

The Irish Paediatric Early Warning System (PEWS)

National Clinical Guideline No. 12



HSE National Clinical Programme for
Paediatrics and Neonatology



This National Clinical Guideline has been developed by the Irish Paediatric Early Warning System (PEWS) Guideline Development Group (GDG), within the HSE National Clinical Programme for Paediatrics and Neonatology.

The NCEC was commissioned by the Minister for Health to develop the guideline arising from a significant patient safety/policy matter.

Using this National Clinical Guideline

This National Clinical Guideline applies to infants and children admitted to paediatric inpatient settings. It does not apply to infants within maternity and neonatal units. This National Clinical Guideline is relevant to all healthcare professionals working in paediatric inpatient settings.

Disclaimer

NCEC National Clinical Guidelines do not replace professional judgement on particular cases, whereby the clinician or health professional decides that individual guideline recommendations are not appropriate in the circumstances presented by an individual patient, or whereby an individual patient (or their parent/carer in the case of children) declines a recommendation as a course of action in their care or treatment plan. In these circumstances the decision not to follow a recommendation should be appropriately recorded in the patient's healthcare record.

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Version history

Date	Version	Full update or rapid update	Details
November 2015	1		New
November 2016	2	Rapid update	Refer to 'summary of updates table'

Membership of the Guideline Development Group

The GDG was chaired by Dr. John Fitzsimons, Chair of the National PEWS Steering Group and Clinical Director for Quality Improvement, Quality Improvement Division, Health Service Executive (HSE). This National Clinical Guideline is supported by the HSE National Clinical Programme for Paediatrics and Neonatology, the Faculty of Paediatrics, Royal College of Physicians of Ireland (RCPI) and the Clinical Strategy and Programmes Division, HSE.

Membership nominations were sought from a variety of clinical and non-clinical backgrounds so as to be representative of all key stakeholders within the acute paediatric hospital sector. GDG members included those involved in clinical practice, education, administration and research methodology, as well as representation from PEWS pilot sites and parents. In addition, when required, a process of consultation was employed with subject matter experts.

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1 These members of the GDG are also current members of the National PEWS Steering Group. The National PEWS Steering Group is responsible for the development of the Irish Paediatric Early Warning System, and oversees implementation activities nationally.

2 Membership of the Guideline Development Group: Rapid Update November 2016

Terms of reference

The main objective of the PEWS Guideline Development Group was to utilise available evidence with the knowledge, experience and expertise of clinicians and parent representatives in the development of more responsive, effective and efficient services for children. The Guideline Development Group provided a forum for communication and expert clinical advice to inform the development of a National Clinical Guideline on PEWS.

The systematic literature review, focus groups and baseline evaluation were funded by the Clinical Effectiveness Unit, Department of Health. The views or interests of the funding body did not influence the recommendations contained within this National Clinical Guideline. In addition, no conflicts of interest were declared by GDG members.

Credits and acknowledgments

The role of the NCEC is to prioritise, quality assure and recommend clinical guidelines to the Chief Medical Officer for National endorsement by the Minister for Health. The endorsed National Clinical Guideline is published and launched. It is intended through Ministerial endorsement that full implementation of the guideline will occur through the service plan.

The NCEC and the Department of Health acknowledge and recognise the Chair and members of the Guideline Development Group for development of the guideline. The NCEC and Department of Health wish to express acknowledgement and sincere gratitude to all persons contributing to this National Clinical Guideline; especially those that give of their time on a voluntary basis, such as parents, clinicians and patients.

The following credits and acknowledgements are made by the Chair of the Guideline Development Group:

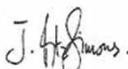
The Chair, Dr. John Fitzsimons wishes to acknowledge Ms Rachel MacDonell and Ms Claire Browne as full contributors, credited with having given substantial intellectual leadership to the National Clinical Guideline, meeting at least the following:

- Actively engaged in the planning, organisation, analysis and interpretation of evidence; and drafting the guideline/recommendations including critical revisions; and also
- Involved in final approval of the version of the NCG to be published by the Department of Health; and agreement to be accountable for surveillance of new evidence and the development of guideline updates as considered necessary.

Ms Rachel MacDonell and Ms Claire Browne submitted the guideline proposal to the NCEC. Ms Rachel MacDonell, Ms Claire Browne and Dr. Veronica Lambert agreed the scope and developed the clinical questions. Dr Veronica Lambert of Dublin City University carried out the search for evidence and systematic review and conducted the budget impact analysis. Ms Rachel MacDonell successfully submitted the proposal/guideline for NCEC quality assurance. All authors approved the final guideline. The external review carried out by Dr Lachman and Dr Rowland is acknowledged.

All GDG members contributed to the 2016 rapid update.

A full list of members of the Guideline Development Group is available in the previous pages.

Signed by the Chair 

Dr John Fitzsimons

Date: November 2016

National Clinical Guidelines

Providing standardised clinical care to patients in healthcare is challenging. This is due to a number of factors; among them variations in environments of care and complex patient presentations. It is self-evident that safe, effective care and treatment are important in ensuring that patients get the best outcomes from their care.

The Department of Health is of the view that supporting evidence-based practice, through the clinical effectiveness framework, is a critical element of the health service to deliver safe and high quality care. The National Clinical Effectiveness Committee (NCEC) is a Ministerial committee set up in 2010 as a key recommendation of the report of the Commission on Patient Safety and Quality Assurance (2008). The establishment of the Commission was prompted by an increasing awareness of patient safety issues in general and high profile health service system failures at home and abroad.

The NCEC on behalf of the Department of Health has embarked on a quality assured National Clinical Guideline development process linked to service delivery priorities. Furthermore, implementing NCEC National Clinical Guidelines sets a standard nationally, to enable healthcare professionals to deliver safe and effective care and treatment while monitoring their individual, team and organisation's performance.

The aim of National Clinical Guidelines endorsed by the NCEC is to reduce unnecessary variations in practice and provide a robust basis for the most appropriate healthcare in particular circumstances. As a consequence of Ministerial mandate, it is expected that NCEC National Clinical Guidelines are implemented across all relevant services in the Irish healthcare setting.

The NCEC is a partnership between key stakeholders in patient safety. NCEC's mission is to provide a framework for national endorsement of clinical guidelines and audit to optimise patient and service user care. The NCEC has a remit to establish and implement processes for the prioritisation and quality assurance of clinical guidelines and clinical audit so as to recommend them to the Minister for Health to become part of a suite of National Clinical Guidelines and National Clinical Audit. The aim of the suite of National Clinical Guidelines is to provide guidance and standards for improving the quality, safety and cost-effectiveness of healthcare in Ireland. The implementation of these National Clinical Guidelines will support the provision of evidence-based and consistent care across Irish healthcare services.

NCEC Terms of Reference

1. Provide strategic leadership for the national clinical effectiveness agenda.
2. Contribute to national patient safety and quality improvement agendas.
3. Publish standards for clinical practice guidance.
4. Publish guidance for National Clinical Guidelines and National Clinical Audit.
5. Prioritise and quality-assure National Clinical Guidelines and National Clinical Audit.
6. Commission National Clinical Guidelines and National Clinical Audit.
7. Align National Clinical Guidelines and National Clinical Audit with implementation levers.
8. Report periodically on the implementation and impact of National Clinical Guidelines and the performance of National Clinical Audit.
9. Establish sub-committees for NCEC work-streams.
10. Publish an annual report.

Summary of guideline updates November 2016

Section	Details
Section 1. Background	<p>Glossary: Child/children refers to an infant, child or adolescent admitted to inpatient paediatric services.</p> <p>Section 1.13 Audit outcomes updated</p>
Section 2. Recommendations Note: recommendations have been renumbered in this updated version	<p>Recommendation 1 Updated to provide clearer guidance for hospitals on applicable/ non-applicable areas for implementation and how to ensure continuity of observation trending between areas.</p> <p>Recommendation 2 & 3 (formerly recommendation 2 & 5) New layout of two sections on concern/clinical judgment. Additional reference to resources and standardised approach to assessment of parent/carer concern.</p> <p>Recommendation 9 (formerly recommendation 9 & 10, see revised wording below) Revised wording reflects national experience and learning. Greater clarity provided regarding use of clinical judgement (use of variance orders) and application to parameter scoring or escalation guide.</p> <p>The GDG decided to give responsibility to local governance structures for assessing whether sufficient paediatric experience and support is available to safely use the Medical Escalation Suspension facility. A decision may be made to operate PEWS without the Medical Escalation Suspension option in use.</p>
Section 3. Appendices	<p>Appendices on implementation, audit, chart examples and international systems in use have been removed from main document and are now available online at www.hse.ie/pews</p> <p>Appendix 3.4 New implementation toolkit overview Appendix 3.5 New audit overview section including KPI</p>

Changes to recommendations

	Version 1 text (November 2015)	Version 2 updated text (November 2016)
Rec 9	<p>A parameter amendment should only be decided by a doctor of registrar grade or above, for a child with a pre-existing condition that affects their baseline physiological status.</p> <p>If an unwell but stable child has an elevated PEWS score, a decision to <u>conditionally</u> suspend escalation may be made by a doctor of registrar grade or above.</p>	<p>Variances to PEWS parameters or Escalation Guide may be made by senior medical personnel with caution in certain permitted circumstances.</p>

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Glossary of Terms and Abbreviations

Definitions within the context of this document

Child/Children Refers to an infant, child or adolescent admitted to inpatient paediatric services.

Clinician A health professional, such as a doctor or nurse, involved in clinical practice.

Early Warning Score A bedside score and 'track and trigger' system that is calculated by clinical staff from the observations taken, to indicate early signs of deterioration of a patient's condition

Family A set of close personal relationships that link people together, involving different generations, often including (but not limited to) parents and their children. These relationships are created socially and biologically, and may or may not have a formal legal status.

Infant A child, from birth to one year of age.

ISBAR A communication tool: the acronym stands for Identify, Situation, Background, Assessment, and Recommendation.

Nurse in charge A nurse assigned to manage operations within a specific clinical area for the duration of the shift.

Senior Doctor A medical professional of registrar level or higher.

Senior Nurse This refers to a senior nursing colleague who may be a Senior Staff Nurse, Shift Leader, CNM or ADON/DNM for example.

Track and Trigger A 'track and trigger' tool refers to an observation chart that is used to record vital signs or observations so that trends can be 'tracked' visually and which incorporates a threshold (a 'trigger' zone) beyond which a standard set of actions is required by health professionals if a patient's observations breach this threshold.

