Clinical Pathways

Suspected Shunt Infection

Jonathan Martin, MD Petronella Stoltz, DNP, APRN







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

Objectives of Pathway



- Early recognition and appropriate care for suspected shunt infection patients
- Decrease unnecessary antibiotic usage
- Ensure appropriate lab tests are ordered for suspected shunt infection
- Ensure appropriate antibiotic initiation in the emergency department
- Ensure timely surgical interventions
- Ensure appropriate adjustment of antibiotics post operatively in consultation with Infectious Disease physicians

Why is Pathway Necessary?



- The goal of this pathway is to standardize care, improve outcomes and reduce cost.
- Recognizes and initiates early intervention and care for patients improving outcomes





Effectiveness of a clinical pathway for patients with cerebrospinal fluid shunt malfunction:

- Patients with CSF shunts often present to the emergency department (ED) with suspected shunt malfunction. Timely assessment and treatment are important factors affecting patient outcomes. A protocol was implemented at a tertiary children's hospital ED to expedite the care of these patients. This study evaluated the effectiveness of this protocol. Effectiveness of a clinical pathway for patients with cerebrospinal fluid shunt malfunction:.
- Clinically, more patients underwent surgery in the expedited pathway than the default pathway (36% vs 17%), and patients in the expedited pathway had a shorter hospital stay (3.4 ± 0.9 days vs 5.7 ± 4.0 days; p = 0.02). An ED-based protocol helped identify patients at risk for shunt failure early in the triage process and shortened the assessment process prior to neurosurgical intervention. Improving the timeliness of care for patients with shunt failure is important because morbidity and mortality associated with shunt failure are time dependent. Effectiveness of a clinical pathway for patients with cerebrospinal fluid shunt malfunction:

¹ Journal of Neurosurgery Pediatrics

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This is the Suspected Shunt Infection Clinical Pathway.

We will be reviewing each component in the following slides.



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CLINICAL PATHWAY: **Suspected Neurosurgical Shunt Infection** Inclusion Criteria: Clinical suspicion of shunt infection by Emergency Department physician based on clinical judgment ency Department physician based on clinical judgment and/or presence of ≥ 1 risk factors for shunt infection¹ ors for shunt infection rce for fever identified Exclusion Criteria: alternative source for fever identified ¹Risk Factors for Shunt Infection Vital signs q1hr then q2hr when more stable: temperature, BP, HR, RR, O2 sat, neuro check Weight, head circumference (for <12 month old) Notify Neurosurgery attending at first suspicion of shunt infection Shunt lia, hypertension or depresse am: See Appendix A. surgery TRIAGE: within Vital signs q1hr then q2hr when more stable: temperature, BP, HR, RR, O2 sat, neuro check urine culture n, gram stain, aerobic cultu previous 6 Weight, head circumference (for <12 month old) d if imaging modality if con via skull x-ray; Appendix months Place on continuous CR monitoring Clinical signs at patient has a program *Notify Neurosurgery attending immediately if bradycardia, hypertension or depressed LOC is noted * ofinfection Obtain detailed history/initial exam: See Appendix A. involving e, UA/urine culture, and eks PMA[‡]/about <3 mo old: 15 mg/kg q8hr or as determ shunt AUC; ≥52 weeks PMA[‡]/about ≥3 months old - 11 years old: 70 mg/kg/day div q6 NPO and start IVF at maintenance (with 0.45 or 0.9% NaCl depending on serum Na level hardware PMA (Post-Menstrual Age) = gestational age + postnatal ag Pre-Op: Admit to PICU on Neurosurgery service including OR case request for externalization (Neurosurgery to obtain o Continuous CR monitoring (close monitoring for bradycardia) skin erosion, Continue NPO and IVE Post-Op: admit back to PICU EVD/externalized shunt parameters per surgeon; follow post-op cellulitis, **Initial Triage:** incisional Antibiotic abs/Monito Pain/Fever drainage or ^facute kidnev iniurv²: Avoid NSAIDs or discu abdominal Consult CSE studies: cell count and ephroloav for approval Infectious culture to lab per Toradol N 0.5 mg/kg/dose g6hr (may 3 Vital signs and neuro score hourly Neurosurgery and/or ID Disease (ID) x6 doses pseudocyst 6 hours after last toradol dose, start Continue empiri If CSF culture positive, repeat ibuprofen PO 10 mg/kg/dose g6hr Pl antibiotics in 24-36 hours to document Clinical signs Head circumference if less than 1 year (Vancomycin sterilization 40 mg/kg/day or 2,400 mg/day, whi and Ceftazidime) If persistently febrile or clinica x24 hours or pe of meningitis deterioration: repeat CSF Acetaminophen IV 15 mg/kg/dose g6hr A hours (max 1,000 mg/dose) ID recs culture is warranted. Consider After 24 hours of IV acetaminophen, Adjust blood, urine and respiratory Continuous cardio-respiratory monitoring No other antibiotics based to PO acetaminophen: 15 mg/kg/dos evaluation \bullet on culture and ID nitoring: PRN pain; (max 75 mg/kg/day or 4,000 Continuous CR monitoring day) for mild/moderate pain; may use recs obvious >5 day antibiotics Vitals q1hr if unstable; q2hr ir acetaminophen for infants PICU if stable; q4hr on MS Morphine IV 0.05 – 0.1 mg/kg/dose IV q3hr xpected, consider source of ona term IV access severe pain (max 5 mg/dose) Neurosurgery attending should be notified fever Internalization Criteria: If CSF culture is positive, discuss timing of shunt replacement and duration of antibiotics with Neurosurger Previous Terminal sites dependent on clearance of end-organ space infections. If still present, wi immediately if any bradycardia, hypertension, or Post-Op care: Transfer to MS floors and resume all pre-internalization care an shunt Bacitracin to scalp incision, Tegaderm/Telfa to abdominal/chest/clavicular/n placement or daily cultures needed unless persistently febrile >36 hours, i infection depressed Level of Consciousness is noted, as Discharge Criteria: stable neuro exam; pain well controlled on PO meds; afebrile x24 hrs; I 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 mil ate pain. Acetaminophen PO: 15 mg/kg/dose

these could be signs of impending herniation.

