Lumbar puncture Mastery

Pre-learning materials

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Click on any button to visit the topic or click next to continue.

Intended Learning Outcomes

By the end of this Mastery pre-learning package you will be able to:

1. Describe the indications for performing a lumbar puncture and its use in clinical practice

2. Explain the risk assessment, patient safety concerns and contraindications to lumbar puncture

3. Describe the potential complications of the procedure and the basic principles of their management.

4. Explain the practicalities of performing a lumbar puncture in a safe and structured fashion.

5. Recognise your limitations and when to obtain help from a senior clinician.

6. Describe the process for ensuring the correct CSF results are requested and obtained.

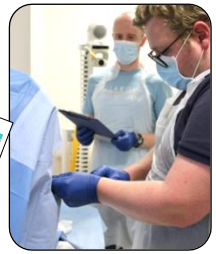
Modified Mastery Pathway

Enhanced Pre-Learning

Peer-Assisted Deliberate Practice

Facilitated Furthering

Simulated Performance & Assessment



Mastery Session

Lumbar puncture

Please watch the below LP exemplar video [20 minutes]

Lumbar Puncture (scot.nhs.uk)

Lumbar puncture

Please watch the below LP learner Mastery session video
[49 minutes]

Lumbar Puncture (scot.nhs.uk)

LP Mastery assessment checklist

Lumbar puncture checklist

This is the checklist you will be assessed against at your Mastery session

Consider these steps as you read through the rest of the pre-learning

Phase 1 – Preparation + Positioning
Identifies correct patient and lists contra-indications (Sheet 1, Q1)
List core consent topics (Sheet 1, Q2)
Lists essential equipment + ensures trained assistant present (Sheet 1, Q3)
Describes optimal position (left lateral)
Optimises / Describes ergonomics (seat/bed height/equipment)
Identifies and marks insertion site (L3/4 or L4/5)
Phase 2 – Asepsis + Anaesthesia
Puts on surgical Mask + Hat / Washes Hands / Gown + Sterile Gloves
Applies antiseptic skin wash + allows to dry (non-touch)
Avoids contamination of equipment and gloves by the cleaning solution
Drapes the patient (non- touch +/- tape by assistant)
Infiltrates local anaesthetic – skin bleb +/- deeper
Phase 3 – Procedural Pause
Performs final equipment check + assembles manometer
Performs 3-point check: Patient, Assistant and Clinician
Phase 4 – Insertion
Inserts introducer
Inserts pencil-point spinal needle
Obtains CSF flow within 3 attempts
Measures opening pressure
Collects CSF: 3 samples of at least 2mls (utilises assistant)
Phase 5 – Anchoring + Dressing
Not applicable
Phase 6 – Completion + Global Points
Describes aftercare: Samples / Analgesia / Pt instructions / Documentation
Maintains control of introducer and needle throughout
Demonstrates safe sharps management throughout
Maintains asepsis throughout
Demonstrates effective communication with assistant throughout

Indications

DIAGNOSIS OF LIFE-THREATENING CONDITIONS

Subarachnoid haemorrhage

Acute Central Nervous System (CNS) infections

- meningitis
- encephalitis

DIAGNOSIS OF NEUROLOGICAL CONDITIONS

Other meningitides

e.g. tuberculosis, carcinomatous

Demyelination/ Inflammatory conditions

e.g. Guillain Barre Syndrome, Multiple Sclerosis, Vasculitis

Raised intracranial pressure

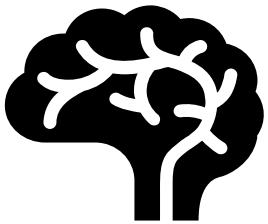
e.g. Idiopathic intracranial hypertension, cerebral venous sinus thrombosis

Cognitive decline

e.g. Creutzfeldt-Jakob Disease

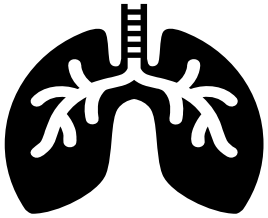
Contra-indications (CIs)

All potential contraindications should be assessed and a decision made about the risk versus benefit of the procedure for each individual.

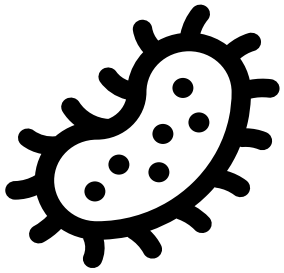


Raised ICP

Bleeding Risk



Respiratory Compromise

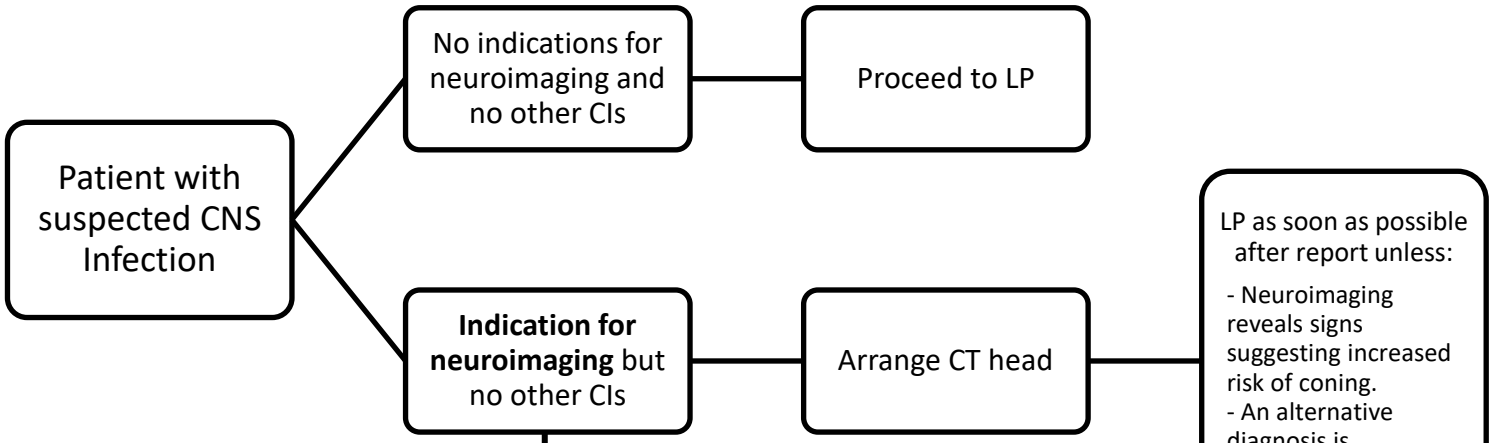


Skin infection at site

Agitated/ confused patient

More details to help you assess these are on the following slides

MENINGOENCEPHALITIS



Indications for neuroimaging prior to LP[2]

1. **Focal neurological signs**
2. **Presence of papilloedema**
   - inability to view the fundus is not a contraindication to LP, especially in patients who have had a short duration of symptoms.
3. **Continuous or uncontrolled seizures**
4. **GCS ≤ 12**
   - LP without prior neuroimaging may be safe at levels below this, but there is increased risk of coning

Immunocompromise is listed in some sources as an indication for CT head prior to LP, due to an increased risk of Space Occupying Lesions. However there is no evidence to support this risk if none of the above clinical signs are present.

