

Case for change: a standardised inpatient paediatric early warning system in England

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ABSTRACT

Most children in hospital who are clinically deteriorating are monitored regularly, and their treatment is escalated effectively. However a small, but significant, number of deteriorating children experience suboptimal outcomes because of a failure to recognise and respond to acute deterioration early enough leading to unintended harm. Tragically this occasionally can have fatal consequences. Investigations into these rare events highlight common themes of missed early signs of deterioration in children, prompting regulatory agencies to suggest paediatric early warning systems (PEWS) to aid clinical practice. In England, track and trigger tools (TTT), which are one facet of PEWS have been widely rolled out but in a heterogeneous fashion. The evidence for TTT is mixed but they are complex interventions and current outcomes do not fully define the entirety of their potential impact. This article explains the rationale behind the decision of the NHS England and NHS Improvement, Royal College of Paediatrics and Child Health and Royal College of Nursing to implement a standardised inpatient PEWS as part of a system-wide paediatric observations tracking system in England and how this fits into a wider programme of activity.

INTRODUCTION

The UK has a higher medical mortality in the young than the European average for preventable deaths from common infections and respiratory conditions.¹ Evidence suggests missing early deterioration and variation in responses to deterioration can contribute to this.² The reasons why early deterioration in children is missed, can be grouped into themes:³

- ▶ Systems failure issues, for example, staffing number and skill mix, multiple simultaneous demands.
- ▶ Delayed recognition or response to physiological changes.
- ▶ Inability to capture and act on parental or healthcare worker's instinctive concerns about deterioration which may not be reflected in physiological measurements.

Previous national work in children improving recognition and response to deterioration in children has focused on the whole system response rather than the component of measured observations and has sought to drive national systemwide quality improvement.^{3–5} This differs from the National Early Warning Score (NEWS and NEWS2) for adults which is a single system with standardised assessment and response to acutely ill adults.⁶ The

What is already known?

- ▶ Paediatric early warning systems (PEWS) are recommended by a number of national organisations and regulators in the UK.
- ▶ In 2020, 100% of UK hospitals had PEWS in use.

What this study adds?

- ▶ Most hospitals use very similar parameters to measure deterioration.
- ▶ Marginal local gains in outcome after developing a unified English system should lead to detectable effect on national morbidity and mortality.

NEWS2 programme aims to increase early identification of patients who deteriorate while in hospital and has a projected potential to save over 1800 lives/year. Fortunately, child death is rare, but a similar programme may improve the timeliness of interventions in children and reduce hospital mortality and/or future morbidity. Given Scotland,⁷ Northern Ireland and Ireland⁸ have rolled out standardised paediatric early warning systems (PEWS) across inpatient settings there have been calls by clinicians, families, coroners and regulators to do the same in England.

A Delivery Board came together in June 2018 with representation from (NHS England and Improvement, the Royal College of Paediatrics and Child Health and the Royal College of Nursing (RCN)) to review the need for an English national PEWS. In 2020, the programme was renamed system-wide paediatric observations tracking (SPOT) to recognise that deterioration may occur from primary and community care, through ambulance services, emergency departments and into hospitals. We describe the underpinning concepts and evidence which the Delivery Board have used to make the case to implement a standardised PEWS in inpatients, as the first part of a programme of SPOT work.

What is deterioration?

Deterioration is the progressive worsening of the physiological condition of a patient. Failure to detect or act on preventable deterioration is a source of harm in clinical settings.

It is known that some children who die or deteriorate unexpectedly in hospitals will have observable

Table 1 PEWS charts validation process

Key findings	Description
Age brackets	The most common split for ages is 0–1 year, 1–4 years, 5–12 years, 12+ years—with most variation in the 0–1 year age group.
Calculation of the score	There is wide variation in which and how many (abnormal) parameters contribute to the score.
Measured parameters	Remarkably similar although there is variation around whether the BP is recorded and forms part of the score (vs just being recorded) and how behavioural change and parental/nurse concern are captured/scored.
Meaning of a high/low score	Not all scores had the higher value representing greater concern.
Additional features	Sepsis tools; tools for escalation and tools for mandating a response were the most frequent.
Hospital-specific elements	For example, contact details for bleeps and ward extensions.