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Follow Up: 2-3 weeks post discharge

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

NEXT PAGE

Call NSG if: fever >101.5°F, vomiting >3 times in a 12 hours period, excessive irritability or sleepiness, severe headad

CLINICAL PATHWAY: Suspected Neurosurgical Shunt Infection **CLINICAL PATHWAY:** Inclusion Criteria: Clinical suspicion of shunt infection by Emergency Department physician based on clinical judgment **Suspected Neurosurgical Shunt Infection** and/or presence of ≥ 1 risk factors for shunt infection¹ Appendix A: Obtaining a Detailed History and Physical Exclusion Criteria: alternative source for fever identified Important factors to consider include: surgery Notify Neurosurgery attending at first Notify Neurosurgery attending at first suspicion of shunt infection Shunt Type: TRIAGE: o ventricular-atrial shunt Vital signs g1hr then g2hr when more stable: temperature, BP, HR, RR, O2 sat, neuro check ventricular-plural shunt . ventricular-peritoneal shunt Weight, head circumference (for <12 month old) Headache History: Place on continuous CR monitoring . location quality *Notify Neurosurgery attending immediately if bradycardia, hypertension or depressed LOC is noted * duration Obtain detailed history/initial exam: See Appendix A. treatment Vomiting History: source of If large or complex pseudocyst: CT of the abdomen with co fever Antibiotics and Fluids o timina Previous Start both empiric antibiotics listed after obtaining blood cult rine culture, and CSF culture, if possible shunt any precipitating events Ceftazidime IV: 150 mg/kg/day divided q8hr (max 2 g/d infection Vancomycin IV: <52 weeks PMA⁺/about <3 mo old: 15 nr or as determined by pharmacy based on estimated Neurological symptoms: UC: >52 weeks PMA[‡]/about >3 months old = 11 yea g/kg/day div q6hr; ≥12 yrs old: 60 mg/kg/day div q8h on serum Na levels) change in LOC ○ ↑ irritability Pre-Op: Admit to PICU on Neurosurgery service ²Consider Acute Kidney Injury (AKI) based on th following criteria: Increase in serum creatinine by 1.5-1.9 times OR case request for externalization (Neurosurgery to obtain consent for OR weakness Continuous CR monitoring (close monitoring for bradycardia) baseline within the prior seven days, or seizures Increase in serum creatinine by ≥0.3 mg/dL from baseline (≥26.5 mcmol/L) within 48 hours, or Continue NPO and IVF up/downward gaze For those with unknown creatinine, an eGFR <9 ml/min/1.73m ○ ↑ letharav Abdominal symptoms: FEN/GI Other o significant ↑ abdominal girth Appendix A includes important details that should o pain intenance IVE OT/PT: activity to tenderness 1:1 replaceme include OOB with be included as part of the History and Physical h CSF output EVD clamped for mass ons: therapies if stable dansetron 0.1 and tolerating General /kg/dose a8hr clamping trauma ax 4 mg/dose) SCD/compression exam. boots for DVT pp √ nausea/ fontanels niting per hospital policy head circumference vethylen Incentive ol 17 g daily o spirometer or I breath sounds for pleural shunts bubbles for stipation atelectasis/PNA ocusate sodiun prevention 50 mg/day PRN long term IV access. floors severe pain (max 5 mg/dose) constipation Internalization Criteria: If CSF culture is positive, discuss timing of shunt replacement and duration of antibiotics with Neurosurgery and ID based on clinical status and response to therapy Terminal sites 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 PC 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 g6hr 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 headach CONTACTS: JONATHAN MARTIN, MD I PETRONELLA STOLTZ, APRN NEXT PAGE CONTACTS: JONATHAN MARTIN, MD | PETRONELLA STOLTZ, APRN @2019 Connecticut Children's Medical Center. All rights reserved

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INITIAL MANAGEMENT:

Labs:

- 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, a erobic culture and anaerobic culture

Imaging:

- Reduced shunt protocol MRI brain without contrast is preferred if imaging modality if confirmation patient has nonprogrammable 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 Neuros urgery 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 listed after obtaining blood culture, UA/urine culture, and CSF culture, if possible:
 - Ceftazidime IV: 150 mg/kg/day divided q8hr (max 2 g/dose) <u>AND</u>
 - 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: 70 mg/kg/day div q6hr; ≥12 yrs old: 60 mg/kg/day div q8hr
- NPO and start IVF at maintenance (with 0.45 or 0.9% NaCl depending on serum Na levels)