CT prior to LP

The BIA Meningitis guidelines provides a summary on p9-10 of the evidence and rationale for these recommendations

MENINGOENCEPHALITIS

The gold standard of care for suspected CNS infection would include:

1. Urgent clinical assessment
   - The need for a rapid LP has to be weighed against the desire to start antimicrobial treatment urgently[1].

2. Rapid lumbar puncture prior to antimicrobials
   - Even if antimicrobial treatment has been initiated, a LP should still be performed as soon as possible, preferably within 4 h of commencing antibiotics, to help identify the cause of meningitis[2].
   - The culture rate (and PCR positivity) can drop off rapidly after that time and it can become difficult to identify the causative bacteria in cases of bacterial meningitis[1].

3. Prompt antimicrobials
   - Intravenous antibiotics should be given promptly in hospital as there is evidence that delays increase mortality[3, 4, 5].

OTHER INDICATIONS

In suspected SAH CT head should be performed prior to LP.
LP should be delayed until >12 post headache onset to improve diagnostic yield

Lumbar Puncture and Bleeding Risk

A brief guide to managing antiplatelets and anticoagulation in patients requiring lumbar puncture (LP).

Patient requires lumbar puncture

Consider Bleeding Risk

Performing an LP with coagulopathy increases the risk of spinal haematoma

Consider Thrombosis Risk

Suspending antithrombotic treatment comes with an increased risk of thrombosis

The following slides are not a local protocol and in cases of uncertainty advice should be sought from the local Haematology team

Reference[6]: Dodd, K. C. et al. (2018) 'Periprocedural antithrombotic management for lumbar puncture: Association of British Neurologists clinical guideline', Practical Neurology, 18(6), pp. 436–446. doi: 10.1136/practneurol-2017-001820.

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Performing an LP with coagulopathy increases the risk of spinal haematoma

- **Routine coagulopathy testing in unselected patients is not recommended**
- **Consider a patient's risk of haemorrhage on an individual basis**
- **Consider checking platelet count is >40 x10^9 and PT/APTT within normal range if high risk for coagulopathy:**
  - liver or renal failure
  - heparin treatment for >5 days
  - haematological disorder
  - disseminated intravascular coagulation
  - personal/family history of unexplained bleeding

If at high risk for bleeding discuss with haematology team or consider postponing LP

Consider Thrombosis Risk

Suspending antithrombotic treatment comes with an increased risk of thrombosis

Haematology comments:

Almost all patients will have a FBC +/- coagulation screen performed prior to LP, so always check the results of these if available.

Although a coagulation screen is not required routinely, it should be performed in the context of thrombocytopaenia as the most likely cause of this in the context of CNS infection would be consumption/DIC

In the context of platelets <40x10^9 consideration of platelet transfusion

Ultimately your decision is balancing the risk of delaying an LP to perform a coagulation screen versus the risk of missing a coagulopathy and increased risk of spinal haematoma

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Suspending antithrombotic treatment comes with an increased risk of thrombosis

Consider bridging with treatment dose heparin:

Venous Thrombembolism
- Patients with a VTE within previous 3 months.
- Very high risk patients such as patients with a previous VTE whilst on therapeutic anticoagulation who now have a target INR of 3-5.

Atrial Fibrillation
- Patients with a previous stroke/TIA in last 3 months.
- Patients with a previous stroke/TIA and three or more of the following risk factors:
  - *Congestive cardiac failure*
  - *Hypertension (>140/90 mmHg or on medication)*
  - *Age >75 years*
  - *Diabetes mellitus*

Mechanical Heart Valve
- MHV patients other than those with a bileaflet aortic valve and no other risk factors

Very high risk for stopping antiplatelets:
- drug eluting stent <12 months
- bare metal stent <1 month

→ Consider postponing LP

Intermediate risk:
- on dual antiplatelets or complex cardiac history

→ Consider aspirin bridging and discuss with cardiology

Bridging guidelines here: Keeling, D., Tait, R.C., Watson, H. and (2016), Peri-operative management of anticoagulation and antiplatelet therapy. Br J Haematol, 175: 602-613. https://doi.org/10.1111/bjh.14344

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Urgent LPs: Patients may require an urgent LP outside of these time frames. Discuss with haematology about reversing warfarin and some DOACs. In other situations it may be decided that the benefit of an LP outweighs the increased bleeding risk, but the patient must be informed of this risk and be carefully monitored for new neurological symptoms or signs.

Bleeding risk: discontinuing antiplatelets

Discontinuing medications in patients with normal renal function

Antiplatelets	Withhold prior to LP	First dose after LP
Aspirin low dose 75mg	Continue	No delay
Clopidogrel	7 Days consider aspirin cover	6 Hours
Prasugrel	7 Days consider aspirin cover	6 Hours
Ticagrelor	5 Days consider aspirin cover	8 Hours
Dipyridamole	24 Hours	6 Hours
Tirofiban + Eptifibatide	4-8 Hours	24 Hours
Abciximab	48 Hours	24 Hours

Haematology comments:
Consider aspirin cover in patients at high risk of thrombosis who were on alternate antiplatelets

All patients on antiplatelets should have a FBC checked to assess for thrombocytopaenia prior to LP

This slide is an amalgamation of the following guidelines:

Harrop-Griffiths, W. et al,. (2013), Regional anaesthesia and patients with abnormalities of coagulation. Anaesthesia, 68: 966-972. doi.org/10.1111/anae.12359

Dodd, K. C. et al. (2018) 'Periprocedural antithrombotic management for lumbar puncture: Association of British Neurologists clinical guideline', Practical Neurology, 18(6), pp. 436–446. doi: 10.1136/practneurol-2017-001820.

Bleeding risk: discontinuing anticoagulants

Discontinuing medications in patients with normal renal function

Haematology comments:

Any patient whose anticoagulation is being stopped is likely to need thromboprophylaxis unless contraindicated

When stopping warfarin, prophylaxis should be started once the INR is <2, not when the first dose is missed.

If LP is essential in the context of Fondaparinux treatment then this can be discussed with haematology

This slide is an amalgamation of these guidelines:

Harrop-Griffiths, W. et al,. (2013), Regional anaesthesia and patients with abnormalities of coagulation. Anaesthesia, 68: 966-972. doi.org/10.1111/anae.12359

Saja, K. Addendum to the guideline on the peri-operative management of anti-coagulation and anti-platelet therapy. Br J Haematol. 2022; 197: 188– 189. https://doi.org/10.1111/bjh.18114

Dodd, K. C. et al. (2018) 'Periprocedural antithrombotic management for lumbar puncture: Association of British Neurologists clinical guideline', Practical Neurology, 18(6), pp. 436–446. doi: 10.1136/practneurol-2017-001820.