Abbreviations

Abbreviation	Meaning
ABC-SBAR	Airway, Breathing, Circulation followed by Situation, Background, Assessment, and Recommendation
ADON	Assistant Director of Nursing
AVPU	Alert, Voice, Pain, Unresponsive
BIA	Budget Impact Analysis
BLS	Basic Life Support
CEMACH	Confidential Enquiry into Maternal and Child Health
CEO	Chief Executive Officer
CEWT	Children's Early Warning Tool
CNM	Clinical Nurse Manager
CPR	Cardiopulmonary Resuscitation
CRD	Centre for Reviews and Dissemination
DCU	Dublin City University
DNM	Divisional Nurse Manager
DoH	Department of Health
EPOCH	Evaluating Processes of Care and the Outcomes of Children in Hospital
EWS	Early Warning Score
GDG	Guideline Development Group
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HIQA	Health Information and Quality Authority
HSE	Health Service Executive
ICT	Information and Communication Technology
ICTS	Irish Children's Triage System
ICU	Intensive Care Unit
IMC	Irish Medical Council
IMEWS	Irish Maternity Early Warning System
IO	Intraosseous
IPATS	Irish Paediatric Acute Transport System
ISBAR	Identify, Situation, Background, Assessment, and Recommendation
IV	Intravenous
KPI	Key Performance Indicator
ManchEWS ²	Manchester Children's Early Warning Score
MDT	Multidisciplinary Team
MET	Medical Emergency Team
NCAA	National Cardiac Arrest Audit
NCEC	National Clinical Effectiveness Committee
NCEPOD	National Confidential Enquiry into Patient Outcomes and Deaths
NCG	National Clinical Guideline
NEWS	National Early Warning Score (Adults)
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NICU	Neonatal Intensive Care Unit

Abbreviation	Meaning
NMBI	Nursing and Midwifery Board of Ireland
NPSO	National Patient Safety Office
NTS	Neonatal Trigger Score
ONMSD	Office of the Nursing and Midwifery Services Director
PASQ	Patient Safety and Quality of Care
PEW	Paediatric Early Warning
PEWS	Paediatric Early Warning System
PICANet	Paediatric Intensive Care Audit Network
PICO	Population, Intervention, Comparison, Outcome
PICU	Paediatric Intensive Care Unit
QI	Quality Improvement
RCN	Royal College of Nursing
RCP	Royal College of Physicians
RCPCH	Royal College of Paediatrics and Child Health
RCPI	Royal College of Physicians of Ireland
RCT	Randomised Controlled Trial
RESPOND	REcognising Signs of Paediatric hOspital iNpatients Deterioration
RRS	Rapid Response System
RRT	Rapid Response Team
SAFE	Situation Awareness For Everyone
SBAR	Situation, Background, Assessment, and Recommendation
SCBU	Special Care Baby Unit
SIGN	Scottish Intercollegiate Guideline Network
SIRS	Systemic Inflammatory Response Syndrome
SOP	Standard Operating Procedure
TeamSTEPPS	Team Strategies and Tools to Enhance Performance and Patient Safety
UK	United Kingdom
US	United States

1 Background

1.1 Need for national clinical guideline

In response to the Health Information and Quality Authority (HIQA) *Patient Safety Investigation Report into Services at University Hospital Galway* (2013), the NCEC was requested by the Minister for Health to commission and quality assure a number of National Clinical Guidelines. The National Early Warning Score (NEWS) has been introduced for non-pregnant adult patients in collaboration with the National Clinical Programme for Acute Medicine. The National Clinical Guideline No. 1 (NEWS) was published in February 2013. The Irish Maternity Early Warning System (IMEWS) provides guidance and processes for the early detection of life threatening illness in pregnancy and for up to 42 days post-natally. The National Clinical Guideline No. 4, (IMEWS) was endorsed by the Minister for Health and published in November 2014. This National Clinical Guideline for the Irish Paediatric Early Warning System (PEWS) has been developed in collaboration with the National Clinical Programme for Paediatrics and Neonatology and the Quality Improvement Division of the HSE. It provides the framework for implementation and governance of PEWS in inpatient paediatric settings in Ireland.

A systematic literature review was commissioned in 2014 by the Department of Health and undertaken by DCU. This review identified that paediatric early warning systems are widely used around the world; though a lack of consensus exists about which system is most useful. Notwithstanding the lack of evidence for a definitive system, positive trends in improved clinical outcomes, such as reduced cardiopulmonary arrest or earlier intervention and transfer to Paediatric Intensive Care Unit (PICU), were noted. Paediatric early warning systems have also been shown to enhance multidisciplinary team (MDT) working, communication, and confidence in recognising and making clinical decisions about clinically deteriorating children (Lambert et al., 2014).

A robust system specifically designed for the identification of the clinically deteriorating child is important and necessary. The application of early warning systems is more challenging in paediatric patients compared to adults for several reasons, including:

- Variation in age-specific thresholds for normal and abnormal physiology
- Children's inability or difficulty to articulate how or what they feel
- Children's ability for early physiological compensation
- Need for greater focus on respiratory deterioration in children.

The Irish PEWS is a multifaceted approach to improving patient safety and clinical outcomes. It is based upon the implementation of several complementary safety interventions, including national paediatric observation charts, PEWS scoring tool and escalation guide, effective communication using the national standard (ISBAR communication tool for patient deterioration), timely nursing and medical input, and clear documentation of management plans. The key to success for the PEWS at institutional level is strong governance and leadership, targeted training, on-going audit, evaluation and feedback. In other countries, earlier recognition and timely intervention in clinical deterioration has been shown to improve outcomes such as reduced unplanned PICU admissions, shorter length of stay in PICU or a lesser severity of illness on admission to PICU (Tibbals et al., 2005). In addition, it is likely that incidence of respiratory and cardiopulmonary arrests may be reduced (Brilli et al., 2007; Zenker et al., 2007). The outcome for clinicians, children and families is a greater awareness and understanding of the child's clinical condition and needs. PEWS depends on the implementation of complex interventions such as improved safety culture, team work and situation awareness (i.e. knowing what is going on). Such interventions are supported by the application of quality improvement

methods in many of the studies that informed this guideline. It is recommended that similar supports are put in place to ensure the reliable introduction of new practices in all settings.

1.2 Critical illness in children

In a landmark study of paediatric mortality in the United Kingdom (UK), it was estimated that one in five children who die in hospital have avoidable factors leading to death and up to half of children have potentially avoidable factors (CEMACH, 2008). Evidence of deterioration, physiological and behavioural changes, may be present in the 24 hours preceding a cardiopulmonary arrest (Robson et al., 2013; McLellan et al., 2013). Adverse outcomes following clinical deterioration in children admitted to hospital are frequently preventable through identification of those children for referral to critical care experts (Parshuram, 2009). This supports renewed focus on prevention, early detection through early warning systems and scores, and appropriate timely responses to the clinically deteriorating child.

There are 1,600 admissions per year into Ireland's two paediatric intensive care units in Dublin, of which 440-600 are admissions from external hospitals:

- Our Lady's Children's Hospital, Crumlin PICU admits approximately 1,100 patients per year, of which 30-40% are unplanned or emergency admissions.
 - Temple Street Children's University Hospital PICU admits 500 patients annually, of whom 80% are unplanned.
- (Source PICANet)

The difficulty with much critical illness in childhood is the ability to recognise it early and to differentiate it from minor illness. In 2011, there were 153,905 hospital discharges of children in Ireland (DCYA, 2012). More than half of the total hospital discharges were of infants (< 1 year of age) and children aged 1-4 years old (21.9% and 29.0% respectively). Many children admitted to paediatric wards every year will have features of critical illness but most will stabilise following initiation of therapy. Others will require additional monitoring for evidence of deterioration and the possibility of needing escalation to a higher level of care. Some paediatric centres, outside of the children's hospitals, have the ability to provide a higher level of care (one to one nursing, increased monitoring, limited respiratory or cardiovascular support) to small numbers of sick children which may avoid escalation to PICU. Smaller paediatric units may only see a few children each year who deteriorate to the extent that they require transfer to PICU. In this context, severe critical illness is an uncommon event, relative to the number of children passing through the facility. If escalation to a higher level of care is required, admission to an adult intensive care unit (ICU) may be advised, depending on local arrangements, for stabilisation prior to transfer to PICU.

Three observational/quasi-experimental study review papers revealed some evidence to support the effectiveness of paediatric rapid response systems with a number of studies reporting statistically significant reduction in mortality rates and cardiorespiratory arrest rates after implementation (Winberg et al., 2008; Chan et al., 2010; VanderJagt, 2013). National implementation of PEWS should improve the management of critical illness in children by facilitating earlier recognition and response to deterioration and in turn preventing unplanned admission to PICU.

1.3 Clinical and financial implications of the Paediatric Early Warning System

Failure to detect and respond appropriately to clinical deterioration in a child has been shown to be a contributing factor in a significant percentage of in-hospital serious events and deaths (CEMACH, 2008; McLellan et al., 2013; Robson et al., 2013). Though the incidence of in-hospital cardiac arrest is reported as low, Tibballs et al. (2005) reported a reduction in cardiac arrest numbers following introduction of a PEWS. Similarly, both Brilli et al. (2007) and Zenker (2007) noted a significant reduction in respiratory and cardiac arrests by means of a chart review pre- and post-PEWS implementation. In addition, both papers also report increased staff satisfaction following the introduction of a PEWS.

To date, there is no published evidence for the resource implications of a complete paediatric early warning system (implementation, education, detection, response). Studies on the detection and response components of PEWS provide results using a variety of clinical and process outcome data, e.g. cardiopulmonary arrest, unplanned transfer to PICU, length of stay in PICU, but none of those papers estimated costs or savings. Bonafide et al. (2014b) costed the medical emergency team (MET) element of response within a PEWS in a tertiary setting and found that three clinical deterioration events would offset the costs of the MET (compared to pre-MET). Beyond this break-even point, all clinical deterioration events averted (by the MET) after that would represent savings, as patients with clinical deterioration events have higher costs.

Many recommendations in this guideline represent existing good practice and are therefore cost neutral. It is acknowledged that the required level of governance, implementation oversight, on-going audit and staff training may result in additional costs. Therefore, should resourcing require additional staff hours, there may be a budget impact for some paediatric units. However, such costs may be minimised or eliminated with judicious rostering or utilisation of appropriate existing quality, risk, patient safety or audit roles. Implementation is addressed in the budget impact analysis (BIA) through approximate training, materials and audit costing. It is not possible to estimate savings related to improved outcomes until a national evaluation of PEWS takes place, to include actual economic impact. The BIA for PEWS implementation is summarised in Appendix 3.1.

1.4 Aim of National Clinical Guideline

The purpose of this National Clinical Guideline is to improve prevention and recognition of, and response to, children at risk of clinical deterioration in paediatric inpatient settings through the implementation of a standardised paediatric early warning system.

1.5 Scope of National Clinical Guideline, target population and target audience

This National Clinical Guideline applies to infants and children admitted to paediatric inpatient settings. It is not for use within neonatal and maternity units, paediatric intensive care units or perioperative settings. PEWS is not an emergency triage system and should not be used for this purpose.

National Clinical Guideline No. 1; National Early Warning Score (NEWS) is for use in non-pregnant adults, while National Clinical Guideline No. 4; Irish Maternity Early Warning System (IMEWS) is for use in women with a confirmed pregnancy and for up to 42 days post-natally.

This guideline makes recommendations on the process of implementation and utilisation of the Irish Paediatric Early Warning System. It is relevant to hospital management, healthcare professionals, children and their families. It is intended to complement, not replace, clinical judgement. Cases should be considered individually and, where necessary, discussed with a senior or more experienced colleague.

1.6 Methodology and literature review

A systematic review of clinical and economic literature was commissioned by the Department of Health and undertaken by the School of Nursing and Human Sciences, Dublin City University (DCU), to support the development of this National Clinical Guideline. This review, completed in August 2014, assessed evidence on the use, validation, education and cost-effectiveness of early warning, or 'track and trigger', systems used for paediatric patients in acute healthcare settings, including emergency departments, for the detection and/or timely identification of deterioration of children aged 0-16 years. Broad PICO's (Population, Intervention, Comparison, Outcome) were determined for the systematic review search strategies in order to draw on all available evidence.

The findings of the literature review were described in various thematic domains: PEWS detection systems, PEWS response systems, implementation strategies/processes, educational interventions, cultural influences and economic reviews. A series of clinical questions were formulated to organise the evidence from the literature review and to structure this National Clinical Guideline. Specific searches were not undertaken for individual clinical questions. Evidence from the systematic literature review and a small number of additional studies (mostly published after completion of the literature review), combined with the experience from the pilot of the Irish PEWS, was used to formulate and grade the individual recommendations. For each clinical question, the informing literature is detailed in the evidence summaries and statements. The wording of each recommendation was decided by consensus of the GDG members through a process of 'considered judgement', which took account of the factors described in section 1.8.

