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Review article

Systematic review of paediatric track and trigger systems for hospitalised children☆

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ABSTRACT

Context: Early and accurate recognition of the deteriorating hospitalised child is complex. Paediatric track and trigger systems (PTTS) support clinical decision-making by 'tracking' the child's condition through monitoring of clinical signs and 'triggering' a request for an appropriate review when pre-determined criteria are breeched.
Objective: To describe the number and nature of published PTTS and appraise the evidence on their validity, calibration, and effect on important patient outcomes (death, cardiac and/or respiratory arrest, unplanned transfer to intensive/high dependency care, immediate/urgent request for review, rapid response system activation).
Method: GRADE methodology. Papers identified through electronic database and citation searching.
Results: Thirty-three PTTS were identified from 55 studies. There was considerable variety in the number and type of parameters, although all contained one or more vital signs. The evidence to support PTTS implementation was very low and the majority of outcomes did not achieve statistical significance. When PTTS was implemented as part of a rapid response system, the evidence was moderate to low but there was some evidence of a statistically significant improvement in outcome.
Conclusion: There is now some limited evidence for the validity and clinical utility of PTTS scores. The high (and increasing) number of systems is a significant confounder. Further research is needed particularly around the thresholds for the vital signs and the reliability, accuracy and calibration of PTTS in different settings.

Introduction

Effective management of clinical deterioration in hospitalised children is a priority for healthcare professionals, patients and carers alike. Optimal care for a deteriorating child is complex.[1] It requires that: signs and symptoms of deterioration are recognised by ward staff; staff are empowered to call for assistance promptly; the assistance is readily available and appropriately skilled; and the interventions arising from this response improve outcomes. The first 'link' in this chain is early, accurate recognition of clinical deterioration. This is frequently inadequate.[2–4]

A number of tools are available to help staff identify deteriorating children. These 'early warning systems' prompt calls for senior assistance with changes in vital signs or other parameters.[5] In 2005 21.5% of UK paediatric centres reported using an 'early warning system'[6]; this rose to 85% by 2013.[7] Many different systems are in use but they appear in two main forms: 'score' and 'trigger'-based systems. Score-based systems assign values to vital signs, and other clinical indicators, representing the extent of deviation from 'normal.' These component values are combined to generate an overall score. Higher scores should represent an increased risk of deterioration, prompting review by senior clinicians. Trigger-based systems contain a number of pre-defined thresholds. When one or more thresholds are breeched, this 'triggers' a pre-determined response. Unlike score-based systems, trigger-based systems result in a dichotomous 'all or nothing' response. This typically means activation of a rapid response system (RRS) (also known as 'criti-

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cal care outreach', 'rapid response' or 'medical emergency' teams). Although there are differences between these types of tools, they share two common characteristics: the ability to 'track' the child's condition through ongoing monitoring and the facility to 'trigger' a request for an appropriate clinical review. Therefore, for the purpose of this review, score and trigger-based systems will be collectively referred to as paediatric track and trigger systems (PTTS).

The ideal PTTS utilises routinely monitored clinical signs, is simple to use and acceptable to users with robust validation in a relevant population.[5] As with all clinical prediction tools, there is an important trade-off between sensitivity and specificity. The overall predictive performance of a tool is most commonly summarised by the area under the receiver operator characteristic (AUROC) curve, with values greater than 0.7 regarded as useful. Score-based systems should also have acceptable calibration, and accurately classify children into low, medium and high risk categories.[8] As score-based PTTS are generally used with an action/escalation plan, calibration indicates the appropriateness of the response to each PTTS score in light of the degree of risk.

We conducted a systematic review of PTTS performance in 2009 and reported that the evidence on validity, calibration, reliability and utility was weak, and adoption of PTTS into clinical practice could not be recommended (findings summarised in Supplemental data Table A).[5] Since this work there has been widespread implementation of PTTS and an increase in the literature describing their predictive performance. This updated systematic review is necessary to reconsider these recommendations.

Objectives

This review was undertaken to examine the key characteristics of PTTS and to appraise the evidence on their validity, calibration and clinical utility.

Methods

Paediatric track and trigger systems were defined to be any system which attempts to identify hospitalised children who are at risk of, or suffering from, critical deterioration through ongoing monitoring of clinical signs. Children in critical care, emergency room and theatres were excluded as they have differing staffing and monitoring strategies.

The review protocol rigorously adhered to the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach.[9] The review was framed using the PICO criteria (Table 1). Quality of evidence was assessed as high, moderate, low or very low using the GRADE approach where randomised controlled trials start as high quality evidence, and observational studies as low level. Five factors can lead to evidence being downgraded and three factors may result in evidence upgrade. Results are presented as an evidence profile, a detailed assessment of the quality of the evidence together with a summary of the findings for each outcome. Where sufficient detail was provided, the risk ratio (RR) and 95% confidence intervals (CI) for each outcome were calculated. Results were separated into studies examining the introduction of a PTTS alone and those introducing a PTTS as part of a package of interventions, such as a RRS. Predictive validity was also summarised. There were no amendments to the protocol during the study.

Inclusion criteria

- Randomised controlled trials and observational studies describing the effect of PTTS (either alone or as part of a package of interventions) on ward in-patient outcomes (listed in Table 2).
- Observational studies describing the performance of PTTS in detecting these outcomes or its use in clinical practice.

Exclusion Criteria

- Studies set in the emergency department, operating theatre or critical care unit.
- Studies concerning both adult and paediatric patients unless the paediatric data could be adequately separated.

Primary outcomes

In accordance with GRADE, outcomes were identified and ranked in terms of their importance to patients (Table 2).

Search strategy

The following databases were searched: AMED, CINAHL, Cochrane Library, EMBASE, and OVID Pubmed (Supplemental data Table B). A broad search strategy was adopted, informed by the previous systematic review[5] with Medical Subject Headings (MeSH) and free text searching using keywords in the title or abstract. Results were limited to papers from 1990 relating to children. Google scholar was searched using the terms paediatric early warning system/score and paediatric rapid response/medical emergency team. Abstracts from the annual conferences of the Royal College of Paediatrics and Child Health (RCPCH); European Society of Paediatric and Neonatal Intensive Care (ESPNIC) and European Society of Intensive Care Medicine (ESCIM); together with the bi-annual World Congress in Paediatric Intensive Care were hand-searched from 2000 onwards.

After removal of duplicates, the title and abstract of records were independently screened by two researchers (SC and JW). The full-text of 155 papers were reviewed. Eligible studies underwent manual searching of references and citation searching on the Web of Science database. Uncertainty regarding inclusion of a paper was resolved through discussion within the research team.

Data extraction

Three data extraction forms were developed based on the initial systematic review.[5] Separate forms were developed for randomised control trials, observational studies and studies of diagnostic accuracy (Supplemental data C). Extracted data were entered into Microsoft Excel for Mac 2011 (version 14.4.7).

Evidence appraisal and analysis

PTTS were firstly categorised as '*scoring*' or '*trigger*' systems. Systems were then classified as being either '*age-independent*' (a single system applied regardless of age) or '*age-dependent*' (multiple systems with differing age-related thresholds).

Risk of bias for diagnostic accuracy studies was assessed using QUADAS 2 (Supplemental data Table D).[10] Remaining quantitative studies were assessed against criteria in the GRADE handbook (Supplemental data Table E).[11] The risk of bias of qualitative studies was not assessed. Pooled risk ratio and 95% confidence intervals for each outcome were calculated using Vasser stats.[12] The overall quality of evidence for each patient-important outcome was ranked following the GRADE approach. Evidence profiles were formulated in GRADE Pro GDT.[13]

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