Paediatric early warning scores on a children’s ward: a quality improvement initiative

Linda Ennis discusses the implementation and evaluation of a track and trigger system to improve the care, referral and outcomes for acutely ill young patients.

Abstract

The aim of this quality improvement initiative was to incorporate a paediatric early warning score (PEWS) and track and trigger system in the routine care of children in an acute general children’s ward at a regional hospital in the Republic of Ireland. In the absence of a nationally recommended specific PEWS strategy, a local plan was developed. The experience of structuring and implementing the PEWS and track and trigger system is presented in this article. Data from the first year of use were collected to evaluate the clinical utility and effectiveness of this system. In the busy acute children’s service, the PEWS initiative was found to benefit processes of early detection, prompt referral and timely, appropriate management of children at potential risk of clinical deterioration. Nursing staff were empowered and supported to communicate concerns immediately and to seek rapid medical review, according to an agreed PEWS escalation plan. Outcomes were significantly improved.

Keywords

Acute children’s ward, early detection, paediatric early warning score, staff empowerment, track and trigger system

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SOME OF THE main issues surrounding the deterioration of children in hospital include failure of staff to monitor clinical status, recognise deterioration, communicate concerns effectively and respond appropriately (National Institute for Health and Care Excellence (NICE) 2007, National Patient Safety Agency 2007). Even when deterioration is recognised, the hierarchical nature of health care can often promote a culture that compounds ineffective communication and subsequent ineffective response (Azzopardi et al 2011, Institute for Safe Medication Practices 2012).

In response to international and local recommendations to incorporate an early warning score in routine care provision for children in hospital (NICE 2007, Pearson 2008), a patient safety initiative was undertaken in 2012 in a 30-bed acute children’s ward in the Republic of Ireland. Its purpose was to prevent avoidable deterioration or adverse outcomes for children and to increase the efficiency of care provision.

Aims

The project aimed to support staff in recognising changes in a child’s physiological status and making appropriate clinical decisions, to promote early proactive intervention/management and improve the outcome. A secondary objective was to evaluate the clinical utility and effectiveness of this paediatric early warning score (PEWS) system, when incorporated in routine nursing observation and multidisciplinary team communication processes.

The project had several targets, including full concordance with the use of PEWS tools, the agreed standards for patient assessment/monitoring and timely recognition, referral and response to a trigger PEWS and therefore a reduction in the number of unanticipated critical care/intensive care referrals.

Literature review

A literature review was undertaken to evaluate PEWS-related research, systems and tools, and to support evidence-based decision making for selecting a suitable PEWS system. Nationally, it has been found that just six of the 23 acute children’s services in Ireland have implemented a PEWS system and that there is little consistency in the systems applied (Nursing and Midwifery Project Officer, Office of Nursing and Midwifery Service Director, personal communication, September 3, 2013). The National Clinical Programme (NCP) for Paediatrics and Neonatology (2013) also identified significant variation in the adoption of recognised...
good practices, such as use of PEWS systems and standard communication/handover, in acute children’s care provision in Ireland. In recognising the need to adopt practices to improve patient safety, quality of care and clinical effectiveness, the NCP for Paediatrics and Neonatology (2013) has committed to work on developing such quality improvement strategies nationally.

It could be argued that the absence to date of a national co-ordinated approach to PEWS systems has been a contributing factor in the slow adoption and implementation of PEWS in Ireland. In addition, the lack of strong evidence to support the validity, reliability and utility of published PEWS models and criteria in clinical practice (Chapman et al 2010, Roland et al 2013) makes the selection of a particular system a challenge, from local and national perspectives.

A review of the evidence base of the published PEWS systems found that, in studies reporting on the diagnostic accuracy of PEWS criteria, the most common outcome measures evaluated were cardiopulmonary arrests, transfer to intensive care facilities and referral to rapid response teams (Haines et al 2006, Brilli et al 2007, Tucker et al 2009, Parshuram et al 2009).