The literature review was guided by the framework of the Centre for Reviews and Dissemination (CRD) (2008) guidelines for undertaking a healthcare systematic literature review and the NCEC Guideline Development Manual (2013) with regard to considering evidence for the review. The HIQA Guidelines for Budget Impact Analysis of Health Technologies in Ireland (2015) were also adopted to guide budget impact analysis for the Irish PEWS.

The objectives and research questions governing this review were:

- What neonatal and paediatric early warning, or 'track and trigger', systems (including escalation protocols and communication tools) are currently in use internationally for the detection of deterioration and/or timely identification of deterioration in children aged 0-16 years? This included early warning scores in the emergency department.
- What is the level of clinical validation of these neonatal and paediatric scoring systems including escalation protocols and communication tools?
- What education programmes have been established to train healthcare professionals in the delivery of neonatal and paediatric early warning scoring systems?
- What level of evaluation has been used for these education programmes?
- What are the findings in the economic literature of cost effectiveness, cost impact, and resources involved with early warning or track and trigger systems in the detection and/or timely identification of deterioration in paediatric patients, including implementation costs?
- To conduct a budget impact analysis on the implementation of PEWS.

A variety of electronic databases and other resources were searched to retrieve published and unpublished evidence nationally and internationally; including clinical guidelines, primary research studies, secondary reviews, economic evaluations/analysis and grey literature. Key findings are summarised in Appendix 3.2. The full systematic literature review is available on the Clinical Effectiveness website.

1.7 Grading of systematic literature review evidence

An adapted Grading of Recommendations Assessment, Development and Evaluation (GRADE) process was used for this clinical guideline, as two separate grading processes were undertaken.

The first, for the systematic literature review, made use of Scottish Intercollegiate Guideline Network (SIGN) criteria for assessment of studies based on type of study design. Assessing comparative quality across the eligible studies included in the PEWS systematic review proved difficult due to the heterogeneous nature of the research methodologies employed; including disparate research designs, different ranges for collecting data over time periods (from months to years), localised small case and comparative group selections, and diverse clinical contexts ranging from general medical and surgical units to specialised settings such as oncology, cardiac, endocrine and rehabilitation units. However, to gain some understanding of the body of evidence available and to inform standards required for the development of this National Clinical Guideline, the type of study was classified according to the SIGN criteria for assignment of levels of evidence as summarised below in Table 1. This was conducted by two reviewers with discussion to reach consensus on the overall hierarchy of evidence of rating. The individual study ratings are detailed in Table 3.2.3 of Appendix 3.2.

Separately, the GDG considered the quality of the evidence combined with expert opinion and experience from the pilot of the Irish PEWS. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) process was then used to assign strength of recommendation as detailed in section 1.8.

Table 1: Evidence Classification for Systematic Literature Review

Level 1 Evidence (n=0)	The review identified no level one evidence (i.e. meta-analysis, systematic reviews of randomised controlled trials (RCTs) or RCTs) on the effectiveness of paediatric early warning systems for the detection and/or timely identification of, and response to, deterioration in improving clinical outcomes for children aged 0-16 years in inpatient hospital settings. The levels of evidence sourced ranged from level 2 to 4.
Level 2 Evidence (n=33)	<p>33 papers were classified as level 2 evidence; inclusive of review papers of studies other than RCTs such as descriptive, observational and/or quasi-experimental studies; and localised single site observational studies such as case control and cohort studies and quasi-experimental designs such as interrupted time series and/or before and after studies. It is worth noting that while these studies have been classed as level 2 evidence based on the fact that they have been described as case control or control studies often the data collection methods in these studies were similar to those described in level 3 evidence (i.e. retrospective data extraction from medical charts/databases and/or prospectively evaluating patient physiological measurements/early warning scores or documented rapid response team data).</p> <p>Of the level 2 evidence, two multi-centre studies were identified. One focusing on paediatric early warning (PEW) detection systems was conducted in four hospitals (three in Ontario and one in Birmingham) with a total number of 2,074 patients (case 686; control 1388) (Parshuram et al., 2011a). Owing to the multi-centre nature and larger sample size of this study perhaps it could be classified at the upper end of the level 2 evidence in comparison to other studies. However, arguably the study was also limited in that the study involved individual units within each hospital as opposed to hospital wide inclusion. The other level 2 multi-centre study was conducted in four hospitals in Ontario Canada and focused specifically on PEW response systems (Kotsakis et al., 2011). Although specific to one site and cultural context, the work of Brady et al. (2013) offers promise in assisting one to move beyond considering "early warning" of clinical deterioration as merely a solitary 'score' but rather as a complex 'system' with a multitude of components; all of which will be influenced by the 'patient safety/risk' cultural milieu of the health care system within which it is situated.</p>
Level 3 Evidence (n=20)	20 papers were categorised as level 3 evidence; largely inclusive of chart reviews and case reports. The research designs of these studies were generally described in line with the method of data collection such as descriptive audits and/or before and after chart reviews. While chart reviews provided valuable retrospective and prospective data on PEW system detection tools and rapid response systems the studies often suffered from missing data. How such missing data was managed varied across different studies ranging from assuming missing data as normal; using the most recently reported data; excluding incomplete data from analysis; and/or replacing missing data by a value drawn from an estimate of distribution of variance to create a complete dataset. This was also pertinent for some level 2 evidence whereby the primary means of data collection for some case control and/or cohort studies was patient medical records and/or localised electronic databases as aforementioned.
Level 4 Evidence (n=17)	17 papers were identified as level 4 evidence, classified as expert opinion approaches inclusive of localised quality improvement initiatives; qualitative interviews and cross-sectional survey design studies which drew on small localised samples to gather the perspectives of various interdisciplinary members of the health care team. Notwithstanding these limitations, these studies offer a valuable contribution in understanding the complexities of implementing PEW systems. One level 4 study described a multi-centre multi-disciplinary collaborative improvement project conducted across 20 children's hospitals under the Child Health Corporation of America (Hayes et al., 2012).

1.8 Grading of recommendations

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) categories were used to assign the quality of evidence for each clinical question (Tables 2 and 3 below). This involved consideration of the assigned level of evidence in the context of the GDG's expert opinion and findings from the Irish PEWS pilot to determine applicability to clinical practice. The adapted GRADE process was further followed to assign recommendation *strength*; the GDG considered and rated the quality of evidence of supporting material together with an assessment of the balance of benefits and harms, values and preferences, and resource (cost) implications for each recommendation. The GRADE system has two categories for recommendation strength, which Guyatt et al. (2008b) classified as 'strong' or 'weak'. Guyatt et al. (2008b) also advised that guideline panels may choose different words to characterise the two categories of strength. The PEWS GDG classified the overall strength of each recommendation as either **strong** or **conditional** (weak).

Of note, National Health Service (NHS) Evidence, SIGN and UpToDate® have endorsed GRADE criteria for deciding recommendation strength. This system was agreed to best meet the needs of the guideline and the GDG, given the absence of RCTs in many of the areas covered. The SIGN principles for application of GRADE methodology are detailed in Appendix 3.3.

Quality of evidence

The evidence discussed for each recommendation comprised the available published evidence from the systematic literature review, experiential evidence from the PEWS pilot and expert consensus from the GDG and consultation processes. The quality of all the available evidence was then assigned according to the GRADE criteria described in Table 2.

Table 2: Quality of Evidence for Recommendations (Guyatt et al., 2008a; reproduced with permission)

Quality of evidence	Description
High quality	Further research is very unlikely to change our confidence in the estimate of effect
Moderate quality	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate
Low quality	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate
Very low quality	Any estimate of effect is very uncertain

Strength of recommendation

The strength of each recommendation was decided following a process of considered judgement by the GDG that took into account the potential benefits and harms of implementation, the available evidence as described above, the values and preferences of the target audience including clinicians, the child and family and finally the cost implications of implementation as described in Table 3. The GRADE tables detailing the decision-making process for each recommendation are included in Appendix 3.3.

Table 3: Assessment of Balance (Guyatt et al., 2008b; adapted with permission)

Factor	Comment
<i>The balance of desirable and undesirable effects</i>	The larger the difference between the desirable and the undesirable effects, the higher the likelihood that a strong recommendation is warranted. The narrower the gradient, the higher the likelihood that a weak or conditional recommendation is warranted.
<i>Quality of evidence</i>	The higher the quality of evidence, the higher the likelihood that a strong recommendation is warranted.
<i>Values and preferences</i>	The more values and preferences vary, or the greater the uncertainty in the values and preferences, the higher the likelihood that a weak or conditional recommendation is warranted.
<i>Resource use</i>	The higher the costs of an intervention – that is, the greater the resources consumed- the lower the likelihood that a strong recommendation is warranted.

Some recommendations can be made with more certainty than others. The wording used in the recommendations in this National Clinical Guideline denotes the certainty with which the recommendation is made (i.e. the 'strength' of the recommendation). The 'strength' of a recommendation takes into account the quality (level) of the evidence as well as the other factors described. Although higher quality evidence is more likely to be associated with strong recommendations than lower quality evidence, a particular level of evidence quality did not automatically lead to a particular strength of recommendation. Other factors that were taken into account when forming recommendations included:

- relevance to the Irish healthcare setting;
- applicability of published evidence to the target population;
- consistency of the body of evidence; and
- the balance of benefits and harms of the options.

The strength of each recommendation was assigned based on the factors just described and following operational definitions agreed by the GDG.

A **strong** recommendation reflects the GDG's consensus that based on the available evidence, the expected benefits outweigh any potential harms, the values and preferences of patients and professionals are represented and cost implications are highlighted.

A **conditional** (weak) recommendation reflects the GDG's consensus that although the evidence base is limited in some aspects, the GDG remains confident of the likelihood of benefits outweighing harms.

1.9 External review

In August 2015, the draft of this National Clinical Guideline was circulated for review to the RCPI Paediatric Clinical Advisory Group, the Office of the Nursing and Midwifery Services Director (ONMSD) in the HSE and other national stakeholders, with a defined period to provide feedback. Sepsis considerations were developed in collaboration with Dr. Vida Hamilton, HSE National Sepsis Lead. In addition, the draft National Clinical Guideline was externally peer reviewed by two international experts in this field. Members of the GDG were aware of their work and their contribution to the academic literature, as well as their involvement with RCPCH and NHS programmes on patient safety in paediatrics.

Dr. Peter Lachman, Assistant Medical Director, Great Ormond Street Hospital and Dr. Damian Roland, Consultant and Honorary Senior Lecturer in Paediatric Emergency Medicine, University of Leicester completed the external expert international review of this National Clinical Guideline.

The GDG is very grateful to both reviewers and appreciates the time commitment that was involved in their review. Overall, the external reviewers concluded that this National Clinical Guideline was a well-researched, readable and balanced account of the current available evidence. All feedback received on the draft National Clinical Guideline was reviewed and incorporated where appropriate. This specifically included amendments to sections concerned with implementation, additional safety structures and use of quality improvement methodology for successful management of change.

1.10 Procedure for update of National Clinical Guideline

A planned review of the PEWS documentation and implementation tools in 2016 incorporated new learning from national and international fields and resulted in some significant changes to the national observation charts and associated training materials. As the policy framework for PEWS implementation, this national clinical guideline required revision to reflect these changes which were approved by the NCEC in October 2016 through the rapid update process. An updated literature review was not performed at this time. A full guideline update will occur as planned in 2018 at which time a repeat systematic review will be undertaken and the guideline amended to encompass any relevant new evidence and feedback from national and international experts on the current guideline.