BP, blood pressure; PEWS, paediatric early warning systems.

features before the seriousness of their condition is recognised. It has been estimated that approximately one in five children who die in hospital have avoidable factors contributing to their death, with up to half having other potentially avoidable factors.⁹ A previous confidential enquiry into childhood death concluded ‘there should be ways of telling if something is wrong with a child as early as possible, for example, an early warning scoring system’.⁹

Unique challenges of children

Children are a very different population group when compared with adults. Therefore, we cannot directly replicate NEWS2, but there are similarities and learning that can be shared. Children and young people (CYP) are a complex population because they:

1. Exhibit a *vast change* in *physiology* between birth and adulthood.
2. Tend to *compensate* physiologically, making it difficult to spot the acutely ill child early.
3. Often *decompensate* very rapidly.
4. May *not communicate* their symptoms as effectively as adults.

5. Are usually accompanied by *parents/carers* who possess unique *insight* into their child’s well-being.
6. Have *lower morbidity and mortality rates* compared with adults.

Several issues emerge when considering the impact of an intervention designed to improve the response to deterioration. First, all types of deterioration need to be considered. Recent national policy focused on sepsis,¹⁰ but deaths from asthma and other diseases continue to occur.¹¹ Second, clinical judgement and parent/carer concerns must be able to override any score and prompt escalation where appropriate. Evidence and case reviews highlight that inability to respond to concerns are often involved in missed deterioration. Third, nearly half of hospitals in England operate paper systems.¹² While there is a clear national direction towards implementation of digital care records, paper systems still need to be in place for organisations who are still on this journey, or when digital processes fail.

What are PEWScores and PEWS (systems)?

Paediatric Early Warning Scores (PEWScores) describe any tool collating vital signs and other observable or measurable characteristics producing thresholds for response. This may be a numerical score based on the individual components summated into an overall number (with the score determining the level of escalation required), or trigger based with any one component exceeding predefined thresholds. Score and trigger-based tools are sometimes brought together under the collective title of ‘track and trigger’ tools.

Responding to a track and trigger alert can be an action for an individual (via the child’s normal clinical team) or by a hospital wide team such as a rapid response team (RRT). The RRT comprises individuals, who may not be involved in the normal care of the deteriorating patient, but have specialist skills in these situations.

PEWS (Paediatric Early Warning Systems) describe the entirety of the process including PEWScores if present and the response (single clinician or RRT) and organisational policies surrounding escalation and communication.

Standardised capture and record of the child’s observations and evaluating them to inform the wider PEWS process is critically important. This could fall between score and system, but is considered here because it is often undertaken by junior staff, who will often move between different centres. There are examples of Human Factors research demonstrating that minor variations in the dataset, layout (on paper or digital systems) or methodology in such circumstances could lead to failure.¹³

What is the evidence for PEWS?

Chapman *et al*¹⁴ examined paediatric alert criteria, advising that studies were needed to determine which physiological

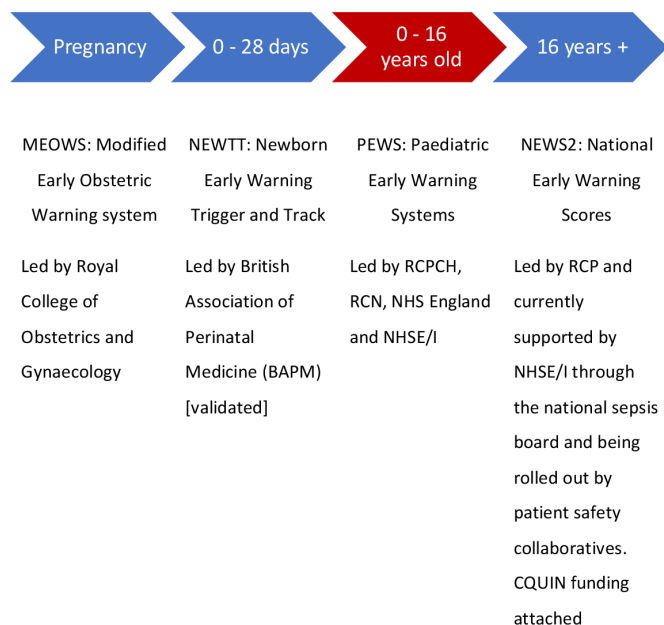


Figure 1 A summary of early warning systems used at different ages throughout the life course. CQUIN, Commissioning for Quality and Innovation; NHSE/I, NHS England and NHS Improvement; RCN, Royal College of Nursing; RCPCH, Royal College of Paediatrics and Child Health.