In a prospective evaluation, Tucker et al (2009) found a 13-criteria PEWS tool to be sensitive enough but not sufficiently specific to predict children who required transfer to children’s intensive care facilities. Edwards et al (2009), using an eight-criteria PEWS system, drew similar conclusions related to the use of this system to activate an emergency call or rapid response team. Two retrospective studies (Akre et al 2010, Parshuram et al 2011) found that PEWS systems could potentially identify early signs of deterioration in a child, up to 11 hours and 24 hours respectively, before a clinical deterioration event. The authors concluded that this PEWS information could enable earlier interventions by medical teams.

Consistent with these findings, it could be argued that the requirement for an emergency resuscitation or a rapid response team call, either of which is a late response, could be avoided through earlier proactive interventions. Chapman et al (2010) and Parshuram et al (2011) recommend further prospective clinical evaluations to assess the effect of PEWS systems in practice.

A further notable deficit in the literature is the lack of PEWS studies undertaken in acute children’s wards in general hospitals. In the absence of a nationally used PEWS tool or evidence to support the validity, utility and generalisability of published PEWS systems across various hospital settings, many local acute children’s services have either continued to await national guidance or have developed or adapted a PEWS systems to suit their own environment.

**Implementation, tactics and strategy**

Led by the children’s service nurse management, the present quality improvement initiative was embraced collaboratively by the multidisciplinary team, which consistently strives to ensure a ward culture of safe, effective and child-centred care. A project team was established and a local plan developed.

A two-step approach was taken to implementation. First, to support effective communication, a structured method of communicating critical information was introduced through the use of a framework based on the acronym ISBAR: Identify, Situation, Background, Assessment and Recommendation (Health Service Executive (HSE) 2011). This was followed by the selection and implementation of a PEWS track and trigger system. At the same time, a prospective observational study was undertaken to follow any children who triggered a PEWS alert (PEWS≥3) during their inpatient stay until discharge from the ward.

**Selecting a system** In the absence of national PEWS tool or a recommended evidenced-based PEWS system for use in acute children’s wards in general hospitals, it was decided to consider the use and applicability of the NHS Institute’s (NHSI) PEWS charts (NHSI 2011). These age-specific paediatric observation and PEWS charts apply a multiparameter bedside score system, which is designed to reflect the age-specific needs and variable clinical observation parameters of children across the age ranges in a children’s ward (0-1 year, 1-5 years, 5-12 years and >12 years).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Escalation protocol</th>
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<tbody>
<tr>
<td>Paediatric early warning score (PEWS)</td>
<td>Early warning escalation plan/action to be taken*</td>
</tr>
<tr>
<td>0, 1</td>
<td>Continue monitoring</td>
</tr>
<tr>
<td>2</td>
<td>Nurse in charge review</td>
</tr>
<tr>
<td>3, 4</td>
<td>Nurse in charge and senior house officer review and inform registrar</td>
</tr>
<tr>
<td>5, 6, 7</td>
<td>Nurse in charge and registrar review and inform consultant</td>
</tr>
</tbody>
</table>

*These are the minimum measures recommended
Human-factor design principles that consider the many factors that can influence people and their behaviours – such as the physical environment, physical demands, mental demands, distractions, product design and process design – were also applied in developing these NHSI PEWS charts. An awareness of human factors in product, system or process design aims to minimise risk, the potential for human error and improve safety for patients and staff.

The NHSI PEWS charts and criteria were chosen because they use existing, routinely monitored clinical observations, are simple to apply, easy to calculate and require minimal staff time. In a multidisciplinary review process, the charts were adapted slightly (with the permission of the NHSI) and the respiratory assessment section was prioritised in the upper section of the charts.

The PEWS score was calculated using seven criteria/observations:

- Respiratory rate.
- Degree of respiratory distress.
- Oxygen use.
- Stridor or apnoea.
- Heart rate.
- Consciousness level.
- Level of concern of the nurse/doctor/parent.