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

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Antibiotics	abs/Monitoring	Pain/Fever	FEN/GI	Other
 Consult Infectious Disease (ID) Continue empiric antibiotics (Vancomycin and Ceftazidime) x24 hours or per ID recs Adjust antibiotics based on culture and ID recs sexpected, consider long term IV access. 	Labs: CSF studies: cell count and culture to lab per Neurosurgery and/or ID If CSF culture positive, repeat in 24-36 hours to document sterilization. If persistently febrile or dinical deterioration: repeat CSF culture is warranted. Consider blood, urine and respiratory evaluation. Constinuous CR monitoring Vitals q1hr if unstable; q2hr in PICU if stable; q4hr on MS floors	If acute kidney injury ² : Avoid NSAIDs or discuss with Nephrology for approval. • Toradol V 0.5 mg/kg/dose q6hr (max 30 mg/dose) x6 doses • 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 less) • Acetaminophen IV 15 mg/kg/dose q6hr ATC for 24 hours (max 1,000 mg/dose) • After 24 hours of IV acetaminophen; Smg/kg/dose q6hr PRN pain; (max 75 mg/kg/day or 4,000 mg/ day) for mid/moderate pain; may use PR ocetaminophen for infants. • Morphine IV 0.5 – 0.1 mg/kg/dose IV q3hr PRN severe pain (max 5 mg/kg/dose)	IVF: • Maintenance IVF • NS 1:1 replacement with CSF output Medications: • Ondansetron 0.1 • Mykg/dose @hr (max4 mg/dose) PRN rausea/ vomiting • Polyethylene glycol 17 g daily or BID PRN constipation • Docusate sodium S0 mg/day PRN	 OT/PT: activity include OOB wit EVD clamped for therapies if stat and tolerating clamping SCD/compressive SCD/compressive soft for VTP per hospital pol Incentive spirometer or bubbles for atelectasis/PNA prevention
Adjust antibiotics based on culture and ID recs If >5 day antibiotics expected, consider long term IV access.	Contract of women and respiratory evaluation. Monkoring: Continuous CR monitoring Vitals gathr if unstable; gathr in PICU if stable; g4hr on MS floors	 o After 24 hours of Vacetaminophen, switch to PO acetaminophen: 15 mg/kg/dose q6hr PRN pair, (max 75 mg/kg/dy or q7.000 mg/ day) for mild/moderate pair, may use PR acetaminophen for infants. Morphine IV 0.05 – 0.1 mg/kg/dose IV q3hr PRN severe pair (max 5 mg/dose) 	 Dolyethylene glycol 17 g daily or BID PRN constipation Docusate sodium 50 mg/day PRN constipation 	 Incentive spirometer or bubbles for atelectasis/PN prevention
If CSF culture is p	ositive, discuss timing of shunt replace Terminal sites dependent on cleara Transfer t • Bacitracin to scalp inc replacement or daily (ment and duration of antibiotics with Neurosurgery and ID ince of end-organ space infections. If still present, will consi <u>Post-Op care:</u> to MS floors and resume all pre-internalization care and sta sion, Tegaderm/Teifa to abdominal/chest/clavicular/neck cultures needed unless persistently febrile >36 hours, clinic:	based on clinical status and der alternate site if possible. rt incision; may shower POD 3; ally deteriorating	response to therapy. ; no further CSF
	Discharge Criteria: stable neuro ex	vam: pain well controlled on PO meds: afebrile x24 brs: how	al mayomont: adoquato PO	

Initial Management:

- Labs are directed to assess for infection and includes studies from CSF
- New for 2024:
 - Procalcitonin can assist in determining if a bacterial infection is present.
 - In addition to aerobic cultures, anaerobic cultures should be sent to ensure proper organism isolation if present.

Imaging includes reduced shunt protocol MRI brain without contrast.

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.

Labs:

- 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, a erobic culture and anaerobic culture

Imaging

 Reduced shunt protocol MRI brain without contrast is preferred if imaging modality if confirmation patient has nonprogrammable shunt (if not documented in chart, may confirm via skull x-ray; Appendix B: Radiographic Appearance of Shunt Valves)

INITIAL MANAGEMENT:

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- o 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 listed after obtaining blood culture, UA/urine culture, and CSF culture, if possible:
 - Ceftazidime IV: 150 mg/kg/day divided q8hr (max 2 g/dose) <u>AND</u>
 - 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: 70 mg/kg/day div q6hr; ≥12 yrs old: 60 mg/kg/day div q8hr
- NPO and start IVF at maintenance (with 0.45 or 0.9% NaCl depending on serum Na levels)

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



INITIAL MANAGEMENT:



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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 nonprogrammable and programmable shunts. The sources of these images are:

- http://www.kinderneurochirurgie-leipzig.de/therapeuticfocus/hydrocephalus/radiologicidentification-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



Labs:

- CBC w diff, CRP, iStat chem 7, procalcitonin, blood culture, UA, urine culture
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 - Vancomycin IV: <52 weeks PMA[‡]/about <3 mo.old: 15 mg/kg.g8br.or.as determined by pharmacy based on estimated

Appendix B outlines radiographic imaging examples provided.

div q6hr; ≥12 yrs old: 60 mg/kg/day div q8hr Na levels)

Other

OT/PT: activity to

FFN/G

Maintenance IVE

considerations when evaluating a shunt, with



NSAIDs or discuss with

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INITIAL MANAGEMENT:

Labs:

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Antibiotics	abs/Monitoring	Pain/Fever	FEN/GI	Other
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Consult Infectious Disease (ID) Continue emplific antibiotics (Varcomycin and Ceftazidime) x24 hours or per ID recs Adjust antibiotics based on culture and ID recs If 3-5 day antibiotics sevected, consider long term IV access.	Labs: CSF studies: cell count and culture to lab per Neurosurgery and/or ID If CSF culture positive, repeat in 24-36 hours to document sterilization. If persistenthy febrile or clinical deterioration: repeat CSF culture is warranted. Consider blood, unne and respiratory evaluation. Monitoring: Continuous CR monitoring Vitals qLhr if unstable; q2hr in PICU if stable; q4hr on MS floors	ffacute kidney injury ² : Avoid NSAIDs or discuss with Nephrology for approval. • Toradol VO.5 mg/kg/dose q6hr (max 30 mg/dose) x6 doses • 6 hours after last toradol dose, start • ibuprofen PO 10 mg/kg/dose q6hr FRN (max 40 mg/kg/day or 2,400 mg/day, whichever is less) • 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 mid/moderate pain; may use PR acetaminophen for infonts. • Morphine V0.05 – 0.1 mg/kg/dose IV q3hr PRN severe pain (max 5 mg/dose)	IVF: Maintenance IVF NS 1:1 replacement with CSF output Medications: Ondansetron 0.1 mg/kg/dose qBhr (max 4 mg/dose) PRN nauseal yean Hing Polyethylene glycol 17 g daily or BID PRN constipation Docusate sodium S0 mg/day PRN constipation	 OT/PT: activity to include OOB with EVD clamped for therapies if stable and tolerating clamping SCD/compression boots for DVT pps per hospital policy Incentive spirometer or bubbles for ateletasis/PNA prevention
antibiotics based on culture and ID recs. If >5 day antibiotics expected, consider long term IV access.	evaluation. Montoring: • Continuous CR monitoring • Vitals q1hr if unstable; q2hr in PICU if stable; q4hr on MS floors • Continuous CR monitoring of shunt replaces stilve, discuss timing of shunt replaces	to PO acetaminophen: 15 mg/kg/dose q6hr PRN pani; (max 75 mg/kg/day or 4, 000 mg/ day) for mild/moderate pain; may use PR acetaminophen for infants. Morphine V0.05 - 0.1 mg/kg/dose V q3hr PRN severe pain (max 5 mg/dose) Internalization Criteria: ment and duration of antibiotics with Neurosurgery and ID	glycol 17 g daily or BID PRN constipation • Docusate sodium 50 mg/day PRN constipation	spirometer or bubbles for atelectasis/PNA prevention
	Transfer t Bacitracin to scalp inci replacement or daily c	$\frac{Post-Opcare:}{sion, Tegademontparts and the section of the sec$	irct incision; may shower POD 3 ally deteriorating	; no further CSF
Ibuprof q6hr PR Follow Call NS	Discharge Criteria: stable neuro ex: en PO 10 mg/kg/dose q6hr PRN (max: N pain (max 75 mg/kg/day or 4,000 m Up: 2-3 weeks post discharge G If: fever >101.5°F, vomiting >3 times	am; pain well controlled on PO meds; afebrile x24 hrs; box. Discharge Instructions/Medications: 40 mg/wg/day or 2,400 mg/day, whichever is less) for mild, g/day) for mild/moderate pain; Polyethylene glycol PO an in a 12 hours period, excessive initability or sleepiness, se	rel movement; adequate PO /moderate pain, Acetamino , d/or Docusate to prevent co vere headache	phen PO: 15 mg/kg/dose
		NEXT PAGE		
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Initial Management:

- Antibiotics:
 - Start vancomycin and ceftazidime for adequate coverage *after* obtaining cultures, if possible
- Fluids:
 - All patients are made NPO and given IVF in preparation for the Operating Room
 - Ask about the last PO last meal, snack, drink

¹Risk Factors for

Pre-Op:

- Admit to PICU on Neurosurgery service
- Enter case request for the OR
- Continuous Cardiorespiratory monitoring
 - Be alert for bradycardia

Pre-Op: Admit to PICU on Neurosurgery service

• OR case request for externalization (Neurosurgery to obtain consent for OR)

Inclusion Criteria: Clinical suspicion of shunt infection by Emergency Department physician based on clinical judgmen

and/or presence of ≥1 risk factors for shunt infectio

- 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 below



¹Risk Factors for

Shunt Infection

surgery within

Shunt

Post-Op:

- Patient will return to the PICU with an externalized shunt
 - Shunt parameters are set by the surgeon

Pre-Op: Admit to PICU on Neurosurgery service

• OR case request for externalization (Neurosurgery to obtain consent for OR)

Inclusion Criteria: Clinical suspicion of shunt infection by Emergency Department physician based on clinical judgmen

and/or presence of ≥1 risk factors for shunt infection

Exclusion Criteria: alternative source for fever identified

surgery attending at first suspicion of shunt infec

- 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 below



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Post-Op Management: Antibiotics

- Consult with Infectious Disease (ID)
- Continue empiric antibiotics for 24hr or per ID direction
 - Adjust antibiotics based on culture results.