Table 2 Principles underlying maturity at each level (relevant to inpatient wards)

Level 1 (PEWS 1.0—relevant to majority of hospitals)	<ul style="list-style-type: none"> ▶ Observation and monitoring guidance aligned to RCN guidance on vital signs measurement in CYP²⁴ ▶ Use of standardised observation charting to transfer physiological data into a composite score ▶ In use in all paediatric inpatient care areas in the organisation ▶ Regular audit of practice on vital signs measurement and escalation
Level 2 (PEWS 2.0—relevant to selection of hospitals)	<ul style="list-style-type: none"> ▶ PEWS includes subjective data (eg, parent/carer/professional concern) ▶ Policy and practice acknowledge situational awareness with PEWS part of a wider system that may include watchers, huddles and senior walk rounds ▶ Escalation processes and communication tools such as SBAR in operation ▶ Key outcomes monitored on regular basis ▶ Evidence of iterative feedback and engagement with staff ▶ In use in paediatric emergency departments and assessment units in some hospitals
Level 3 (PEWS 3.0—for introduction in 2021+)	<ul style="list-style-type: none"> ▶ A standardised approach to educating staff in recording observations (objective and subjective) in all environments (primary/secondary/tertiary care) ▶ Evidence of initiatives to develop and demonstrate cultures in healthcare environments to foster the reduction of hierarchy between staff and parent/carers and within specialty and professional groups of all grades ▶ Utilisation of national principles for 'standards for escalation' ▶ A route map to electronic data collection clear for each trust

CYP, children and young people; PEWS, paediatric early warning systems; RCN, Royal College of Nursing; SBAR, situation, background, assessment, response.

parameters or combinations best predicted serious adverse events and a subsequent review of Track and Trigger systems by Chapman¹⁵ found considerable variation in their performances. A more recent systematic review¹⁶ found limited evidence that PEWS incorporating a paediatric track and trigger tool reduced deterioration or death in practice. It did highlight the potential for track and trigger systems benefit communication, teamwork and empowerment of junior staff. Standardising PEWS, with uniform data collected across hospitals and subjected to machine learning, will enable exploration of these possible benefits. Child mortality is rare and is not a useful surrogate outcome for the success of a PEWS. The EPOCH study,¹⁷ the first multicentre study of a PEWS concluded '*implementation of the Bedside Paediatric Early Warning System compared with usual care did not significantly decrease all-cause mortality among hospitalized paediatric patients*' but there were trends in earlier intensive care admission. It is necessary to ensure the national SPOT programme develops a constellation of factors to support detection, planning and action in response to deterioration across all settings; these three components derived from a systematic review of factors enabling the effectiveness of systems to detect deterioration in children and adults.¹⁸

Current use of PEWS

A survey of organisations providing services to children in ED, assessment, or inpatient settings in 2011¹⁹ showed use of PEWS, in the Great Britain had increased from 21% in 2005 to 85%.²⁰ In 2018/2019, a national survey²¹ generated a snapshot of current PEWS use and RRTs. In this survey, 100% organisations in England reported using a PEWS chart (paper or electronic). The survey found wide variation across the country of the chosen chart model, scoring system, make-up of the RRT and age segmentation. However, there were similarities in some parameters scored—heart rate and respiratory rate contributed to the score in all the PEWScores. Respiratory effort, oxygen therapy, oxygen saturation and abnormal consciousness were in approximately 75% of PEWScores.

The survey found a plethora of other practices, tools and initiatives to detect and escalate management of deterioration in children. These included simulation training, safety huddles, learning from incidents and successful episodes of care. Since the 2011 survey at least 25% of organisations in England have introduced electronic PEWScores (e-PEWS) with a further c. 30% planning to implement e-PEWS within a year. With over half of the organisations using e-PEWS shortly, it is critical to develop an electronic format alongside a paper-based system.

PEWS charts variation

Using a purposive sampling technique, a selection of PEWS charts from around the UK were brought together. The critical findings from this review are framed in [table 1](#).

