Clinical Procedure
Paediatric Lumbar Puncture

SETTING
Bristol Royal Hospital for Children

FOR STAFF
Staff undertaking lumbar punctures

PATIENTS
Children requiring a lumbar puncture; except those undertaken by oncology where local guidelines will be followed.

What is a lumbar puncture?
A lumbar puncture (LP) is a method of obtaining cerebrospinal fluid (CSF) for diagnostic and therapeutic purposes.

Indications
- Diagnostic- For the diagnosis of central nervous system (CNS) infection and inflammation.
- Specialist investigations- For example;
  - Neurotransmitters, Lactate, Amino acids, Glucose, e.g. neuro-metabolic conditions
  - Auto-antibodies (e.g. NMDAR antibodies), e.g. suspected autoimmune encephalitis
  - Oligoclonal bands, e.g. demyelinating disorders
  - Opening pressure, e.g. Idiopathic Intracranial Hypertension (IIH).
  - Cytocentrifugation (Cytospin), e.g. CNS involvement in acute lymphoblastic leukaemia
- Therapeutic - Lowering of CSF pressure in IIH or administration of drugs.

Contraindications
- Signs of raised intracranial pressure (ICP):
  - Reduced or fluctuating consciousness (Glasgow Coma Scale (GCS) score <9 or a drop of 3 or more).
  - Cushing’s triad (Consider if ≥2 of the following): Bradycardia, hypertension and irregular breathing.
  - Focal neurological signs (e.g. unequal pupils, a cranial nerve palsy or limb/s weakness).
  - Abnormal posture (decerebrate /decorticate posturing).
  - Papilloedema (N.B: LP can be performed in the case of idiopathic intracranial hypertension after normal imaging is obtained and discussion with a consultant).
- Shock or respiratory insufficiency.
- After convulsions until stabilised.
- Coagulation abnormalities (Discuss with haematology prior to LP and reverse abnormalities)
  - Abnormal coagulation screen.
  - Platelet count <40×10⁹/L.
  - On anticoagulants (See trust Warfarin guideline).
- Local superficial infection at LP site.
- Children with intrathecal baclofen pumps and lumbar peritoneal shunts (discuss with consultant).
## Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Comment</th>
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| Post LP (low-pressure) headache     | Reported in up to one third of LPs. Thought to arise due to persistent CSF leak from puncture site. Headache is exacerbated by upright posture and typically lasts less than a week. Preventive measures include:  
  - Use of smaller gauge needle  
  - Needle bevel facing the ceiling  
  - Reinserting the stylet before withdrawing the needle  
  Management is by hydration, analgesia and occasionally anti-emetics. Rarely, caffeine or epidural blood patching is required. |
| Backache                           | Likely to be reported after multiple attempts |
| Brain herniation                   | Due to an increase in the pressure differential between the cranial and spinal compartments when the lumbar compartment pressure is lowered by needle penetration.  
  One study showed herniation following lumbar puncture (LP) occurs in 5% of patients with bacterial meningitis.  
  Clinical signs include decerebrate posturing, unresponsiveness, dilated pupils and vomiting. |
| Infection                          | Extremely rare when a sterile technique is used. Vertebral osteomyelitis, discitis, epidural abscess and bacterial meningitis have been reported. |
| Bleeding (intraspinal or intracranial) | Rare. Intraspinal bleeding presents with severe low back or radicular pain soon after LP with paresis and sensory loss in a saddle distribution along with loss of sphincter control. |
| Transient dyasaesthesia            | Symptoms of abnormal lower limb sensations. Occurs during the procedure if the needle makes contact with cauda equina nerve roots. Resolves immediately with needle repositioning. Permanent nerve damage is rare. |

## The role of the CT scan

A normal CT scan does not rule out raised ICP. However, a CT scan is recommended prior to LP if signs of raised ICP are present (See above).
Pre-procedure

Consent
- Written consent is required for an LP requiring a general anaesthetic. The parents should always be aware of the indication, possible complications and method used.