A score of 1 is applied for observations that fall outside normal parameters. A PEWS of 3 or more is a critical trigger for escalation and rapid review by the paediatric medical team or relevant specialist team, with a further escalation when the score is ≥5.

The PEWS escalation plan was modified slightly to reflect the local medical staff structure and desired management framework, which specified the criteria and arrangements for escalating the care of deteriorating children (Table 1). As the degree of respiratory distress categories (mild, moderate or severe) was not defined in the NHSI PEWS assessment tool, the World Health Organization adapted framework for assessment of severity of breathing difficulty/respiratory distress (Lakhanpaul et al, 2009) (Table 2) was applied to ensure consistency and objectivity in determining and recording severity. A PEWS escalation plan/deteriorating child management algorithm was subsequently developed for quick reference by ward staff (Figure 1, page 28).

**Training and communication** A comprehensive training programme was provided for all nursing and medical staff in the children's department, in small-group, practice-based training workshops. The training sessions addressed the use of the ISBAR communication framework and of the PEWS track and trigger system, and also provided staff with refresher training in local policy and procedures for assessing, measuring and monitoring vital signs in children.

A4 posters titled 'Key points about PEWS' and the 'PEWS escalation plan/deteriorating child management algorithm' were also displayed throughout the ward to prompt and support staff to use the PEWS system. Information about the PEWS initiative and the new practices and processes involved was provided to all clinicians on the children’s ward. A PEWS management policy was developed to support and reinforce required clinical practices. Signed understanding of this policy is mandatory for children’s ward staff and the policy is incorporated in the induction programme for all new staff.

**Change management** The clinical practice changes and the change management required for successful implementation of this PEWS initiative were recognised as critical elements by the project planning team. Ward managers and senior staff played a significant and positive leadership role in educating staff, promoting and ensuring the correct use of the PEWS system and encouraging staff engagement.

Subsequently, continuing audit by the clinical nurse managers in the children's service has monitored the effect of the PEWS system on staff practices, in terms of accuracy and full...
completion of the paediatric observation/PEWS charts and adherence to the escalation protocol. These audits provide evidence of sustained, high levels of concordance with the standards and key performance indicators defined in the local PEWS policy. Formal and informal staff feedback were encouraged and contributed to the review process.

**Prospective evaluation**

The adapted NHSI PEWS system was implemented in January 2012, and a prospective cohort observational study was undertaken over a four-month period to assess the clinical utility and

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**Box 1 Data collected**

- Paediatric early warning score (PEWS) at alert to doctor.
- Diagnosis before PEWS alert.
- Length of stay from admission to PEWS alert.
- Presence and category of most senior doctor at the PEWS rapid medical review.
- Response time from PEWS alert to PEWS review.
- Response action.
- Post-PEWS placement.
- Condition at 24 hours post-PEWS alert.
- Patient outcome.
- Issue arising/risks identified.
- Total length of hospital stay.
effectiveness of the system when used as part of routine nursing observation and multidisciplinary team communication processes.

Data collection and analysis Data were manually collected prospectively from patient documentation (observation charts and nursing/medical notes) on all children who obtained a trigger PEWS of ≥3 over an 18-week period, between January 23 2012 and May 27 2012, up to their discharge from the ward. Data collection on children with PEWS≤2 was limited to those who required a rapid medical review irrespective of the PEWS score, and was carried out by the senior nurse manager for the children’s and neonatal services and one associate, a paediatric clinical nurse specialist.

A specific data collection template was developed as part of the study protocol to ensure consistency and objectivity. Box 1 summarises the type of data recorded and outcome measures evaluated. All data were de-identified and entered in a spreadsheet application for analysis. Quantitative analysis was limited to simple descriptive statistics.

