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# Documentation of cerebrospinal fluid opening pressure and other important aspects of lumbar puncture in acute headache

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## Abstract

Background: Measuring CSF opening pressure by lumbar puncture is an essential tool in the investigation of patients with acute headache.

Aim: To assess documentation of opening CSF pressure in those with acute headache undergoing lumbar puncture. General documentation of the procedure and CSF investigations was also assessed.

Methods: Retrospective review of medical records of patients admitted to a teaching hospital Acute Medical Admissions Unit over a three month period with a presenting complaint of headache.

### Results:

106 patients presented with headache of whom 48 patients had at least one LP attempted. Only 41 patients (85%, 95% CI 72-94) had their LP documented. Out of 47 patients that had a successful LP, 22 (47%) had a recorded opening pressure. 18 (32%) of all patients had their position recorded, with 7 (15%) patients having had position and opening pressure documented. 20 patients (43%) had the appropriate results documented. 12 patients (31%) had paired serum glucose measured.

### Conclusions:

Documentation of a lumbar puncture for headache in the acute setting was generally poor. CSF opening pressure measurement was frequently omitted and no appropriate action taken if high. Paired serum glucose was rarely measured. Acute physicians may benefit from a proposed protocol and documentation sticker.

## What is already known about this topic?

1. Measuring CSF opening pressure by lumbar puncture is essential when investigating of headache in the acute setting
2. Adequate documentation of LP procedure and results is important, both for clinical management and medico-legal purposes

## What does this article add?

1. Frequency of measurement of CSF opening pressure in the context of acute headache and general documentation of many aspects of the LP procedure itself is surprisingly poor.
2. Measurement of paired serum glucose is also poor in the acute setting.
3. Acute physicians may benefit from a proposed protocol and documentation sticker.

## Documentation of cerebrospinal fluid opening pressure and other important aspects of lumbar puncture in acute headache

### Introduction

Since its first description by Quincke in 1891<sup>1</sup>, the lumbar puncture (LP) has become an important diagnostic tool. In the context of acute headache, LP is an essential tool in the investigation of suspected subarachnoid haemorrhage (SAH) with a normal computerised tomography (CT) brain scan, meningitis, cerebral venous sinus thrombosis and idiopathic intracranial hypertension (IIH).

Whereas laboratory investigation of the collected cerebrospinal fluid (CSF) guides or confirms the diagnosis of SAH and meningitis, a raised CSF opening pressure may be the only indication of the presence of a cerebral venous sinus thrombosis and is a requirement for the diagnosis of IIH, whilst a low CSF pressure may suggest intracranial hypovolaemia, although ideally the latter should be diagnosed without LP which may exacerbate the headache<sup>2</sup>.

It is therefore necessary to attempt to measure the CSF opening pressure whenever performing a diagnostic LP, especially in the context of acute headache. To ensure that this important aspect of LP was being performed, a study was carried out in which the primary objective was to assess the frequency of measurement of CSF opening pressures as part of the investigation of acute headache.

The opportunity was also taken to assess the general documentation of LPs and to assess the further CSF investigations requested. For all the patients who underwent an LP for acute headache, it was confirmed whether a definitive diagnosis was made at discharge. These were the secondary objectives.

### Methods

One author (RH) retrospectively reviewed all the medical notes of patients admitted with the presenting complaint of headache to the acute medical admissions unit (AMAU) of the Aberdeen Royal Infirmary between 10<sup>th</sup> March and 10<sup>th</sup> June 2008 inclusive. Identification of these patients was made by review of the AMAU admissions logbook which gives details of every patient admission and their presenting complaint.

The same author reviewed the clinical notes, the discharge summary and the laboratory results for each patient that was admitted with a presenting complaint of a headache to confirm whether an LP had been performed. If an LP had been performed, data were collected on patient demographics, the documentation of the indication for the LP, brain imaging, different aspects of the LP procedure and the CSF opening pressure. The results of the CSF and paired serum glucose sent to the laboratory were also analysed (a paired serum glucose was regarded as acceptable if the sample was received at the laboratory within six hours of the CSF arrival) and the discharge diagnosis was recorded. 95% confidence intervals (95% CI) were calculated using web-based software (<http://www.surveysystem.com/sscalc.htm>).