Anticoagulants	Withhold prior to LP	First dose after LP
Warfarin	5 Days check INR ≤1.4	No delay
LMWH prophylaxis	12 Hours	4 Hours
LMWH treatment	24 Hours	4 Hours (24 hours if traumatic)
Fondaparinux prophylaxis	36 Hours	6-12 Hours
Fondaparinux treatment	Avoid LP	12 Hours
Unfractionated heparin IV	4-6 Hours	4 Hours
Rivaroxaban + Apixaban	48 Hours	6 Hours
Dabigatran	48 Hours	6 Hours

Bleeding risk: bridging

Discontinuing medications in patients with normal renal function

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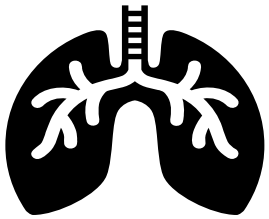
Bridging Protocol for High Risk Patients

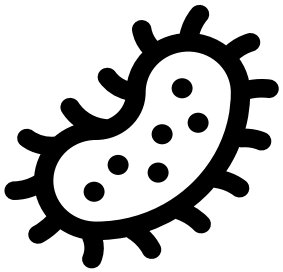
Day	-5	-4	-3	-2	-1	LP	+1	+2	+3
Warfarin	x	x	x	x	x	x Check INR ≤1.4	✓ Usual or double usual dose	✓ Usual or double usual dose	✓ Check INR
LMWH	x	✓ Once INR subtherapeutic	✓	✓	x Withhold at least 24hrs before	✓ 4 hours after	✓	✓	? Stop once INR in target range

Other contraindications



RESPIRATORY COMPROMISE

- Patients with any form of respiratory compromise (especially respiratory muscle weakness) present significant risk in the context of invasive procedures.
- Particular attention must be paid to positioning, ventilatory and physical support of such patients.
- If the patient is deemed fit enough, by senior clinicians, to undergo such a procedure, it should ideally be performed in the upright position.



SKIN INFECTION

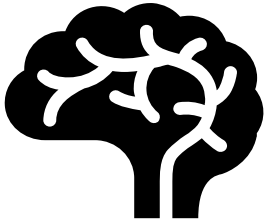
- Skin infection, cellulitis or suspected epidural abscess at the site of the LP can potentially introduce infection into the CSF space.
- If any concerns, delay procedure and seek help.

AGITATED OR CONFUSED PATIENT

- There is a higher chance of failure, trauma and infection if the patient is unable to remain still.
- A senior, experienced clinician should attempt the LP for an agitated patient.
- The patient may require mild sedation and discussion with anaesthetists.

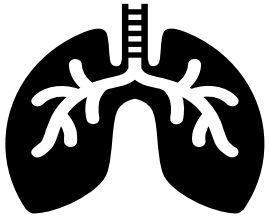
Contraindications

Click any of the icons to return and review that contraindication

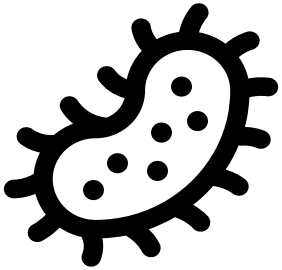


Raised ICP

Bleeding Risk



Respiratory Compromise



Skin infection at site

Agitated/ confused patient

Patient safety considerations

When performing lumbar puncture, the goal is to safely obtain diagnostic information having removed or minimised any potential risk factors.

If there is any concern that significant risk of harm may compromise patient safety, delay the procedure and seek senior advice.

Resuscitation equipment

- Resus trolley available
- Consider IV access pre-procedure

Competent practitioner

- Supervisor available for practitioner, if required

Skilled assistant

- Competent in equipment checking and ensuring patient comfort
- Familiar with environment and procedure

Questions to consider prior to LP

Consider these questions prior to any invasive procedure:

- Does it need to be done?
- Does it need to be done now?
- Am I competent to do this?
- Is supervision/ assistance available?
- Am I familiar with the equipment?
- Does the patient have capacity to consent to the procedure?

Discussion with patient and consent

The patient should be made aware:

- Why they are having the procedure
- The benefits
- The potential risks/ complications (outlined on next 2 slides)
- The alternatives to the procedure.

Once this has been done, informed consent should be sought and documented. There is a consent form available in NHS Lothian which can be used for written consent for lumbar puncture.

If the patient does not have capacity to give informed consent, and the procedure is deemed clinically necessary, ensure an Adults with Incapacity form is completed.

Always establish whether the patient has any known allergies prior to the procedure - they may have an allergic reaction to local anaesthetic or antiseptic skin preparation.

What are the risks?

A recommended script for discussion with patients:

The most common side effects of having a lumbar puncture are[7]:

- Short-lived back pain (1 in 6 people)
- Shooting leg pain during the procedure (1 in 9 people)
- Headache (1 in 10 people).

Sometimes the first attempt at the procedure is not successful. In this case we may need to repeat it.

There are also some more serious, rare risks[8]:

- Infection: Abscess (1 in 47,000 people) and Meningitis (less than 1 in 200,000 people)
- Serious bleeding: Spinal haematoma (less than 1 in 100,000 people)
- Permanent nerve damage (1 in 100,000 people).

Note that the best evidence is derived from National Audit of spinal procedures involving mainly spinal anaesthesia which generally use large bore needles and consequently have higher risks of bleeding and infection. The risks are likely lower for diagnostic lumbar puncture[8]

Risks from Lumbar puncture and management

Complication	Estimated incidence	Clinical presentation	Recommended action
Post dural puncture headache	**1 in 10**	Headache following lumbar puncture which is usually worse sitting/standing and improved on lying flat.	See next slide
Backache[7]	**1 in 6**	Mild localised or generalised lumbar pain	Simple analgesia, reassurance and worsening advice for symptoms of more severe complications below
Infection: **local cellulitis**[7]	**No frequency data**	Spreading cutaneous erythema without evidence CNS infection	IV antimicrobials as per local guidelines Consider deeper infection
Infection: **Vertebral canal abscess & Discitis/Osteomyelitis**[8]	**1 in 47,000**	Local signs of infection +/- systemic signs of infection. Delayed presentation of weeks/months possible	MRI spine Blood cultures Infectious diseases, neurosurgery and neuroradiology discussion
Infection: **Meningitis/ meningoencephalitis**[8]	**<1 in 200,000**	Pyrexia, neck stiffness, confusion, altered consciousness. May be atypical presentation.	LP Infectious diseases referral
Spinal or extradural haematoma[8]	**1 in 117,000**	Persistent/severe back pain Lower limb neurological deficit	Urgent MRI spine Neurosurgical discussion
Cerebral herniation	*Risk theoretical based on historical studies*[9]	Reduced GCS, Coma, dilated fixed pupils, Bradycardia and hypertension (Cushing's reflex)	ICU referral Neurosurgical discussion

Risks: Post dural puncture headache

Definition and aetiology

Headache following a lumbar puncture (LP) typically has a low-pressure phenotype; i.e. worse upright and better lying flat. It is usually caused by a dural tear sustained at the time of LP and does not relate to the volume of cerebrospinal fluid (CSF) taken. In most cases it is self-limiting although a few patients may require a blood patch for persistent headache, and rarely the low pressure may be associated with the development of subdural haematomas.

