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Can clinical prediction tools predict the need for computed tomography in blunt abdominal? A systematic review

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ABSTRACT

Introduction: Blunt abdominal trauma is a common reason for admission to the Emergency Department. Early detection of injuries is an important goal but is often not straightforward as physical examination alone is not a good predictor of serious injury. Computed tomography (CT) has become the primary method for assessing the stable trauma patient. It has high sensitivity and specificity but there remains concern regarding the long term consequences of high doses of radiation. Therefore an accurate and reliable method of assessing which patients are at higher risk of injury and hence require a CT would be clinically useful. We perform a systematic review to investigate the use of clinical prediction tools (CPTs) for the identification of abdominal injuries in patients suffering blunt trauma.
Materials and methods: A literature search was performed using Medline, Embase, The Cochrane Library and NHS Evidence up to August 2014. English language, prospective and retrospective studies were included if they derived, validated or assessed a CPT, aimed at identifying intra-abdominal injuries or the need for intervention to treat an intra-abdominal after blunt trauma. Methodological quality was assessed using a 14 point scale. Performance was assessed predominantly by sensitivity.
Results: Seven relevant studies were identified. All studies were derivative studies and no CPT was validated in a separate study. There were large differences in the study design, composition of the CPTs, the outcomes analysed and the methodological quality of the included studies. Sensitivities ranged from 86 to 100%. The highest performing CPT had a lower limit of the 95% CI of 95.8% and was of high methodological quality (11 of 14). Had this rule been applied to the population then 25.1% of patients would have avoided a CT scan.
Conclusions: Seven CPTs were identified of varying designs and methodological quality. All demonstrate relatively high sensitivity with some achieving very high sensitivity whilst still managing to reduce the number of CTs performed by a significant amount. Further studies are required to validate the results obtained by the highest performing CPTs before any firm recommendation can be used regarding their use in routine clinical practice.

Introduction

Blunt abdominal injury (BAT) is common and is associated with intra-abdominal injury (IAI) in 8–17% [1–4]. Early detection of these life threatening injuries is critically important. Physical examination alone is not a good predictor of IAI [5–8]. Significant, life threatening injuries can be present in the absence of obvious clinical signs [2,8]. This is especially true in the presence of a head injury or other distracting injuries [7,9].

Computed tomography (CT) has become the primary method for investigating the stable trauma patient. The sensitivity and specificity of CT for identifying IAI is high at 96–100% and 94–100% respectively [10–14] and it has a very low rate of missed injuries12. However, the pick-up rate from such scans if often very low15. One study suggested that as few as 1% of haemodynamically stable patients with BAT have significant IAI [16]. Other studies have suggested that stable BAT patients without clinical evidence of IAI can be safely managed without CT [17–19].

Increasingly whole-body CT (WBCT) is being used as a form of triage [20–22]. Supporters have argued that WBCT enables more rapid diagnosis and therefore earlier treatment and that it leads to fewer missed injuries [23–27]. Opponents will argue that it can

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delay intervention, is more expensive and exposes patients to higher radiation doses [28,29].

A number of studies have attempted to demonstrate a benefit to unselected WBCT [30–40]. Most of these studies agree that unselected WBCT reduces time to diagnosis, time to surgery and time spent in the Emergency Department [30–32,35,41]. Its use has been shown to reduce mortality in patients with impaired consciousness and haemodynamic instability [33,36]. Of course, demonstrating the utility of WBCT in high risk patients (such as those with impaired consciousness and haemodynamic instability) is not the same as proving it is appropriate for patients without obvious signs of injury. Gupta et al. found there was a very low incidence of clinically relevant abnormalities when WBCT was performed in the absence of a specific clinical indication [38].

Only one study has specifically studied the use of routine WBCT in haemodynamically stable patients with no signs or symptoms of injury [37]. It claimed that 7.1% of abdominal CT scans showed clinically significant findings. However, most of these injuries were relatively minor and it is unknown how many of these injuries may have been suggested by physical examination or bedside diagnostic studies.

Increasingly, concerns have been raised about the risks posed by excessive use of CT. Ionising radiation is a known carcinogen and is associated with a number of malignancies [42,43]. Much of the evidence behind this comes from non-medical radiation exposures [44–46], but there is evidence to suggest that exposure to doses of 10–100 mSv (the range more relevant to medical imaging) can increase the risks of malignancy [47]. Compared with conventional radiography, CT exposes patients to significantly higher radiation doses and these doses have been shown to increase substantially when liberal trauma CT policies are implemented [48].

