Ventricular Shunt Infections

Setting the stage
- Overview patient population
  - Clinical presentation
### Disclosure slide for speaker at “Update on diagnostic and clinical management of complex foreign body infections”

#### Disclosure of speaker’s interests

<table>
<thead>
<tr>
<th>(Potential) conflict of interest</th>
<th>none</th>
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</thead>
<tbody>
<tr>
<td>Potentially relevant company relationships in connection with event</td>
<td>none</td>
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<tr>
<td>- Sponsorship or research funding</td>
<td>none</td>
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<td>- Fee or other (financial) payment</td>
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<td>- Shareholder</td>
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<td>- Other relationship, i.e. …</td>
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My Clinical Practise in ventricular shunt infection

• Patients: critically ill ?
  Not all. Mixed ICU 35-40 beds

• Materials: type of shunts
  EVD / ELD mostly

• Surveillance: signal and noise
  inflammation > infection

• Infection: can we treat it ?
  Often

• Experience ?
  Limited

• The patient with a SAH
CT: SAH – subarachnoid hemorrhage

Patient with some loss of consciousness

How are the vitals?

Have we stabilized the patient?
neuro critically ill patient; not all the same

Intensivist
Not a neurosurgeon

- SAH
- IVH - hCVA
- Meningitis
- Shunt infection
- Shunt dysfunction
Acute hydrocephalus; CSF volume overload
Pressure builds up

Patient is deteriorating: somnolence towards stupor, vomiting, aspiration, hypoventilation, hypoxia

- Communicating Hydrocephalus
  - Resolution problem
- Non-communicating Hydrocephalus
  - Blockade at foramina by
    - Mass effect e.g. Tumor
    - Blood

intervention
- ELD / EVD
- EVD
EVD: JNS 2013, Oh et.al.

H. Tillmanns, 1908: successful drainage and technical review
Hill, 1850: “neither difficult nor dangerous”

W.W. Keen, 1890: sterile technique

Ingraham and Campbell, 1941: standardized closed drainage system
Pepen, 1943: “500 patients, without untoward effects”

Robinson, 1948: double stopcock system
White, 1969: Silastic Catheter
Wyler, 1972: Antibiotic prophylaxis

LeMole, 2007: Virtual simulator training

Adson and Lillie, 1927: application of manometry in EVD
Lundberg, 1960: ICP monitoring is safe, reliable, and should be used in clinical practice

Narayan, 1982: Applications in TBI

2012: Antibiotic catheter trials
CSF: 10 ml/hr
Produced in the lateral ventricles: choroid plexus
Flow through foramina and duct
Absorbed by the Arachnoid villi
(Adults) 11–12 cm behind nasion
3 cm off midline

Aim catheter toward ipsilateral medial canthus and ipsilateral tragus
1 cm anterior to coronal suture
R/ cefazolin 2 gr i.v, or
With b-lactam allergy: clindamycin 600 mg or vancomycin 1000mg
CSF-drainage

- head 30 degree up
- closed system
- stop drainage during transport
- reservoir position vertical

Complications:
- clogging obstruction, leakage!
- dyslocation / tear!
- overdrainage!
- pneumencephalus
- ventriculitis / meningitis
Collection of CSF

The on-off ratchet clamp is closed during patient transport.

A check valve prevents reflux.

A pump chamber is used to transport CSF.

The Luer-Lock connector connects the kit to a ventricular catheter or to an intraventricular Spiegelberg ICP-probe.

The proximal three-way stopcock is used to connect to a pressure transducer.

The distal three-way stopcock is used to connect to a pressure transducer.

The drip chamber is aerated with a replaceable filter.

The drip chamber is mounted on a plate that is hung to an IV pole.

The plate has pressure scales in mmHg and cmH₂O.

Cerebrospinal fluid accumulates in the drip chamber and the quantity is determined in it.

The on-off ratchet clamp is used to close off the discharge tube during collection.

The large inner diameters of the discharge tube and the connector allow for rapid discharge.
Effect drainage
When Awake: less Intensive Care
To much blood?
Double EVD?
More fever
More manipulation?
More risk
## Types of shunts