Sedation and anaesthesia
- A calm environment with nursing support +/- play therapist is vital.
- In infants younger than 3 months oral sucrose can be considered.
- Local anaesthesia (*Consider in all patients*).
  - Topical EMLA or LMX (takes 30 minutes).
  - Injection of 1% Lidocaine solution (0.3ml/kg) -however, this may cause initial pain which leads to increased anxiety.
- Sedation (Document in notes method used)
  - Nitrous oxide (Entonox) should be considered if child can hold the mouthpiece and understand instructions.
  - Conscious sedation with a benzodiazepine e.g. Midazolam or Chloral hydrate. (*N.B. See separate sedation guidelines*)
- General anaesthetic
  - Required in non-compliant patients.
  - Discuss with on-call paediatric anaesthetist (VOIP 27888) and theatre coordinator (Bleep 2025). Child should also be added to the emergency (CEPOD) theatre list via BlueSpier.

Monitoring
All unwell children and those who have been sedated should have pulse oximetry as a minimum requirement.

Equipment list
- Sterile dressing pack
- Sterile gloves
- Skin cleaner – Chlorhexidine (Chloraprep stick) or Iodine
- Bevelled 22-gauge (or smaller in neonates) BD Quincke spinal needles (Various lengths available (See below)
- Manometer (to measure CSF opening pressure)
- Universal containers and other required containers
- Plaster
Procedure

**Preparation**
- Indication ascertained, contraindications excluded
- Explanation offered, consent obtained and documented
- Analgesia and sedation as appropriate
- Equipment prepared

**Paired Blood Samples**
- Plasma glucose and lactate
- Special tests eg. serum oligoclonal bands, plasma amino acids

**Positioning**
- Experienced nurse/s to help
- Patient in lateral position (or sitting position in neonates)
- Hips should be FULLY flexed, upper shoulder on same vertical line as lower one; same for hips. No need to flex neck.
- If measuring opening pressure the child must be laid on his/her side; not sitting upright.

**Puncturing**
- Vertical line dropped from superior iliac spine, where this crosses vertebral column is L3 (See figure below)
- Clean the lumbar skin with two applications of Chloraprep
- Slowly advance needle, bevel up and parallel to floor between L3-L4 or L4-L5 aiming for the umbilicus.
- Remove stylet as needle is advanced every few millimetres checking for CSF back flow

**CSF collection**
- Measure opening pressure with manometer tubing as indicated
- Collect at least 3 pre-numbered plain universal containers, plus one fluoride oxalate
- Collect special tests as required

**Post-CSF collection**
- Re-insert stylet before withdrawing needle
- Apply plaster
- Commence antibiotics/antivirals if indicated (do not delay if delay in LP)
- Monitor for and treat complications
CSF needles and depth of subarachnoid space
22G BD Quincke needles are available in the following sizes: 3.8cm / 6.4cm / 8.8cm.
It is best to estimate the depth of the subarachnoid space and then pick an appropriate sized needle. This is estimated using weight by the formula below.

\[
\text{Depth (mm)} = 0.4 \times \text{weight} + 20
\]

CSF Manometry
Manometry allows measurement of the CSF pressure.
The child \textbf{must} be laid flat (not upright)
Connect the tubing using the attachment to the hub of the LP needle (See below). Keep the manometer upright. When the meniscus stops rising read the CSF pressure from the scale.

A normal opening pressure in a child with a normal BMI and non-sedated is \(<25\text{cmH}_2\text{O}\).
A normal opening pressure in a child with an elevated BMI and or sedated is \(<28\text{cmH}_2\text{O}\). (7)

When removing CSF in children with Idiopathic Intracranial Hypertension (IIH) document the opening pressure and volume of CSF removed. Aim for a closing pressure of around \(15\text{cmH}_2\text{O}\).
**Routine CSF tests**
Discuss with the registrar or consultant prior to the LP to ensure that the indicated investigations are ordered.