It was proposed that the number, type and timing of proactive ward-based medical interventions as a direct result of a PEWS would be useful indicators of the effectiveness and utility of the PEWS system in clinical practice. A medical intervention was defined as any intervention that aimed to modify clinical status and health outcome, and included prescription of oral, intravenous or nebulised drugs, intravenous fluids, inhalers, alteration in percentage or method of oxygen administered, non-invasive or invasive respiratory support, additional diagnostics and care plan changes. Preventable adverse outcomes were defined as unexpected and sudden deterioration, out-of-intensive care unit (ICU) respiratory/cardiac arrest, and death.

**Ethical considerations** The paediatric department management team, the director of nursing and the clinical risk manager approved the project and study. Because of the prospective observational study design - without alterations in the routine and expected standard of care in relation to nursing observations recorded - the HSE regional research ethics committee advised that no formal ethical approval process was required for this study, but ethical issues and practices were considered throughout, with confidentiality of data maintained.

**Population characteristics** The total number of inpatient admissions to the children’s ward during the study period was 1,618, of which 76% (n=1,230) were emergencies. Most (62%, n=1,004) were admitted to hospital under the care of paediatricians (Table 3). Over the 18-week study period, there were 72 instances of PEWS ≥3, involving 35 children (2.16% of 1,618 admissions). Of the 72 PEWS alerts to medical staff, 64 were for children with a PEWS of 3-4 (Table 4). Most (83.3%, 60/72) of PEWS alerts were for children younger than five years old, with an even distribution of alerts in children in the youngest age categories (Table 5, page 30). All 35 children with a PEWS ≥3 were inpatients under the care of paediatricians; 97% of these children (n=34) had a respiratory condition on admission, with bronchiolitis being the most common diagnosis.

**Project impact and outcomes** Analysis outcomes found that for children with a PEWS of 3-4 (n=64 occasions), there was 97% concordance with the standard that these children should be reviewed rapidly by the relevant senior house officer in a maximum response time of 30 minutes, with the registrar informed of the change in the child’s clinical status; 92% of these reviews were undertaken within 15 minutes.
two occasions that did not meet agreed response times, the medical reviews took place within one hour of the initial review request (Table 6). For children with PEW≥3 (n=8 occasions), there was 100% concordance with the standard that they should be reviewed by the registrar within 15 minutes, with the relevant consultant informed of the child’s clinical status.

Over the study period, no child had a preventable adverse outcome during their hospital stay. Most (97%, 34/35) with a PEW≥3 had additional medical intervention following a first PEWS alert review. Most PEWS alerts (82%, 59/72) resulted in a specific intervention or change to the treatment plan. The medical responses to 18% of all PEWS alerts (n=13) was ‘continue to monitor’; 12 of these 13 were for children with an earlier PEWS review and intervention. Most children (85%, n=30) with a PEW≥3 improved within 24 hours following initial rapid medical review/interventions.

Table 5  
<table>
<thead>
<tr>
<th>Age</th>
<th>Total number of instances of paediatric early warning score ≥ 3</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth-1 year</td>
<td>30</td>
<td>41.6</td>
</tr>
<tr>
<td>1-5 years</td>
<td>30</td>
<td>41.6</td>
</tr>
<tr>
<td>5-12 years</td>
<td>12</td>
<td>16.6</td>
</tr>
<tr>
<td>&gt;12 years</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All ages</td>
<td>72</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>1,618</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 6  
<table>
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<tr>
<th>Most senior doctor present at paediatric early warning score (PEWS) review</th>
<th>Number of PEWS alerts</th>
<th>Percentage of PEWS alerts (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior house officer</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>Registrar</td>
<td>45</td>
<td>62.5</td>
</tr>
<tr>
<td>Consultant</td>
<td>14</td>
<td>19.5</td>
</tr>
</tbody>
</table>

ICU-level monitoring and non-invasive respiratory support on the children’s ward. The presence of experienced senior clinicians (registrars/consultants) at the PEWS-triggered review was also notably high (82% of all PEWS reviews) (Table 6). Although correlation was not conclusive, it could be surmised that such senior clinical review and decision making was likely to have been of benefit to the management and outcomes of children in this study.