1.11 Implementation of National Clinical Guideline

The HSE, hospital groups and individual healthcare institutions are responsible for the implementation of the Irish Paediatric Early Warning System using this guideline as a framework.

It is recommended that hospitals use quality improvement (QI) methodology when implementing the Irish PEWS. Such methods enhance stakeholder engagement and support local adoption through the use of testing, measurement and feedback of key interventions. Recognition must also be given to the complex task of improving patient safety climate (beliefs and attitudes) and culture (actions) that successful implementation of the PEWS depends upon. Programmes such as the Situation Awareness For Everyone (SAFE) partnership in the UK (run by the Health Foundation and the Royal College of Paediatrics and Child Health) have used quality improvement methods and patient safety science to assist hospitals to collaborate in addressing these challenges.

Specific guidance on implementation of PEWS has been developed for hospitals (see Appendix 3.4). It is recommended that local medical and nursing leads are identified at each site, who will then establish a project group to oversee implementation and evaluation. This group may contain, but is not limited to, medical, nursing, quality and risk, education or practice development and hospital management representatives. **There should be designated local PEWS coordinator(s), with appropriate protected time, to coordinate implementation, audit and evaluation** and to report directly to the hospital PEWS Governance group.

Some of the potential barriers and enablers for implementation of PEWS are listed in Table 4. These have been adapted from other international early warning score (EWS) evaluations and the Irish PEWS pilot findings. This is not an exhaustive list; local issues should be identified and managed by each paediatric unit.

Table 4: Barriers and Enablers to Implementation of PEWS

Barriers	Enablers
<ul style="list-style-type: none"> • Lack of local leadership • Lack of clearly defined roles and responsibilities • Lack of governance within the organisation • Lack of resources for the PEWS response system, e.g. staff, systems for recording and communicating information • Lack of clear, standardised communication • Lack of education, training and resources for staff on PEWS, and the early detection and management of a deteriorating child • Lack of audit and evaluation supports, e.g. ICT and other resources • The paediatric population makes up a very small cohort of patients within large regional centres 	<ul style="list-style-type: none"> • Good local leadership • Clearly defined roles and responsibilities • Good governance • Good multidisciplinary working • Effective communication • Complementary safety initiatives such as briefings, huddles and safety pauses • Arrangements in place for the safe and timely transfer of patients to a higher level of care, including close links with the Irish Paediatric Acute Transport Service (IPATS) • Ongoing targeted training and reinforcement of learning • Regular audit and evaluation, with the results informing quality improvement plans

Barriers to implementation should be identified and addressed locally by the PEWS governance team/committee/group as part of organisational quality improvement. Attention to the enablers listed above for implementation planning and strategy may aid the implementation process within that hospital setting.

1.12 Roles and responsibilities

This National Clinical Guideline should be reviewed by each hospital's senior management team, in conjunction with the relevant local implementation leads and project groups, to appropriately plan implementation of the recommendations. This will ensure that the inpatient care of children admitted to their facility is optimised, irrespective of age, location or reason for admission.

1.12.1 Organisational responsibilities:

Within each paediatric inpatient facility, the Chief Executive Officer (CEO)/General Manager has corporate responsibility for implementation of this National Clinical Guideline to ensure that there is a system of care in place for the prompt identification and management of the clinically deteriorating child.

1.12.2 Senior Managers responsibilities:

- Provide a local governance structure to support the implementation and ongoing evaluation of this National Clinical Guideline
- Assign personnel with responsibility, accountability and autonomy to implement this National Clinical Guideline
- Provide managers with support to implement this National Clinical Guideline and ensure that clinical staff undertake PEWS training as appropriate
- Ensure local policies and procedures are in place to support implementation
- Monitor implementation of this National Clinical Guideline, support ongoing evaluation and any actions required as a result
- Link the implementation team/group with corporate governance

1.12.3 Clinicians responsibilities:

- Comply with this National Clinical Guideline and related policies, procedures and protocols
- Adhere to relevant code of conduct and scope of practice guidelines appropriate to role and responsibilities
- Maintain competency in the assessment and management of the child in hospital
- Be aware of the role of appropriate delegation in using this National Clinical Guideline

This National Clinical Guideline, using a multidisciplinary approach, has been prepared to promote and facilitate standardisation and consistency of practice. **Clinical material in this National Clinical Guideline does not replace or remove clinical judgement, or professional care and duty.** The PEWS score alone is a tool to aid assessment and does not replace the clinical judgement of any healthcare professional. Where there are concerns regarding a child's condition, staff should not hesitate in contacting a senior member of the child's medical team to review the patient, irrespective of the PEWS score.

This guideline does **NOT** address all elements of good practice and assumes that individual clinicians are responsible for:

- Discussing care with the child and family in an environment that is appropriate and which enables respectful, confidential discussion;
- Advising children and families of their choices and ensuring that informed consent is obtained, thus meeting all legislative requirements and maintaining standards of professional conduct;
- Applying standard precautions and additional precautions, as necessary, when delivering care;
- Documenting all care in accordance with local and mandatory requirements.

1.13 Audit criteria

Audit can be a powerful tool to assess the impact of interventions, the quality of care and clinical outcomes (RCP, 2012). Regular audit of implementation and impact of this National Clinical Guideline is recommended to support continuous quality improvement. The audit process is coordinated in each paediatric unit under the local PEWS governance committee and should be undertaken from a multidisciplinary perspective where appropriate. Audits will require planning and resourcing. The PEWS governance committee may seek to allocate responsibility for the audit element of PEWS to an existing risk, quality or research department/role. Decisions regarding allocation of audit responsibility may have an impact on local resources (refer to budget impact analysis in Appendix 3.1) and are the responsibility of the local PEWS Governance Group.

Audit should be undertaken using the national PEWS Audit toolkit. The recommended frequency is at least weekly during the initial 12 week implementation phase and then at least monthly for ongoing monitoring. There is mandatory reporting of PEWS Key Performance Indicators (KPI) to the HSE Business Intelligence Unit. The format of the KPI will be reviewed annually to ensure valuable data collection, reflective of changes in national data collection processes and maturity of implementation.

Process audit

This is undertaken using the tools contained in the PEWS Audit toolkit. Data to be gathered include compliance with correct completion of the charts and documented evidence of response to triggers. In particular, it is essential to audit the clinical path of children whose observations are placed under a variance order (parameter amendment or medical escalation suspension: see section 2.3) to ensure these orders are being used appropriately.

For process audits, the recommended standard is 100% compliance. Where compliance falls below the standard, quality improvement action plans should be put in place to identify and address the causes.

Outcomes audit

Measurement of clinical outcomes is of particular importance in demonstrating the effectiveness or otherwise of the intervention for patients. It is recommended that the following outcome measures are monitored:

- Number of recorded urgent PEWS call triggers (PEWS Score ≥ 7)/MET/emergency team activations including PEWS total score and trigger parameters
- Unplanned admissions to PICU/adult ICU, including readmissions
- Length of stay in PICU/adult ICU
- Incidence and outcomes from in-hospital paediatric cardiac arrest, using a standardised minimum data set such as the UK and Ireland National Cardiac Arrest Audit (NCAA) (2014):
 - Age in years
 - Sex
 - Length of stay in hospital prior to arrest
 - Reason for admission to/attendance at hospital
 - Location of arrest
 - Presenting or first documented rhythm.

To ensure this data is meaningful from an improvement perspective, it could be presented locally as 'days since last urgent PEWS call' or 'days since last arrest' or 'days since last PICU transfer'. The PEWS audit toolkit for outcome and process measure data collection and interpretation is available at <http://www.hse.ie/pews>. Collection of this data is a requirement within the HSE KPI suite for PEWS.

1.14 Implications for research

To date, the lack of level 1 evidence and mixed outcomes from other levels of evidence, does not allow for definitive conclusions on the effectiveness of any particular system for the detection of, and response to, a clinically deteriorating child. There is a body of evidence which suggests positive directional trends in clinical outcomes, e.g. reduced cardio-pulmonary arrests, earlier intervention and transition to PICU, and potential improvements in MDT working, communication and confidence among clinicians in recognition, reporting and decision making around a child's clinical deterioration.

A core limitation noted within the PEWS systematic literature review was the lack of published evidence of PEWS as a 'complex healthcare intervention'; the focus has been placed instead on one facet of a system such as detection, response or education interventions for example. This limits the development of an underpinning theory and affects the consistency with which paediatric early warning systems are defined, implemented and measured for effectiveness. Several ongoing studies that are as yet unpublished may influence future developments with paediatric early warning systems. There is a need for examination of the system as a whole to validate the education programme, scoring system, process of escalation and outcomes following PEWS implementation in the Irish context. There is a growing body of work in this area, with the work at Cincinnati Children's Hospital at the forefront. PEWS is noted to be a facet of a wider safety programme at that hospital.

Evaluation of the Irish PEWS pilot across four sites, through facilitated focus groups with clinicians, revealed five key areas for future development including:

- Engagement with surgical teams, anaesthetics and other non-medical professionals as appropriate for PEWS implementation;
- Enhancement of parental involvement in PEWS;
- Use and integration of ISBAR with PEWS and handover communication;
- Establishment of briefings and huddles to enhance situation awareness;
- Use of PEWS in situations such as a child transitioning between highly monitored settings and ward areas.

2 National Clinical Guideline recommendations

In the following section, evidence for each of the 18 recommendations is outlined. For recommendations 1-10 the GDG formulated a series of clinical questions to organise the evidence from the literature review and to structure this National Clinical Guideline.

- A **strong** recommendation reflects the GDG's consensus that based on the available evidence, the expected benefits outweigh any potential harms, the values and preferences of patients and professionals are represented, and cost implications are highlighted.
- A **conditional** (weak) recommendation reflects the GDG's consensus that although the evidence base is limited in some aspects, the GDG remains confident of the likelihood of benefits outweighing harms.

Good practice points are included that denote recommended best practice based on the clinical expertise of the GDG. In addition, the GDG offers practical guidance where it is felt that this may aid implementation. Implementation of recommendations 1-10 is supported through the standardised training programme. Section 2.5 details specific implementation guidance for PEWS as a complex healthcare intervention providing clear recommendations for governance, aids to implementation using quality improvement methodology, and additional patient safety practices, training standards and systems for monitoring and audit of PEWS.

All recommendations are of equal importance and should be implemented without preference or bias.

The recommendations are presented under the following themes:

1. **Measurement and documentation of observations**
2. **Escalation of care and clinical communication**
3. **Paediatric sepsis**
4. **Governance**
5. **Supporting practices**
6. **Training**
7. **Audit**

Responsibility for Implementation of Recommendations

The CEO/General Manager, Clinical Director and Director of Nursing of each hospital (and/or hospital group) are accountable for the operation of the Paediatric Early Warning System.

While the Senior Management Team of each hospital has corporate responsibility for the implementation of the recommendations within this National Clinical Guideline, each member of the multidisciplinary team is responsible for the implementation of individual guideline recommendations relevant to their role.

