Post-neurosurgical Infections for the ID/MM Fellow

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Overview

Neurosurgical procedures for the ID/MM consultant
CSF shunt-related infections
Brain surgery-related infections
Spinal surgery-related infections
Considerations for antimicrobial therapy in post-neurosurgical infections
Napping slide

• The most common post-neurosurgical infections are VP shunt infections, post-craniotomy infections and discitis/vertebral osteomyelitis

• Most post-neurosurgical infections require a heightened index of suspicion coupled with a combined medical-surgical approach

• Treatment usually requires CSF-active antibiotics
There is very little data supporting the diagnosis and management of these infections. There are no RCTs, systematic reviews, or even well-performed case-control studies. Thus, there is a fair amount of “expert opinion” here (unless stated otherwise).
Neurosurgical Procedures for the ID/MM Consultant

- Shunt insertion for hydrocephalus
- Open intracranial surgery (e.g. for resection of tumour)
- Spinal surgery
Shunt Insertion for Hydrocephalus

- Ventriculo-Peritoneal Shunt
- Lumbar-Peritoneal Shunt
- Ventriculo-Atrial Shunt
Shunt Insertion for Hydrocephalus

1. Make scalp incision
2. Make burr hole and perforate dura
3. Make incision just below xiphoid process
4. Tunnel with a metal cannula through the space between the subcutaneous layer and the fascia of the superficial muscles
5. Make incision between left and right rectus abdominus
6. Tunnelise peritoneal catheter
7. Position ventricular catheter
8. Connect ventricular catheter to peritoneal catheter
9. Close incisions
Laminectomy

Normal Spine

Operated Spine following Laminectomy

- Spinous Processes
- Interspinous ligament

Interspinous ligament Disrupted
Laminectomy: spinal stabilization

**Pedicle screws**: provide a means of gripping onto a vertebral segment and limiting its motion

**Interbody cages** (both anterior and posterior): cylinders placed in the disc space

**Spinal rods**: used in conjunction with screws and cages to stabilize the spine

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Case 1

- 51 y.o. F with Arnold-Chiari malformation and VP shunt re-do 10 days earlier (because of shunt malfunction)
- admitted with headache, nausea, and fever
- CT head shows worsening hydrocephalus
- shunt aspirate shows 120 WBCs, normal protein and glucose
- CSF Gram stain: nil seen
- CSF Culture: *Propionoacterium acnes*
- ID consult for antibiotic therapy
Case

• ID Fellows’ Recommendations ...

... Diagnosis?
... Management?
CSF shunt-related infections
Pathogenesis

• not well understood
• the current belief is that CSF shunt infections are surgical site infections (with the majority being caused by staphylococci, esp. coagulase-negative)
• coagulase-negative staphylococci stick to the shunt like glue, and elaborate a protective slime to ward off the host’s defenses
CSF shunt-related infections
Pathogenesis

Lancet Infect Dis 2002;2:677–85
CSF shunt-related infections
Microbiology

- although *Staph.* species account for majority in most Canadian centres, GNB are causative in many other centres worldwide

- recently, there has been an emergence of diphtheroids (e.g. *Propionobacterium acnes* and corynebacteria)
CSF Shunt-related Infections

- can present with
  - systemic signs of infection (+/- fever)
  - local signs of infection (head or peritoneum)
  - shunt malfunction
  - glomerulonephritis (a feature of shunt peritonitis only)

- ventricular drain infections usually produce ventriculitis not meningitis (so neck stiffness is an unusual feature)

- 2/3 of isolates are *Staph.* species
CSF Shunt-related Infections
Systemic Signs of Infection

• fever is very sensitive, although there is a wide variation in its sensitivity (14-100%) in the published literature

• anorexia, lethargy and malaise also present in many patients
CSF Shunt-related Infections
Focal Signs of Infection

• when present, focal pain will either localize to the distal site (e.g. peritoneum) or to the wound

• careful examination of the wound can often reveal the site of infection
CSF Shunt-related Infections
Evidence of Shunt Malfunction