Practices associated with reduced risk of post-LP headache

Finer gauge needles[10, 11]	Decreased risk with smaller gauge needles. Although smaller needles take longer to collect the required samples, this is not associated with patient discomfort[24]. 22G is likely the ideal size, balancing collection duration with reduction in risk
Atraumatic needles[11, 12]	Atraumatic (e.g. Whitacre/Sproute) needles should be used first line. There is high quality evidence that these lead to a lower risk of post-LP headache than traumatic (e.g. Quincke) needles
Orientation of the bevel of the needle[13, 14]	Use of needle in a transverse plane (perpendicular to the longitudinal axis) This is less relevant when using an atraumatic needle
Replacement of the stylet [15]	Unlikely to be relevant with atraumatic needles.
Experience and number of attempts[16]	Fewer attempts at dural puncture is associated with a decreased incidence of headache after lumbar puncture

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Practices NOT proven to reduce risk of post LP headache

Reducing the volume of CSF taken[17]	There is no evidence that the amount of CSF removed influences the incidence of post LP headache
Bed rest[18, 19]	Patients are often advised to lie recumbent for a period of time after an LP but there is no evidence that this reduces the risk of headache.
Hydration[19]	There has only been one study looking at fluid post LP as a preventative strategy and it showed no difference between those who took 1.5 L and those who had 3 L post LP.
Caffeine	IV caffeine can be used to treat post LP headache but there is no evidence that either oral or IV caffeine can prevent the headache. Oral caffeine can be recommended if the patient develops a headache, but this is not evidence based.

Needle selection

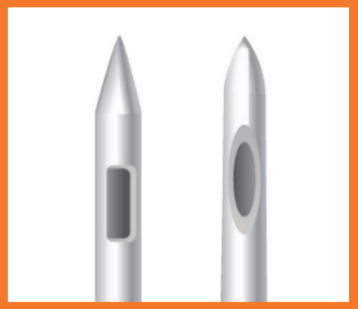
Conventional needle

Lumbar puncture with any conventional needle

or

Atraumatic needle

Lumbar puncture with any atraumatic (pencil point) needle



Conventional needle | **Atraumatic needle**

Strong | Weak | Weak | Strong

We recommend the use of atraumatic over conventional needles

Comparison of benefits and harms

Favours conventional needle | No important difference | Favours atraumatic needle

	Events per 1000 people			Evidence quality
Postdural puncture headache	98	59 fewer	39	★★★★ High
Need for epidural blood patch	24	12 fewer	12	★★★★ High
Backache	166	No important difference	159	★★★★ High
Hearing disturbance	53	40 fewer	13	★★★★ High
Nerve root irritation	126	37 fewer	89	★★★☆ Moderate
Hospital for fluids or analgesia	39	22 fewer	17	★★★★ High
Failed lumbar puncture	38	No important difference	33	★★★★ High

Source[20]: Atraumatic (pencil-point) versus conventional needles for lumbar puncture: a clinical practice guideline | The BMJ

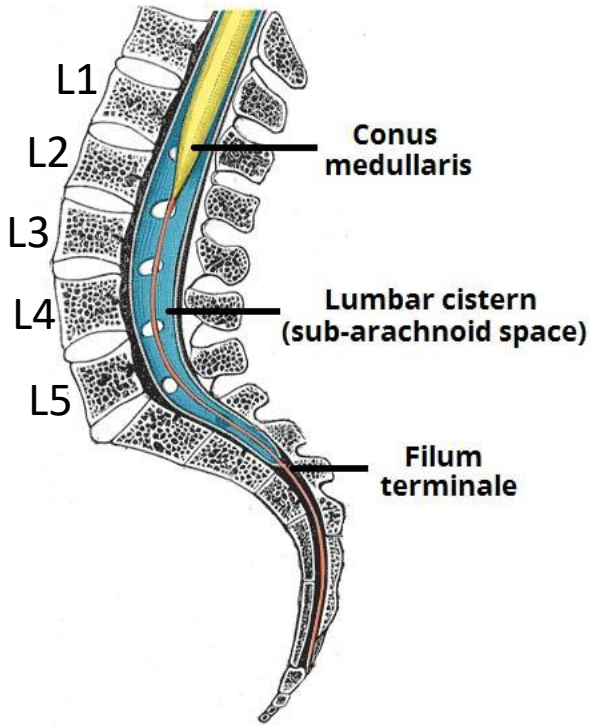
CEREBROSPINAL FLUID (CSF)

- provides hydromechanical protection of the central nervous system and plays a prominent role in brain development and regulation of brain interstitial fluid homeostasis, influencing neuronal functioning.
- The mean CSF volume in adults is 150ml, with 25ml in the ventricles and 125ml in subarachnoid spaces.
- Approximately 500-600mls of CSF is produced by the choroid plexus (and other cells) over 24 hours i.e. the entire volume is renewed about four times every day.
- Approximately 15-17ml of CSF can be safely taken in adults (~250-280 drops)
- The normal range for adult CSF opening pressure (measured with the patient in a lateral position) is 10-25cmCSF.

	Mean CSF production rate (ml/h)	CSF volume (mls)	Safe CSF volume to take at LP (mls)
Adult	22	150–170	15–17
Adolescent	18	120–170	12–17
Young child	12	100–150	10–15
Infant	10	60–90	6–9
Term Neonate	1	20–40	2–4

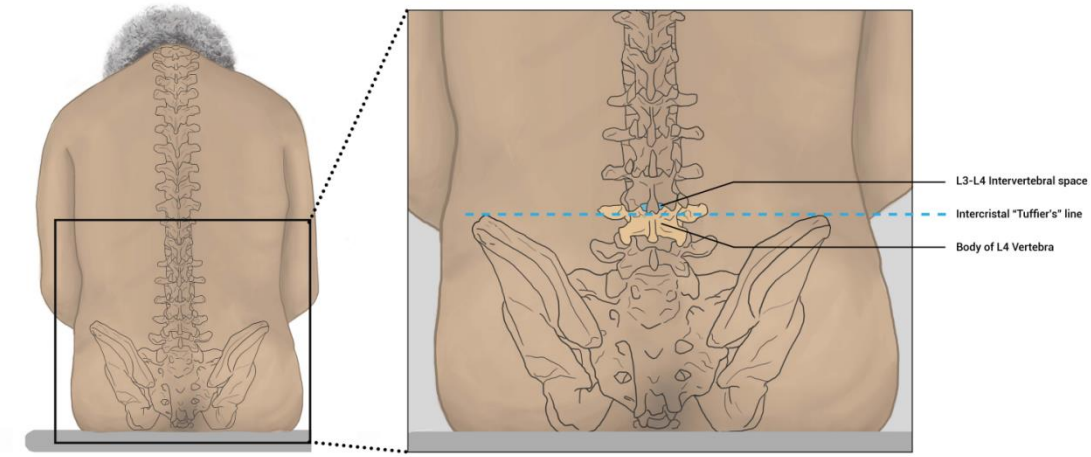
Table: Estimates of CSF production rate and safe volume to take[27]

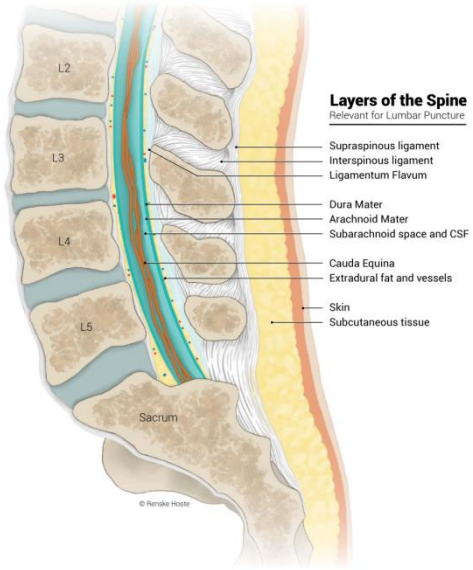
The spinal cord in adults
Image source *(used with permission of creator)* and to learn more:
The Spinal Cord - Meninges - Vasculature - TeachMeAnatomy



SURFACE ANATOMY

An imaginary line connecting iliac crests at the level of the L4 vertebral body in most patients. Sometimes called Tuffier's line.





