Clinical Pathways

Suspected Neurosurgical Shunt Malfunction

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What is a Clinical Pathway?

An evidence-based guideline that decreases unnecessary variation and helps promote safe, effective and consistent patient care.
Objectives of Pathway

• Improve recognition of shunt malfunction on presentation to ED
• Initiate appropriate care for patient with suspected shunt malfunction
• Prevent delay in treatment and management
• Improve patient and family satisfaction
• Improve standard of care!
Why do we need this pathway?

• To change practice for these select group of patients with early recognition of potential shunt malfunction and early appropriate imaging and care
• To guide care for these children
• To ensure standard of care is successfully implemented for the safety of the patient
• Ventriculoperitoneal (VP) shunt insertion remains the mainstay of treatment for hydrocephalus despite a high rate of complications
• In the United States alone, more than 30,000 procedures to relieve hydrocephalus are performed every year
• The 1-year failure rate for VP shunts had been reported at around 40-50% for pediatric patients
• VP shunt malfunction remains the most frequent reason for shunt revisions and one of the most frequent complication
• Early recognition and treatment improves patient outcomes and decreases hospital stays
The Shunt Malfunction pathway has 2 areas of care: Emergency Department and Inpatient.

We will be reviewing each component in the following slides.
We will start with reviewing the Emergency Department pathway.

The goal of the Emergency Department Pathway is to rapidly identify and diagnose patients with shunt malfunction so they can be prepared for surgery as soon as possible.

We will start with reviewing the Emergency Department pathway.
Children may present with different symptoms based on their age.
- All children under 2 years of age should have a head circumference documented

Providers should complete a thorough history and physical exam
- See Appendix A

If there is concern for shunt infection, please follow the Shunt Infection Clinical Pathway.

Inclusion Criteria: A child that presents with a pre-existing shunt (VP/V/A/V/pleural) 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

**Triggers:**
- 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)
Inclusion Criteria: A child that presents with a pre-existing shunt (VP/V/A/Vp/pleural) 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
- **Toddler:** 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:**
- Vital signs: 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)

Appendix A provides guidelines for pertinent history and physical exam factors which will be important for correct diagnosis.
Initial management includes obtaining imaging, sending screening lab work, and making the patients NPO in prep for surgery.

The neurosurgery attending should be notified after imaging is completed and with ANY signs of increased ICP.
Before MRI, confirm that the patient has a non-programmable shunt.

If there is a programmable shunt present, check with the Neurosurgery team and ensure they are able to reprogram the shunt within 24 hours of imaging.
CLINICAL PATHWAY: Suspected Neurosurgeonal Shunt Malfunction

Appendix B: Radiographic Appearance of Shunt Valves

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:

- [https://www.spaq-guide.de](https://www.spaq-guide.de)
- [https://radiopaedia.org](https://radiopaedia.org)

Appendix B outlines radiographic considerations when evaluating a shunt, with imaging examples provided.
Once a patient is identified as having a shunt malfunction, they will be admitted (to the Med/Surg unit or PICU depending on their clinical stability) or taken to the OR.

Post-operatively, the inpatient portion of the pathway will be launched.
The goal of the Inpatient pathway is to guide postoperative care of patients who underwent surgical correction of a shunt malfunction.
Antibiotics are only given for the first 24 hours post-operatively, unless otherwise indicated.

**Antibiotics**

*Antibiotics to be given for only 24 hours post-operatively unless otherwise indicated.*

**Cefazolin IV**
- **100 mg/kg/day div q8hr** (max 2000 mg/dose)
- **OR**
- **Nafcillin IV**
  - **200 mg/kg/day div q6hr** (max 12 g/day), adult dose **2g q6hr**

If β-Lactam allergy:

**Vancomycin IV**:
- **<52 weeks PMA**/about <3 months old: **15 mg/kg q8hr** or as determined by pharmacy based on estimated AUC
- **≥52 weeks PMA**/≥ about 3 months old to 11 years old: **70 mg/kg/day div q6hr**
- **≥12 yrs old**: **60 mg/kg/day div q8hr**

1 PMA (Post-Menstrual Age) = gestational age + postnatal age
Pain can typically be managed by toradol/ibuprofen and acetaminophen. However, those with renal disease or impairment should avoid the use of NSAIDs.

Note: the definition of AKI has been updated and is available as a key.
Patients will need typical post anesthesia nursing care but with close observation of the surgical sites for leakage.
PT and OT are initiated on post operative day 1 to encourage early movement.
There is NO routine blood work required post operatively.

Diet is advanced as tolerated.

Bowel regimen is essential and should be started as soon as possible post procedure.
Certain criteria must be met prior to discharge, including adequate pain control and bowel movements.

Medications focus on pain management and maintaining adequate bowel movements.

Education regarding when to call neurosurgery post discharge is very important to ensure no complications exist post operatively. Early recognition is important.
Review of Key Points

• Appropriate imaging to rule out shunt malfunction is imperative to determine need for surgical intervention
• Timely pre operative care helps facilitate timely transfer to OR
• Standardized post-operative care assists in management, discharge planning and follow up
Quality Metrics

• Percent of patients with pathway order set usage
• Percent of patients with deep wound infections
• Percent of patients with superficial wound infections
• Number of patients with organ space infection within 30 days of principal operative procedure
• Number of patients with shunt malfunction within 90 days of principal operative procedure
• Percentage of patients with cerebrospinal fluid leak
• Number of readmissions within 30 days
• Number of patients with return to the OR within 30 days


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About Connecticut Children’s Pathways Program

Clinical pathways guide the management of patients to optimize consistent use of evidence-based practice. Clinical pathways have been shown to improve guideline adherence and quality outcomes, while decreasing length of stay and cost. Here at Connecticut Children’s, our Clinical Pathways Program aims to deliver evidence-based, high value care to the greatest number of children in a diversity of patient settings. These pathways serve as a guide for providers and do not replace clinical judgment.