- patients will usually present with symptoms associated with increased intracranial pressure
  - headache
  - nausea and/or vomiting
  - altered mental status
- proximal CSF shunt infection often results in a ventriculitis without meningitis
- distal shunt infections can present with a peritonitis and/or shuntoma +/- glomerulonephritis
CSF Shunt-related Infections Principles of Management

- make the diagnosis of shunt infection
- don’t try to treat with antibiotics alone
- remove the shunt
- treat with antibiotics according to Gram stain and culture
- delay replacement as long as possible
- remember to modify surgical prophylaxis
Summary

- coagulase-negative staphylococci are the most common organisms causing CSF shunt infections
- CSF shunt infections may present with features of local inflammation, systemic inflammation, or as shunt malfunction
- removal of the infected device, along with delayed replacement is an ideal management strategy
Case 2

- 59 y.o. M with 6 week history of progressive headache, and diagnosed with bilateral subdural haematomas
- Haematoma drained 3 weeks ago via bilateral frontal burr holes AND craniotomy
- Has had a less-than-perfect postoperative course, and now presents with pus coming from one of the burr holes and headache
Case 2

What are the most likely organisms? What antibiotics are you going to start? And at what dose? The surgeon is reluctant to take to the OR. Is it worth fighting for?
Potential Post-craniotomy Infections

Brain abscess: pus within the brain parenchyma, surrounded by a vascularized capsule

Cerebritis: pus within the brain parenchyma without a capsulate

Subdural empyema: pus between the dura and arachnoid membranes

Epidural abscess: pus between the dura and the skull
Definitions

- Subdural empyema
- Brain abscess and Cerebritis
- Epidural abscess
Post-craniotomy infections

- most likely organisms are those that colonize the scalp: these differ depending on the circumstances (e.g. elective surgery vs. emergency surgery, duration of hospitalization, etc.)
- *S. aureus* is always an important player, but *Streptococcus* spp. and Gram-negatives are also important players.
Antibiotics in Neurosurgery

• it ain’t simple knowing which drugs penetrate the BBB
  - you need to think about
  - CSF penetration
  - dosing
  - cidal vs. static

• you probably don’t need to think about
  - activity in purulent CSF (and we don’t have much data on this, anyway)
  - mode of administration
CSF Penetration of Antibiotics

**Excellent**
- ceftazidime
- meropenem
- chloramphenicol
- levofloxacin
- metronidazole
- TMP/SMX
- rifampin
- fluconazole
- flucytosine

**Useless**
- cefazolin
- aminoglycosides
- clindamycin
- macrolides
- amphotericin (theory only)
- itraconazole

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## Antibiotic Dosing in CNS Infections

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Dose/d</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>ampicillin</td>
<td>12 g/d</td>
<td>(2g q4h)</td>
</tr>
<tr>
<td>ceftriaxone</td>
<td>4g/d</td>
<td>(2g q12h)</td>
</tr>
<tr>
<td>cefotaxime</td>
<td>12g/d</td>
<td>(3g q6h or 2g q4h)</td>
</tr>
<tr>
<td>ceftazidime</td>
<td>6g/d</td>
<td>(2g q8h)</td>
</tr>
<tr>
<td>vancomycin</td>
<td>3g/d</td>
<td>(1g q8h)</td>
</tr>
<tr>
<td>meropenem</td>
<td>6 g/d</td>
<td>(2g q8h)</td>
</tr>
<tr>
<td>ciprofloxacin</td>
<td>1200 mg/d</td>
<td>(600mg q12h)</td>
</tr>
<tr>
<td>rifampin</td>
<td>600 mg/d</td>
<td></td>
</tr>
<tr>
<td>chloramphenicol</td>
<td>4g/d</td>
<td>(1g q6h)</td>
</tr>
<tr>
<td>TMP/SMX</td>
<td>20 mg/kg/d</td>
<td>(10mg/kg q12h)</td>
</tr>
<tr>
<td>metronidazole</td>
<td>2 g/d</td>
<td>(500mg q6h)</td>
</tr>
</tbody>
</table>
Case 3

- 29 yo M admitted following a motor vehicle accident (he was unbelted driver) with multiple trauma incl.
  - diffuse axonal injury
  - intraparenchymal haemorrhage
- had surgical evacuation of haematomas, followed by insertion of external ventricular drain
Case 3

