

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)
- Children and adults:** 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
- Weight
- 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)
 - If tapped, send STAT cerebrospinal fluid culture and gram stain

Imaging:

- Head ultrasound 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.
 - 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:

- NPO
- IVF D5 NS with 20 mEq KCl/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 Intellidesk

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

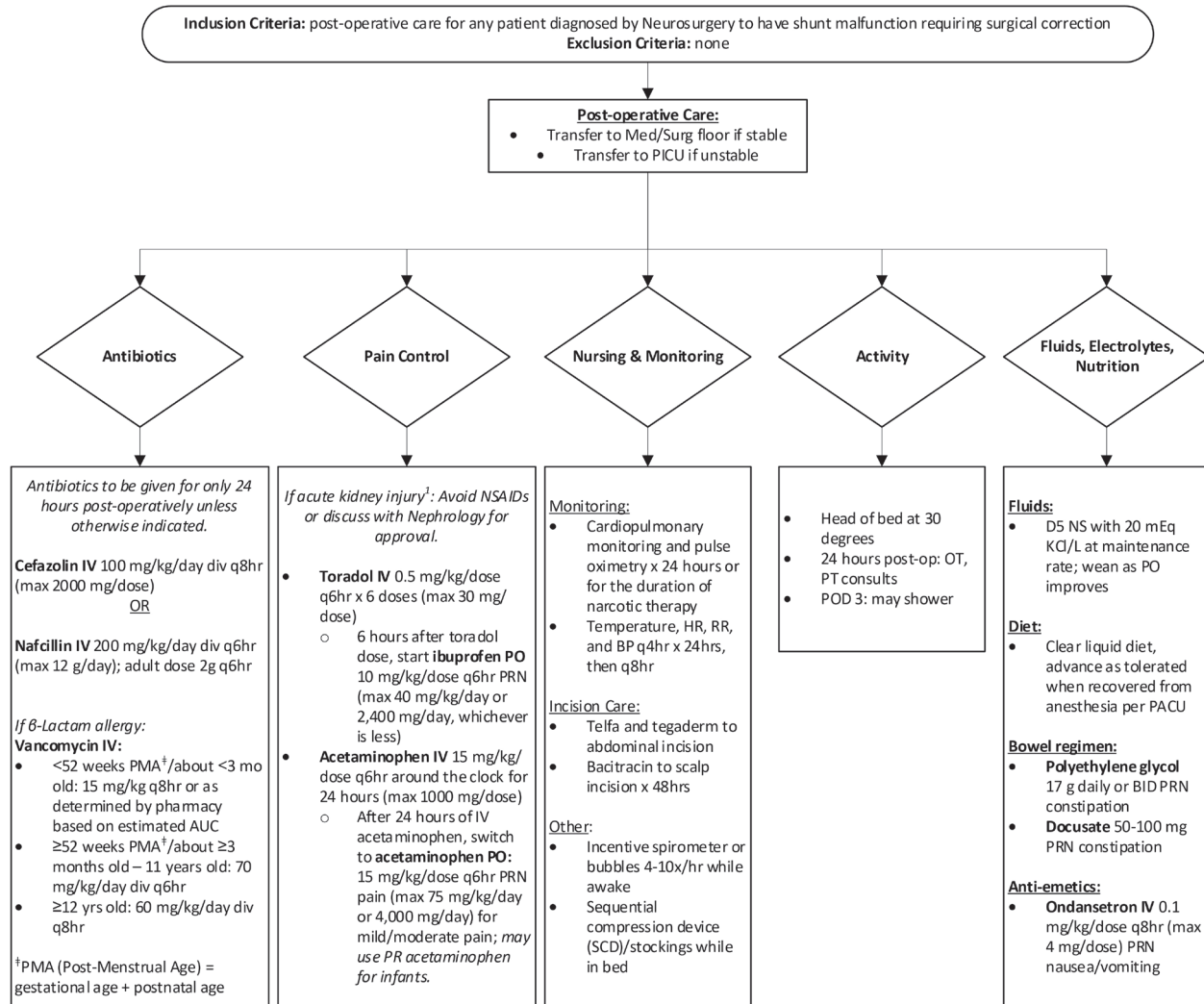
To OR

Post-Op:

See [Suspected Neurosurgical Shunt Malfunction Inpatient Pathway](#)

NEXT PAGE





Discharge Criteria:

- Baseline neurological examination
- Pain well-controlled on oral medication
- Afebrile x 24 hours
- Bowel movement
- Taking adequate fluid and nutrition orally
- Cleared 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

¹**Consider Acute Kidney Injury (AKI) based on the following criteria:**

- 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 μmol/L) within 48 hours, or
- For those with unknown creatinine, an eGFR <90 ml/min/1.73m²



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
 - 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
 - Pain
 - Tenderness
 - Mass
- Trauma history
- Physical exam findings:
 - Fontanels
 - Head circumference
 - Decreased breath sounds for pleural shunt



RETURN TO
THE BEGINNING



CLINICAL PATHWAY:
Suspected Neurosurgical Shunt Malfunction
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/>



RETURN TO
THE BEGINNING

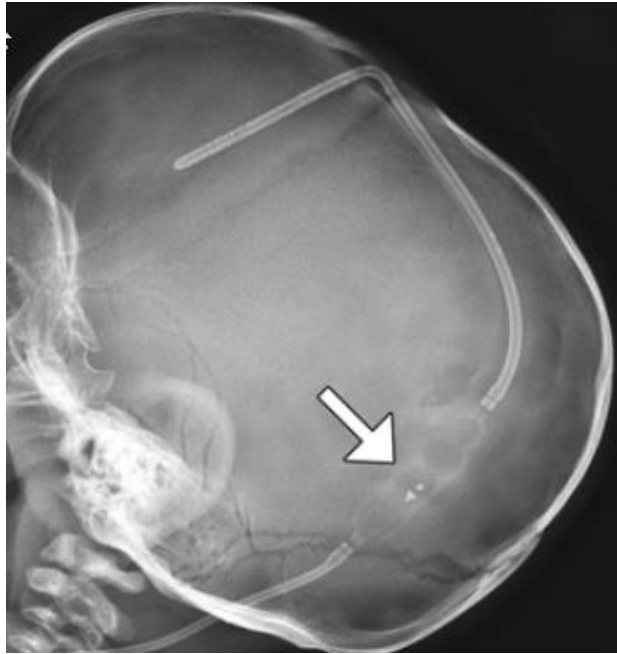


CONTACTS: MARKUS BOOKLAND, MD | JONATHAN MARTIN, MD | PETRONELLA STOLTZ, APRN, DNP

LAST UPDATED: 01.10.24

©2019 Connecticut Children's Medical Center. All rights reserved.

Non-Programmable Valve Examples:



Medtronic Delta Fixed Pressure Valve



Medtronic PS Medical Pressure Differential Valve (non-programmable)