INTERNAL ANATOMY

Sagittal section. The spinal needle will pass through skin, supraspinous ligament, interspinous ligament, ligamentum flavum and into the epidural space

Click the buttons below to view a 3D model:

Animated needle

Annotated model

The procedure: required equipment & resources 1

The following should be available before commencing the procedure.

PPE & Arranging equipment

Full asepsis should be maintained throughout the procedure.

Use of surgical gown, mask, hat is recommended. There is evidence of iatrogenic infective complications following spinal procedures[8]

ARRANGE EQUIPMENT

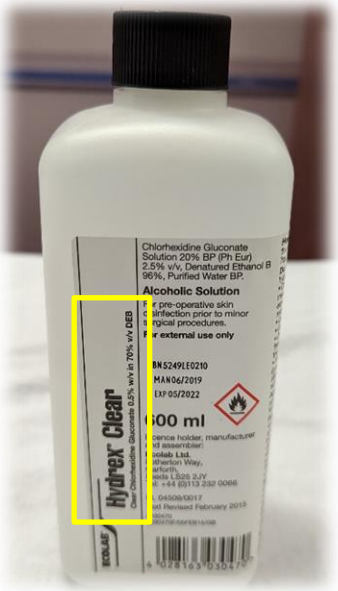
- Put on head-cap and face-mask prior to opening sterile equipment.
  - In the rare cases of epidural abscess most reports identify bacteria that are found to have come from the operator's oral flora.[8]
  - Oral flora can contaminate samples if a mask is not worn
- Open sterile pack onto procedural trolley
- Open procedural equipment onto the trolley
- Ensure trolley on correct side for clinician

Skin cleaning[21]

Should be performed with **0.5% Chlorhexidine + 70% ethanol (Hydrex clear)**

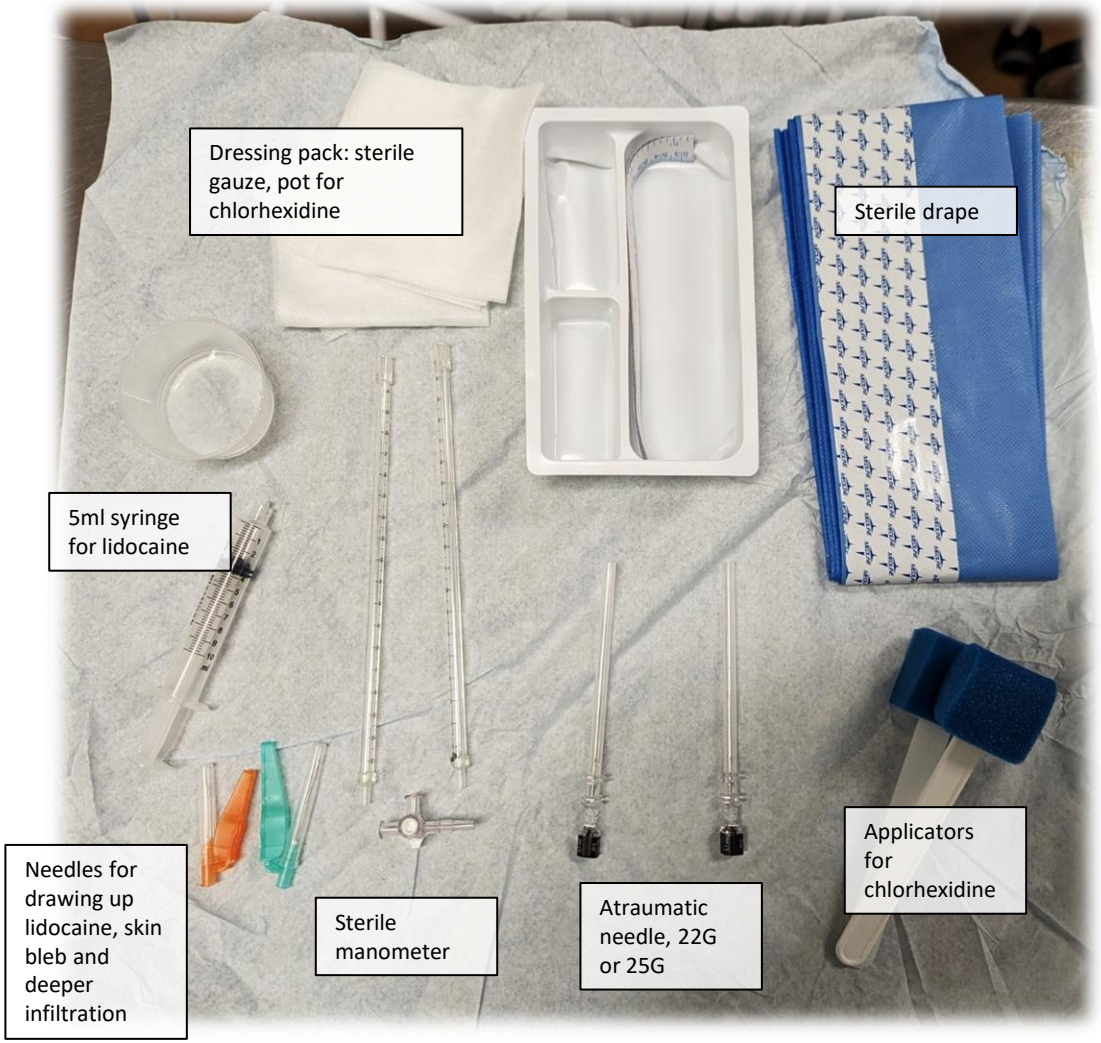
- Iodine has less antiseptic effect
- 2% Chlorhexidine has been associated with arachnoiditis
- ***Avoid contaminating the spinal needle with chlorhexidine solution***

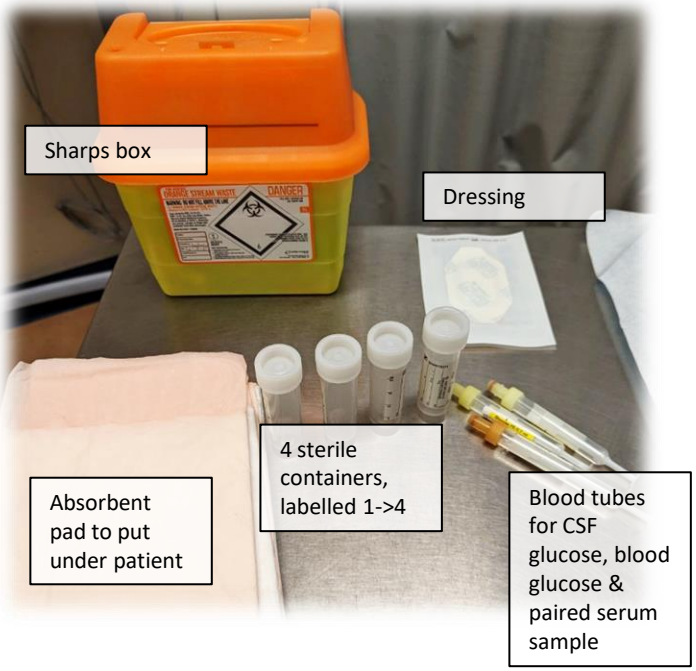
21. Wash & go – but with what? Skin antiseptic solutions for central neuraxial block - Checketts - 2012 - Anaesthesia - Wiley Online Library



The procedure: required equipment & resources 2

The following should be available before commencing the procedure.

