A systematic review and meta-analysis of diagnostic performance of imaging in acute cholecystitis
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CRD summary
This well-conducted review concluded that cholescintigraphy was the most accurate imaging modality for the diagnosis of acute cholecystitis, while ultrasound and magnetic resonance imaging were equally associated with substantial error, and computed tomography was under studied. These conclusions accurately reflect the data presented and are likely to be reliable.

Authors' objectives
To update estimates of the accuracy of different imaging modalities, for the diagnosis of acute cholecystitis.

Searching
MEDLINE, EMBASE, CINAHL and The Cochrane Library were searched to March 2011, without data, publication status, and language restrictions. Search terms were reported. The bibliographies of included studies were screened for additional articles.

Study selection
Studies of ultrasound, cholescintigraphy, computed tomography (CT), or magnetic resonance imaging (MRI) to assess adults, with suspected acute cholecystitis, were eligible for inclusion. Studies had to report the criteria used to define a positive imaging result; use surgery, clinical follow-up, or both as the reference standard; and report sufficient data to derive 2x2 tables of the numbers of true-positive, false-positive, false-negative and true-negative results. Case reports and studies conducted in intensive care settings were excluded.

The included studies were published between 1978 and 2010 and were conducted in departments of Radiology, Surgery, Nuclear Medicine, Emergency Medicine, or Internal Medicine. Most were conducted in North America or Europe. The age of the patients ranged from nine to 98 years and most of them were female (median 61%; range 14 to 85).

Two reviewers assessed studies for inclusion, and any disagreements were resolved by discussion or consultation with a third reviewer.

Assessment of study quality
Two reviewers independently assessed the methodological quality of the included studies, using the 14-item QUADAS tool; any disagreements were resolved by discussion.

Data extraction
Data were extracted to populate 2x2 tables for each imaging modality. Two reviewers independently extracted the data and any disagreements were resolved by discussion.

Methods of synthesis
Summary estimates of sensitivity and specificity, with 95% confidence intervals, were calculated for each imaging modality, using a bivariate random-effects model. Summary receiver operating characteristic curves were drawn. The sensitivity and specificity estimates were compared, between imaging modalities, using a z-test for unpaired data. Studies of head-to-head comparisons of two or more imaging modalities, were analysed separately.

Between-study heterogeneity was quantified using I². Sources of heterogeneity that might effect diagnostic performance were incorporated in the bivariate model (prevalence of acute cholecystitis, year of publication, and individual QUADAS criteria). Where four or more studies assessed the same imaging modality, subgroup analyses were used to explore the factors affecting diagnostic performance (prevalence of acute cholecystitis, year of publication, description of participant selection criteria, verification with the reference standard in all or a random sample of participants,
adequate description of the reference standard, and reporting of inconclusive test results and withdrawals from the study).

**Results of the review**
Fifty-seven studies, with 5,859 patients, were included in the review. Cholescintigraphy was evaluated in 40 studies with 4,090 patients, ultrasound was evaluated in 26 studies with 2,847 patients, MRI was evaluated in three studies with 131 patients, and CT was evaluated in one study with 49 patients.

The included studies were of poor to moderate quality. Most included a representative sample of patients, used an appropriate reference standard, provided an adequate description of the index test, and interpreted the index test results blind to the reference standard and with access to appropriate clinical information. Most studies (about 60%) did not describe the selection criteria, were susceptible to verification bias, or did not adequately describe the reference standard.

The summary estimates for cholescintigraphy were 94% (95% CI 92 to 96) for sensitivity, and 90% (95% CI 85 to 93) for specificity. For ultrasound, they were 82% (95% CI 75 to 87) for sensitivity, and 81% (95% CI 73 to 87) for specificity. For MRI they were 86% (95% CI 66 to 95) for sensitivity, and 82% (95% CI 69 to 90) for specificity. The one study that assessed CT reported a sensitivity of 94% (95% CI 73 to 99) and a specificity of 59% (95% CI 42 to 74).

The sensitivity for cholescintigraphy was significantly higher than that for ultrasound or MRI, and there were no significant differences in specificity. Pooled estimates from 11 head-to-head comparisons between cholescintigraphy and ultrasound found significantly higher estimates of both sensitivity and specificity with cholescintigraphy. Two head-to-head comparisons of ultrasound and MRI found no significant differences in sensitivity and specificity.

Regression analysis indicated that only the prevalence of cholecystitis was significantly associated with diagnostic performance (lower specificity) for cholescintigraphy. There were no significant differences between any of the subgroups assessed.

**Authors’ conclusions**
Cholescintigraphy was the most accurate modality for the diagnosis of acute cholecystitis. Ultrasound was associated with substantial error and its performance was comparable to that of MRI. There was little evidence for CT.

**CRD commentary**
The review stated a clear objective and defined appropriate inclusion criteria. A range of sources was searched for relevant studies and no language or publication status restrictions were applied, increasing the likelihood of retrieving a high proportion of relevant material. Measures to minimise error and bias were applied throughout the review. The methodological quality of the included studies was assessed, and the possible effects of quality issues on estimates of test performance were explored. There were some discrepancies in the reported summary estimates of sensitivity and specificity between the text and forest plots. Appropriate meta-analytic methods were used, and direct and indirect comparisons of test performance were analysed separately.

The authors’ conclusions accurately reflect the data presented and are likely to be reliable.

**Implications of the review for practice and research**
**Practice:** The authors stated that ultrasound was frequently used to detect acute cholecystitis, but it had a substantial margin of error and cholescintigraphy should be considered for clinically equivocal cases. They stated that MRI could be used to detect cholecystitis, but data on its accuracy were limited.

**Research:** The authors stated that more studies were needed to assess MRI and CT in the detection of acute cholecystitis.

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