- patient has been doing relatively well in ICU, but “surveillance CSF fluid studies” demonstrate WBC 720/\( \text{mm}^3 \) (90% neutrophils), but normal protein and glucose
- physical examination reveals fever (present since admission despite cefazolin use), neck stiffness, and nil else
- ID consulted for advice on treating ventriculitis
External Ventricular Drains

- usually inserted intraoperatively for the purpose of monitoring intracranial pressure (following intracranial haemorrhage)
- infection rates vary widely, but are probably about 10%
- fever, neck stiffness, peripheral WBC count, CSF glucose and CSF protein are unreliable predictors of infection
External Ventricular Drains

- cell count correlates relatively well with positive CSF cultures, whereas duration of drainage does not

Distribution of CSF cell counts from bacteriologically positive samples

*J Neurology Neurosurg Psych* 2003;74:929-932
Case 3

- **Diagnosis:** Ventriculitis
- **Management:**
  - remove EVD (or, if it cannot be removed, then change EVD under sterile conditions)
  - consider vancomycin
Summary

• craniotomy infections can be complicated by cerebritis/brain abscess, meningitis and subdural empyema
• if the blood-brain barrier needs to be crossed, antibiotics need to be carefully chosen and dosed in order to be effective
Case 4

- 73 yo woman underwent elective cervical laminectomy with spinal fusion, hardware and bone grafting for spinal stenosis
- post-op course noteworthy only for some local incisional neck pain and redness (treated by FP with acetaminophen + codeine)
- saw spinal surgeon last week, who prescribed cephalexin for 7 days
Case 4

- presents to the OR with 2 day history of fever, chills, drenching night sweats, accompanied by worsening back pain
- physical exam is noteworthy for wound dehiscence and frank pus draining from the incisional site
- ID consulted for empiric therapy, investigation, management, followup
MRI of C-spine
Infectious Complications of Spinal Surgery

- possibilities are:
  - superficial wound infection
  - wound dehiscence
  - vertebral osteomyelitis
  - discitis
  - epidural abscess

- in practice, most of these coexist, and diagnosing one to the exclusion of the others is not usually possible
Infectious Complications of Spinal Surgery

Epidemiology

- rare, occurring in approximately 3-6% of spinal surgeries
- most (~80%) post-spinal surgery infections occur in the first 4 weeks post-operatively
- a combined anterior-posterior surgical approach appears to carry the highest risk of infection
Infectious Complications of Spinal Sx
Initial Investigation and Management

• because this patient appears to have a deep infection, the initial management is a surgical one (involving debridement and irrigation)
• antimicrobial therapy must cover for *S. aureus*, as approximately 75% of such infections are caused by *S. aureus*
• if an initial MRI is not done, obtain one
Case 4

- wound swabs and intraoperative specimens (incl. infected bone) grow methicillin-sensitive _S. aureus_ (S cloxacinin, cefazolin, clindamycin, erythromycin, ciprofloxacin, rifampin, TMP-SMX, and vancomycin; R ampicillin)

- blood cultures x 3 negative

Further investigation and management? Duration of Rx? Followup?
Post-acute Management of Spinal Infections

- get bactericidal antibiotics that will be delivered to the site of infection most effectively
- I usually use a fluoroquinolone + rifampin where possible
- treat for 6 weeks minimum
Tips to make you look good in the Management of Spinal Infections

• ALL patients with discitis/vertebral osteomyelitis develop chronic low back pain: it does not mean treatment failure
• I sometimes use an NSAID as adjunctive therapy
• there may even be accompanying drenching night sweats
• CRP is VERY useful in this setting
• MRI remains abnormal for at least a year—it is not useful in following patients after initial Rx
Summary

- post-spinal surgery infections usually occur within the first month post-op
- *S. aureus* is a usual infecting organism
- treatment is usually for 6 weeks
- signs and symptoms may suggest treatment failure where none exist
Napping slide

• the most common post-neurosurgical infections are VP shunt infections, post-craniotomy infections and discitis/vertebral osteomyelitis

• most post-neurosurgical infections require a heightened index of suspicion coupled with a combined medical-surgical approach

• treatment usually requires CSF-active antibiotics
Questions?

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