(Inclusion Criteria: Clinical suspicion of shunt infection by En and/or presence of ≥1 risk	mergency Department physician based on factors for shunt infection ¹	dinical judgment	¹ Risk Factors for
(Exclusion Criteria: alternatio	ve source for fever identified		Shunt Intection Shunt
	Notify Neurosurgery attending a TRI/	t first suspicion of shunt infection AGE:		within previous 6
	 Vital signs e² - in g2hr when more stable: temperature Wet (for <12 month old) 	re, BP, HR, RR, O2 sat, neuro check		months Clinical signs
<	Antibiotics	dycardia, hypertension or depressed LOC i	is noted*	of infection involving
		NAGEMENT:		shunt hardware
Ŀ	CBC w diff, Coexistat chem 7, procalcitonin, blood cultur	e, UA, urine culture		including skin erosion,
1	Shunt tap by send STAT CSF for cell count, glucose, maging:	protein, gram stain, aerobic culture and a	naerobic culture	cellulitis, incisional
		ferred if imaging modality if confirmation nfirm via skull x-ray; Appendix B: Radiogr	raphic Appearance of	abdominal
		MRI, please ensure a Neurosurgery provid	der is able to reprogram	 Clinical signs of meningitis
•	Concult	are that patient has a programmable shut		 No other obvious
•	Consult	ontrast		source of fever
	Infectious	culture, UA/urine culture, and CSF culture g/dose) <u>AND</u>	e, if possible:	 Previous shunt information
		15 mg/kg q8hr or as determined by phan ars old: 70 mg/kg/day div q6hr; ≥12 yrs o	macy based on estimated Id: 60 mg/kg/day div q8hr	intection
	Disease (ID)	I depending on serum Na levels)		
•	Continue empiric	Neurosurgery service	2 Consider Acute Kidn follow	ey Injury (AKI) based on the ving criteria:
-		monitoring for bradycardia)	Increase in serum baseline within th Increase in serum	creatinine by 1.5-1.9 times e priors even days, or creatinine by ≥0.3 mg/dL from
	antibiotics	back to PICU rs per surgeon; follow post-op care below	W baseline (≥26.5 m • For those with uni ml/min/1.73m ²	cmol/L) within 48 hours, or known creatinine, an eGFR <90
	Wancomvcin	•	4	
	(Vancomycin	Pain/Fever	FEN/GI	Other
	(Vancomycin and Ceftazidime)	Pain/Fever	FEN/GI	Other V
	(Vancomycin and Ceftazidime)	Pain/Fever iury ² : Avoid NSAIDs or discuss with oproval. 0.5 mg/kg/dose q6hr (max 30 mg/dose)	FEN/GI VF: • Maintenance IVF • NS 1:1 replacement	Other Other OT/PT: activity to include OOB with
	(Vancomycin and Ceftazidime) x24 hours or per	Pain/Fever ury ² : Avoid NSAIDs or discuss with poroval. D.5 mg/kg/dose q6hr (max 30 mg/dose) s after last toradol dose, start	FEN/GI VF: • Maintenance IVF • NS 1:1 replacement with CSF output Medications:	• OT/PT: activity to include OOB with EVD clamped for therapies if stable
	(Vancomycin and Ceftazidime) x24 hours or per ID recs	Pain/Fever Uny ² : Avoid NSAIDs or discuss with pprovd. D.5 mg/kg/dose q6hr (max 30 mg/dose) rs after last toradol dose, start ofen P0 10 mg/kg/dose q6hr PRN (max /kg/day or 2,400 mg/day, whichever is	FEN/GI VF: Maintenance IVF NS 1:1 replacement with CSF output Medications: Ondansetron 0.1 mg/kg/dose g8hr mg/kg/dose g8hr	• OT/PT: activity to include OOB with EVD clamped for therapies if stable and tolerating clamping
_	(Vancomycin and Ceftazidime) x24 hours or per ID recs	Pain/Fever Ury ² : Avoid NSAIDs or discuss with aproval. J5 mg/kg/dose q6hr (max 30 mg/dose) safter last toradol dose, start safter last toradol dose, start safter / 10 mg/kg/dose q6hr PRN (max /kg/day or 2,400 mg/day, whichever is shen N 15 mg/kg/dose q6hr ATC for 24 1000 mg/kg/dose q6hr ATC for 24	FEN/GI FEN/GI Maintenance I/F Maintenance I/F Molintenance I/F Molintenance I/F Modiasteron 0.1 mg/kg/dose q8hr (max 4 mg/dose) PRN rausea/ vomitine	Other O
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• If >5	(Vancomycin and Ceftazidime) x24 hours or per ID recs Adjust antibiotics based on culture and ID recs 5 day antibiotics	Pain/Fever ury': Avoid NSAIDs or discuss with paroval. D.5 mg/kg/dose q6hr (max 30 mg/dose) rs.after last toradol dose, start den PO 10 mg/kg/dose q6hr PRN (max /kg/day or 2,400 mg/day, whichever is behn VLS mg/kg/dose q6hr ATC for 24 1,000 mg/dose) 24 hours of IV acetaminophen, switch acetaminophen: IS mg/kg/dose q6hr ain; (max 75 mg/kg/dose q6hr ATC for 24 1,000 mg/dose) 24 hours of IV acetaminophen, switch acetaminophen for infonts. v 0.05 – 0.1 mg/kg/dose V q3hr PRN (max 5 mg/kg/dose) v 0.05 – 0.1 mg/kg/dose IV q3hr PRN (max 5 mg/kg/dose) v 0.05 – 0.1 mg/kg/dose IV q3hr PRN (max 5 mg/dose) some all pre-internalization care and sta effa to abdominal/chest/clavicular/nest. lass persistently febrile >36 hours, clinica	FEN/GI FEN/GI FAIN/GI FAIN/GI Maintenance NF NS 1.1 replacement writh CSF output Medications: Ondansetron 0.1 mg/kg/dose g&hr (max 4 mg/dose) PRN rausea/ vomiting Polyethylene glyool 17 g daily or BiD PRN constipation Docusate softum So mg/day PRN constipation Dased on clinical status and der alternate site if possible rt findskor; may shower POD 3 ally deteriorating	Other O
• If >5 expe	(Vancomycin and Ceftazidime) x24 hours or per ID recs Adjust antibiotics based on culture and ID recs day antibiotics ected, consider	Pain/Fever ury ² : Avoid NSAIDs or discuss with paroval. D.5 mg/kg/dose q6hr (max 30 mg/dose) rs after last toradol dose, start sfen P0 10 mg/kg/dose q6hr RN (max /kg/day or 2,400 mg/day, whichever is ohen W15 mg/kg/dose q6hr ATC for 24 1,000 mg/dose) 24 hours of 1V acetaminophen, switch acetaminophen: 15 mg/kg/dose q6hr mild/moderate pain; may use PR minophen for infonts. v ind/switch pain; may use PR minophen for infonts. w index (Moderate pain; may use PR minophen for infonts. some all pre-internalization care and sta effa to abdominal/chestyClavicular/neck less persistently fehrle >36 hours, clinicz v DO meds; afebrde s24 hrs; bow naturations/Medications: mol moderations.	FEN/GI FEN/GI Maintenance NF NS 1:1 replacement with CSF output Medications: Ondansetron 0.1 mg/kg/dose other mg/dose other	Other O
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• If >5 expe long	(Vancomycin and Ceftazidime) x24 hours or per ID recs Adjust antibiotics based on culture and ID recs day antibiotics ected, consider term IV access.	Pain/Fever ury ¹ : Avoid NSAIDs or discuss with sproval. D.S mg/kg/dose q6hr (max 30 mg/dose) rs after last toradol dose, start sfen P0 10 mg/kg/dose q6hr PRN (max kg/day or 2,400 mg/day, whichever is shen IV 15 mg/kg/dose q6hr ATC for 24 1,000 mg/dose) 24 hours of IV acetaminophen, switch acetaminophen: 15 mg/kg/dose q6hr ATC for 24 24 hours of IV acetaminophen, switch acetaminophen: 15 mg/kg/dose q6hr 1,000 mg/dose) 24 hours of IV acetaminophen, switch acetaminophen: 15 mg/kg/dose q6hr acetaminophen: 15 mg/kg/dose q6hr 1,000 mg/dose) mailzation Criteria: of antibiotics with Neurosurgery and ID pace infections. If still present, will Consil Post-Do_care: sume all pre-internalization care and sta effa to abdominal/chest/clavicular/nedk less persistent/fehrle >36 hours, clinicz rolled on PO medis; afebrile s24 hrs; bow nstructions/Medications: ,400 mg/day, withever is less) for mild/ oderate pain; Połyethylene głycol PO and od, excessive initability or sleepiness, see	FEN/GI FEN/GI Maintenance I/F Maintenance I/F NS 1:1 replacement with CSF output Medications: Ondansetron 0.1 mg/kg/dose qahr mg/dose) PRN reusea/ vomiting PRV reusea/ vomiting Occustes online So mg/day PRN constipation Docustes contin So mg/day PRN constipation Docustes contin der alternate site if possible rt mcision; may shower POD 3 moderate pain, Acetaming //or Docuste to prevent co revent	Other O