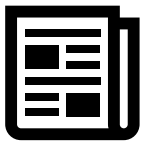




Not pictured:

1. Experienced And Skilled Assistant
2. Stool/Chair For Operator To Sit On During Procedure
3. Pillows (X2)
4. Procedural Trolley
5. Lidocaine 1% Or 2% - 5ml Ampoule
6. Black Bag/ Tin Foil/Envelope (To Protect Sample From Light)
7. Venepuncture equipment

The procedure: preparation and assistance



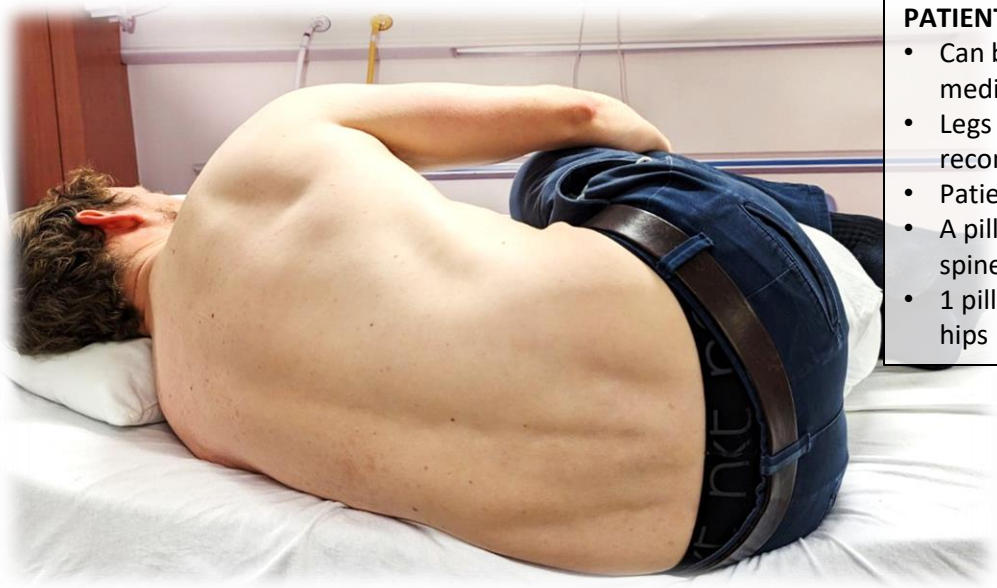
Explain the procedure

Consider contraindications

Patient and clinician preparation

- The patient may wish to visit the bathroom prior to positioning
- Ensure clinician to patient position is appropriate and seat available if required. Ideally have the needle at eye level when sitting, as this makes obtaining the correct insertion angle easier
- Remove pager and/or phone
- Ensure your assistant is prepared
- Reassure the patient

The procedure: patient positioning and set up



PATIENT POSITIONING:LATERAL POSITION

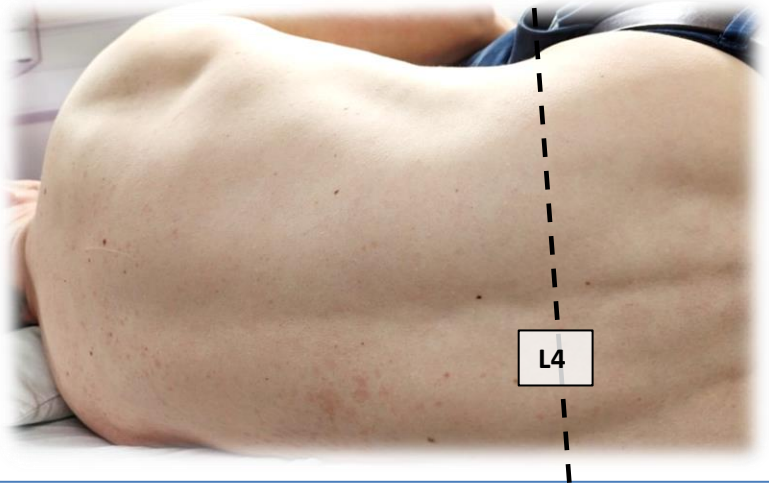
- Can be either left or right lateral position. Left lateral is standard in most medical units
- Legs should be flexed as much as possible. Neck flexion is not recommended.
- Patient must be comfortable and steady
- A pillow can be placed under the patient's head for comfort. Ensure spine is as horizontal as possible.
- 1 pillow between the patient's knees to minimise axial rotation at the hips

PATIENT POSITIONING: SITTING POSITION

- Sitting position is an appropriate alternative, although opening pressure not comparable.
- Sitting erect with legs over the side of the bed
- Use chair for patient's feet to rest on. This tends to roll the inferior pelvis anteriorly and help promote an outward curvature of the lumbar vertebrae.
- Use a pillow and ask patient to hug it. This will promote the patient leaning forward and again increase the outward curvature of the lumbar vertebrae.

IDENTIFY LANDMARKS

- Most lumbar punctures are inserted at the L3/4 interspace.
- L2/3 and L4/5 are also suitable in adults.
- Tuffier's line, a line drawn between the posterior iliac crests, corresponds with the body of the L4 vertebra.
- Mark the intended insertion space with an indentation or a marker pen



The procedure: clinician position and needle control

Clinician

- Sit on a chair
- If safe to do so, raise the patient's bed until the spine is at eye level for the clinician. This will make it easier to judge the angle of needle insertion
- Place the procedure trolley nearby, using your assistant to move equipment

Needle control

- Insert the introducer using your dominant hand, then hold the introducer with your non-dominant hand to maintain control whilst inserting the spinal needle with your dominant hand.
- Rest your non-dominant hand against the patient's back to increase your needle control

The procedure: asepsis

Ensure that the patient is lying on absorbent pads and that clothing has been moved out of the way.

- Wash hands and dry with sterile hand towels.
- Put on sterile gown and gloves.
- Apply antiseptic skin wash.
- Ensure that equipment is not at risk of exposure to antiseptic spray/ liquid drops.
- Allow the chlorhexidine to dry whilst you prepare yourself and your equipment.
- Be vigilant that nothing contaminates the area whilst the chlorhexidine is drying.

DRAPE THE PATIENT

- Remove the adhesive strips from the drape and, without contaminating the field, apply the drape to the patient with the circular cut-out centred on the intended vertebral interspace

Chlorhexidine Gluconate 0.5% w/v in 70% w/v DEB

The procedure: analgesia & anaesthesia

LOCAL ANAESTHETIC

- Ask assistant to open and hold vial of lidocaine and draw it up
- Ensure no allergy to lidocaine
- Infiltrate skin with lidocaine. Depending upon the amount of subcutaneous tissue up to 3-4ml of lidocaine 1% or 2% may be appropriate.
- Infiltrate the intended track to the ligamentum flavum, there should be resistance to infiltration once the ligament is reached.

