APPENDIX 1:

Equipment list

- Appropriate personal protective equipment including sterile gloves
- Sterile pack/field
- Cleaning solution (See local policies)
- Sterile gauze
- Dressing towel/drape
- LP needle +/- introducer for atraumatic needle (and spare) – diameter no smaller than 22G (0.7mm outer diameter), length sufficient for patient.
- Compatible manometer and 3-way-tap (and spare)
- Sterile plaster or dressing
- CSF and blood sample collection bottles
- Filter needle for drawing up lidocaine
- Syringe and needles for lidocaine administration
- Equipment for blood sampling
- Lidocaine
- Entonox
- Assistant for positioning patient (non-sterile)
- Assistant for sample collection (non-sterile)

Example procedure checklist

1. Confirm routine observations and GCS within acceptable parameters.
2. Ensure recent neuroimaging available to exclude radiological contraindications to LP.
    a. If signs of raised ICP evident on neuroimaging, review decision whether to proceed with LP with the patient's Consultant.
3. Exclude other contraindications to LP including thrombocytopaenia or abnormal coagulation profile in the context of suspected increased bleeding risk, for example with a personal or family history of bleeding, in the context of sepsis and haematological disorders, as well as in suspected renal or liver failure.
    a. Discuss with Haematology/Clotting specialist before LP if suspected bleeding risk and for patients on anticoagulant medications.

4. Review patient medication administration record / drug chart for medications and allergy history which may impact safety of LP e.g. low molecular weight heparins, warfarin, clopidogrel, direct oral anticoagulants.
5. Ensure laboratory are prepared to receive samples.
6. Confirm all members of medical/nursing/AHP/play teams present.
7. Team briefing
8. Check all equipment prepared and within expiry dates.
9. Offer patient opportunity to use toilet facilities prior to procedure.
10. "Sign in", including confirmation of patient identity, consent, procedure and patient allergies.
11. Position patient, team members and equipment appropriately.
12. Inspection of patient's back to ensure no obvious abnormal spinal anatomy, no superficial infection, and no gross contamination of skin (e.g. faecal matter, in which case the patient should be washed prior to proceeding).
13. "Time out" with re-confirmation of patient identity, procedure, required samples and re-confirmation of no other contraindications.
14. Take paired blood tests (if applicable)
15. Proceed with lumbar puncture (including local/general anaesthesia or sedation if applicable)
16. Collect CSF neurotransmitters (if applicable)
17. Measure opening pressure
18. Collect samples
19. Repeat opening pressure measurement
20. Remove further CSF as required
21. Repeat opening pressure measurement (closing pressure)
22. Confirm all samples required collected
23. Ensuring replacement of stylet, remove needle and apply sterile pressure dressing or equivalent.
24. "Sign out" with confirmation of completion of procedure, sample labelling, safe disposal of any sharp instruments and documentation of procedure.
25. Team debrief
26. Ensure samples transported correctly to laboratory

APPENDIX 2:

"Snapshot" measurements of lumbar pressure opening pressure are likely to be an over-estimate of the true ICP, which may mis-lead clinical management[S1]. Monitoring dynamic changes in CSF pressure ameliorates the impact of variation in CSF pressure over time and may give more accurate information. One study measured CSF pressure using lumbar puncture for as long as 60 minutes[S2]; clearly keeping a patient in the LP position for this long may be challenging. One article, however, was able to demonstrate a significant fall in CSF pressure over 20 minutes[S3] – a much more practical duration. The two previous studies additionally employed an electronic pressure transducer, eliminating the need to hold and take readings from a manometer column, making their approach more practical. Such apparatus also provides a real-time indication of CSF pressure and the amplitude of the pressure wave, aiding the interpretation of findings.

"CSF infusion studies" take this approach further, combining a transduced pressure measurement together with controlled infusion of fluid (usually over 20-30 minutes) into the subarachnoid space. Such techniques' dynamic measurements provide detailed information regarding an individuals' CSF circulation, such as the capacity of an individual to accommodate changes in CSF pressure (compliance)[S3].

The definitive means to measure intracranial pressure, however, remains invasive neurosurgical monitoring using an intraparenchymal pressure sensor, or transduced from an external ventricular drain. This enables recording of pressure, amplitude and waveform, but is not without risk of infection[S4], and is significantly invasive in comparison to lumbar puncture.

S1 Cartwright C, Igbaseimokumo U. Lumbar puncture opening pressure is not a reliable measure of intracranial pressure in children. *J Child Neurol* 2015; 30(2):170-173. DOI: 10.1177/0883073814533006

S2 Bono F, Salvino D, Tallarico T, Cristiano D, Condino F, Fera F, Lanza PL, Lavano A, Quattrone A. Abnormal pressure waves in headache sufferers with

bilateral transverse sinus stenosis. Cephalalgia 2021; 30(12):1419-1425. DOI: 10.1177/0333102410370877

S3 Lalou AD, McTaggart JS, Czosnyka ZH, Garnett MR, Krishnakumar D, Czosnyka M. Cerebrospinal fluid dynamics in pediatric psedotumor cerebri syndrome. Child's Nervous System 2020 36:73-86. DOI: 10.1007/s00381-019-04263-4

S4 Czosnyka M, Pickard JD. Monitoring and interpretation of intracranial pressure. J Neurol Neurosurg Psychiatry 2004; 75:813-821. DOI: 10.1136/jnnp.2003.033126

Supplementary materials online: Video 1

https://drive.google.com/file/d/1GRNYVYJ2o6Fv7rdzRYwEVt3J3b6tm2PF/view