2.1 Summary of recommendations

Section	Recommendations	Recommendation Number
Measurement and documentation of observations	<ul style="list-style-type: none"> The Paediatric Early Warning System (PEWS) should be used in any inpatient setting where children are admitted and observations are routinely required. PEWS should complement care, not replace clinical judgement. Clinician or family concern is a core parameter and an important indicator of the level of illness of a child, which may prompt a greater level of escalation and response than that indicated by the PEWS score alone. The core physiological PEWS parameters must be completed and recorded for every set of observations. Observations and monitoring of vital signs should be undertaken in line with recognised, evidence-based standards. 	1-5
Escalation of care and clinical communication	<ul style="list-style-type: none"> The PEWS escalation guide should be followed in the event of any PEWS trigger. The ISBAR communication tool should be used when communicating clinical information. Management plans following clinical review must be in place and clearly documented as part of the PEWS response. Variances to PEWS parameters or Escalation Guide may be made by senior medical personnel with caution in certain permitted circumstances. 	6-9
Paediatric sepsis	<ul style="list-style-type: none"> Once a diagnosis of sepsis has been made, it is recommended that the Paediatric Sepsis 6 is undertaken within one hour. 	10
Governance	<ul style="list-style-type: none"> The Chief Executive Officer / General Manager, Clinical Director and Director of Nursing of each hospital or hospital group are accountable for the operation of the Paediatric Early Warning System (PEWS). A formal governance structure, such as a PEWS group or committee, should oversee and support the local resourcing, implementation, operation, monitoring and assurance of the Paediatric Early Warning System. The PEWS governance committee should identify a named individual(s) to coordinate local PEWS implementation. 	11-12
Supporting practices	<ul style="list-style-type: none"> Hospitals should support additional safety practices that enhance the Paediatric Early Warning System and lead to greater situation awareness among clinicians and multidisciplinary teams. The Paediatric Early Warning System should be supported through the application of quality improvement methods, such as engagement strategies, testing, and measurement to ensure successful implementation, sustainability and future progress. 	13-14
Training	<ul style="list-style-type: none"> The PEWS governance committee in each hospital must ensure that PEWS training is provided to all clinicians. Clinicians working with paediatric patients should maintain knowledge and skills in paediatric life support in line with mandatory or certification standards. 	15-16
Audit	<ul style="list-style-type: none"> The national PEWS Audit toolkit should be used to aid implementation and to regularly quality assure the Paediatric Early Warning System. 	17

2.2 Measurement and documentation of observations

Clinical question 1

Should PEWS be used for all children in paediatric inpatient settings for the early identification of, and response to, clinical deterioration?

Summary of evidence

Level 2 evidence from the systematic literature review includes a review of observational/quasi-experimental studies (Chapman et al., 2010), three cohort studies (McLellan et al., 2013; Sharek, 2007; Theilen et al., 2013; Lobos, 2014), a pre-post design and staff satisfaction survey (Zenker et al., 2007), two before and after studies (Hunt et al., 2008; Kotsakis et al., 2011), two interrupted time series and chart reviews (Hanson et al., 2010; Bonafide et al., 2014) and two case control studies (Parshuram, 2011; Robson et al., 2013). Level 3 evidence includes a descriptive study/chart review (Tucker, 2009), five chart review studies (Tibballs et al., 2005; Brilli et al., 2007; Tibballs & Kinney, 2009; Haque, 2010; Roland et al., 2010), two database reviews (Wang et al., 2010; Panesar et al., 2014) and two case example papers (VanVoorhis & Willis, 2009; Avent et al., 2010). Level 4 evidence includes data from expert opinion surveys (Chen et al., 2012; Roland, 2014) and telephone surveys (VandenBerg, 2007; Sen, 2013). Additional evidence was sourced from a UK report titled 'Why Children Die' which reported on causes of paediatric mortality (CEMACH, 2008).

Although the percentage of paediatric cardiopulmonary arrests has been reported as low (0.7-3%) for inpatient admissions (Tucker et al., 2009; Chapman et al., 2010); survival to discharge for children that experience in-hospital cardiopulmonary arrest has been reported as poor (11-37%) (Tucker et al., 2009; McLellan et al., 2013). With increased acuity of care and higher technology dependency recent years have witnessed an increased risk of paediatric cardiopulmonary arrest, and its associated mortality, in acute healthcare settings (Robson et al., 2013). Given this, and the evidence that many paediatric deaths are identified as either avoidable or potentially avoidable (CEMACH, 2008), with evident deterioration of symptoms often present in the 24 hours preceding an arrest (Robson et al., 2013; McLellan et al., 2013), there is a solid foundation for increased attention to prevention of deterioration, early detection through implementation of early warning scores, and appropriate timely response to the clinically deteriorating child.

The PEWS literature review indicated that PEW detection (i.e. PEW system score) and response systems (i.e. rapid response teams, RRT, medical emergency teams, MET) are extensively used in paediatric hospitals internationally. Four cross-sectional surveys were identified that reported on the use, implementation and prevalence of paediatric early warning detection and response systems in paediatric hospitals (VandenBerg et al., 2007; Sen et al., 2013; Roland et al., 2014; Chen et al., 2012). The studies reported that 79-100% of hospitals surveyed maintained an immediate response team. Chen et al. (2012) also noted that respondents from institutions with RRTs were more likely to agree that RRTs improve patient safety and are worth the money and staff invested than respondents from institutions without. Early adopters of RRTs were more likely than late adopters to believe that RRTs reduce the number of "codes" on the wards.

Roland et al.'s (2014) UK survey revealed that 85% of paediatric units were using paediatric early warning systems; this was most likely to be in tertiary centres as opposed to paediatric units in district general hospitals (90% vs. 83%). Notwithstanding this, the majority of paediatric units were using PEW scoring systems that were unpublished and not validated with variable assessment criteria. No national standardisation was evident.

The majority of research papers specifically examining rapid response, medical emergency or emergency response teams were conducted in freestanding tertiary children's hospitals making generalisation problematic (Tibballs et al., 2005; Brilli et al., 2007; Sharek et al., 2007; Zenker et al., 2007; Hunt et al., 2008; Tibballs & Kinney, 2009; VanVoorhis & Willis, 2009; Wang et al., 2010; Avent

et al., 2010; Hanson et al., 2010; Haque et al., 2010; Kotsakis et al., 2011; Bonafide et al., 2012; Theilen et al., 2013; Bonafide et al., 2014a; Lobos et al., 2014; Panesar et al., 2014). Parshuram et al. (2011) identified this gap and in a prospective before and after observational study, evaluated the impact of implementing the Bedside PEWS score in a 22-bed inpatient paediatric ward in a community hospital. They found trends towards improvement in the reduction of significant deterioration events, reduced 'stat' calls to respiratory therapists and paediatricians and an increase in the number of interhospital transfers to the local paediatric referral centre.

Clinical outcomes measured across studies varied substantially. Rates of cardiorespiratory arrest, mortality rates, unplanned transfers to PICU and interventions required were the most common outcomes reported. Eight RRT studies reported an evident reduction in rates of cardiac arrest (Tibballs et al., 2005; Brilli et al., 2007; Hunt et al., 2008; Tibballs & Kinney, 2009; VanVoorhis & Willis, 2009; Hanson et al., 2010; Kotsakis et al., 2011; Bonafide et al., 2014a). Three papers reported a notable reduction in respiratory arrest (Brilli et al., 2007; Hunt et al., 2008; Bonafide et al., 2014a). One study highlighted that the incidence of cardiopulmonary arrest decreased by 60% after MET implementation compared with baseline (Brilli et al., 2007). Another indicated that the incidence of both cardiac and respiratory arrests decreased from 8 to 5.1 per 1000 discharges, representing a decrease of 36% ($p=0.19$) (Zenker et al., 2007). However, no findings were statistically significant.

The most frequent interventions reported were mechanical ventilation, vasopressors and suctioning. One study (Bonafide et al., 2014a) reported that the rapid response system, utilising an adjusted interrupted time series model, was associated with a considerable decrease in the trajectory of mechanical ventilation use in the 12 hours following transfer to the ICU and a net reduction in events by 83% in comparison with the pre-implementation trend. Similarly, it was also associated with a notable decrease in the trajectory of vasopressor use in the 12 hours following transfer to the ICU and a net reduction in events by 80% in comparison with the pre-implementation trend (Bonafide et al., 2014a). Again, no findings were statistically significant.

Seven studies reported hospital mortality data. No results for hospital mortality improvement were statistically significant, however there was a trend towards reduced PICU mortality and overall hospital mortality across all studies (Brilli et al., 2007; Sharek et al., 2007; Hanson et al., 2010; Haque et al., 2010; Kotsakis et al., 2011; Bonafide et al., 2014a). One of these studies reported a substantial reduction in hospital mortality (Kotsakis et al., 2011); whilst another (Haque et al., 2010) reported that mortality rates of patients admitted to PICU from the wards decreased from 50% to 15%. Bonafide (2014a) reported unchanged rates of hospital mortality.

Duration of stay was reported in three studies (Brilli et al., 2007; Avent et al., 2010; Theilen et al., 2013); of these two reported PICU length of stay, whilst Brilli et al. (2007) reported both PICU and hospital ward length of stay. Thirteen studies reported on the number of unplanned transfers to PICU (Tibballs et al., 2005; Brilli et al., 2007; Zenker et al., 2007; Tibballs & Kinney, 2009; VanVoorhis & Willis, 2009; Hanson et al., 2010; Avent et al., 2010; Kotsakis et al., 2011; Bonafide et al., 2012; Theilen et al., 2013; Bonafide et al., 2014a; Lobos, 2014; Panesar et al., 2014). Of these, one study found that the rate of unplanned transfers to ICU was substantially higher in the post-implementation period than in the pre-implementation period (Bonafide et al., 2014a); one study reported that 30% of all activations led to an unplanned PICU admission (Kotsakis et al., 2011) and one study found that the majority of unplanned PICU admissions were without involvement of the RRT (Theilen et al., 2013).

Similarly to clinical outcomes, process outcomes measured across studies varied substantially. Rates of MET utilisation/calls and 'Code Blue' activations were the most common outcomes reported ($n=14$). Broad categories were used to report reasons for activation, with respiratory distress being the most common indication for activating RRT/MET (Brilli et al., 2007; VanVoorhis & Willis, 2009; Haque et al., 2010; Kotsakis et al., 2011; Lobos et al., 2014). Cardiovascular, circulatory, neurological and staff concerns were also identified as additional reasons for

activation. One study (Panesar et al., 2014) found that the most significant reason RRTs were called were for tachycardia. Another study (Brilli et al., 2007) reported staff concern about the patient as the most frequent trigger to activate MET and laboured breathing as the most frequent physiological disturbance cited for activation. In one study, faster transportation time to ICU (within 40 minutes of RRT activation) was recorded (Avent et al., 2010). Theilen et al. (2013) reported a reduction (23% to 2%) in the number of patients who received a first response to deterioration after more than 12 hours and additionally found that a reduction in time for escalation of deteriorating patients (n=56) to intensive care support was most marked out-of-hours (median time 11 h vs. 7 h, $p = 0.038$).

In a telephone survey carried out for the systematic literature review (Lambert et al., 2014), five expert respondents cited evidence of altered clinical outcomes, examples of which included rate of arrest showing some improvement, early warning signs in several cases likely to be spotted earlier than before implementation of paediatric early warning systems, raised awareness of babies in difficulty and help with appropriate escalation of care. In addition, the average wait time to see a doctor improved with more observations being undertaken.

Finally, evidence to support the use of PEW scores in contexts such as neonatal populations and paediatric emergency departments was limited. In a cohort study, the neonatal trigger score (NTS) out-performed PEWS with significantly better sensitivity (Holme et al., 2013). Three studies focused specifically on the validation of PEW scores for use in paediatric emergency department settings. One was described as retrospective audit (Bradman & Maconochie, 2008) and two were prospective observational studies (Breslin et al., 2014; Seiger et al., 2013). Bradman and Maconochie (2008) and Breslin et al. (2014) found the Brighton PEWS of limited value in predicting need for hospital admission or intensive care support in children presenting to the emergency department. Seiger et al. (2013) contended that paediatric early warning systems can be useful to detect children presenting to an emergency department in need of ICU admission (although not necessarily hospital admission), however they remained cautious in recommending early warning systems as triage tools to prioritise patients based on the lack of evidence on patient outcomes and cost analysis compared to conventional triage tool systems.