ANALGESIA

- In patients who are very anxious consider oral analgesia or oral anxiolytics prior to the procedure.
- Note conscious sedation should not be carried out in ward areas without anaesthetic support.

Maximal lidocaine doses

- **4.5mg/kg** in adults and children >12 years
  previous guidance with different recommendations with/without adrenaline have been removed.
- **3mg/kg** in children<12 years
- Not to exceed **200mg** in healthy adults

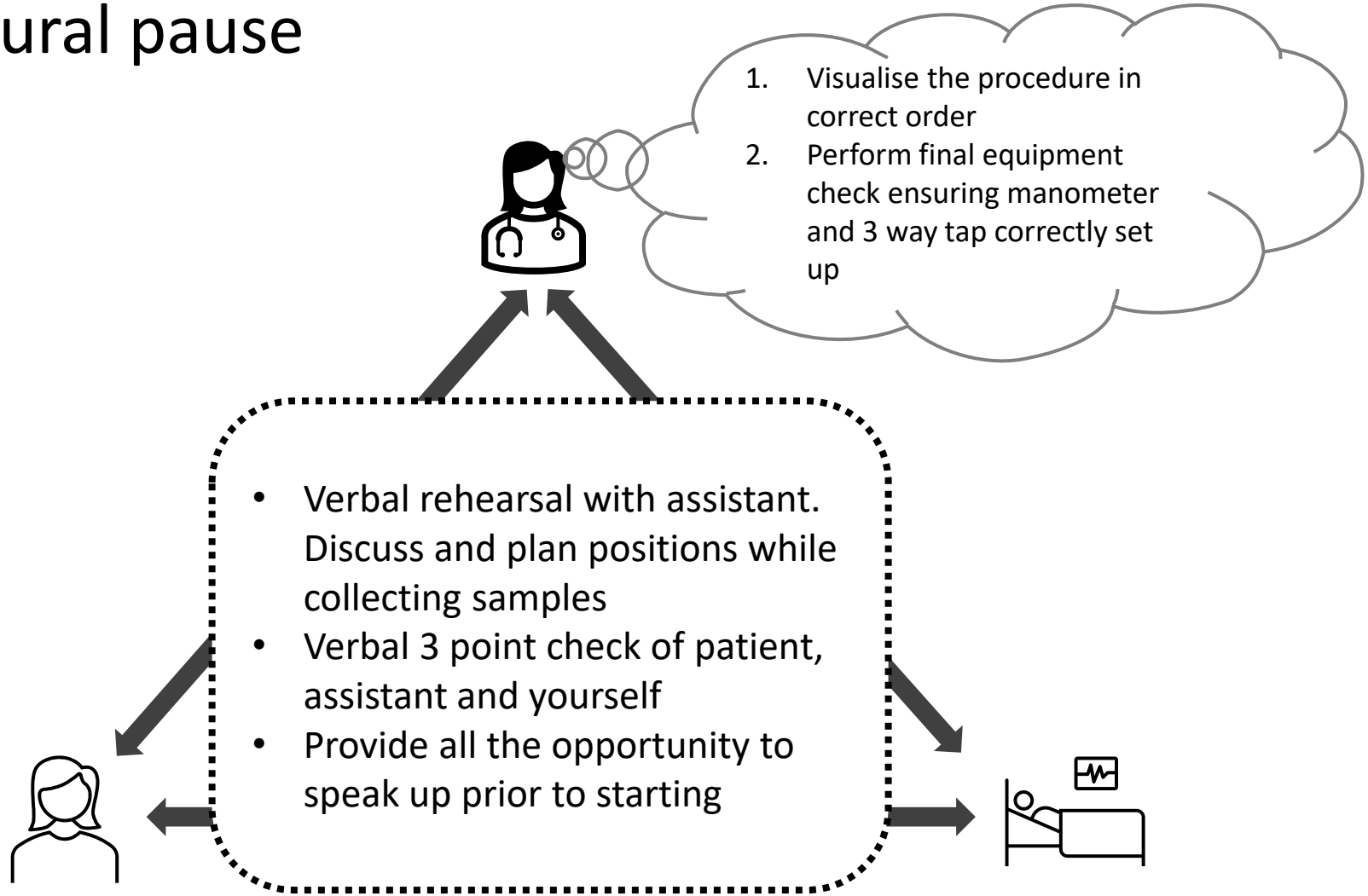
Lidocaine Hydrochloride Injection Summary of Product Characteristics (SmPC) - (emc) (medicines.org.uk)

Example for 60kg patient: Local Anesthetic Dosing Calculator - MDCalc

- Maximal dose = 200mg (290mg by weight but note 200mg max)
- Lidocaine 1% = 1g/100ml
- Maximum dose = 20mL

Formula: patient weight(kg)x 0.45 = maximal lidocaine 1% dose in mL

Procedural pause



Insertion

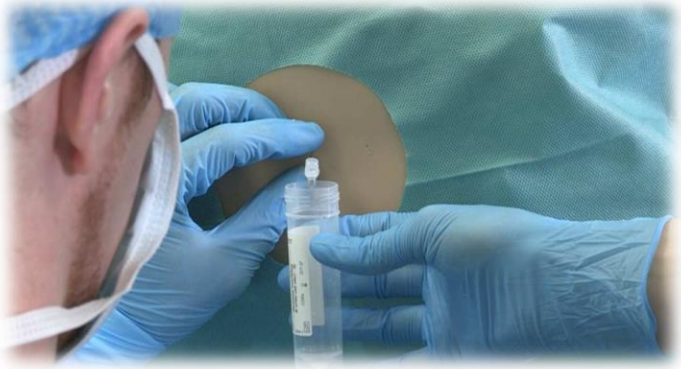
INSERTION OF SPINAL NEEDLE

Confirm your landmarks and the spinal interspace. Note that an introducer is required for the pencil point needle you will use; this will be included with the spinal needle in its sterile pack.

Watch the associated video for more details about needle technique.

OPENING PRESSURE

Use the manometer and measure the opening pressure for every patient (95% reference interval for normal pressure is 10-25 cmCSF)



The procedure: troubleshooting

Initial LP plan:
- left lateral position
- 22-24G atraumatic needle with introducer. L3/4 or L4/5 disc space

Success!