Two audit tools were developed:

- A tool to assess the use and accuracy of completion of the patient observation chart incorporating the PEWS. This tool incorporates the collection of specific data for at least ten children on the ward, including all sets of observations for the previous 48 hours for each child.

- A tool to assess compliance with the use of the escalation protocol in response to the PEWS for all children who trigger a PEWS of 3 or more.

The one-year post-implementation audit demonstrated that 100% of children had vital signs assessed at least six hourly, with increased frequency of monitoring in response to detection of abnormal physiology. An accurate PEWS was recorded for 91% of sets of vital signs assessed; 7% of vital signs audited did not have any PEWS recorded and a further 2% had an inaccurate PEWS calculation recorded.

A continuous quality improvement plan has been established to address improvement in this area, re-enforce the PEWS policy and correct PEWS practices. The plan includes the following strategies:

- Clinical nurse managers/senior staff to re-enforce the PEWS policy, and the use and accurate completion of paediatric observation/PEWS charts with all staff, through ongoing education and daily monitoring of practice. Clinical nurse managers to emphasise the requirement that every set of observations must be complete and an accurate PEWS calculated and recorded.

- The clinical nurse manager/staff nurse in charge should address any educational requirements of relief staff providing care in the children’s ward in using and accurately completing paediatric observation/PEWS charts, at the start of each shift. Relief staff in the ward was seen as a contributing factor to errors in PEWS calculation.

The one-year audit also noted that there was 100% concordance with the escalation protocol – that is, the assessing nurses immediately informed the relevant clinician and requested rapid review, and the clinician’s PEWS-triggered reviews of children were undertaken within agreed time frames, with management plans formulated and documented.
There has been positive feedback from all staff during and since implementation. Medical staff have reported that the new paediatric observation/PEWS charts enable easy visualisation of a child’s status and of when a child’s observations deviate from the usual range. A staff questionnaire was developed to assess staff satisfaction and knowledge of the PEWS track and trigger system, as part of a formal staff evaluation one year after implementation.

Nurses’ responses highlighted that the PEWS was easy to calculate and required only minimal extra time. Nurses also reported that they felt empowered and supported in communicating concerns and seeking rapid medical review based on the clinical observations, the PEWS recorded and the agreed escalation plan. The questionnaire also enabled nurses to comment on any issues and suggest improvements. This formal feedback supported a number of minor improvements, including the addition of the ISBAR tool (HSE 2011) to the paediatric observation/PEWS charts.

Conclusion
The project outcomes provide positive reassurance that this PEWS system can quantify effectively the status of acutely ill children in hospital, enabling early recognition of clinical deterioration by staff, effective communication and timely management of a change in a child’s clinical status.

The consistent, rapid response to a PEWS alert was considered one of the main benefits of the PEWS system implemented. All nursing referrals and 98.6% of all PEWS-triggered medical reviews, and subsequent medical management, were undertaken within agreed rapid response times, to ensure timely communication and more effective care provision.

Critical success factors included: strong front line nursing leadership, multidisciplinary engagement and buy in, a structured education and training programme, day-to-day support for use of the new age-specific paediatric observation/PEWS charts, and regular review and feedback of evaluation and audit results.

The experience of, and response to, this local initiative highlighted the need nationally for a co-ordinated approach to developing and implementing PEWS systems in children’s services in Irish hospitals. A number of other acute children’s services have since expressed interest in implementing this system.

Just as national early warning score systems have been introduced for adult and maternity populations in Irish hospital (Department of Health 2013, Royal College of Physicians of Ireland and Health Service Executive 2013), so a similar national, co-ordinated approach to developing and implementing PEWS systems can encourage the establishment and evaluation of PEWS in acute children’s services.

References
Roland D et al (2013) Use of paediatric early warning systems in Great Britain: Has there been a change of practice in the last 7 years? Archives of Disease in Childhood. 99, 1, 26-29.
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