Evidence statement

The systematic review (Lambert et al., 2014) details evidence that paediatric early warning systems have shown positive directional trends in improving clinical outcomes, e.g. reduced cardio-pulmonary arrests, earlier intervention and transfer to PICU for children who are clinically deteriorating. In addition, favourable outcomes for enhanced multi-disciplinary team work, communication and confidence in recognising, reporting and making decisions about child clinical deterioration were evident.

Consequently, while many paediatric early warning systems have been developed and implemented locally, uncertainty remains as to which early warning system is most effective for the detection and/or timely identification of, and response to, deterioration in children aged 0-16 years in inpatient hospital settings. This uncertainty is largely as a consequence of the lack of level-one evidence, and mixed outcomes from other evidence such as observational and quasi-experimental studies.

Recommendation 1

The Paediatric Early Warning System (PEWS) should be used in any inpatient setting where children are admitted and observations are routinely required.

Quality of evidence: Moderate

Strength of Recommendation: Strong

Good practice point

The national paediatric observation charts replace existing observation charts in paediatric inpatient settings with some exceptions:

PEWS is not intended for use in

- adults
- pregnant women
- paediatric intensive care units (PICU)
- perioperative units
- neonatal units (post-natal, special care baby units or neonatal intensive care settings)
- paediatric emergency triage

PEWS is recommended in

- emergency departments from the 'decision to admit' or earlier if local policy requires

PEWS may be used in

- adult intensive care settings (while awaiting transfer)

The last set of observations for any clinical area not using PEWS (e.g. PICU, recovery area or postoperative unit) should be documented on the child's paediatric observation chart.

Practical guidance for implementation

There are five age-specific paediatric observation charts with defined age ranges (samples available online at www.hse.ie/pews)

0-3 months	From presentation to paediatric unit until 12 completed weeks of age or for premature infants until 12 weeks corrected gestational age.
4-11 months	From the 1st day of the fourth month post-birth until the day before the first birthday.
1-4 years	From the child's first birthday until the day before the 5th birthday.
5-11 years	From the child's 5th birthday until the day before the 12th birthday.
12+ years	From the child's 12th birthday onwards.

Clinical question 2

What is the role of clinician or parent concern in the Irish PEWS?

Summary of evidence

This question was addressed in two parts:

- *Should clinician/family concern be included as a core parameter in the PEWS scoring tool for the identification of clinical deterioration of children in inpatient settings?*
- *If a child triggers a low PEWS Score but there is clinical concern, does this replace clinical judgement?*

Summary of evidence for concern as a core parameter

Mixed levels of evidence including chart reviews and reports of quality improvement initiatives on family activated response systems were identified in the PEWS systematic review (Lambert et al., 2014). Focus group findings from the PEWS pilot (Lambert, 2015), work in the field of situation awareness, nominally that of Brady et al. (2013) who described the concept of the 'watcher' and a recent systematic review on nurses' worry or concern and early detection of deteriorating patients (Douw et al., 2015) were considered.

Many of the international paediatric early warning scoring tools reviewed included concern as a parameter though it was not universally scored (Tibballs, 2005; Brilli, 2007; Sharek, 2007; Kleinman and Romano, 2010). The existing PEWS guidelines included in the literature review included processes for communicating the concern regarding the severity of a child's condition.

Four papers reported on family activated response systems (Dean et al., 2008; Ray et al., 2009; Hueckel et al., 2012; Paciotti et al., 2014). Three of these papers described quality improvement initiatives modelled on the concept of RRTs through which families could alert a rapid response team when concerned about a change in their child's condition (Dean et al., 2008; Ray et al.; 2009; Hueckel et al., 2012). Interestingly, Ray et al. (2009) found that on average only 27% of families (n=376) surveyed understood when and how to activate the response. Family awareness ranged from as high as 58% to as low as 6% and varied greatly between paediatric services and within the same service each month. Dean et al. (2008) further reported that the main reason for each family activated call was communication breakdown between child/parents and the clinical staff (physician/nurse).

Dean et al. (2008) also reported on a number of quality improvement changes that were implemented as a consequence of family activated response systems, most notably improved communications around realistic expectations, pain management, discharge planning and family involvement. One paper explored physician's perspectives on the value that families could provide in the identification of child clinical deterioration (Paciotti et al., 2014) and while physicians were sceptical about whether families should be able to directly activate a MET, they valued family input and particularly depended on families to explain the child's baseline condition and identify subtle child changes from their baseline.

Brady et al.'s (2013) work on situation awareness in relation to clinical deterioration refers to a formalised process where the bedside nurse and clinician proactively identify risk, which includes assessment of both family concern about patient safety and the nurse/clinician's concern or 'gut feeling' that the child might be at risk of deterioration; a concept which the authors refer to as "watcher" or "watch-stander". Brady et al. identified these risk factors following review of 20 consecutive serious safety events and 80 consecutive ICU transfers to identify potential predictors of deterioration.

This work is substantiated by a recent systematic review which examined the signs and symptoms underlying worry or concern of nurses in relation to early recognition of deteriorating patients on general wards in acute care hospitals (Douw et al., 2015), which revealed ten general indicators, representative of 37 signs and symptoms that can alert nurses to a deteriorating patient; including subjective nurse observation and 'knowing without a rationale'. Significantly, seven studies reported the presence of nurse worry or concern before vital signs deteriorated; thereby highlighting the importance of the availability of a medical response to nurse concern, otherwise the opportunity for early intervention might be missed (Douw et al., 2015). While acknowledging the limitations of this systematic review, which examined studies with retrospective design in general adult contexts and recognising the need for prospective evaluations to assess the clinical relevance of nurse worry or concern in paediatric settings, this review does highlight that nurses' subjective feelings of worry or concern are valuable in the process of recognising deteriorating patients.

The review is further supported by observational work conducted by van den Bruel et al. (2012) on clinicians' gut feeling about serious infection in children. The authors found that clinicians' intuition that something was wrong, in spite of a clinical assessment of non-severe illness, substantially increased the risk of serious illness. Clinicians acting on their gut feeling potentially prevented two of six cases being missed. A strong contextual factor was parent concern that the illness was different from their previous experience. Van den Bruel et al. (2012) recommended that clinicians' 'gut feeling' about the appearance of a child and parent concern should not be ignored but used in decision making, as they are important diagnostic signs that should trigger action such as seeking the opinion of someone with more expertise or scheduling a review of the child.

This is in keeping with findings from the PEWS pilot focus groups (Lambert, 2015), during which the theme of concern generated much discussion. The inclusion of concern was strongly supported

from the outset of development of the Irish PEWS, though there were initial reservations regarding 'misuse' of the score. There was debate about separating scores for nurse and family concern. A parent may be concerned when the nurse is not and the subjectivity of the concept, if separated, could give rise to communication errors or conflict. The consensus of the National PEWS Steering Group was to continue to combine nurse and family concern as a single core parameter.

Evidence statement for concern as a core parameter

Though it is noted that the evidence is not conclusive in demonstrating the effectiveness of family activated response systems, there is a body of evidence to support the value of family or clinician concern as a diagnostic aid and a reasonable prompt for action. The presence of concern on the part of the family or clinician is a significant clinical indicator of deterioration and is included in the Irish PEWS as a core parameter.

Recommendation 2

Clinician or family concern is a core parameter and an important indicator of the level of illness of a child, which may prompt a greater level of escalation and response than that indicated by the PEWS score alone.

Quality of evidence: Moderate

Strength of Recommendation: Strong

Good practice point

The PEWS score should never undermine the intuition of the child's family or clinician.

Open communication and active engagement in the care partnership with the child and family from admission will facilitate participation in PEWS and enable and encourage expression of clinical concern.

Communication between all multidisciplinary team members is essential for the effective interpretation of clinical concern.

Clinicians should use their clinical judgement when determining the level of response required to the concern expressed and act accordingly.

Practical guidance for implementation

An assessment of parent concern is recorded with every set of observations. To enhance the validity of the score, parents and carers should be engaged in this assessment. Parents and carers should be given information about PEWS at admission or at the earliest opportunity following admission. Verbal and written information sharing is encouraged.

Despite the provision of information, parent/carer concern may not be explicit. Open-ended questioning techniques may elicit responses from the parent/carer that indicate the presence and degree of concern for their child. Examples include: *How do you feel your child is doing today? or How does your child look to you today? Do you feel that this is an improvement?* Direct questions may be appropriate, such as: *Are you worried/concerned about your child?*

A toolkit to support clinician and parent/carer engagement, PEWS: Listening to you', is available at <http://www.hse.ie/pews>

Other useful resources may be accessed at:

<http://www.rcpch.ac.uk/safe-system-framework/2-partnerships-patients-and-their-families/safe-system-framework-2-partnership>

Summary of evidence for the application of clinical judgment to clinical concern

The evidence on the performance criteria of PEW scoring systems, response system activation criteria and the concept of situation awareness identified in the PEWS systematic literature

review (Lambert et al., 2014), alongside the findings from the PEWS pilot focus groups conducted following the pilot of the Irish PEWS (Lambert, 2015) addressed this question.

Level 2 evidence includes a systematic review paper (Douw et al., 2012), two cohort studies (Sharek, 2007; Sefton et al., 2014), a before and after study (Hunt et al., 2008) and an interrupted time series and chart review (Hanson et al., 2010). Level 3 evidence included four chart review studies (Tibballs et al., 2005; Brilli et al., 2007; Tibballs & Kinney, 2009; Haque, 2010), a database review (Panesar et al., 2014), an observational study (Van den Breul, 2012) and two case example papers (VanVoorhis & Willis, 2009; Avent et al., 2010). Level 4 evidence includes data from expert opinion interviews (Brady & Goldenhar, 2013).

Drawing on the PEWS systematic literature review, 13 papers reported on the performance criteria (sensitivity and specificity) of paediatric early warning scoring tools; six of which reported predictive values illustrative of the probability that a child is truly clinically deteriorating if they triggered a high PEWS score (i.e. positive predictive value) or the probability that a child is not clinically deteriorating if they scored low on the PEWS tool (i.e. negative predictive value) (Duncan, 2006; Edwards, 2009; Edwards, 2011; McLellan, 2013; Parshuram, 2011; Tucker, 2009). These results illustrate that there can be potential cases of 'false negatives', i.e. children who are clinically deteriorating who do not trigger PEWS. Calling criteria and their thresholds varied considerably between studies. The information reported within studies also varied. Ten studies identified staff concern as a trigger (Avent et al., 2010; Brilli et al., 2007; Hanson et al., 2008; Haque, 2010; Hunt, 2008; Panesar et al., 2014; Sharek, 2007; Tibballs et al., 2005; Tibballs & Kinney, 2009; Vanvoorhis & Wills, 2009).

Expression of concern is a representation of situation awareness. In their qualitative work, Brady & Goldenhar (2013) discussed situation awareness as supplementing an early warning score, most notably acknowledging the tacit knowledge of experienced clinicians in deterioration and critical care through a process of better assessment skills, critical thinking and clinical judgement. This is strongly supported by the data that emerged from the focus groups following the pilot of the Irish PEWS (Lambert, 2015). A core theme discussed across all pilot sites was that PEWS is not just a numerical score; rather it is one piece of a complex intervention, an aspect of which is clinician clinical experience and clinical judgement. These findings were echoed in the grey literature examined for the PEWS literature review and are in keeping with the Bristol PEWS as modified by Sefton et al. (2014) which states as a core principle that the tool does not replace clinical judgement.