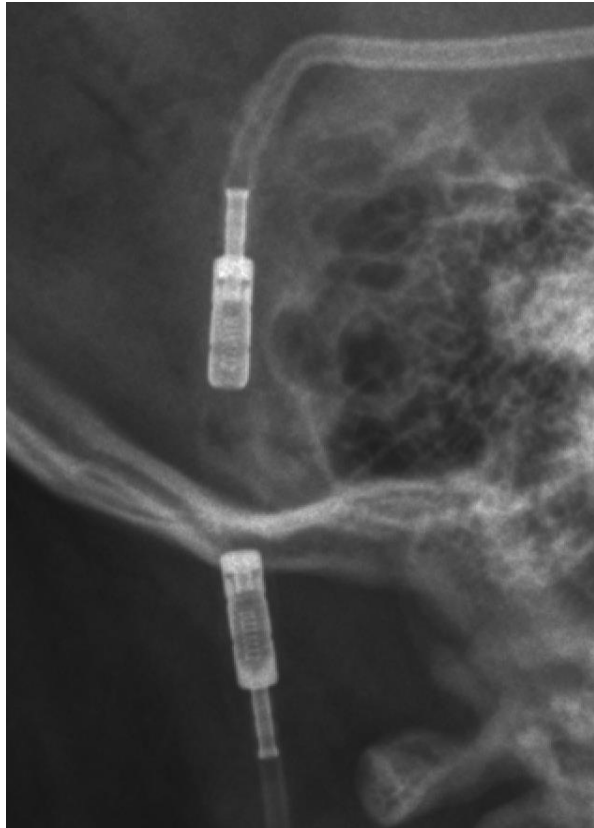


RETURN TO
THE BEGINNING

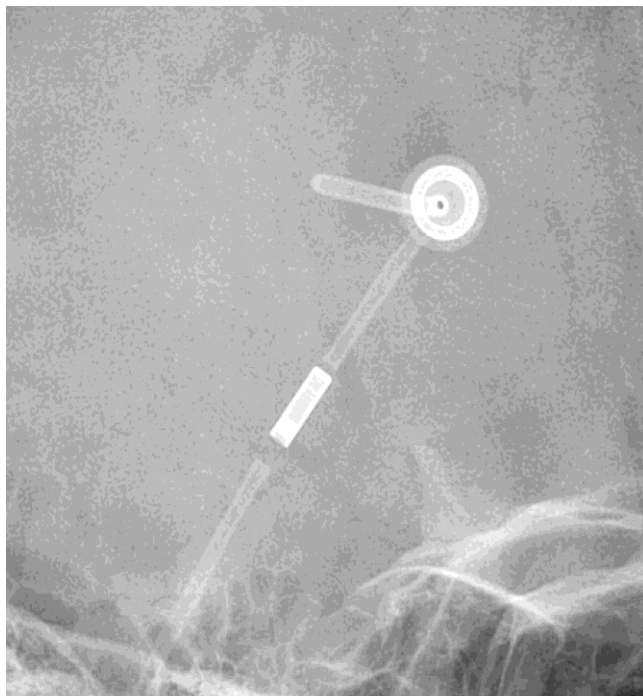


CLINICAL PATHWAY:
Suspected Neurosurgical Shunt Malfunction
Appendix B: Radiographic Appearance of Shunt Valves

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



Spitz-Holter Non-Programmable Valve



Integra Omni Shunt Fixed Pressure Valve



RETURN TO
THE BEGINNING



CONTACTS: MARKUS BOOKLAND, MD | JONATHAN MARTIN, MD | PETRONELLA STOLTZ, APRN, DNP

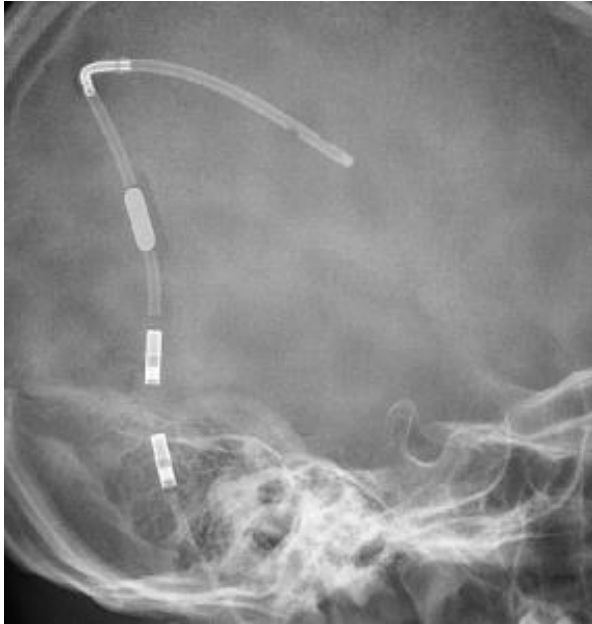
LAST UPDATED: 01.10.24

©2019 Connecticut Children's Medical Center. All rights reserved.