## Results

A total of 106 patients were admitted to AMAU with headache as a presenting symptom over the three-month period. Forty-eight patients had at least one LP attempt. Of these 48, 24 patients were female and the mean age at presentation was 41.7 years (SD 14.8).

Only 41 patients (85%, 95% CI 75-95) had one or more LPs documented in their inpatient medical record. The indication for the LP was not documented in a further 7 patients (15%) [figure 1]. The brain imaging modality was documented in the notes as CT head in 41 patients (86%), Magnetic Resonance Imaging (MRI) in one patient (2%). No imaging was performed in two patients (4%) considered to have meningitis and the type of imaging was not documented in four patients who had CT head performed (8%).

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Of the 48 patients who had LPs performed, 10 were unsuccessful at first attempt. Eight LPs were repeated successfully on the ward, one LP was referred for radiologically guided assistance and one LP was abandoned and not repeated. Therefore, there were a total of 57 attempted or successful LPs that served as the denominator for the documentation of LP procedure (Table 1).

The documentation of the different aspects of CSF collection for the 47 successful LPs (documented and non documented) is shown in Table 2. Thirty-two (68%) of successful LPs had some form of results documented. The results were compared to the indication for the LP and recorded as appropriate if the result of the spectrophotometry had been documented in possible SAH, or if the microbiology results had been documented in possible meningitis. Only 20 (43%) of successful LPs had appropriate results.

The tests requested on the CSF were compared with the documented indications for the LPs (Table 3). This demonstrates that 97% of possible SAH had spectrophotometry requested. 100% of possible meningitis had microbiology requested, 50% possible meningitis had virology requested. Only 26% of all CSF sent for glucose had a paired serum glucose requested. Furthermore only 20% of possible meningitis had paired serum glucose requested.

Table 4 demonstrates that 23 patients (48%) had a diagnosis for the acute headache that attempted to describe the aetiology of the headache. 25 (52%) patients had no appropriate diagnosis including 13 patients with no diagnosis documented (27%).

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## Discussion

We have highlighted a number of problems in the documentation of LPs in the context of investigating acute headache in a medical admission unit of a major teaching hospital. Whilst poor documentation does not necessarily imply poor performance, it does raise concern.

### *CSF opening pressure*

The primary aim of this study was to assess the frequency of measurement of CSF opening pressure, which should be measured and documented in all patients with acute headache undergoing an LP. However, it was only recorded in 47% of those who had a successful LP. There are few data on the upper and lower limits of normal recumbent CSF opening pressure but a recent large study found a 95% reference interval of 12 to 25cmCSF though some patients with an opening pressure of 28 had no symptoms of increased ICP<sup>3</sup>. In our study four patients had opening pressures greater than 25cmCSF: one patient was known to be in the upright position, rendering the measurement invalid<sup>4</sup> but no action was taken nor discussion recorded in the notes of the other three patients. No patient in this study had a documented CSF pressure less than 10cmCSF.

It may be that a proportion of our patients were not in the lateral decubitus position when the CSF was collected, which is why CSF pressure was not recorded. Anecdotally, it is sometimes easier to perform a successful LP whilst the patient is in the upright position (this increases the interspinous distance<sup>5</sup>), although there are no studies that evaluate the success of LP with different patient positions<sup>6</sup>. However, we were unable to confirm this because patient position was recorded in only 32% of LPs.

### *Documentation of procedure*

General assessment of LP documentation in this study revealed that it was generally poor to the extent that 15% (7/48) of patients had no documentation of the LP at all in the case notes. We concentrated on documentation of aspects of the procedure that we felt were important clinically or had evidence to support their use in making LP safer (e.g. in reducing post LP headache). Consent was documented in only 35% of LPs performed. Whilst there are no specific guidelines concerning how consent for LPs should be obtained, generally we believe it is appropriate to document at least verbal consent has been obtained for most LPs given that it is an invasive procedure with a significant risk of adverse events. The LP should be performed in the L3-L4, L4-L5, L5-S1 intervertebral space to avoid the risk of damaging the conus medullaris<sup>7</sup> although there is no evidence as to the optimal site for the initial attempt and the accuracy in documenting the correct disc space has not been studied. 37% of the LPs in this study had a documented space, but it is unknown whether other attempts were made at other levels and for two attempts the documented level was inappropriately high (L2-L3).

