Critical Review Form

Meta-analysis

Does this Adult Patient Have a Blunt Intra-abdominal Injury?

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Objective: "To assess test characteristics of clinical findings to identify intra-abdominal injury, counting all injuries as important."

Methods: A librarian-assisted, structured search (detailed in the eAppendix) included electronic searches of MEDLINE (1950-Jan 2012) and EMBASE (1980-Jan 2012) for English language studies examining the identification of intra-abdominal injuries. Additional articles were identified by searching the bibliographies of relevant studies. A second structured search was conducted for studies specifically evaluating bedside ultrasonography. This second strategy first identified "high quality systematic reviews" by a Pubmed search of "ultrasound abdominal trauma AND systematic [sb]" to serve as a filer to primary diagnostic studies. The authors then retrieved the original articles from these systematic reviews before seeking newer studies.

The article selection process is detailed in the eAppendix. Two reviewers independently reviewed all abstracts for inclusion. Articles were selected if they evaluated test characteristics of history or physical examination in adult patients with suspected intra-abdominal injury. Studies were selected if they compared at least one history, physical exam, lab, or ultrasound finding with an acceptable criterion standard. Acceptable gold standards included abdominal CT, DPL, laparotomy, autopsy, and/or a clinical course of observation following potential intra-abdominal injury. A MOOSE-checklist was used to assess the quality of ultrasound systematic reviews. Due to the large number of high quality ultrasound studies, the authors only included Level I and Level 2 studies in this meta-analysis.

Two authors independently performed critical appraisal and data extraction. Level 1 studies included an independent, blind comparison of sign, symptom, or diagnostic results with a criterion standard and at least 500 patients. Level 2 studies met all Level 1 criteria with less than 500 patients. Level 3 studies had independent, blinded comparisons but had a non-consecutive (convenience) patient sampling method. Level 4 studies had non-independent sampling (patients chosen based on the

presence of disease), while Level 5 studies used the presence of the physical examination finding as an inclusion criteria. Level 4 study results were not included in any summary estimates and Level 5 studies were excluded from this meta-analysis. Data abstracted included study size and duration, study design, study setting, patient demographics, inclusion/exclusion criteria, variables collected, blinding of physical examination, application of the gold standard, and outcome measures.

Sensitivity, specificity, and likelihood ratios were calculated with confidence intervals for each symptom, sign, lab, or imaging test. The summary pre-test probability was calculated with random-effects measures and risk factors were assessed with odds ratios. When only two studies reported diagnostic estimates, ranges were reported whereas a univariate random-effects summary measure was used when three studies evaluated a diagnostic test. When four or more studies were available for meta-analysis, a bivariate random-effects model was used to create summary measures. Publication bias for ultrasound studies was assessed using the funnel plot, Egger test, and the trim-and-fill procedure to impute the effect of missing studies.

Guide	Question	Comments
I	***Are the results valid?***	
1.	Did the review explicitly address a sensible question?	Yes, since most didactic courses (like ATLS) and textbooks that strive to standardize the assessment of abdominal trauma do not quantify the diagnostic accuracy of history, physical exam, labs, or bedside ultrasound the authors sought "To systemically assess the precision and accuracy of symptoms, signs, laboratory tests, and bedside imaging studies to identify intra-abdominal injuries in patients with blunt abdominal trauma."
2.	Was the search for relevant studies detailed and exhaustive?	Yes, the authors searched two electronic engines and conducted a bibliographic hand-search of relevant articles. However, they did not include research abstracts or contact industry/investigators for "gray literature".
3.	Were the primary studies of high methodological quality?	No. The authors included two Level 1 studies, seven Level 3 studies, and three Level 4 studies in their results. However, as noted above the Level 4 study's point estimates were not included the meta-analysis summary estimates. "All studies were prospective, with consecutive enrollment and blinding." (p 1520)

<table>
<tr><td>4.</td><td>Were the assessments of the included studies reproducible?</td><td>Uncertain, since the authors did not report any inter-rater reliability assessment (i.e. kappa) of the level of evidence appraisal. In addition, they do not use a validated quality of evidence assessment instrument for diagnostic studies such as the QUADAS-2.</td></tr>
<tr><td>II.</td><td>What are the results?</td><td></td></tr>
<tr><td>1.</td><td>What are the overall results of the study?