An observational study of 'gut feelings' in primary care settings notes that an inexplicable (or not fully explicable) gut feeling is an important diagnostic sign and should prompt three mandatory actions: the carrying out of a full and careful examination; seeking advice from more experienced clinicians (by referral if necessary); and providing the parent with carefully worded advice to act as a "safety net" (Van den Breul, 2012). Douw et al.'s (2015) systematic review of 18 papers employing mixed methodologies was concerned with identifying what signs and symptoms trigger nurse concern. They concluded that nurses' subjective feeling of worry or concern is valuable in the process of recognising deteriorating patients. The NHS Standards (RCPCH, 2012) set out the principal that 'concern about a patient's clinical condition should always override the NEWS if the attending healthcare professional considers it necessary to escalate care.'

Evidence statement for the application of clinical judgment to clinical concern

Clinical concern is universally regarded as essential. PEWS is a safety net designed to detect deterioration in vital signs/observations but should not prevent action or falsely reassure any clinician. Some children may present with a condition that is concerning though not displaying abnormal physiological trends; it is imperative that all clinicians understand that they should escalate to a senior/more experienced colleague or higher level of care if there is any concern regarding a child's condition. PEWS is intended to complement the practices of experienced

clinicians, not undermine their expertise. It is also intended to assist a less experienced clinician practice safely and refer to a senior colleague with any concern.

Recommendation 3

Clinicians should escalate concern about an individual child, irrespective of the PEWS score. The level of escalation should be reflective of the degree of clinical concern.

Quality of Evidence: High**Strength of Recommendation: Strong****Clinical question 3**

What physiological parameters should be included in assessment to generate a valid PEWS score? How and when should these observations be performed?

The PEWS systematic literature review (Lambert et al., 2014) and O'Leary et al.'s (2015) recently published cross-sectional study provided evidence of published centile data and international practices. A number of sources provided evidence for standard measurement of observations; Royal College of Nursing (RCN) *Standards for Assessing, Measuring and Monitoring Vital Signs in Infants, Children and Young People* (RCN, 2013), the UK *Confidential Enquiry into Maternal and Child Health* (CEMACH, 2008, 2014), Department Of Health *Competencies for Recognising and Responding to Acutely Ill Patients in Hospital* (2009), the NHS *Kettering General Hospital PEWS Guideline for Paediatric Patients* (Kettering General Hospital, 2011), GDG consultation with stakeholders internationally and PEWS pilot focus group research to support the development of PEWS for the Irish health system (Lambert, 2015). A systematic review, existing clinical guidelines and a number of descriptive papers informed the GDG's decisions around frequency of observations.

Summary of evidence for selection of physiological parameters

Reported across 11 studies (Duncan, 2006; Haines, 2006; Brill, 2007; Hunt, 2008; Shilkofski, 2007; Tibballs, 2009; Edwards, 2009; Monaghan, 2005; Tucker, 2009; Sharek, 2007; Tibballs, 2005) the PEWS systematic literature review identified seven original paediatric early warning scoring tools for use in inpatient settings (Monaghan, 2005; Tibballs et al., 2005; Duncan et al., 2006; Haines et al., 2006; Parshuram et al., 2009; Edwards et al., 2009; McLellan et al., 2013). An additional eight studies reported validating modified versions of these originally developed paediatric early warning scoring systems for use in their own specific paediatric hospital setting, population groups and for different end points (Akre et al., 2010; Edwards et al., 2011; Skaletzky et al., 2012; Tucker et al., 2009; Bell et al., 2013; Solevag et al., 2013; Fujikschot et al., 2014; Sefton et al., 2014). A close review of these PEWS scoring systems revealed that there was some, but limited, consistency across scoring tools on the number, type, classification, scoring and calling criteria of the measurement parameters for PEWS. For example, some tools used single parameter trigger scores, whereas other tools used an aggregate weight with an overall threshold score for triggering action. The total number of parameters for scoring ranged from five to 16 items across all systems, with scoring system ranges extending from 0-26. While the majority of PEWS scoring tools contained measures on neurological, cardiovascular and respiratory status, there was considerable diversity in the specific physiological variables measured within these categories.

The performance criteria of PEWS scoring tools were reported in 12 papers (Akre, 2010; Duncan, 2006; Edwards, 2008 & 2011; Fujikschot, 2014; Haines, 2006; Parshuram, 2009 & 2011; McLellan, 2013; Robson, 2013; Skaletzky, 2012; Tucker, 2009). Different settings adopted and self-regulated different markers and/or endpoints for clinical deterioration, e.g. "Code Blue" call, PICU admission, death and interventions, resulting in multiple threshold scores and wide ranging sensitivity and specificity percentage values. It was rare to identify a PEWS scoring tool that had both a high sensitivity and specificity. In the majority of instances, sensitivity was sacrificed for specificity or vice versa. The sensitivity and specificity of PEWS scoring tools to detect deterioration is dependent not only on the score itself but also on the definition of deterioration

used in the study. The Bedside PEWS is the only PEW system score identified that was validated in multiple sites with a large paediatric patient population; other validation studies were conducted with small paediatric patient ranges in single hospital sites with variable outcomes (Parshuram et al., 2009 & 2011).

Eleven studies were identified that described trigger or calling criteria. Calling criteria, thresholds and reported information varied considerably across these studies. From the evidence available, staff and/or family concern, haemodynamic, cardiovascular, respiratory and neurological changes were identified as the most common trigger criteria (Avent, 2010; Brill, 2007; Hanson, 2010; Haque, 2010; Hunt, 2008; Kotsakis, 2011; Panesar, 2014; Sharek, 2007; Tibballs, 2005; Vanvoorhis & Willis, 2009; and Zenker, 2007 [cited in Lambert 2014]).

Evidence statement for selection of physiological parameters

The PEWS literature review revealed diversity in paediatric physiological (and other) parameters, differences in age-dependent vital sign reference ranges and limited consensus on clinical deterioration outcome measures in systems, making it difficult to compare and contrast the performance criteria of paediatric early warning detection and scoring systems. However, although rare for any system to have both a high specificity and sensitivity, some scoring systems did show promising sensitivity and specificity, e.g. Duncan (2006), Parshuram (2009 & 2011). Alongside considering the validity of a scoring system, many contexts chose simplicity and clinical utility as a priority in selecting which paediatric early warning detection system score to implement.

The values and thresholds chosen for the PEWS triggers were agreed by the National PEWS Steering Group. This was a consensus process that drew on the systematic review of the literature pertaining to paediatric early warning scores and systems in use internationally, the Irish Children's Triage System (ICTS) and published data on physiological measurements for well children (Fleming et al., 2011; Bonafide et al., 2013; O'Leary et al., 2015). The most widely validated PEWS triggers came from the Canadian Bedside PEWS and this was the anchor point for many values.

Following the Irish PEWS pilot, thresholds to score for high blood pressure were reduced based on feedback from test sites. The blood pressure thresholds that score for the Irish PEWS are now significantly lower than other international scoring charts. The National PEWS Steering Group agreed that the current thresholds represent a safe compromise between the importance of recognising raised blood pressure in childhood, and the possibility of having an over sensitive threshold which may generate unnecessary triggering and evaluation. It is important to state that because a value is given a score of 1, 2 or 3 this does not reflect the relevance of that value to every clinical situation, but rather its ability to act as an early warning indicator across the whole paediatric population. Parameters may need to be amended down as well as up to cover specific clinical situations. Guidance on this matter is given within the PEWS training programme, including recommendations on the assessment of the child with any blood pressure trigger.

It is the view of the National PEWS Steering Group that there is no exact or 'perfect' threshold for any physiological parameter that identifies deterioration. Combining and monitoring parameters over time creates situation awareness of a child's clinical status that can be shared with other team members. In addition, using triggers from one parameter, e.g. raised heart rate, to promote information seeking from other parameters, e.g. central capillary refill time and blood pressure, enhances the clinical picture.

Core scoring physiological parameters	Additional scoring physiological parameters	Non-scoring elements
<ul style="list-style-type: none"> Respiratory rate Respiratory effort Oxygen therapy Heart rate Level of consciousness* 	<ul style="list-style-type: none"> Oxygen saturation Systolic blood pressure Central capillary refill time 	<ul style="list-style-type: none"> Mode of oxygen delivery Skin colour Temperature

Recommendation 4

The core physiological PEWS parameters must be completed and recorded for every set of observations*.

Quality of Evidence: Moderate

Strength of Recommendation: Strong

Good practice point

To obtain the total PEWS score:

1. Complete and record the core physiological parameter observations*
2. Score individual observations according to the colour coded criteria on the age-specific paediatric observation chart
3. Calculate the total PEWS score by adding the scores for each core parameter together
4. Additional parameter observations should be completed and recorded as clinically appropriate

* Where a child is sleeping, with normal sleep pattern and no concern about neurological status, it may not be necessary to wake them to check AVPU (Alert, Voice, Pain, Unresponsive).

Summary of evidence for standardisation of observation and monitoring practices in children

A UK audit of paediatric deaths in hospitals noted that in one quarter of cases there were recognisable vital sign abnormalities (CEMACH, 2008). Health services do not always deliver optimal care for children and young people and lives may be lost as a result (RCPCH, 2014a). It is important that measures are taken to improve recognition and management of serious illness across the health service. The Why Children Die report illustrates the importance of access to high quality paediatric healthcare. All healthcare professionals who come into contact with children and young people must be trained to be competent and confident in the recognition of a sick child, thus enabling early identification and treatment (RCPCH, 2014b).

The Department of Health in the UK (2009) published competencies for the recognition and response to deteriorating patients, which stated:

“Staff caring for patients in any acute hospital setting should have competencies in monitoring, measurement, and interpretation of vital signs, equipping them with the knowledge to recognise deteriorating health and respond effectively to acutely ill patients, appropriate to the level of care they are providing.”

Standardisation of equipment and practices will maintain or improve patient safety by providing consistency in the quality of physiological findings and interpretations. Techniques of measurement or enquiry used by health professionals may affect the information ascertained from the child/family, with the quality of observation assessment data dependent on a combination of reliability (repeatable with precision) and validity (accuracy) (Aylott, 2006). The process of assessment is dynamic; involving review, re-evaluation and interpretation of clinical findings to ensure care is meeting a child’s current need (Aylott, 2006). Staff should be trained on physiological observation procedures and their relevance (Kettering General Hospital, 2011). The Australian Commission on Safety and Quality in Healthcare has published a National Consensus Statement (ACSQH, 2011), within which a number of key tasks that all doctors and nurses should be able to perform are outlined. These include systematically assessing a patient and understanding and interpreting abnormal physiological parameters and other abnormal observations.

The Royal College of Nursing, UK (RCN, 2013) has published standards for assessment, measurement and monitoring of vital signs in children. Specific Nursing and Midwifery Board of Ireland (NMBI) guidance in relation to assessment skills for children (cited below) is taken from the *Requirements and Standards for Nurse Registration Education Programmes* (NMBI, October 2016), and recommends use of a model/framework to guide systematic assessment of the child to identify health and nursing needs and the development of a child-centred plan of care.

Evidence statement for standardisation of observation and monitoring practices in children

A standard national guideline for observation and monitoring in paediatric nursing and medical care has not been developed in Ireland. However, other international early warning systems have developed standard operating procedures (SOP) for assessing and recording observations and IMEWS clearly sets out standard practices for physiological assessment of a pregnant woman. The Quality Care Metrics Initiative uses the RCN *Standards for assessing, measuring and monitoring vital signs in infants, children and young people* as the benchmark for quality in auditing compliance within the vital signs/quality care metric. The GDG concluded that development of a new SOP for the Irish context was not required at this time. The United Kingdom (UK) RCN standards are recommended for clinical observation and monitoring of children in Irish paediatric inpatient care settings.