Of note NEWS2 for adults starts at 16 years of age and is used on adult wards.⁶ Children transition into adult services between 16 and 25 years old, depending of specialty, service and organisation. To reduce human error, we propose a pragmatic approach, to solely use PEWS on paediatric wards (even if the young person is over 16 years of age) and NEWS2 on adult wards. It was also noted that many neonatal departments use the NEWTT tool²² to cover the first month of life. An overview of the acute deterioration response tools used at different stages of life is summarised in [figure 1](#).

The case for standardisation

There are a number of arguments in favour of a standardised systems. First Scotland, Ireland and Northern Ireland have implemented systems without evidence of harm. The failure of England to do so would put children in an iniquitous position compared with children in devolved nations and adults. Second, the majority of parameters used have greater similarity than dissimilarity, making the move to a single system potentially less complex. However, it is acknowledged there will be significant local challenges in deimplementing current systems and these need both local and national support. Third, while child mortality is lower than that in adults, it is expected that there will be long-term gains in reduced morbidity and mortality from a standardised system with a national dataset calibrated by continuous analysis and adjusted in real-time through algorithmic developments.

Development of an e-PEWS model ties in with the NHS Long Term plan²³ of embedding digital services. With standardisation, system-wide data collection and system interoperability, individual and collective physiological and other results will be visible across the system will and follow the patient from one care setting to the next

To aid strategy and deployment, three stages of PEWS maturity have been identified (outlined in [table 2](#)): the basic levels (1+2) should be achievable by all providers of acute paediatric services, if not already in place. Level 3 will require a system-wide approach across sustainability and transformation partnerships or integrated care systems, including more systematic action to identify acute serious illness in the community.

A standardised PEWS in a wider context

Given the complexity of the implementation task, the SPOT Board agreed it would first focus first on developing a system

that worked in an acute inpatient hospital setting. This pragmatic approach mirrors how NEWS2 was developed. However, cross-system work will progress in parallel to ensure that emergency departments as well as community, ambulance and primary care services engage in future (contextual) development and their approaches will be aligned with the standardised PEWS approach, although not necessarily containing all components. The objective is to develop a system of scoring and escalation which delivers a flexible, but synergistic, approach to acute deterioration in CYP. In particular, it is acknowledged that mental health deterioration can exhibit in various ways, which may not necessarily be captured by a traditional PEWS approach based on physiological variables. Comprehensive sets of observations may not be suitable for other community settings but it will be important to align key components to aid communication in referral and transfer.

CONCLUSION

The lack of a single, nationally validated system recognising and responding to acutely unwell children in England presents a patient safety risk. It complicates training, creating risks with staff groups working on multiple sites. Many children are appropriately managed, but local and national case reviews show that this is not always the case. A standardised system used in every inpatient setting may eliminate present variation and reduce the likelihood of treatment failure as a result of unfamiliarity with systems.