Physical Exam Diagnostic Accuracy
<table>
<tr><th></th><th>LR+</th><th>LR-</th></tr>
<tr><td>Seat Belt Sign</td><td>9.9</td><td>0.53</td></tr>
<tr><td>Rebound</td><td>6.5</td><td>0.96</td></tr>
<tr><td>Initial BP<90</td><td>5.2</td><td>0.90</td></tr>
<tr><td>Distension</td><td>3.8</td><td>0.90</td></tr>
<tr><td>Guarding</td><td>3.7</td><td>0.80</td></tr>
<tr><td>Femur Fx</td><td>2.9</td><td>0.92</td></tr>
<tr><td>GCS <14</td><td>2.0</td><td>0.87</td></tr>
<tr><td>Abd pain</td><td>1.6</td><td>0.52</td></tr>
<tr><td>Costal margin tender</td><td>1.5</td><td>0.74</td></tr>
<tr><td>Abd tenderness</td><td>2.0</td><td>0.50</td></tr>
</table>
Lab/X-ray Diagnostic Accuracy
<table>
<tr><th></th><th>LR+</th><th>LR-</th></tr>
<tr><td>Base Deficit < -6</td><td>18</td><td>0.12</td></tr>
<tr><td>AST or ALT >130</td><td>5.2</td><td>0.46</td></tr>
<tr><td>Hematuria
>10 rbc
>25 rbc
>50 rbc</td><td>
2.7
4.1
3.7</td><td>
0.52
0.66
0.44</td></tr>
<tr><td>Hematocrit
<30%
<36%
Change >5%</td><td>
3.3
2.2
0.91</td><td>
0.79
0.76
1.0</td></tr>
<tr><td>WBC >10</td><td>1.7</td><td>0.35</td></tr>
<tr><td>Lactate >2.2</td><td>1.3</td><td>0.61</td></tr>
<tr><td>Abnl CXR</td><td>3.8</td><td>0.78</td></tr>
<tr><td>Abnl PXR</td><td>1.6</td><td>0.96</td></tr>
</table></td><td>

The initial search for non-ultrasound studies identified 2704 studies from which 2669 were excluded after review of the title/abstract alone leaving 35 citations. These 35 citations were reduced to 12 research manuscripts that were included in the meta-analysis (eFigure1).
The initial search for ultrasound studies identified 47 systematic reviews from which 35 were excluded based on lack of disease specificity and 8 more because they were not systematic reviews. From the four remaining systematic reviews, 163 studies were identified with 146 excluded (mostly due to 129 duplicates), leaving 17 citations. An additional two studies were found from other sources. An additional three studies published after the systematic reviews were found using supplementary search methods for a total of 22 studies (eFigure 2).
Based on 23 studies of 15750 patients the prevalence (pre-test probability) of intra-abdominal injury in adult ED patients with blunt abdominal trauma was 13% (95% CI 10%-17%, I^2 = 96%) while the prevalence of clinically significant injuries was 4.7% (95% CI 2.5%-8.6%, I^2 = 96%).
History did not significantly increase the probability of an intra-abdominal injury, including mechanism, alcohol intoxication (OR 0.46, 95% CI 0.24-0.89), or intubation (OR 2.5, 95% CI 1.1-5.9).
Some findings on physical exam were useful (see left which summarizes the most optimistic values of LR+ and LR- since no meta-analysis was conducted for these diagnostic tests), including the presence of a seatbelt sign, rebound tenderness, or initial hypotension.
No finding on physical exam was sufficient to significantly reduce the probability of an intra-abdominal injury (eTable 1).
Among lab tests, a base deficit less than -6 mEq/L significantly increased and decreased the post-test probability (see left from eTable 2 where PXR = pelvic x-ray).
The bedside FAST exam is by far the most accurate diagnostic test available, although using the funnel plot

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</table>

	Clinical Gestalt (Percentile Scale) **Clinical Gestalt (Ordinal Scale)**	and Egger methods there was evidence of publication bias (noted in eFigure 4 on a funnel plot) so the authors reported the diagnostic accuracy for bedside ultrasound for the identified studies and an adjusted analysis (using the trim-and-fill method) with slightly less impressive diagnostic accuracy: Bedside Ultrasound Positive FAST exam LR 69 (95% CI, 38-101) I^2=75% P<0.001 Normal FAST exam LR 0.18 (95% CI 0.11-0.25) I^2=89% P<0.001 Bedside ultrasound adjusted for publication bias: Presence of intraperitoneal fluid or organ injury **LR 30** (95% CI, 20-46) Normal Ultrasound **LR 0.26** (95% CI 0.19-0.34) • The authors also assessed the diagnostic accuracy for studies including patients with hemodynamic instability noting a summary LR+ 82 (95% CI 39-125) and LR- 0.16 (95% CI 0.10-0.21) versus a summary LR+ 36 (95% CI 3.8-69) and LR- 0.33 (95% CI 0.08-0.58) for studies that excluded hemodynamic instability (p=0.06). • Two **clinical decision rules** were identified (Holmes 2009 and Poletti 2004) and compared these CDR's with clinical gestalt noting the diagnostic accuracy of clinical gestalt on two scales at left (from Table 5). One scale assigns percentile risk of intra-abdominal injury while the second uses a one to five ordinal scale of no suspicion to most likely to have an injury. • **Combinations of findings** were also assessed with no significant LR+ noted, but several significant LR- including 1) Hematuria (>25 rbc), abnormal CXR, abdominal tenderness, GCS <14, costal margin tenderness, femur fracture, or hematocrit < 30% (LR- 0.10, 95% CI 0.06-0.17). 2) Abnormal mental status, abdominal guarding, abdominal tenderness, AST >50, WBC >10,000, or hematocrit < 36% (LR- 0.06, 95% CI 0.01-0.45). 3) Abnormal mental status, abdominal guarding, abdominal tenderness, AST > 50, WBC >10,000, hematocrit < 36%, abnormal FAST exam, or abnormal CXR (LR- 0.05, 95% CI 0-0.80).