The time of the LP was only recorded in 60%, but this is important in the investigation of SAH since it is recommended that LPs are ideally performed more than 12 hours after the onset of the headache to allow the in vivo enzymatic process of haemoglobin breakdown to bilirubin<sup>8</sup>, noted clinically as xanthochromia or measured by spectrophotometry. If performed too early, it may render the procedure invalid.

1  
2  
3 Aseptic technique, important for all invasive procedures, was recorded in 72% of our  
4 LPs, although the incidence of post LP meningitis is low<sup>9</sup>. All LPs in this study were  
5 done with Quincke cutting needles, which are conventionally used by non-  
6 anaesthetists. Although the anaesthetic literature has conclusively shown that  
7 atraumatic needles significantly reduce the incidence of postdural headache<sup>10</sup>, their  
8 use would require widespread retraining of medical specialists in the UK due to the  
9 different insertion technique. Only six LPs (11%) in this study documented the gauge  
10 of the spinal needle (20G and 22G). A larger needle has been shown in many studies  
11 to cause more post LP headache<sup>13</sup> thought to be due to a larger dural hole and thus  
12 more CSF leak. The incidence of postdural headache with 20-22G Quincke needles  
13 can be up to 40%, but can be reduced to 5% using 24-27G needles<sup>11</sup>. However, a  
14 study using smaller than 22G needles showed that it took more than six minutes to  
15 collect 2ml CSF, and measurement of OP was similarly slow and potentially  
16 inaccurate<sup>12</sup>. Hence, we would recommend that a needle of 22G be used in the context  
17 of acute headache.  
18

19 There was no documentation on bevel orientation or stylet reinsertion before spinal  
20 needle removal in this study despite some evidence that insertion with the bevel  
21 parallel to the axis of the spine and stylet reinsertion reduces the incidence of post LP  
22 headache<sup>13,14</sup>.  
23

#### 24 **CSF collection**

25 74% of successful LPs had CSF colour documented and all were 'crystal clear' or 'gin  
26 clear'. The colour of normal CSF is crystal clear and may become turbid with as few  
27 as 200 or more white blood cells, or become yellow, orange or pink with  
28 xanthochromia. Visual inspection of xanthochromia is debatable, as a high CSF  
29 protein seen in inflammatory conditions or infections, bilirubinaemia or a traumatic  
30 tap can be mistaken for xanthochromia<sup>15</sup>. The use of spectrophotometric detection of  
31 CSF bilirubin has a high sensitivity<sup>16</sup> and should be used in all suspected SAH.  
32  
33

34 A traumatic tap occurs in approximately 20 percent of lumbar punctures<sup>8</sup>. A common  
35 practice is to measure cell counts in three consecutive tubes of CSF. If the number of  
36 red blood cells is relatively constant, then it is assumed that the blood is caused by an  
37 intracranial hemorrhage. A falling count is attributed to a traumatic tap. The three-  
38 tube method, however, is not always reliable<sup>8</sup> and visual inspection after centrifuging  
39 may be better.  
40

#### 41 **Post LP advice**

42 Post LP advice was recorded as having been given in 47% of successful LPs but was  
43 usually not evidence based. Patients were advised to lie flat for varying lengths of  
44 time and take 'clear fluids' despite the fact that systematic reviews have shown no  
45 benefit from bedrest<sup>17,18</sup> or hydration in reducing post LP headache<sup>19</sup>.  
46  
47

#### 48 **Results**

49 The results of the CSF analysis were documented in the notes in 68% of patients with  
50 a successful LP. This is poor, yet when comparing the results documented against the  
51 original indication for the LP, e.g. result of spectrophotometry in the case of a  
52 possible SAH or microbiology with possible meningitis, it is poorer still since only  
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43% had appropriate results documented. All but one (97%) of the possible SAH had spectrophotometry performed. 100% of the possible meningitis had microbiology performed, but only 50% of possible meningitis had virology polymerase chain reaction (PCR) requested. Requesting viral PCR or serology with possible meningitis is important in making an accurate diagnosis, which may have implications for treatment e.g stopping inappropriate antibiotics.

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**Deleted:** and thus in the selection of the appropriate antimicrobial and duration of use.

