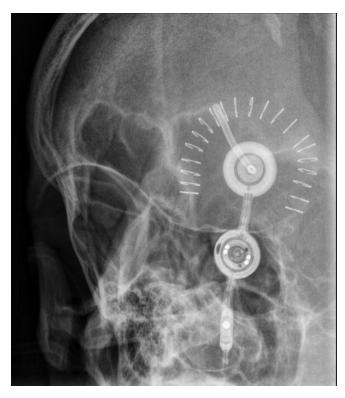
Codman Hakim Programmable Shunt Valve











Unidentified Programmable Valve (likely Sophysa model)



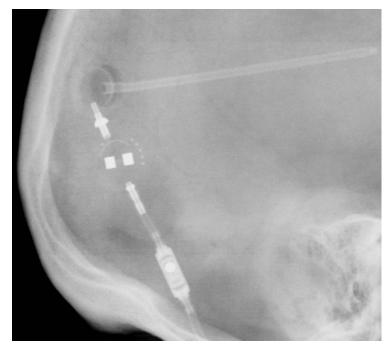
ProGrav Adjustable Valve



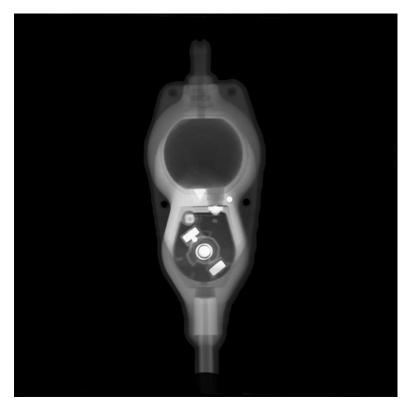








Sophysa Programmable Valve



Certas Programmable Valve





