How do I perform a lumbar puncture and analyze the results to diagnose bacterial meningitis?

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CRD summary
This review assessed interventions to reduce headache after lumbar puncture, as well as the diagnostic accuracy of cerebrospinal fluid analysis. It concluded that atraumatic needles may decrease headache risk, the stylet should be reinserted before needle removal, and bed rest is unnecessary. Three diagnostic tests were recommended. Limited evidence and methodological and reporting issues mean that the conclusions should be interpreted cautiously.

Authors' objectives
To assess the effectiveness of interventions to reduce the risk of adverse events during diagnostic lumbar puncture (LP); and to determine the test accuracy of cerebrospinal fluid (CSF) analysis in patients with suspected bacterial meningitis.

Searching
The Cochrane Library, MEDLINE and EMBASE were searched from inception to January 2006 without any language restrictions; the search terms were reported. The reference lists of retrieved articles were also checked.

Study selection
Study designs of evaluations included in the review
For the review of intervention studies, randomised controlled trials (RCTs) were eligible. Studies of other designs were included if no RCTs of a particular intervention were available.

Specific interventions included in the review
Studies of interventions to reduce headache and backache at the time of LP were eligible for inclusion. The included studies assessed the use of atraumatic versus standard needles, reinsertion of the stylet before removing the needle, bed rest after the procedure and use of supplementary fluids.

For the diagnostic accuracy part of the review, studies of biochemical analysis of CSF were eligible. The included studies assessed cerebrospinal Gram staining, white blood cell count, glucose level, blood glucose ratio and/or lactate level.

Reference standard test against which the new test was compared
For the diagnostic accuracy component of the review, the authors stated that studies were required to use an appropriate reference standard (e.g. CSF culture or bacterial antigen) in all patients. The included studies used one of these or both interchangeably.

Participants included in the review
Studies of adults undergoing diagnostic LP were eligible for inclusion. Studies of patients undergoing LP during spinal anaesthesia or myelography were excluded.

For the diagnostic accuracy part of the review, eligible studies involved predominantly adult patients with suspected acute bacterial meningitis.

Outcomes assessed in the review
For the review of intervention studies, the specified outcome of interest was headache occurring up to 7 days after LP. Studies of backache and possibly other adverse events were also eligible.
Inclusion criteria for the outcomes were not specified for the diagnostic accuracy part of the review. The outcomes reported were the sensitivity and specificity of Gram staining and the positive and negative likelihood ratios (LRs) for other biochemical tests.

How were decisions on the relevance of primary studies made?
Two independent reviewers assessed the studies for relevance. Any differences were resolved by discussion, with arbitration by a third reviewer if required.

Assessment of study quality
The quality of the intervention studies was assessed on the basis of criteria such as the method of randomisation, the presence of blinding and the method of outcome assessment. For diagnostic accuracy studies, the presence of blinding was assessed. Two reviewers independently assessed the quality of the studies. Any differences were resolved by discussion, with arbitration by a third reviewer if required.

Data extraction
Two reviewers independently extracted the data. Any differences were resolved by discussion, with arbitration by a third reviewer if required. For intervention studies, data on the numbers of headaches in each group were used to calculate the odds ratio (OR) and associated 95% confidence interval (CI). For the diagnostic studies, relevant data were extracted and used to derive diagnostic accuracy outcomes.

Methods of synthesis
How were the studies combined?
Quantitative data from intervention studies were combined as ORs or absolute risk ratios (ARR) by meta-analysis using a random-effects model (DerSimonian and Laird). Where test accuracy data were combined, summary LRs were calculated using a random-effects model. The studies were also combined in a narrative.

How were differences between studies investigated?
The statistical heterogeneity of the intervention studies was assessed; however, no results were presented. Other differences between the studies were discussed in the text.

Results of the review
Fifteen RCTs of interventions were included; the sample sizes ranged from 44 to 600 but the total number of participants was not provided. Studies of other designs were discussed in the text. Six diagnostic accuracy studies were included: 1 prospective cohort (n=710), 2 cohort studies of uncertain design (n=700) and 3 retrospective studies (n=562, 80 CSF samples and 2,635 CSF samples).

Intervention studies.
Atraumatic needles did not significantly reduce the risk of headache compared with standard needles (5 studies; ARR 12.3%, 95% CI: -1.7, 26.2). Mobilisation after diagnostic LP did not significantly affect the risk of headache compared with bed rest (4 studies; ARR 2.9%, 95% CI: -3.4, 9.3). Reinsertion of the stylet before removing atraumatic needles reduced headache risk in 1 study (ARR 11.3%, 95% CI: 6.5, 16.2).

Diagnostic accuracy studies.
Data from 3 studies suggested that CSF lactate of 31.5 mg/dL or more accurately diagnosed bacterial meningitis (positive LR 21, 95% CI: 14, 32; negative LR 0.12, 95% CI: 0.07, 0.23). A CSF:blood glucose ratio of 0.4 or less and a CSF white blood cell count of 500 per microL or more were also accurate, based on single studies.

Authors' conclusions
Atraumatic needles may decrease risk of headache after diagnostic LP. The stylet should be reinserted before removal.
of the needle. Bed rest after the procedure is not necessary.

**CRD commentary**
This publication included a review which addressed two separate questions. The inclusion criteria for the study designs were broad, and the way in which the review was reported made it difficult to be sure how many and which studies were included. The authors searched a range of sources without language restrictions. Unpublished studies were not sought, which could have introduced publication bias into the review; the risk of publication bias was not assessed. Appropriate methods were used to reduce bias and errors during the review process. Study quality was assessed, although the methods used were not described clearly and it was unclear how the results were used in the review. Where quantitative data synthesis was undertaken, heterogeneity was not reported; this made it difficult to assess the appropriateness of the analysis. The narrative synthesis was difficult to interpret because it discussed further studies apart from the included studies and not all included studies were tabulated. Some conclusions were based on single studies rather than the results of a meta-analysis or synthesis of several studies. Overall, the authors' conclusions should be treated with caution in view of the limitations of the evidence and the methodological and reporting issues highlighted above.

**Implications of the review for practice and research**
Practice: In addition to their conclusions, the authors stated that CSF:blood glucose ratio, CSF white blood cell count and CSF lactate level can be considered for use along with appropriate cultures, Gram stain and serologic studies in patients with suspected bacterial meningitis.

Research: The authors stated that research is required to evaluate interventions to optimise the success of diagnostic LP and improve procedural skills.

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This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.