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<tr>
<th>Test</th>
<th>Minimum CSF volume (NB 20 drops of CSF= 1ml)</th>
<th>Comments</th>
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<tbody>
<tr>
<td><strong>Biochemistry</strong></td>
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<tr>
<td>Glucose (absolute value and CSF: Plasma ratio)</td>
<td>0.25 ml (5 drops)</td>
<td>- Send in a fluoride-containing tube</td>
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<td></td>
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<td>- Requires paired plasma sample before procedure is undertaken</td>
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<tr>
<td>Lactate</td>
<td>0.25 ml (5 drops)</td>
<td>- Send in fluoride-containing tube</td>
</tr>
<tr>
<td>Protein</td>
<td>0.25 ml (5 drops)</td>
<td>- Send in a universal tube</td>
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<tr>
<td><strong>Microbiology</strong></td>
<td></td>
<td></td>
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<tr>
<td>Gram staining, culture and sensitivity plus cells count</td>
<td>0.5 ml (10 drops)</td>
<td>- First drops to be collected (Unless neurotransmitters required)</td>
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<td></td>
<td></td>
<td>- Collect in sterile universal tubes</td>
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<td>- If blood-stained send first and third bottles to the laboratory</td>
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<tr>
<td>Bacterial DNA PCR</td>
<td>0.25 ml (5 drops)</td>
<td>- Useful if partially treated meningitis suspected</td>
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<tr>
<td><strong>Virology</strong></td>
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<tr>
<td>PCR (e.g. Herpes simplex virus, enterovirus)</td>
<td>0.5 ml (5 drops)</td>
<td>- Samples collected within 72hrs from symptoms onset may be falsely negative in HSV infection</td>
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<tr>
<td>Problem</td>
<td>Likely explanation/s</td>
<td>Remedy</td>
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| Difficulty getting the child into the correct position                 | ▪ Poor communication with the team (and child)  
▪ Analgesia and sedation not considered  
▪ Deep infiltration of the local anaesthetic if used (not necessarily needed and may increase discomfort)  
▪ Occasionally midazolam, if used, causes a paradoxical reaction | ➢ Get help from experienced nurses, play therapists etc. as available  
➢ Clear instructions to the person/s holding the child  
➢ Offer explanation and reassurance for the older child  
➢ A parent’s presence may help  
➢ Consider conscious sedation or (rarely) a general anaesthetic in certain circumstances |
| Physiologic instability during procedure (e.g. hypoxia)                | ▪ Neck flexion when child is held  
▪ Prolonged procedure time (e.g. multiple attempts)  
▪ Child is significantly unwell | ➢ Ensure neck is in the neutral position. Neck flexion is not necessary  
➢ Seek senior help  
➢ Postpone procedure if necessary and treat appropriately (e.g. oxygen, fluids, antibiotics etc.) |
| Resistance felt and needle cannot be advanced further                  | ▪ Most likely obstruction is bone | ➢ Needle can be partially withdrawn, the angle adjusted, and then reattempted  
➢ Needle should remain in the midline, parallel to the floor |
| CSF is slow-flowing or seems to be stopping                            | ▪ A nerve root is obstructing the flow of CSF | ➢ Rotate the needle anticlockwise by 90° facing the bevel towards the direction of CSF flow.  
➢ Never use a syringe to withdraw CSF (risk of herniation and haemorrhage) |
| CSF is still slow-flowing or seems to be stopping                      | ▪ Blood clot in the needle lumen | ➢ Re-introduce stylet fully and withdraw again |
| ’Dry’ tap despite needle being advanced adequately                    | ▪ Insertion point in the sacral area  
▪ Insertion point above or below horizontal plane | ➢ Withdraw needle completely  
➢ Reposition patient if necessary  
➢ Re-identify landmarks  
➢ Reattempt with a new needle |
| Traumatic tap                                                          | ▪ Puncturing of a nerve root blood vessel  
▪ Penetration of epidural veins when needle is inserted too deep | ➢ Withdraw needle back slightly and check if CSF clears as it flows  
➢ Re-insertion of needle may be required, with removal of stylet every few millimetres |
**After care**
Ensure simple analgesia is prescribed.
Lying flat post procedure has not been shown to be beneficial.
Document the procedure in the patient’s notes.

**Discharge**
If performed as a day case the child can be discharged once they have eaten and drunk, sat up and must have ambulated appropriately.

**References**
2. Guideline for lumbar puncture, Nottingham University Hospital NHS Trust
5. A handbook of Neurological Investigations in Children, King M, Stephenson B. 2009
8. Taken from: This is Spinal Tap (Group 7), Brandan Penaluna et al. 2014

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**RELATED DOCUMENTS**
- BRHC Clinical Guideline on Sedation in children and young people
- BRHC Clinical guideline on Warfarin.

**AUTHORISING BODY**
Children’s CEC

**QUERIES**
Contact Paediatric Neurology registrar on bleep 6734