Risk factors for brain stem herniation from a lumbar puncture (LP) in adults suspected of having bacterial meningitis.

Summary:
Diagnostic lumbar puncture (LP) results in a mild and transient reduction in cerebral spinal fluid (CSF) pressure due to removal of CSF for diagnostic purposes and ongoing low-volume leakage of CSF from the site of arachnoid membrane puncture. In the presence of intracranial space occupying lesions (inflammatory, neoplastic, or hemorrhagic) or other inflammatory conditions that increase CSF pressure, diagnostic LP can create an acute pressure gradient that results in downward displacement of the cerebrum and brainstem. This places patients at risk for cerebral herniation, a rare but often-terminal complication. While the clinical entities for which LP is used as a diagnostic tool (ie. subarachnoid hemorrhage and acute bacterial meningitis) demand prompt treatment, every effort should be made to protect against LP-induced cerebral herniation.

Current Recommendations:
Adult patients with suspected bacterial meningitis with any one of the following baseline characteristics should be considered for a head CT scan prior to undergoing LP:

- Age ≥ 60 years of age
- Immunocompromised state (e.g., HIV, AIDS, receiving immunosuppressive drugs, organ transplantation)
- History of CNS disease (mass lesion, stroke, and focal infection)
- Seizure within 1 week prior to presentation
- Papilledema (showing absence of venous pulsations)
- Neurologic findings (abnormal level of consciousness, inability to answer 2 questions correctly or follow 2 commands correctly, gaze palsy, abnormal visual fields, facial palsy, arm drift, leg drift, abnormal language [aphasia, dysarthria, etc])

If all of the above characteristics are negative, the negative predictive value (for abnormality on head CT) is 97%.

Clinical Considerations:

1. The best prospective data for risk of major adverse event from LP is in the context of patients with bacterial meningitis.
2. Choosing to perform CT prior to LP prolongs time to LP by by 2-3 hours and may also increase the time to initiation of antimicrobial therapy. IDSA recommends blood cultures and initiation of antimicrobials prior to CT in these patients.
3. Normal head CT does not rule out risk of LP-induced cerebral herniation. Indeed, patients with bacterial meningitis are at risk for cerebral edema and nearly one third of deaths are related to cerebral herniation. In patients with signs of impending herniation, LP should be avoided regardless of CT findings.

Editors:

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Supporting Guideline Statements:
IDSA (Infectious Diseases Society of America): "Adult patients with suspected bacterial meningitis and have any of the following criteria (immunocompromised states, history of CNS disease, new onset seizures, papilledema, abnormal level of consciousness, focal neurological deficit) should get a head CT prior to getting an LP. Class B-II" • **Reference:** IDSA Practice Guidelines for the Management of Bacterial Meningitis: Clin Infec Dis 2004;39:1267-84.

Landmark or Original Studies:	
Hasbun R et al. Computed tomography of the head before lumbar puncture in adults with suspected meningitis. N Engl J Med 2001;345:1727-33.	
Study Design:	Prospective, single-center cohort
Sample Size:	n = 301 (adult patients suspected to have bacterial meningitis)
Groups & Interventions:	Cohort of adult patients in the ED suspected to have bacterial meningitis who were assessed at baseline for the following: age ≥ 60 years of age, immunocompromised state (e.g., HIV, AIDS, receiving immunosuppressive drugs, organ transplantation), history of CNS disease (mass lesion, stroke, and focal infection), seizure within 1 week prior to presentation, and/or Neurologic findings (abnormal LOC, inability to answer 2 questions correctly or follow 2 commands correctly, gaze palsy, abnormal visual fields, facial palsy, arm drift, leg drift, abnormal language [aphasia, dysarthria, etc])
Follow-up or Duration:	At least 1 week following LP
Primary Endpoint:	Determine whether the absence of certain clinical features as baseline could be used to identify adults with suspected meningitis who were unlikely to have abnormal CT findings on head CT.
Secondary Endpoint(s):	n/a
Results:	• 235/301 (78%) had a CT scan done prior to LP with 56/235 (24%) having abnormal CT findings and 11/235 (5%) with evidence of a mass effect resulting in 4 (2%) patients not getting an LP • 96/235 patients had none of the 13 screening baseline characteristics with 93/96 having a normal head CT thereby resulting in a negative predictive value of 97%. Of the 3 patients who were misclassified, 1 had a mass effect and all 3 underwent LP without subsequent brain herniation.
Conclusions:	Using 13 baseline characteristics can help to identify patients unlikely to have abnormal findings on head CT
Comments:	Doing a bedside assessment for risk factors for an abnormal CT finding can be helpful at determining who should get a CT scan prior to LP, but did not include papilledema. Furthermore, this study used the Modified NIH Stroke Scale to identify patients with abnormal neurologic findings that warrant a CT scan prior to LP. These findings need to be validated in different populations.
Location(s):	Yale – New Haven Hospital from July 1995 – June 1999.
Funding:	National Research Service Award to Dr Hasbun) and Bayer Corporation