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The measurement of a paired serum glucose is important because normal CSF glucose is about two thirds of the serum glucose measured during the preceding two to four hours in a normal adult<sup>15</sup>. In this study, even when a serum glucose received by the laboratory within 6 hours of the CSF glucose was accepted as a 'paired' glucose, only 26% of successful LPs had a paired glucose. Only 20% of possible meningitis had a paired glucose, arguably the most important indication for a glucose measurement.

### **Final diagnosis**

It is an important part of clinical practice to attempt to formulate a possible diagnosis in order to manage a patient appropriately. A recent study looking at emergency department evaluation of sudden severe headache reported that 40% of patients were discharged without a specific diagnosis<sup>20</sup>, whereas 52% of the patients in this study were given no diagnosis at discharge. This may be because staff felt that the most important diagnostic issue was to exclude an important 'serious' cause for the headache but also probably represents a lack of clinical knowledge as to other possible causes of acute headache.

### **Weakness of study**

It is impossible to know in a retrospective review whether certain aspects of the LP procedure were truly omitted or just not documented. For this reason this is predominantly a study on documentation. Nevertheless, documentation reflects practice in the medico-legal arena and it should always be expected that the clinical notes will be scrutinized at some point. Moreover, in the era of decreasing continuity of care due to shift systems, documentation has become increasingly important in the day-to-day management of patients.

### **Conclusion**

Although this study has primarily shown that the frequency of measurement of CSF opening pressure in the context of acute headache was poor, it has also shown that general documentation of the certain aspects of procedure itself was varied and poor. One solution to the problems identified in this study might be to ensure that all LPs are performed by neurologists who might be expected to be more aware of the need to perform and document LPs adequately. However, this is unlikely to be feasible in many hospitals. Moreover, the LP remains an important test in general medicine, which all acute physicians should be able to perform and document according to best practice. The results of this study, therefore, prompted implementation of a ward-based and trust-wide intranet protocol that aims to improve LP procedure (*figure 2*). To address the poor quality of documentation, a sticky label has also been designed to be placed in the clinical notes after each practitioner's attempt (*figure 3*).

1  
2  
3 **Authors Contributions**

4 Russell Hewett Design, data collection, data analysis/interpretation, statistics, drafting article.

5  
6 Carl Counsell Concept, critical revision of article, approval of article.  
7

8  
9 **Disclosures**

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11  
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13

14  
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## TABLES

Table 1: Documentation of Aspects of LP procedure.

Aspect of LP procedure	Frequency of documentation n=57 (%, 95% CI)
Date	49 (86%, 77-95)
Time	34 (60%, 47-73)
Designation	29 (51%, 38-64)
Consent (verbal or written)	20 (35%, 23-47)
Patient position	18 (32%, 20-44)
Aseptic technique	41 (72%, 60-84)
Local anaesthetic	44 (77%, 66-88)
Needle gauge	6 (11%, 3-19)
Intervertebral space	21 (37%, 25-49)
Bevel direction	0
Stylet reintroduced	0

Table 2: Documentation of Aspects of CSF collection

Aspect of CSF collection	Frequency of documentation n=47 (%, 95% CI)
Opening pressure	22 (47%, 33-61)
CSF colour	35 (74%, 61-87)
Traumatic (blood stained)	9 (19%, 9-31)
Post LP advice	22 (47%, 33-61)
Results	32 (68%, 55-81)
Appropriate results	20 (43%, 29-57)

Table 3: Frequency of CSF laboratory tests and paired serum glucose requested against indication for lumbar puncture.

Indication (n)	CSF scan	Biochem	Micro	Path	Vir	S Gluc
SAH (30)	29	29	28	13	7	7
SAH/Meningitis (5)	5	5	5	1	2	1
Meningitis (5)	5	5	5	3	3	1
No indication documented (7)	6	7	7	2	3	3

CSF scan indicates CSF spectrophotometry; Biochem, biochemistry; Micro, microbiology; Path, pathology; Vir, virology; S Gluc, serum glucose.

Table 4: Final diagnosis in patients presenting with acute headache that had a lumbar puncture performed.

