Cost-effectiveness of diagnostic strategies for evaluation of suspected subarachnoid hemorrhage in the emergency department

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CRD summary
This study examined the cost-effectiveness of strategies to diagnose subarachnoid haemorrhage, in the emergency department, for patients with an acute onset, severe headache and normal neurologic examination. The authors concluded that computed tomography (CT) alone or CT then lumbar puncture were the preferred strategies. The main limitation of the analysis was the lack of description of the data sources, but the authors’ conclusions appear to be robust.

Type of economic evaluation
Cost-utility analysis

Study objective
This study examined the cost-effectiveness of various strategies for the diagnosis of subarachnoid haemorrhage, in the emergency department, for patients with an acute onset, severe headache and normal neurologic examination.

Interventions
The interventions were computed tomography (CT) alone, CT followed by lumbar puncture, CT followed by magnetic resonance imaging (MRI) and angiography, and CT followed by CT angiography.

Location/setting
USA/hospital (emergency department).

Methods
Analytical approach:
The analysis was used a computer-based decision model, with a lifetime horizon. A Markov sub-tree was added to estimate the recurrent rate of developing a malignancy, over time. The perspective was not explicitly stated.

Effectiveness data:
Most of the clinical inputs were from the published literature. The data from several studies were pooled, for some model parameters. Some data came from the authors’ institution, and some were assumed. The accuracy (sensitivity and specificity) of the diagnostic procedures was the key input for the analysis.

Monetary benefit and utility valuations:
The utility values for specific health conditions were from published literature or authors’ opinions.

Measure of benefit:
Quality-adjusted life-years (QALYs) were the summary benefit measure, and they were discounted at an annual rate of 3%.

Cost data:
The economic analysis included all the hospital costs for the diagnostic strategies, their complications, and the long-term treatment of disability due to a missed subarachnoid haemorrhage. The costs were presented as category totals. Most were from Medicare data for diagnosis-related groups, using relative value units as surrogates for facility and professional costs. Some costs were from the US National Physician Fee Schedule and Current Procedural Terminology. 
Analysis of uncertainty:
One- and two-way sensitivity analyses were carried out to assess uncertainty, by varying all the inputs across reasonable ranges. A probabilistic sensitivity analysis was performed, using a Monte Carlo simulation, with specific probability distributions for the model inputs. A hypothetical scenario was considered, with magnetic resonance imaging and angiography, without initial CT, as a further comparator.

Results
The lifetime total costs were $10,339 with CT only, $12,840 with CT then CT angiography, $15,120 with CT then lumbar puncture, and $16,207 with CT then MRI and angiography. The QALYs were 20.250 with CT, 20.238 with CT then CT angiography, 20.366 with CT then lumbar puncture, and 20.265 with CT then MRI and angiography.

The incremental analysis showed that CT alone was the reference strategy. This dominated both CT then CT angiography, and CT then MRI and angiography, as they were less effective and more expensive. The incremental cost per QALY gained with CT then lumbar puncture, over CT alone, was $41,239, which was below the cost-effectiveness threshold of $50,000 per QALY gained.

The sensitivity analysis showed that several inputs affected the cost-effectiveness of the strategies, including the probability of severe disability after early diagnosis of subarachnoid haemorrhage, the sensitivity of contrast head CT for aneurysmal blood, the specificity of lumbar puncture for aneurysmal blood, and the specificity of MRI or MRI and angiography for aneurysm. Variations in some of these inputs changed the most cost-effective strategy. For example, when the CT sensitivity increased, CT alone was the preferred strategy, otherwise CT then CT angiography was most cost-effective.

Increasing the cost-effectiveness threshold to $100,000 per QALY did not alter the findings. The probabilistic sensitivity analysis was used to calculate confidence intervals around the expected costs and QALYs for each strategy, and these overlapped between strategies. In the hypothetical scenario, CT alone and MRI alone were the most cost-effective strategies. The incremental cost per QALY gained with MRI alone, over CT alone, was $17,254.

Authors' conclusions
The authors concluded that CT alone or CT then lumbar puncture were the preferred strategies to diagnose patients, in the emergency department, with suspected subarachnoid haemorrhage.

CRD commentary
Interventions:
The selection of the comparators was appropriate as the available diagnostic approaches were assessed. The authors pointed out that CT then lumbar puncture was the usual diagnostic approach, in most settings. A hypothetical scenario considered MRI alone, as an alternative.

Effectiveness/benefits:
The clinical inputs were from published sources, but the methods used to identify these studies were not described. It was unclear if a systematic review was undertaken to identify them. Their methods were not reported, so no extensive judgement of the validity of the clinical data can be made. QALYs were an appropriate benefit measure, given the impact of a haemorrhage on survival and quality of life, but the methods used to derive the utility values (the instruments and the population studied) were not described. It was unclear if the utility values were relevant to patients with subarachnoid haemorrhage.

Costs:
The perspective was not explicitly stated, but the cost categories and data sources indicated a third-party payer's perspective. The costs were from typical US sources. The authors stated that the use of diagnosis-related group Medicare data could be considered a limitation of their analysis, since the population analysed was 45 years old, and the Medicare data were an older population. A clear breakdown of the cost items was given, and the unit costs were presented, but the resource use was not presented separately. The price year was reported, allowing reflation exercises. The costs were varied in the sensitivity analysis.
Analysis and results:
The expected costs and benefits were appropriately combined in an incremental analysis, which allowed the exclusion of inferior strategies. A conventional threshold was used to identify the best strategy. Deterministic and probabilistic sensitivity analyses were carried out to investigate uncertainty, and their methods were clearly reported. All the results of the main analysis and the sensitivity analyses were clearly reported. The authors acknowledged some limitations to their analysis, which mainly related to the data sources. The results were specific to the USA and might not be transferable to other settings, due to differences in costs and clinical practices.

Concluding remarks:
The main limitation of the analysis was the lack of information on the data sources, but the authors’ conclusions appear to be robust.

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