Supporting Studies	
Gopal AK et al. Cranial computed tomography before lumbar puncture. Arch Intern Med 1999;159:2681-2685.	
Study Design:	Prospective data collection
Sample Size:	n = 111
Groups & Interventions:	Adult patients (≥ 18 yrs) had recorded info: age, temperature, indication for LP, time CT was ordered, time LP was performed, and whether patients received antibiotics before CT scan and then answered the following questions: risk factors for HIV, documented HIV positivity, any immunosuppressive conditions, history of malignant neoplasms, head trauma within the previous 72 hours, history of CNS mass lesion, report of altered mental status, seizures within 72 hours.
Follow-up or Duration:	
Primary Endpoint:	To determine which patient specific items and results would allow for a safe LP without needing a head CT.
Secondary Endpoint(s):	Attempt to identify patients at highest risk for intracerebral lesions and ability to predict the CT findings. Evaluate any potential delay in antibiotic treatment caused by CT.
Results:	• 15% of patients had a new CT-documented lesion with 2.7% having lesions that made LP contraindicated. • 3 predictors were identified for abnormal CT: altered mental status (positive LR, 2.2;

	95% CI 1.5 – 3.2), focal neurological examination (positive LR, 4.3; 95% CI 1.9 – 10), and papilledema (positive LR 11.1; 95% CI 1.1 – 115). • The overall clinical impression had the highest predictive value in identifying patients with the greatest risk of having intracranial lesions that may contraindicate LP.
NNT/NNH:	
Conclusions:	Given the low prevalence of lesions that result in LP being contraindicated, screening cranial CT solely for the purposed of safety in doing an LP does not provide much information. Physicians can use clinical impression and 3 clinical predictors in identifying the patients with the greater chance for an abnormal CT finding.
Comments:	The clinical impression used in this study does not provide a consistent approach to the patient versus the use of a risk stratification scale with higher inter-observer reliability.
Location(s):	Duke University Medical Center
Funding:	Not reported
Baker ND et al. The efficacy of routine head computed tomography (CT scan) prior to lumbar puncture in the emergency department. J Emerg Med 1994;12(5):597-601.	
Study Design:	Retrospective chart review
Sample Size:	n = 112
Groups & Interventions:	Presumed to be adults; indication for LP not reported.
Primary Endpoint:	Compare opening pressures from lumbar puncture (LP) with CT scan diagnosis and complications after LP
Secondary Endpoint(s):	
Results:	• No correlation was found between opening pressure and CT findings. • 13 (31%) of the 42 patients with recorded opening pressures (OP) recorded had an OP > 200 mm H2O with 6 of those 13 patients having a normal head CT and none of the 13 developed any complications within 48 hours following LP.
NNT/NNH:	
Conclusions:	Almost half (49%) of patients with an elevated opening pressure on LP had normal noncontrast head CT thus concluding that a normal head CT scan may not identify a patient with intracranial hypertension. Head CT alone does not predict intracranial hypertension and that routine screening with head CT prior to LP in patients without localizing signs is not indicated.
Comments:	Reason for LP was not mentioned (i.e., the type of patient population being studied).
Location(s):	Emergency Department, Brigham and Women's Hospital, Boston, MA
Funding:	Not reported
*Add more here if needed	

Related Articles & Reviews:
Joffe AR. Lumbar puncture and brain herniation in acute bacterial meningitis: a review. J Intensive Care Med 2007;22(4):194-207. PMID: 17712055
Van Crevel H et al. Lumbar puncture and the risk of herniation: when should we perform CT? J Neurol 2002;249(2):129-137. PMID: 11985377

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