Lifetime risks vary from 1 in 1250 in a 45 year old patient undergoing a whole body CT to 1 in 250 for a 20 year old woman undergoing an abdominal CT [49,50]. The risks are significantly higher in paediatric patients and young adults due to their increased susceptibility to radiation [51–53].

A clinical prediction tool (CPT) is a tool designed to guide clinicians in making management decisions [54]. They combine multiple independent variables to create a score which can be useful in establishing a diagnosis or in deciding on further investigations or treatment options [55]. They are commonly used for determining the need for head and cervical spine imaging after trauma [56–60].

This study aims to perform a systematic review of the literature looking at the use of CPTs aimed at identifying lower risk blunt trauma patients who can be managed without the need for a CT scan of the abdomen. We aim to identify and evaluate the methodological quality and the clinical performance of existing CPTs used in adults with BAT.

Methods

A systematic review and meta-analysis was performed. This was performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) recommendations61.

English language, prospective and retrospective studies were included if they derived, validated or assessed a CPT aimed at identifying IAI (all injuries or clinically relevant injuries only), or the need for intervention to treat an IAI after BAT. For the purposes of this study, a CPT was defined as: a tool which includes three of more variables and where the presence of any one of these variables renders the CPT positive. The variables may be obtained from the history, physical examination or from simple diagnostic tests available at the bedside in the Emergency Department (arterial or venous blood analysis, urinalysis, plain x−rays or focussed assessment with sonography in trauma (FAST) scan).

Studies were excluded if they: assessed the predictive value of individual variables only; assessed the predictive value of variables without the intention of creating a CPT; included only patients under the age of 18; or included patients with penetrating trauma.

A literature search was performed using Medline, Embase, The Cochrane Library and NHS Evidence up to August 2014. The search was performed using combinations of keywords such as: clinical prediction tools; computed tomography; CT scan; blunt abdominal trauma; blunt abdominal injury; intra-abdominal injury (see Appendix A for full search strategy). In addition to the above databases; studies published in four core journals (Annals of Surgery; European Journal of Trauma and Emergency Surgery; British Journal of Surgery and Journal of Trauma and Acute Care Surgery [previously known as the Journal of Trauma; Injury; Infection and Critical Care]) since January 2004 were hand searched. The reference lists of included studies were also searched manually for additional studies.

Studies identified by the search strategy above were screened for inclusion using a two−step process. Firstly, the titles and abstracts of each study were assessed. Secondly, the full text was assessed for studies which were thought to be potentially relevant and studies where relevance remained uncertain.

Data collected included: details on study design; the inclusion and exclusion criteria used in each study; the indications for performing a CT scan; the predictor variables included in the CPT; the outcome measures used; sensitivity, specificity, positive (PPV) and negative predictive values (NPV) and the proportion of patients who would have received a CT had the CPT been implemented.

The included studies were assessed using a 14 point scale adapted from published guidelines used for the derivation of CPTs [62–66]. The 14 questions asked of each paper can be seen in Table 2 (for more details see Appendix B). For each item a mark of 0 was awarded if the criteria was not fulfilled (or if it could not be ascertained from the paper whether the criteria was fulfilled) and a mark of 1 awarded if it was fulfilled. The maximum total score was therefore 14.

CPTs assessing the presence of an injury were assessed separately to those assessing the need for acute intervention. For the purposes of determining the most effective CPT it is assumed that sensitivity is considered the most important single measure.

Stats Direct version 3.0.141 (StatsDirect Ltd., Altrincham, UK)) was used to analyse data. Sensitivity, specificity, PPV and NPV were expressed as a percentage with 95% confidence intervals. Individual predictors were expressed as odds ratios with 95% confidence intervals. Pooled odds ratios were calculated using the Dersimonian-Laird random effects model [67]. A p-value of less than 0.05 was considered statistically significant. Heterogeneity was expressed using I2, where values of 25%, 50%, and 75% correspond to cut off points for low, moderate, and high degrees of heterogeneity.

Results

The literature search produced 72 results. Fig. 1 shows the PRISMA flow diagram detailing the process of study selection. Ultimately the process produced seven studies which were included in the final analysis [1,15,68–72].

Table 1 describes the study designs and population characteristics of the seven included studies.

Methodological quality of the studies is summarised in Table 2. All studies adequately described the study setting and the predictor variables. All studies also produced tools which were clinically sensible and adequately reported their results. The areas which were most infrequently fulfilled were the blinding of those