<b>Diagnosis</b>		<b>No diagnosis</b>	
Migraine	6	None	13
Meningitis	4	Headache ?cause	7
Tension headache	2	SAH excluded	3
Postcoital	2	Supraventricular tachycardia	2
Benign thunderclap Headache	2		
Hypertension Headache	1		
Stress related frontal Headache	1		
Migranous neuralgia	1		
SAH	1		
Sinusitis	1		
Functional	1		
Musculoskeletal	1		

## FIGURES

figure 1: Indications documented for lumbar puncture in acute headache

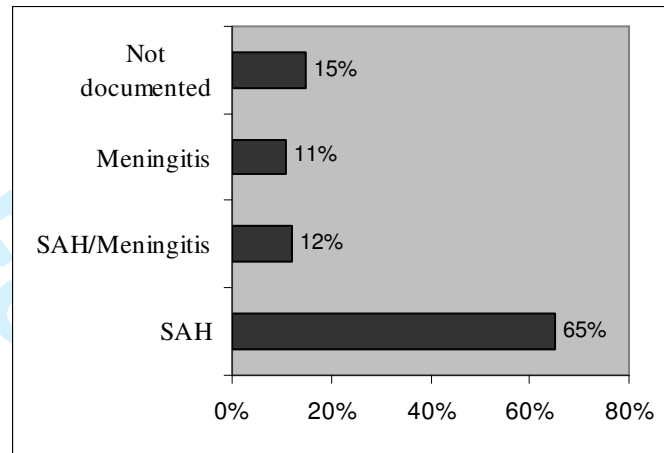


figure 2:

## Lumbar Puncture protocol

All invasive procedures need informed consent:

1. Indication
2. Explanation
3. Complications and their management

Up to 6/10 patients may develop transient headache.

*Analgesia and bed rest. If continual and associated with vomiting or malaise, contact neurologist.*

Up to 4/10 may have mild back ache. *Analgesia.*

Ensure no contraindications:

Raised ICP\*, bleeding diathesis or local infection.

### Procedure

1. **Patient position** – Left lateral position. Neck and legs flexed.
2. **Mark L4-L5 interspace** - (an imaginary line connecting posterior superior iliac spines crosses this). Interspaces L3-L4, L4-L5, L5-S1 can be used.
3. **Aseptic conditions** – sterile gloves and pack, antiseptic skin wash.
4. **Local Anaesthetic** - Infiltrate skin and subcutaneous tissue with small amount of 1-2% Lidocaine.
5. **Spinal Needle** - 22G Quincke (black spinal needle on medical wards) inserted with bevel orientated parallel to long axis of spine. Aim towards umbilicus. Once needle has breached dura, rotating needle may help CSF flow. Reinsert stylet before removing needle.
6. **Attempts** - If 3 attempts by one person fail, it should be attempted by another person in lateral position. If this fails, sit patient upright, leaning over desk with feet supported (greatest interspinous distance). Opening pressure cannot be measured accurately in this position, therefore return patient to lateral position, carefully.
7. **Opening pressure** - Use manometer and measure every patient in lateral position. (95% reference interval for normal pressure = 10-25 cmCSF).
8. **CSF collection** – check for xanthochromia against white background.  
*Biochemistry:* Protein, Glucose. Protect from light for spectrophotometry.  
*Microbiology:* Microscopy, culture and sensitivity. If TB considered, at least 5ml. Virology on all possible meningitis or encephalitis.  
*Pathology:* Cytology. At least 5ml for malignancy considered.
9. **Paired Venous Blood** - glucose essential.
10. **Documentation** - including appropriate results. Use stickers or use them as guideline.

\*Signs of possible raised intracranial pressure

- Decreased GCS, focal neurology, papilloedema, seizures

figure 3: Sticker to place in clinical notes after lumbar puncture attempt

<b><u>Lumbar Puncture</u></b> Consent <input type="checkbox"/>			
Pt name & number:			
Indication:		Imaging :	
Aseptic <input type="checkbox"/>	Local Anaesthetic <input type="checkbox"/>		
Attempt	Position	Intervertebral space	Needle gauge
<b>Opening pressure</b>		CSF colour	
Samples :			
CSF scan (black bag) <input type="checkbox"/>	Biochemistry <input type="checkbox"/>	Microbiology <input type="checkbox"/>	Virology <input type="checkbox"/>
Pathology <input type="checkbox"/>	Paired Venous blood <input type="checkbox"/>	<b>Results</b> (write next to label):	
Operator & Grade-			