Diagnosis and Management of Ventriculitis

Background

- Ventriculitis is inflammation of the ependymal lining of the ventricles secondary to infection of the cerebrospinal fluid (CSF).
- A common cause is secondary to neurosurgical procedures to divert CSF flow; most often temporary external drainage through a ventricular access device (VAD), external ventricular drain (EVD) or lumbar CSF drain (LD).
- The diagnosis of ventriculitis is made clinically with supportive evidence in the form of microbiological investigation of CSF and/or radiological imaging.
- The rate of EVD-related CSF infection in the UK has been shown to be approximately 9.3% of all ventricular catheters inserted.
- The commonest causative organisms in general are coagulase-negative *Staphylococcus* spp. (35-70%), *Staphylococcus aureus* (10-20%) and gram-negative organisms (<15%).
- In NHS Lothian in the year August 2020 to August 2021, there were three confirmed cases of ventriculitis secondary to CSF catheter infection and these grew *Bacillus subtilis, Staphylococcus aureus* and one case was culture negative.

Risk factors for infection

- The risk of CSF infection in the first 3 days following drain insertion is very low and other sources of sepsis should be looked for first.
- CSF sampling from the drainage system is a risk for introducing infection and should be performed as few times as possible.
- Intraventricular haemorrhage and subarachnoid haemorrhage are associated with a greater risk of developing infection.
- The risk of infection increases after approximately 7-10 days of external CSF drainage. The use of antibiotic-impregnated ventricular catheters (Bactiseal™ catheters) increases the time to first infection.

Diagnosis

A diagnosis of ventriculitis is made based on CSF sampling. Clinical features that may be supportive of a diagnosis of CSF infection are:

- Fever over 38^{o}C with no other clearly identified source (centrally mediated pyrexia is common in neurosurgical conditions and if you are unsure, please clarify with neurosurgery the relevance of a pyrexia).
- Signs of meningism (headache, photophobia, phonophobia and neck stiffness).
- Reduced level of consciousness.
- New seizures.
- Findings on contrast-enhanced CT or MRI imaging supportive of ventriculitis.

CSF sampling should be undertaken to investigate suspected infection where evidence for this exists clinically. The decision to sample CSF should be based on a discussion between the intensive care and neurosurgical teams. It should only be performed by a member of staff who is appropriately trained. If there are any concerns regarding a CSF drain, please discuss this with neurosurgery.

If there is a concern regarding a patient with a CSF drain developing features in keeping with ventriculitis, early involvement of the neurosurgery team is essential as the drain may need changing.

CSF microscopy results **suggestive** of a diagnosis of ventriculitis are:

- Organisms visible on gram stain.
- Significantly raised WCC with a majority differential of neutrophils.
    - In the scenario of subarachnoid haemorrhage, the presence of blood (raised RCC) can make interpretation difficult and discussion with neurosurgery should be undertaken.
    - Without a differential white cell assessment, interpretation of the white cell count is difficult.
    - A raised white cell count alone does not necessarily mean that there is infection present.
- A CSF RCC:WCC ratio <500:1 and a Cell Index >1 suggest an increased CSF WCC and this may be indicative of infection.
- Progressively increasing WCC over multiple CSF samples in the absence of other pathology.

Management

Following a CSF microscopy / culture result consistent with the diagnosis of ventriculitis, broad spectrum IV antibiotics with blood-brain barrier penetrance should be started initially:

- Intravenous ceftazidime 2g every 8 hours and a continuous intravenous vancomycin infusion as per critical care vancomycin guideline, aiming for a serum vancomycin level of 20-25mg/l.
- In patients with severe penicillin allergy IV vancomycin (dosing as above) and ciprofloxacin 400mg IV every 8 hours should be used (note MHRA fluoroquinolone warning – full details available in BNF / antimicrobial companion).
- In the critical care environment, IV vancomycin is usually given as a continuous IV infusion.

Intravenous therapy should not be regarded as a complete treatment for ventriculitis but it is a reasonable first step when a diagnosis has been made and intrathecal treatment is not yet available. Broad spectrum IV antibiotics should be stopped as soon as negative CSF cultures have been obtained if started empirically.

Intrathecal antibiotics should be strongly considered with input from microbiology and neurosurgery as they are the gold-standard treatment for confirmed ventriculitis.

Each dose of intrathecal antibiotic must be made in pharmacy individually so <u>early discussion and prescription is essential</u>.

It is also essential to clarify with neurosurgery that the CSF drain present is appropriate for administration of intrathecal antibiotics.

The prescription and administration of intrathecal antibiotics can only be undertaken by appropriately trained staff that are on the critical care or DCN intrathecal register. The register is kept on the NHS Lothian intranet and can be accessed both through the DCN and Critical Care directories to view which members of staff are competent to undertake tasks related to intrathecal drug administration.

- Treatment with intrathecal antibiotics is usually continued for at least 10 days with frequent review by both neurosurgery and microbiology to determine total antibiotic course length.
- A 21-day course of intrathecal and intravenous antibiotics is normally required for Gram negative ventriculitis.

Repeat CSF sampling will be required to monitor the WCC response to treatment (if intrathecal antibiotics are given, this will be obtained daily). Change/removal of the in-situ CSF drain is likely to be required and drain changes may be required more than once.

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