Unsuccessful (no CSF)

Identify issue:
1. Patient position: *adequate lumbar flexion*
2. Clinician position in relation to patient*: height of bed*
3. Needle position: *depth, midline, horizontal angle*

Retract introducer needle almost to skin/remove completely if large reposition required.
Re-insert at correct angle/location

If remains unsuccessful
- Consider attempting alternate disc space
- Consider performing with patient sitting upright (unless opening pressure essential)

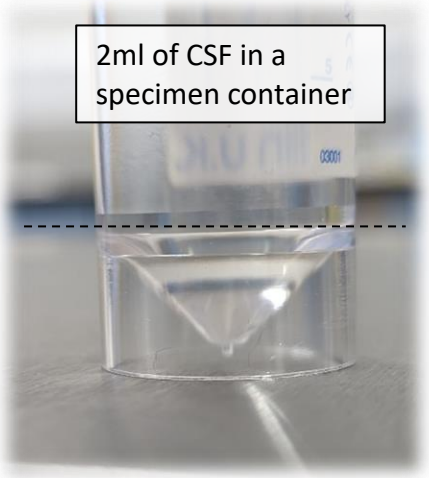
Maximum 3 attempts and ensure patient comfort

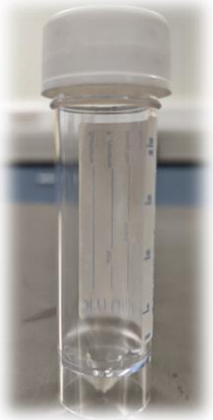
If frank blood aspirated:
- The needle is likely in a paravertebral vein, or the patient may have a SAH.
- If uncertain can collect some sample and if rapidly clots then likely blood from vein rather than CSF.
- Remove needle and apply firm pressure

Unsuccessful
- Discuss with senior
- Consider anaesthetics referral
- Communicate with patient

CSF COLLECTION

- Each drop of CSF is around 0.06mL. 10 drops = 0.6mL
- >2ml (~30 drops) is required for microscopy and culture (MC&S)
  - 10 drops is **not sufficient.**
  - Taking insufficient samples reduces sensitivity, results in some investigations not being performed and may result in the need for a repeat LP
  - Needle size and type does not significantly affect droplet size
- Other investigations may require less volume, details can be found here
- If sample bottles are not externally sterile, the assistant should hold sample collection bottles under LP needle, taking care not to touch anything sterile.
- Ensure the bottle tops are secure.





The safe volume of CSF to take at LP is around 15ml in adults (~250 drops).

Elderly patients may produce reduced volumes

Post procedure: Sample volumes and requests

Biochemistry

- CSF protein, glucose (min volume 0.2ml).
  - Paired serum glucose is essential for interpretation.
  - Ideally send CSF Glucose in yellow top tube (as more stable)
- CSF lactate is a useful test to discriminate bacterial & viral meningitis with reported sensitivity 93% and specificity 96% (if sent prior to antibiotics)[2,22,23]
- Requests for **spectrophotometry** to exclude SAH should be made on the last sample of CSF collected (min volume 0.2ml) and need to be protected from light using an envelope or tin foil
- If testing for Oligoclonal bands, paired serum protein essential

Microbiology/Virology

- Microscopy, culture and sensitivity (MC&S) (volume >2ml, ~30 drops)
- Request CSF viral and bacterial PCR on all possible meningitis/encephalitis CSF samples
- Send EDTA (red top tube) blood sample for bacterial PCR (Meningococcus, Pneumococcus, Haemophilus)
- if TB considered, at least 6ml CSF required[24]
- If CSF antibodies requested, a paired serum sample (brown top tube) is essential (e.g. CNS Lyme)
- Always send blood cultures for patients with suspected CNS infection

Pathology

- at least 5ml if malignancy considered, usually for cytospin

Post procedure: Specimen transport and processing

- Ensure correct minimum volume
- The specimens must be labelled correctly and sealed
- Ensure there are sufficient clinical details in TRAK/on request form as this will affect the tests performed
- Ensure timely arrival at the lab and inform Biomedical Scientist (BMS) that microscopy for cell count required. You should know the process for your local site
    - Details on contacting BMS and how to send samples by each site here: Test Directory | Edinburgh and Lothians Laboratory Medicine (edinburghlabmed.co.uk)
- Consider HIV testing in all patients with Meningoencephalitis as per BHIVA/BASHH/BIA Adult HIV Testing guidelines 2020
- Approximately one white cell is permitted for every 500 cells in the CSF cell count

CSF for cell count is an urgent sample[25]

Cell counts decrease rapidly with time, with a drop in reported neutrophil count of 32% at 1 hr and 50% at 2hr.

Leukocyte survival in cerebrospinal fluid. - PMC (nih.gov)

Post procedure: completion

1. Remove needle and apply pressure with gauze until bleeding stops
2. Provide advice to the patient about follow up/ symptoms to be aware of such as delayed Post LP Headache
3. Label and send CSF samples
4. Return bed to usual position
5. Apply simple dressing to insertion site and ensure no ongoing bleeding
6. Dispose of waste and sharps appropriately
7. Restock LP trolley/box if in use.
8. Document procedure

Why documenting LP accurately is important:

- Communicate to colleagues how procedure was done (may affect results e.g. microscopy)
- Medio-legal if complication occurs (e.g. post dural puncture headache, spinal haematoma)
- Documenting which tests were sent helps team review correct results (and act if results not received)
- Documenting appearance of CSF, e.g. if initial blood clears suggests traumatic LP rather than SAH

Post procedure: documentation

An example documentation short code from NHS Lothian, entered using “\lp”

LUMBAR PUNCTURE DOCUMENTATION

Patient information leaflet & consent form available here: intranet.lothian.scot.nhs.uk/Directory/neurology/PatientLeaflets/LumbarPunctureleaflet.pdf
Information leaflet provided: Y/N/AWI

Indication and procedure explained: Y/N/AWI
Risk of side effects explained: Y/N/AWI
Consent obtained: Y/N/AWI

Pre-procedure checks completed: Y/N
No contra-indications on review: brain imaging; blood tests; allergies; medications:
Guidelines on anti-coagulants and anti-platelet agents:
intranet.lothian.scot.nhs.uk/Directory/anaestheticsandtheatres/AnaestheticsTheatresDocs/Documents/PreoperativeAssessmentandPerioperativeCare/Warfarin, Direct Oral Anticoagulants and Anti-platelet Medication

Operator/supervisor:
Position: lateral/sitting
Vertebral level:
Aseptic technique: Y/N
Local anaesthetic type/dose:
Attempts:
Needle type/gauge:
Opening pressure:
Volume CSF removed:

Always send CSF samples for:
Cell count
C&S (culture & sensitivities)
Protein
Glucose (always send paired serum sample within 4 hours)
Consider sending CSF samples for:
Viral PCR (recommend paired serum HIV test)
Oligoclonal bands (always send paired serum sample)
Spectroscopy/xanthochromia (protect from light and transport by hand, phone the lab if approaching out of hours)
Cytology (5-10mls)
Lactate
Mycobacteria TB Ix (5-10mls)
Mycology fungi Ix (5-10mls)

Post-procedure blood tests obtained: Y/N
Must send: Paired serum glucose (within 4 hours)
Consider: HIV test; paired serum oligoclonal bands; bacterial meningitis PCR profile; blood cultures

Post-procedure advice given: Y/N

The clinical test directory can be found here: https://edinburghlabmed.co.uk/TestDirectory/Pages/default
To ensure accurate reporting of cell count, do not delay in taking samples to the lab

Summary

Thank you for completing this pre-learning

You are now ready to attend an in-person Mastery Learning Session

By the end of this Mastery pre-learning package you will be able to:

1. Describe the indications for performing a lumbar puncture and its use in clinical practice

2. Explain the risk assessment, patient safety concerns and contraindications to lumbar puncture

3. Describe the potential complications of the procedure and the basic principles of their management.

4. Explain the practicalities of performing a lumbar puncture in a safe and structured fashion.

5. Recognise your limitations and when to obtain help from a senior clinician.

6. Describe the process for ensuring the correct CSF results are requested and obtained.

Tip

Clicking the Home icon to return and review any of the sections of this pre-learning

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