	LR
>50%	11
10%-50%	8.9
5%-10%	2.5
1%-5%	0.46
<1%	0.21

	LR
5	19
4	3.2
3	1.6
2	0.57
1	0.38

2.	How precise are the results?	See 95% CI above. Note that the precision for bedside ultrasound increases when the summary estimates are adjusted for publication bias.
3.	Were the results similar from study to study?	No, there was significant inter-study heterogeneity (see I^2 results above) so a random-effects model was used appropriately.
III.	***Will the results help me in caring for my patients?***	
1.	How can I best interpret the results to apply them to the care of my patients?	In order to risk-stratify blunt abdominal trauma patients for intra-abdominal injury, the FAST exam is superior (i.e. more accurate as judged by larger LR+) to history, physical exam, labs, x-rays, or clinician judgment. In fact, a positive FAST exam in a hemodynamically unstable patients (LR+ 82) is highly indicative of intra-abdominal injury increasing a pre-test probability of 13% to a post-test probability of 92% compared with clinical gestalt (LR+ 19) which increases the same pre-test probability to 74%. A negative FAST in high-risk clinically stable patients does not sufficiently exclude intra-abdominal injury (LR- = 0.33). If all of the following findings are not present (LR- 0.05), then a pretest probability of 13% drops to <1%: abnormal mental status, abdominal guarding, abdominal tenderness, AST > 50, WBC >10,000, hematocrit < 36%, abnormal FAST exam, or abnormal CXR
2.	Were all patient important outcomes considered?	No, the studies only assessed the presence or absence of intra-abdominal injury. Only a few looked at clinically significant injuries or injuries requiring intervention. No studies reviewing patient-centric outcomes (mortality, long-term morbidity, costs, length of stay, etc.) were reported.
3.	Are the benefits worth the costs and potential risks?	Probably. FAST is low cost and has no known health consequences as compared to the radiation and dye-related complications of CT. However, ED-based FAST exams are operator dependant in both image acquisition and image interpretation. The current study did not assess the learning curve needed to develop or maintain sufficient expertise with the FAST exam to be reliably accurate. When proficiency is attained and maintained, however, a bedside FAST is indisputably beneficial in unstable blunt abdominal trauma patients.

Limitations

1) **No assessment of reliability for history, physical exam, or ultrasound findings.**

2) **No report of the sonographic expertise of the ED-based ultrasonographers evaluated in the studies.**

3) **No assessment of pediatric blunt abdominal trauma.**

4) **Failure to use validated quality assessment instrument such as QUADAS-2.**

5) **Failure to report interval likelihood ratios for continuous data such as base deficit or lactate.**

6) **Incompletely reproducible search strategy for identification of the ultrasound research. What search terms did they use?**

7) **Insufficient data to assess clinically significant intra-abdominal injury and no patient-centric outcomes (mortality, morbidity) are reported in the various trials.**

Bottom Line

History and physical exam are inaccurate predictors of post-blunt trauma intra-abdominal injury, as is radiographic imaging (chest, pelvis). Clinical decision rules identified (Holmes 2009 and Poletti 2004) should be prospectively validated with the inclusion of bedside ultrasound FAST exams to better understand the value of combinations of findings in ruling in or ruling out intra-abdominal injury. With the exception of a base deficit less than -6 mEq/L (LR+ 18, LR- 0.12), labs are also not accurate predictors of an intra-abdominal injury.

Bedside ultrasound, on the other hand, is an extremely accurate diagnostic test for intra-abdominal injury (LR+ 30, LR- 0.26), particularly when assessing the hemodynamically unstable patient (LR+ 82, LR- 0.16). FAST is low cost and has no known health consequences as compared to the radiation and dye-related complications of CT. However, ED-based FAST exams are operator dependant in both image

acquisition and image interpretation. The current study did not assess the learning curve needed to develop or maintain sufficient expertise with the FAST exam in order for the FAST exam to be reliably accurate. When proficiency is attained and maintained, however, a bedside FAST is almost certainly beneficial in unstable blunt abdominal trauma patients.