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Post-Op Management: Labs/Monitoring

- Ongoing CSF studies will be pulsed per the Neurosurgery and/or ID teams.
- New for 2024:
 - If the CSF culture is positive, it should be repeated every 24-36 hours to document when it becomes negative.
 - If the patient is persistently febrile, repeat investigation should occur.
- Monitoring is based on patients clinical status





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¹Risk Factors for Shunt Infection Shunt surgery within

> previous 6 months Clinical sign

of infection involving shunt

hardwar

including skin erosi

cellulitis, incisional drainage o

abdominal pseudocyst Clinical sign

of meningit No other obvious

source of

fever Previous

shunt

v 1.5-1.9 time

by ≥0.3 mg/dL fro

atinine, an eGFF

Other

OT/PT: activity to

include OOB with EVD clamped for therapies if stabl

and tolerating clamping SCD/compression

boots for DVT pp per hospital polic

Post-Op Management:

Pain and fever:

- NSAIDS should be used as first line for pain and fever management
- Narcotics are for use with severe pain only
- Note: the definition of AKI has been updated and is available as a key.

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

- Toradol IV 0.5 mg/kg/dose q6hr (max 30 mg/dose) x6 doses
 - 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 less)

ergency Department physician based on clinical judgm

- 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)



Post-Op Management:

Fluids, Nutrition, and Bowel management:

- Patients need both maintenance fluid and 1:1 replacement of CSF output
- Anti-nausea medications should be ordered in addition to a bowel regimen



CLINICAL PATHWAY: Suspected Neurosurgical Shunt Infection

Inducion Critoria: Clinical suspision of shunt infaction by Emorraney Donartment physic

Post-Op Management:

- PT and OT should be involved once stable and tolerating clamping
- SCD boots and Incentive spirometry should be used when patients remain with limited mobility