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REFERENCES

- 1 Ward JL, Wolfe I, Viner RM. Cause-specific child and adolescent mortality in the UK and EU15+ countries. *Arch Dis Child* 2020;105:1055–60.
- 2 Draycott T, Lewis G, et al. Saving mothers' lives 2006–2008 centre for maternal and child enquiries (CMACE). *BJOG* 2011;118:e12–21.
- 3 Royal College of Paediatrics and Child Health (RCPCH). Safe system framework for children at risk of deterioration, 2019. Available: <https://www.rcpch.ac.uk/sites/default/files/generated-pdf/document/Safe-system-framework-for-children-at-risk-of-deterioration.pdf> [Accessed 27 Aug 2020].
- 4 Royal College of Paediatrics and Child Health (RCPCH). Situation awareness for everyone (S.A.F.E) toolkit, 2019. Available: <https://www.rcpch.ac.uk/sites/default/files/generated-pdf/document/Situation-Awareness-for-Everyone-%2528S.A.F.E%2529-toolkit-introduction.pdf> [Accessed 27 Aug 2020].
- 5 NHS Improvement. Re-ACT-the respond to ailing children tool, 2017. Available: <https://improvement.nhs.uk/resources/re-act-respond-ailing-children-tool/> [Accessed 27 Aug 2020].
- 6 Royal College of Physicians (RCP). National early warning score (news) 2: standardising the assessment of acute-illness severity in the NHS, 2017. Available: <https://www.rcplondon.ac.uk/projects/outputs/national-early-warning-score-news-2> [Accessed 27 Aug 2020].
- 7 NHS Greater Glasgow and Clyde. Paediatric early warning score: PEWS. Available: <https://www.clinicalguidelines.scot.nhs.uk/ggc-paediatric-guidelines/ggc-guidelines/surgery/paediatric-early-warning-score-pews/> [Accessed 27 Aug 2020].
- 8 Royal College of Physicians of Ireland. Paediatric early warning system (PEWS). Available: <https://www.rcpi.ie/paediatric-early-warning-system/> [Accessed 27 Aug 2020].
- 9 Confidential Enquiry into Maternal and Child Death (CEMACH). Why children die: a pilot study 2006, 2008. Available: <https://www.publichealth.hscni.net/sites/default/files/Why%20Children%20Die%20-%20a%20pilot%20study%202006.pdf> [Accessed 27 Aug 2020].
- 10 NHS England. Sepsis in children: update for general practice, 2016. Available: <https://www.england.nhs.uk/south/wp-content/uploads/sites/6/2016/07/sepsis-in-children-update.pdf> [Accessed 27 Aug 2020].
- 11 Royal College of Paediatrics and Child Health (RCPCH). Why children die – research and recommendations (2014), 2019. Available: <https://www.rcpch.ac.uk/sites/default/files/generated-pdf/document/Why-children-die-research-and-recommendations-%25282014%2529.pdf> [Accessed 27 Aug 2020].
- 12 Building better healthcare (BBH). Majority of NHS trusts yet to fully embrace digital patient records, 2019. Available: https://www.buildingbetterhealthcare.com/news/article_page/Majority_of_NHS_trusts_yet_to_fully_embrace_digital_patient_records/154911 [Accessed 27 Aug 2020].
- 13 Christofidis MJ, Hill A, Horswill MS, et al. A human factors approach to observation chart design can Trump health professionals' prior chart experience. *Resuscitation* 2013;84:657–65.
- 14 Chapman SM, Grocott MPW, Franck LS. Systematic review of paediatric alert criteria for identifying hospitalised children at risk of critical deterioration. *Intensive Care Med* 2010;36:600–11.
- 15 Chapman SM, Wray J, Oulton K, et al. 'The score matters': wide variations in predictive performance of 18 paediatric track and trigger systems. *Arch Dis Child* 2017;102:487–95.
- 16 Trubey R, Huang C, Lugg-Widger FV, et al. Validity and effectiveness of paediatric early warning systems and track and trigger tools for identifying and reducing clinical deterioration in hospitalised children: a systematic review. *BMJ Open* 2019;9:e022105.
- 17 Parshuram CS, Dryden-Palmer K, Farrell C, et al. Effect of a pediatric early warning system on all-cause mortality in hospitalized pediatric patients: the epoch randomized clinical trial. *JAMA* 2018;319:1002–12.
- 18 Jacob N, Moriarty Y, Lloyd A, et al. Optimising paediatric afferent component early warning systems: a hermeneutic systematic literature review and model development. *BMJ Open* 2019;9:e028796.
- 19 Roland D, Oliver A, Edwards ED, et al. Use of paediatric early warning systems in Great Britain: has there been a change of practice in the last 7 years? *Arch Dis Child* 2014;99:26–9.
- 20 Duncan HP. Survey of early identification systems to identify inpatient children at risk of physiological deterioration. *Arch Dis Child* 2007;92:828.
- 21 Wheway J, Stilwell PA, Cook A. A preimplementation survey for a standardised approach to paediatric early warning systems. *Arch Dis Child* 2018;93:1191–4.
- 22 British Association of Perinatal Medicine. Newborn early warning trigger & track (NEWTT) – a framework for practice, 2015. Available: <https://www.bapm.org/resources/38-newborn-early-warning-trigger-track-newtt-a-framework-for-practice-2015> [Accessed 27 Aug 2020].
- 23 NHS England. The NHS long term plan, 2019. Available: <https://www.england.nhs.uk/long-term-plan/> [Accessed 27 Aug 2020].
- 24 Royal College of Nursing. Standards for assessing, measuring and monitoring vital signs in infants, children and young people, 2017. Available: <https://www.rcn.org.uk/professional-development/publications/pub-005942> [Accessed 27 Aug 2020].