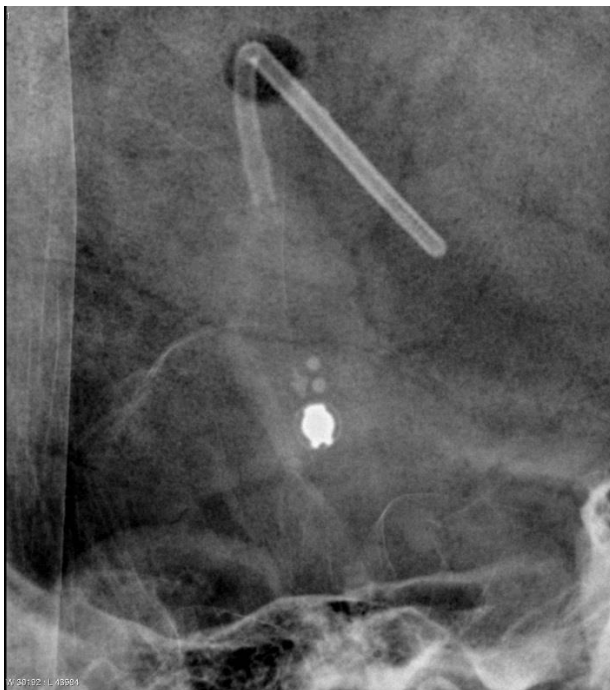
CLINICAL PATHWAY:
Suspected Neurosurgical Shunt Malfunction
Appendix B: Radiographic Appearance of Shunt Valves

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



Integra DP Fixed Pressure Valve

Programmable Valve Examples:



Strata Programmable Valve



RETURN TO
THE BEGINNING



CONTACTS: MARKUS BOOKLAND, MD | JONATHAN MARTIN, MD | PETRONELLA STOLTZ, APRN, DNP

LAST UPDATED: 01.10.24

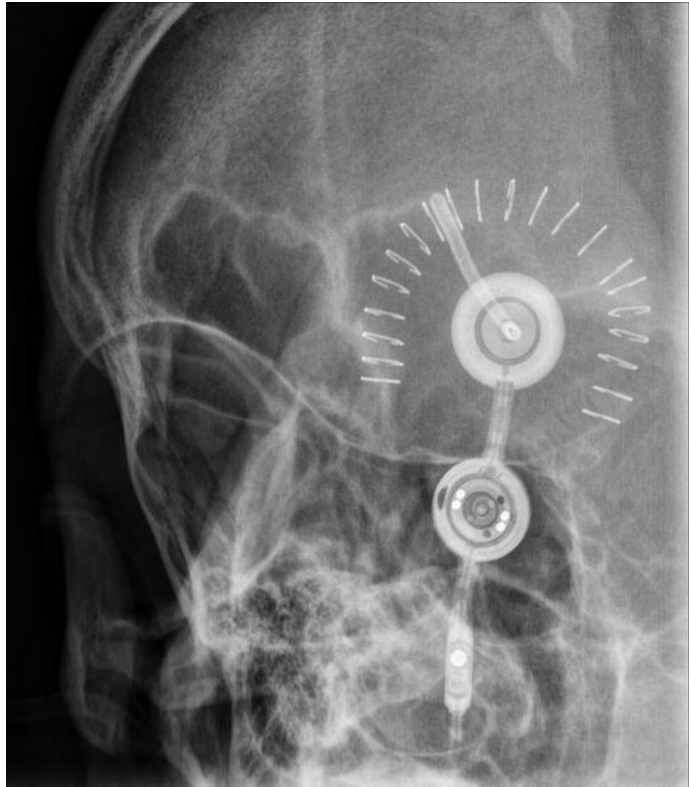
©2019 Connecticut Children's Medical Center. All rights reserved.

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

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



Codman Hakim Programmable Shunt Valve



Unidentified Programmable Valve (likely Sophysa model)