	and/or pr Exclusion (esence of ≥1 risk factors for shunt infectio Criteria: alternative source for fever identif	n ¹ ied	<u> <u> </u></u>	
•	Notify Neurosur Vital signs q1hr then q2hr when more s Weight, head circumference (for <12 m Place on continuous CR monitoring *Notify Neurosurgery attending i Obtain de	gery attending at first suspicion of shunt i <u>IRIAGE:</u> table: temperature, BP, HR, RR, O2 sat, ner onth old) mmediately if bradycardia, hypertension a talled history/initial exam: See Appendix	nfection uro check r depressed LOC is noted* A.	surgery within previous 6 months Clinical signs of infection involving shunt	
Labs: • Imaging:	CBC w diff, CRP, iStat chem 7, procalcit Shunt tap by NSG: send STAT CSF for ce Reduced shunt protocol MRI brain with	INITIAL MANAGEMENT: onin, blood culture, UA, urine culture II count, glucose, protein, gram stain, aero out contrast is preferred if imaging modali out contrast is preferred if imaging modali	bic culture a Ott	her abdominal	
Antibiotics PMA (Post PMA (Post	Reduced shurt protocol MRI brain with Grogrammable shurt is present: the shurt within 24 hours of image of <i>If programmable shurt</i> is present: the shurt within 24 hours of image of <i>If NRI</i> not wildble: CT head with <i>If suspected abdominal pseudocyst or</i> of <i>If ARI</i> not wildble: CT head with <i>If suspected abdominal pseudocyst</i> or and <u>Eluds</u> : Sant both empiric antibiotic listed afte or <u>Containous RNP</u> <i>AuC</i> ; 252 weeks PMA ¹ /about 23 r VRD and start IVF at maintenance (with <i>Menstrual Age) = gestational age</i> + po Continuous CR Continue NPO <i>I</i> Execting <i>Containous CR</i> Continue NPO <i>I</i> EVD/externalize the VD/externalize <i>EVD/externalize</i> the Continue NPO <i>I</i> is EVD/externalize the Continue NPO <i>I</i> is EVD/externalize the Continue NPO <i>I</i> is <i>Continue NPO I</i> is <i>Continue CR</i> monitoring is <i>Vais</i> glihr if unstable: glihr in <i>NPCU I</i> ficture is stime generate to claira <i>Transfert</i> Discharge Criteria: stable neuroe ex <i>Stern</i> PD 10 mg/kg/dose glihr <i>PNN Imax</i> <i>RN pain (max 75 mg/kg/day of 4,000 the Up: 3 weeks post discharge</i> SG if: fever >101.5°F, vomiting >3 timese	out ontrast is preferred if imaging modall di in chart, may confirm via skull x-ray. App prior to ordering MRL please ensure a Net ing. Make MRI aware that patient has a pr out ontrast bdomind symptoms: limited ultrasound of e abdomen with contrast transformer and the symptomer and the abdom of symptoms: limited ultrasound of e abdomen with contrast transformer and the symptomer and the boom of symptoms: limited ultrasound of e abdomen with contrast transformer and the symptomer and the abdom of symptoms: limited ultrasound of e abdomen with contrast transformer and the symptomer and the prost of the symptomer and the symptomer and the symptomer and the gradmit to PlU on Neurosurgery service tf or externalization (Neurosurgery to obt for externalization (Neurosurgery to bot monitoring (close monitoring for bradycar and IVF <u>Past-Og</u> admit back to PlU ed shunt parameters per surgeon; follow p Past-Og admit back to PlU ed shunt parameters per surgeon; follow p Past-Og admit back to PlU ed shunt parameters per surgeon; follow p Past-Og admit back to PlU ed shunt parameters per surgeon; follow p Past-Og admit back to PlU ed shunt parameters per surgeon; follow p Past-Og and the symptomer and the system of the organite of the organ profee PD 10 mg/kg/dose of the rate of end-organ space infections. If still p <u>Past-Og</u> care: to MS floors and resume all pre-internalize ision, Tegaderm/Telf to abdominal/cbes to Sh floors and resume all pre-internalize to MS floors and resume all pre-internalize of MS floors on a c2,400 mg/dx, whicheve g/day) for mid/moderate pain; Polyecthyl sin a 12 hours period, excessive initability	 OT/PT: include OT/PT: include EVD clat therapi and tol clampin SCD/co boots fi per hos Incenti spirom bubble atelect preven 	activity to e OOB with amped for ies if stable erating mpression for DVT ppx spital policy ve eter or s for asis/PNA tion	
		NEXT PAGE			

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Internalization Criteria:

If CSF culture is positive, discuss timing of shunt replacement and duration of antibiotics with Neurosurgery and ID based on clinical status and response to therapy. Terminal sites 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

Internalization criteria:

- New for 2024:
 - If the CSF culture is positive, shunt replacement and antibiotic duration will be determined on a case-by-case basis.