**Temporal: 1st**
- EVD
- ELD
- Monitoring ICP

**Definitive: 2nd**
- VP (peritoneal)
- VA (atrial)
- VP (pleural)

### Table: EVDs, No. (%)

<table>
<thead>
<tr>
<th>Variable</th>
<th>EVDs, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication for EVD placement</td>
<td></td>
</tr>
<tr>
<td>Hydrocephalus</td>
<td>43 (87.8)</td>
</tr>
<tr>
<td>Intracranial bleeding</td>
<td>42 (85.7)</td>
</tr>
<tr>
<td>Intracranial tumor</td>
<td>9 (18.4)</td>
</tr>
<tr>
<td>Trauma</td>
<td>3 (6.1)</td>
</tr>
<tr>
<td>Where was the EVD placed?</td>
<td></td>
</tr>
<tr>
<td>Neuro intensive care unit</td>
<td>28 (57.1)</td>
</tr>
<tr>
<td>Operating room</td>
<td>13 (26.5)</td>
</tr>
<tr>
<td>Outside hospital</td>
<td>5 (10.2)</td>
</tr>
<tr>
<td>Emergency department</td>
<td>3 (6.1)</td>
</tr>
<tr>
<td>Neurosurgical history?</td>
<td></td>
</tr>
<tr>
<td>≤30 d before EVD placement</td>
<td>8 (16.3)</td>
</tr>
<tr>
<td>Surgery while EVD was in place</td>
<td>22 (44.9)</td>
</tr>
</tbody>
</table>
27 % !
Myocardial Dysfunction – Shock by stunning
BACKGROUND:
Fever is commonly observed in patients who have had aneurysmal subarachnoid hemorrhage (SAH), and it has been associated with the occurrence of delayed cerebral ischemia and worse outcomes in previous studies. Frequently, fever is not the result of bacterial infections, and distinction between infection-related fever and fever secondary to brain injury (also referred as central fever) can be challenging.

OBJECTIVES:
Risk factors on admission for the development of central fever in patients with SAH.

METHODS:
Databank analysis was performed using information from demographic data (age, gender), imaging (transcranial Doppler ultrasound, computed tomography, and cerebral angiogram), laboratory (white blood cell count, hemoglobin, renal function, and electrolytes), and clinical assessment (Hunt-Hess and modified Fisher scales on admission, occurrence of fever). A multivariate logistic regression model was created.

RESULTS:
Of 55 patients, 32 developed fever during the first 7 days of hospital stay (58%). None of the patients had identifiable bacterial infections during their first week in the neurocritical care unit. Hunt-Hess scale >2 and leukocytosis on admission were associated to the development of central fever, even after correction in a logistic regression model.

CONCLUSION:
Leukocytosis and a poor neurologic examination on admission might help predict which subset of patients with SAH are at higher risk of developing central fever early in their hospital stay.
What’s the next treatment?

- Coiling
- Surgery
  - Mass effect by hematoma
  - Art.Media Aneurysm

International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in ruptured intracranial aneurysms

Molyneux Lancet. 2002; 360:1267-74
Endovascular Occlusion of an Aneurysm of the Posterior Communicating Artery with Guglielmi Detachable Coils (GDC)

Stent-Assisted Re-Coiling after Recurrence of an Aneurysm Initially Treated with Coiling

Nosocomial infections after aneurysmal subarachnoid hemorrhage: time course and causative pathogens

Kamil G. Laban, Utrecht 2015 World Stroke Organization

To investigate the time course of infection onset and bacterial microorganisms that cause nosocomial infections after aSAH

Methods University Medical Center Utrecht between 2009 and 2011, we analyzed the proportion of patients with infections, day of infection onset, and culture results.

Conclusion Nosocomial infections after subarachnoid hemorrhage are common and mostly occur in the first week after ictus. Future studies should investigate if general hygienic measures, infection awareness, minimizing the duration of mechanical ventilation and use of catheters/drains, or prophylactic antibiotics reduce infections and improve functional outcome.
? MRI or CT to diagnose ventriculitis?

Not common practise

• Ventricular debris was detected in 16 (94%) of 17 cases and was irregular in 13 (81%)
Definitive shunts

Definitive: 2nd
• VP (peritoneal)
• VA (atrial)
• VP (pleural)
## Symptoms of Shunt Malfunction:

<table>
<thead>
<tr>
<th>Infants</th>
<th>Toddlers</th>
<th>Children and Adults</th>
<th>Adults Living with NPH</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Enlargement of the baby’s head</td>
<td>• Head enlargement</td>
<td>• Vomiting</td>
<td>• Return of symptoms that were present before</td>
</tr>
<tr>
<td>• Fontanel is full and tense when the infant is upright and quiet</td>
<td>• Vomiting</td>
<td>• Headache</td>
<td>shunt was placed</td>
</tr>
<tr>
<td>• Prominent scalp veins</td>
<td>• Headache</td>
<td>• Vision problems</td>
<td></td>
</tr>
<tr>
<td>• Swelling along the shunt tract</td>
<td>• Irritability and/or sleepiness</td>
<td>• Irritability and/or tiredness</td>
<td></td>
</tr>
<tr>
<td>• Vomiting</td>
<td>• Swelling along the shunt tract</td>
<td>• Personality change</td>
<td></td>
</tr>
<tr>
<td>• Irritability</td>
<td>• Loss of previous abilities (sensory or motor</td>
<td>• Loss of coordination or balance</td>
<td></td>
</tr>
<tr>
<td>• Sleepiness</td>
<td>function)</td>
<td>• Swelling along the shunt tract</td>
<td></td>
</tr>
<tr>
<td>• Downward deviation of the eyes</td>
<td></td>
<td>• Difficulty in waking up or staying awake</td>
<td></td>
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<tr>
<td>• Less interest in feeding</td>
<td></td>
<td>• Decline in academic performance</td>
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## Symptoms of Shunt Infection:

- All of the above
- Increased temperature / Fever
- In case of VP shunt: Abdominal complaints !
The Insertion and Management of External Ventricular Drains: An Evidence-Based Consensus Statement: A Statement for Healthcare Professionals from the Neurocritical Care Society.
Infection of the EVD system, otherwise known as a VRI, is a primary concern following catheter insertion. Reported infection rates range from between 0 % to 32 %; however, most typically rates of 10 % or less are described [93–95]. Although variable infection control practices undoubtedly affect this risk, a key difficulty interpreting the EVD infection literature is the lack of a consistent definition of ‘infection.’ Many authors use the CDC definition which is based on positive cultures, clinical symptoms, and labora- tory findings [96], while other authors use a definition of positive CSF culture only [97]. Standardizing the diagnostic criteria for VRI is challenging because organisms can colonize the catheter or contaminate the CSF without causing a infection. Further, infection is not the only cause of CSF inflammation. Hemorrhage and neurosurgery alone can cause inflammatory ventriculitis, and there is overlap of CSF parameters between infectious and chemical ventriculitis. Finally, there are no other definitive reference “gold standards” available to diagnose VRI. Without standardization, further research on VRI will continue to yield incongruent results. The Committee made no attempt at standardizing the definition of VRI across the studies it reviewed.
Good practice statement:
External ventricular drains should be **removed as early** as the clinical situation allows

We suggest **one dose of antimicrobials** prior to EVD insertion (Conditional recommendation; low-quality evidence)

Recommendations:
We recommend using **antimicrobial-impregnated** catheters as part of a comprehensive management protocol to reduce the rate of VRI (Strong recommendation; moderate-quality evidence)

The committee strongly supports institutional adherence to a **bundle** of EVD insertion and management techniques.
Silver-Coated Ventriculostomy Catheters Do Not Reduce Rates of Clinically Diagnosed Ventriculitis.
Nilsson A¹, Uvelius E², Cederberg D², Kronvall E².

Abstract

BACKGROUND:
Ventriculitis is a serious complication when using external ventricular drains (EVDs). Bactericidal silver coating has been reported to reduce risk of infection. In the clinical setting, the diagnosis is often made based on symptoms and analyses of cerebrospinal fluid, with treatment initiated before infection is verified by culture. The bactericidal effect might not correlate with a reduced rate of clinically diagnosed infections. This retrospective study aimed to analyze if use of silver-coated EVDs is associated with a reduced rate of ventriculitis.

METHODS:
During 1 year, clinical routine was changed from inserting noncoated catheters to silver-coated catheters. Rate of ventriculitis was compared between patient groups based on catheter type. To examine the clinical impact of silver coating, ventriculitis was defined as cases where antibiotic treatment was initiated on clinical suspicion.

RESULTS:
Among 296 patients (186 noncoated and 110 silver-coated catheters), 18.9% were treated for ventriculitis, with 21.0% in the noncoated group and 15.5% in the silver-coated group (P = 0.242). Silver coating did not reduce the rate of positive cultures. Duration of EVD treatment was the single significant risk factor for ventriculitis. Silver-coated catheters did not reduce the need for cerebrospinal fluid shunt placement, days with antibiotics, days with EVD, or days in the intensive care unit.

CONCLUSIONS:
The previously reported bactericidal effect of silver-coated EVDs did not alter the clinical course to significantly reduce the number of treated cases of ventriculitis. The introduction of silver-coated EVDs cannot be motivated by reduced use of antibiotics or shorter hospital stay.

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UMCG EVD placement

- EVD placement by neurosurgeon (trainee) preferrably in OR, sometimes in the ICU
- Prophylactic; Cefazolin 2 gr i.v.
- In critically ill patients: on ventilator, SDD = systemic 3-4 days Ceftriaxone i.v. + oral decontamination (colistin, amfoB, tobramycin)
- Extubate when possible, head up
UMCG EVD; care & surveillance protocol

• Daily nursing care of EVD insertion site
  • Mouth-nose cap and inspection: inflammation?, discharge?, leakage?
  • Remove dressing
  • Cleaning with NaCl 0,9%
  • Sterile rinsing (sponge- or-pinger-or-gloves) with Alcohol 70%
  • Aply split dressing, & further gauzes

• Daily CSF specimen
  • from collection bag
  • Sent for culture
UMCG EVD;
When surveillance CSF culture is **positive**:

- Collect stat **proximal port** CSF for **gram-stain** and culture. Contact consultant MMB
- Consider bloodcultures
- Gram-stain positive for bacteria: empiric antibiotic: vancomycin i.t. / i.v. or ceftriaxon i.v.
- Always change the collection system
- Discuss options for **EVD change or withdrawal with neurosurgeon**; re-operate or not
- EVD for analysis cultures on a daily basis
- When **cultures remain negative** after 72 hours: consider colonization & stop antibiotics
- When **culture positive** in 72 hours: treat for 14 days i.v.
- Vancomycin: drug level guided 20-25 mg/ml serum daily basis
Universiteitsmuseum Groningen
Oude Kijk in 't Jatstraat 7a
9712 EA Groningen
050-3635083

2 minute walk

Zoological collection