RETURN TO
THE BEGINNING



CONTACTS: MARKUS BOOKLAND, MD | JONATHAN MARTIN, MD | PETRONELLA STOLTZ, APRN, DNP

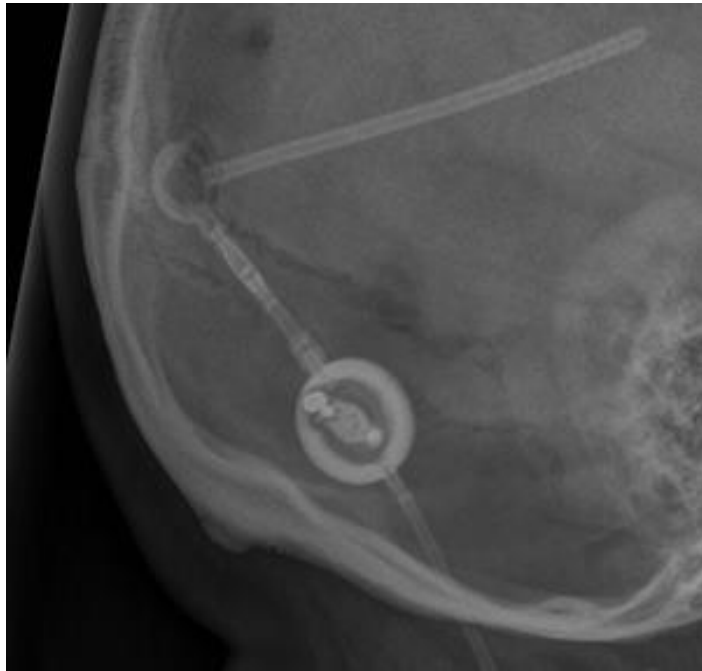
LAST UPDATED: 01.10.24

©2019 Connecticut Children's Medical Center. All rights reserved.



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

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



ProGrav Adjustable Valve



Sophysa Programmable Valve



RETURN TO
THE BEGINNING



CONTACTS: MARKUS BOOKLAND, MD | JONATHAN MARTIN, MD | PETRONELLA STOLTZ, APRN, DNP

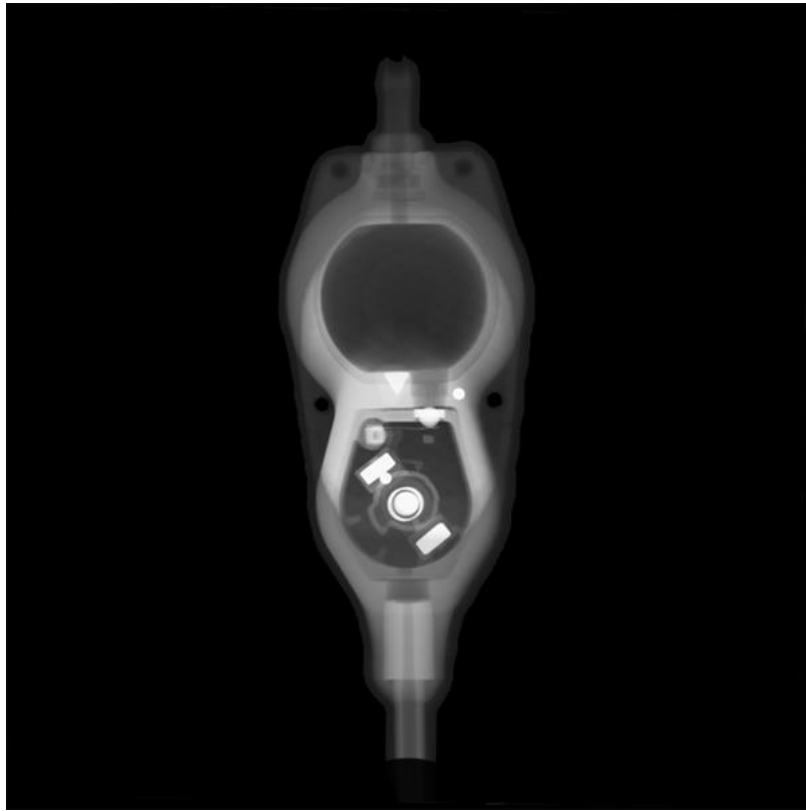
LAST UPDATED: 01.10.24

©2019 Connecticut Children's Medical Center. All rights reserved.



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

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



Certas Programmable Valve



RETURN TO
THE BEGINNING

CONTACTS: MARKUS BOOKLAND, MD | JONATHAN MARTIN, MD | PETRONELLA STOLTZ, APRN, DNP

LAST UPDATED: 01.10.24