	o If progra the shur	I ammable shunt is present: It within 24 hours of imaging at guailable: CT bead with	prior to ordering MRI, please ensure a Neurosurgery provi ng. Make MRI aware that patient has a programmable shu nut contrast	der is able to reprogram nt.	Clinical signs of meningitis No other
Anti	If suspected a If large or con ibiotics and Fluids: Start both em Ceftazid Vancom AUC; ≥5 NPO and start tA (Post-Menstrual A	biominal pseudocyst or al hplex pseudocyst: CT of the piric antibiotics listed after ime IV: 150 mg/kg/day di ycin IV: <52 weeks PMA [†] / 2 weeks PMA [†] /about ≥ 3 n: IVF at maintenance (with ge) = gestational age + pos	a bornow symptoms: limited ultrasound of abdomen abdomen with contrast robtaining blood culture, UA/urine culture, and CSF cultur ided q8hr (max 2 g/docs) <u>AND</u> about <3 m od di: 15 mg/kg qBr about <3 m od di: 15 mg/kg qBr anonths od - 11 years odt: 70 mg/kg/day div q6hr; \geq 12 yrs of 0.45 or 0.9% NaCl depending on serum Na levels) thatal age	e, if possible: macy based on estimated Jld: 60 mg/kg/day div q8hr 	obvious source of fever Previous shunt infection
		Pre-Or OR case reques Continuous CR Continue NPO a EVD/externalize	2.Admit to PICU on Neurosurgery service for externalization (Neurosurgery to obtain consent for O monitoring (close monitoring for bradycardia) ad IVF <u>Post_Op</u> ; admit back to PICU d shunt parameters per surgeon; follow post-op care belo	R) W W	ey Injury (AKI) based on the ving criteria: creatinine by 1.5-1.9 times e prior seven days, or creatinine by 20.3 mg/dL from cmol/J, within & shours, or known creatin he, an eGFR <50
×		*	×	*	×
Antibiotic	\rightarrow \triangleleft	bs/Monitoring>	Pain/Fever	FEN/GI	< Other >
\sim		\checkmark		\sim	
 Consult Infectious Disease (If Continue e Continue e antibiotics (Vancomy and Ceftaa x24 hours ID recs Adjust antibiotics on culture recs f >5 day antibic iong term IV aoc 	Labs: • CSF st cultur Neurc Portice • If CSF: in 24-i cith • If CSF: in 24-i etail • If CSF: in 24-i • If CSF: in 24-i • If CSF: • in 24-i • or per • detail • or per • detail • or per • or per	udies: cell count and et o lab per swigery and/or ID culture positive, repeat ation. istently febrile or clinical oration: repeat CSF e is warranted. Consider unine and respiratory titon. : : q1hr if unstable; q2hr in fstable; q4hr on MS	 If acute karney injury: Avaid NSABs or discuss with Nephrology for approval. Toradol IV 0.5 mg/kg/dose q6hr (max 30 mg/dose) x6 doxes o 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 less) 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 pair, (max 75 mg/kg/day or 4,000 mg/ day) for mid/moderate pair, may use PR acetaminophen for infonts. Morphine V 0.5 0–0.1 mg/kg/dose IV 3hr PRN severe pain (max 5 mg/kg/dose) 	IVF: Maintenance VF NS 1.1 replacement with CS* output Medications: Ondansetron 0.1 mg/kg/dose q8hr (max 4 mg/dose) PRN nausea/ vomiting Ployeol 17 g daily or BID PRN constipation Docusate sodum S0 mg/day PRN constipation	OT/PT: activity to include OOB with EVD clamped for therapies if stable and tolerating clamping SCD/compression boots for DVT pp per hospital polic Incentive spirometer or bubbles for atelectasis/PNA prevention
			▼		
If CSF cult	ture is positive, discu Terminal	ss timing of shunt replacer sites dependent on clearai Transfer t Bacitracin to scalp inci replacement or daily c	Internalization Criteria: Internal duaritori ori artibiotiss with Neurosurgery and ID loce of end-organ space infections. If still present, will consi <u>Post-Op care</u> DMS floors and resume all pre-internalization care and sta son, TegedernyTFIE1 to abdomina/Locest/Lolavical/neck ultures needed unless persistently febrile >36 hours, clinic	based on clinical status and der alternate site if possible rt incision; may shower POD 3 ally deteriorating	response to therapy. ; no further CSF
	Discharg	e Criteria: stable neuro ov	★ m: nain well controlled on PO mede: afebrilo v24 bm: box	el movement: adequato PO	
(. :	Ibuprofen PO 10 m, q6hr PRN pain (ma) Follow Up: 2-3 wee Call NSG if: fever >1	g/kg/dose q6hr PRN (max. 75 mg/kg/day or 4,000 m ks post discharge 101.5°F, vomiting >3 times	Discharge InstructionStyleAdiations Discharge InstructionStyleAdiations 40 mg/kg/day or 2,400 mg/day, whichever is less) for mild, g/day) for mild/moderate pain; Polyethylene glycol PO an in a 12 hours period, excessive irritability or sleepiness, se	moderate pain, Acetamino d/or Docusate to prevent or vere headache	ohen PO: 15 mg/kg/dose
			NEXT PAGE		
JONATHA	N MARTIN, ME) PETRONELLA :	STOLTZ, APRN		

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Internalization Criteria:

If CSF culture is positive, discuss timing of shunt replacement and duration of antibiotics with Neurosurgery and ID based on clinical status and response to therapy. Terminal sites 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

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Post-Op internalization:

- Patient will transfer to a Med-Surg unit
- Resume pre-internalization care EXCEPT:
 - No further CSF replacements
 - New for 2024: No further daily CSF cultures unless persistently febrile or clinically deteriorating
- Wound care and observation of all surgical incisions
- Patient may shower on POD #3



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

Discharge Criteria:

- Stable neuro exam
- Pain well controlled on enteral medications
- Afebrile for over 24 hours
- Adequate oral intake
- Bowel movement has occurred

Discharge Instructions:

- Include provisions for:
 - Pain control
 - Constipation prevention
 - Follow-up
 - When to call Neurosurgery



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Review of Key Points



- Neurosurgery attending should be notified immediately upon suspicion of a shunt infection
- Patients should have continuous Cardio-respiratory monitoring and every 1 -2 hr vital sign and neuro checks
 Watch closely for bradycardia, hypertension, or decreased LOC
- Empiric antibiotics are Vancomycin AND Ceftazidime • Adjust antibiotics based on culture and ID recommendations

Quality Metrics



- Percentage of patients with pathway order set usage
- Percentage of patients with correct empiric antibiotic choice per pathway
- Percentage of patients with antibiotics adjusted based on culture results and Infectious Disease recommendations
- Length of stay in ED (hours)

Pathway Contacts



- Jonathan Martin, MD
 - Pediatric Neurosurgery
- Petronella Stoltz, DNP, APRN
 - Pediatric Neurosurgery





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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.