Performance of abdominal ultrasonography in pediatric blunt trauma patients: a meta-analysis

Holmes J F, Gladman A, Chang C H

CRD summary
The review assessed the performance of abdominal ultrasound (US) in diagnosing intra-abdominal injuries (IAIs) in children and was generally conducted well and reported clearly. Even though better methods could have been used to generate pooled estimates of test performance, the authors’ conclusion that US cannot be used alone to rule out IAIs is likely to be reliable.

Authors' objectives
To assess the performance of abdominal ultrasonography (US) in identifying children with intra-abdominal injuries (IAIs).

Searching
MEDLINE and EMBASE were searched to November 2005. Search terms were reported. Bibliographies of all included studies, four textbooks and five key journals were handsearched and experts in the field were contacted. There were no language restrictions. Unpublished data were excluded.

Study selection
Prospective and retrospective studies assessing US for the detection of intra-peritoneal fluid or IAIs in blunt trauma patients where all participants were under 18 years were eligible for inclusion. Included studies were required to report a minimum of three US views (Morison's pouch, splenorenal fossa and pelvis) and sensitivity and specificity of the US examination; US protocols varied between studies. No inclusion criteria were specified for the reference standard used to establish diagnosis; the reference standards used in included studies were laparotomy, diagnostic peritoneal lavage, abdominal computed tomography (CT) scan and clinical follow-up without further testing; most studies used clinical follow-up. The prevalence of IAI in included studies ranged from 5 per cent to 100 per cent. Two reviewers independently assessed all retrieved abstracts for inclusion.

Assessment of study quality
Methodological quality was classified as: Level 1 (representative sample >50, no selection bias and an independent reference standard (laparotomy, diagnostic peritoneal lavage, or abdominal CT)); Level 2 (sample size >50, minimal selection bias, independent reference standard); Level 3 (sample size >50, minimal selection bias, no independent reference standard); or Level 4 (sample size of <50 or moderate to severe selection bias). Two reviewers independently assessed study quality. Disagreements were resolved by discussion with a third party.

Data extraction
Three reviewers independently extracted data. Disagreements were resolved by consensus. Data were extracted on ultrasound protocol and interpreter and reference standard used.

Methods of synthesis
Simple pooled estimates were calculated for sensitivity and specificity and positive and negative likelihood ratios (LRs) for each of three US protocols. A random-effects model was used. The authors reported a test for between-study heterogeneity (but did not specify the method used). Sensitivity analyses were conducted by separately excluding Level 3 studies, Level 4 studies and all retrospective studies.

Results of the review
Twenty five studies (n = 3,838) were included in the review: two were classified as Level 1; five as Level 2; 13 as Level 3; and five as Level 4.

For the identification of haemoperitoneum using FAST protocol (imaging for intra-peritoneal fluid only) the pooled estimate of sensitivity was 80 per cent (95% CI: 76, 84) and specificity 96 per cent (95% CI: 95, 97). The pooled
estimate for positive LRs was 22.9 (95% CI: 17.2, 30.5) and for negative LRs was 0.2 (95% CI: 0.16, 0.25).

For the identification of any IAI using FAST protocol (imaging for intra-peritoneal fluid only) the pooled estimate of sensitivity was 66 per cent (95% CI: 60, 71) and specificity was 93 per cent (95% CI: 92, 95). The pooled estimate for positive LRs was 9.8 (95% CI: 7.9, 12.1) and for negative LRs was 0.37 (95% CI: 0.32, 0.43).

For the identification of any IAI using imaging for both intra-peritoneal fluid and solid organs the pooled estimate of sensitivity was 82 per cent (95% CI: 78, 86) and specificity was 97 per cent (95% CI: 96, 97). The pooled estimate for positive LRs was 24.5 (95% CI: 19.0, 31.6) and for negative LRs was 0.18 (95% CI: 0.15, 0.23).

No heterogeneity was identified in any data set for sensitivity and specificity. Heterogeneity was present in all three data sets in both positive and negative LRs.

Sensitivity analyses indicated that test performance decreased when only studies of higher methodological quality were included in analyses.

**Authors' conclusions**
The authors concluded that abdominal US is moderately sensitive for the detection of haemoperitoneum in injured children and that a negative US examination cannot be used alone to reliably rule out IAI.

**CRD commentary**
The review stated a clear research question defined by appropriate inclusion criteria. The search strategy used to identify relevant studies was reasonable. No language restrictions were applied. Review methods included appropriate measures to minimise error and bias. A limited assessment of the methodological quality of included studies was undertaken, but important aspects of study quality (e.g. verification biases, blinding of interpreters) were not assessed. Simple sensitivity analyses were conducted to investigate the impact of study quality upon results. Some details of the included studies were reported – including who interpreted the US examination (which can be an important factor in varying diagnostic performance) – but these were not reported alongside study results, limiting their usefulness. Simple pooling of measures of diagnostic performance was undertaken, where the optimal approach would have been to generate a summary receiver operating characteristic (SROC) curve using bivariate or hierarchical modelling methods.

The authors' conclusion that the sensitivity of abdominal US is moderate and that it cannot be used to reliably rule out IAI is a reasonable interpretation of the data presented and is likely to be reliable.

**Implications of the review for practice and research**
Practice: The authors state that because of the risk of IAI, haemodynamically stable injured children with negative US examinations should undergo abdominal CT.

Research: The authors state that there is need for further research to determine if adding US images of solid organs improves the diagnostic accuracy of FAST examinations in children.

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