Lockwood et al. (2004), in their systematic review of 124 papers related to patient vital sign monitoring, noted limited evidence of optimal frequency of vital sign measurement. In some situations, visual observation, rather than vital sign measurement, may be more appropriate. However, no studies have evaluated the role and effectiveness of visual observation to monitor the patient as an alternative to the traditional vital signs. In a descriptive paper, Schulman and Staul (2010) contend that the frequency of measuring vital signs should be based on each patient's individual need rather than on specific time intervals. Schulman and Staul further recommend that hospitals develop local standards for vital sign measurement that meet the needs of the majority of patients in the clinical area while also allowing opportunities for deviation based on the clinician's judgement and/ or individualisation based on a particular patient's situation. In the context of PEWS, the NHS Kettering General Hospital (2011) guidelines included a twelve hour observation monitoring schedule and increasing observation frequency if abnormal physiology is detected. Clinical response to the Brighton PEWS involves informing the nurse in charge and increasing the frequency of observations. Through clinical judgement and critical decision making, care is individualised to the child and the clinical circumstances.

Recommendation 5

Observations and monitoring of vital signs should be undertaken in line with recognised, evidence-based standards.

Quality of Evidence: High

Strength of Recommendation: Strong

Good practice point

The recommended standards for measurement of vital signs and observations are the UK Royal College of Nursing *Standards for Assessing, Measuring and Monitoring Vital Signs in Infants, Children and Young People* (2013).

The baseline frequency of observations will depend on the child's individual clinical circumstances. For all paediatric inpatients, it is recommended that observations are carried out at least once per shift (or once every 12 hours), regardless of reason for admission.

The escalation guide details the minimum observation frequency for any child triggering PEWS.

It is essential to note any individual outlying parameters, observe trends over current and previous shifts, and be aware that a child showing no signs of improvement may quickly lose the ability to compensate.

2.3 Escalation of care and clinical communication

Clinical question 4

In paediatric inpatient settings, when the PEWS is triggered, what is the appropriate response to ensure timely intervention for a child with suspected clinical deterioration?

Summary of the evidence for escalation, communication and documentation responses to PEWS triggers

The evidence on escalation of care algorithms and PEWS response systems identified in the PEWS systematic review (Lambert et al., 2014) and focus group findings (Lambert, 2015), along with key documents such as the UK Department of Health *Competencies for recognising and responding to acutely ill patients in hospital* (2009) and the Royal College of Physicians (RCP, 2012) working party report on *National Early Warning Score (NEWS) Standardising the assessment of acute illness severity in the NHS*, addressed this question.

Escalation

Multifactorial reasons for failures in care have been identified in paediatric in-hospital deaths (CEMACH, 2008), therefore a multifactorial approach to prevention is appropriate. Early warning scores are generated by combining the scores from a selection of routine observations of patients, e.g. pulse, respiratory rate, respiratory distress and level of consciousness. If a child's clinical condition is deteriorating the 'score' for the observations will (usually) increase. Therefore a higher or increasing score gives an early indication that intervention may be required (NHSIHI, 2013). Early intervention can 'fix' problems and can avoid the need to transfer a child to a higher level of care and thus prevent or reduce harm. The Irish PEWS involves multiple components for detection and response to suspected clinical deterioration; an early warning scoring tool, an escalation guideline, a clear framework for communication and requirements for documentation and review.

Three literature reviews of paediatric rapid response systems (RRS) revealed evidence to support the effectiveness of paediatric RRS, with a number of studies reporting statistically significant reduction in mortality rates and cardiorespiratory arrest rates after implementation (Winberg et al., 2008; Chan et al., 2010; VanderJagt, 2013). As a consequence of lack of comparable data, there was limited evidence available on the most optimal RRS to implement. The PEWS focus group findings were supportive of the standardised escalation guide. Although clinical judgement can be used to increase the level of escalation and response to a child whose condition was worrying, clinicians expressed support for the guide which prompted action. Pilot feedback also indicated that unwell children were seen sooner for review than before PEWS implementation. Nurses reported that doctors were prompted to pay attention to a score and to take action, less experienced staff were encouraged to "think and respond", and communication was enhanced between junior and senior staff resulting in a rapid response and overall enhanced sense of urgency and improved safety on the pilot wards (Lambert, 2015).

Communication

Poor communication has been identified as a contributing factor in adverse incidents where patient care is put at risk. In the UK, the *National Confidential Enquiry into Patient Outcomes and Deaths* (NCEPOD, 2005 and 2012) highlighted communication failures between teams as a contributing factor to delays in referrals and in delivering essential care. The Joint Commission (US) (2007) identified that timely, accurate, complete and unambiguous information that is understood by the recipient reduces errors and results in improved patient safety.

Identify, Situation, Background, Assessment and Recommendation (ISBAR) is an easy, structured and useful tool to help communicate concerns, and call for help or action. This tool is used to assist staff in providing focused communication to other healthcare professionals when communicating information.

Documentation

The HSE (2011) has published standards and recommended practices for healthcare records management. The quality of clinical documentation in the healthcare record is essential to:

- a) ensure the continuity and delivery of safe, quality healthcare,
- b) document and facilitate communication of care between service user, family and healthcare teams and provide evidence of same,
- c) justify care delivery in the context of legislation, professional standards, policies, procedures, protocols and guidelines, evidence, research and professional and ethical conduct.

It is specified that:

"the content of the healthcare record provides an accurate chronology of events and all significant consultations, assessments, observations, decisions, interventions and outcomes. The content of each record complies with clinical guidance provided by professional bodies and legal guidance provided by the Clinical Indemnity Scheme. This standard applies to both hardcopy and electronic documentation."(HSE, 2011 p23)

Recommendation 6

The PEWS escalation guide should be used to inform the clinical response in the event of any PEWS trigger.

Quality of Evidence: High

Strength of Recommendation: Strong

Good practice point

If there is clinical concern a higher level of alert and response may be activated regardless of the PEWS score.

Practical guidance for implementation

An urgent response pathway should be agreed under the guidance of the local PEWS governance committee, taking into account suitability and availability of local resources. Team members should be appropriately trained and maintain their competency in the management of an acutely ill child. Guidance on quality standards, team membership and competencies may be found via the following online resources:

1. <https://www.resus.org.uk/quality-standards/acute-care-quality-standards-for-cpr/#prevention>
2. <https://www.rcplondon.ac.uk/sites/default/files/documents/national-early-warning-score-standardising-assessment-acute-illness-severity-nhs.pdf>
3. NHS England ReACT (Response to ailing children tool)
<http://www.england.nhs.uk/ourwork/patientsafety/re-act/>

Recommendation 7

The ISBAR communication tool (Identify, Situation, Background, Assessment and Recommendation) should be used when communicating clinical information.

Quality of Evidence: High

Strength of Recommendation: Strong

Practical guidance for implementation

The National Clinical Guideline No. 11; Communication (Clinical Handover) in Acute and Children's Hospital Services provides detailed information around the use of ISBAR communication for the deteriorating child patient.

Recommendation 8

Management plans following clinical review must be in place and clearly documented as part of the PEWS response.

Quality of Evidence: High

Strength of Recommendation: Strong

Good Practice Point

Management plans should include actions for all members of the team and timeframes in which interventions must occur. Medical staff must always document their impression, which is the provisional diagnosis. When this is done, each member has a clear idea of their roles and responsibilities. A management plan may include directions as to the required frequency of observation until certain measurable improvements are achieved, or criteria for escalation of care to occur. It may also give guidance as to when to be concerned in relation to the management of a deteriorating patient, changes in patient drug therapy or interventions and planned further investigations.

Clinical question 5

What are the appropriate amendments (variances) that can be made to a child's PEWS parameters or escalation response to support clinical judgement?

Existing clinical guidelines examined in the PEWS systematic literature review (Lambert et al., 2014), pilot focus group findings (Lambert, 2015) and expert group consensus addressed this question.

Summary of evidence for variances

It is acknowledged that there is currently a paucity of existing literature to support the practice of permitted variance in PEWS protocols. Clinical guidelines from Worcestershire NHS Trust (2011 and 2013) clearly state that healthcare professionals must exercise their own professional judgement when using the PEWS and that any decision to vary from the guideline should be documented in the patient record to include the reason for variance and the subsequent action taken. In the Starship Hospital in Auckland, New Zealand, a 'variance' box is included within the chart which is completed only after discussion with a consultant or fellow. This is to allow for individual patients whose physiological parameters are expected to sit outside the normal range due to their underlying condition. Similarly, 'modifications' to physiological parameters are permitted, within a local hospital's guidance framework, on the Victorian Children's Tool for Observation and Response (ViCTOR) in the state of Victoria, Australia. The Canadian Bedside PEWS tool recommends the application of frontline clinical staff discretion to an escalation response and is intended to augment rather than replace clinical judgment. Finally, the NHS NEWS report (RCP, 2012) recommends that in circumstances in which the healthcare professional feels the early warning score may be overestimating the severity of a patient's clinical condition, a more senior decision-maker within the clinical team should be consulted to determine whether further escalation of care is warranted. The aforementioned charts, systems and guidelines allow the attending healthcare professional (including senior medical practitioner and registered nurse) to apply clinical judgement to the scoring parameters or escalation guide, in certain circumstances. The requirement for clear documentation in the patient notes of this decision, the underlying rationale and the plan for future observation is a feature of such variance mechanisms.

Evidence statement for variance use

Expert opinion and National PEWS Steering Group consensus contributed to development of the structures for variance within the Irish PEWS. Practices were closely monitored during the Irish PEWS pilot and targeted continuing education was undertaken in response to audit findings. Experiential evidence from the post-pilot focus groups strongly favoured permitting system amendments, under certain circumstances, by senior clinicians and with a clear, reportable monitoring plan in place. Further national implementation experience has re-enforced the view that variances to a child's parameter thresholds or escalation response must be requested only by senior clinicians, following review of an individual child.

Success of the PEWS is dependent on how well it integrates with and supports the judgement of experienced clinical staff. There is currently no early warning score that will detect every deteriorating child, all of the time. The PEWS score is recognised as being sensitive at times

towards certain situations and clinical conditions. The scoring is weighted towards a child with physiological signs of haemodynamic or respiratory instability but some deteriorating children will only display subtle signs or may not show any signs until very late. To compensate for these limitations, **the Irish PEWS promotes the application of experience and clinical judgement alongside the scoring and the escalation guide.** Conversely, there may be situations where escalation to review may not be clinically necessary. In these circumstances, a senior clinician may decide that a variance order is appropriate.

Children are admitted to a variety of clinical settings in Ireland with different levels of paediatric medical support. The core elements of the PEWS; standardised assessment and recording of observations, PEWS Scoring tool, escalation guide, communication framework and clinical response; are applicable to all sites admitting children, as set out in Recommendation 1 of this guideline. All hospitals are required to identify a clear clinical alert and response pathway for a child requiring escalation of care. The PEWS is designed not to replace but to enhance the clinical judgment of the frontline clinical team.

Permitted variance firmly supports the judgement of the clinician and considers the individual circumstances of each child. Variances allow for the child whose baseline is different to the expected range for age and/or whose clinical presentation is as expected though their illness is causing physiological triggers. However, it is also the part of the system which poses a risk as the triggers or escalation safety net is dampened down. Specific paediatric knowledge and experience is essential to support safe variance decisions. Monitoring variance use is essential to ensure adherence to safety measures and learning should be evident in an ongoing training programme.

It is recognised that a number of hospitals that admit children do not have resident paediatric on-call cover. In these sites, the local PEWS Governance Group must have a clear SOP that addresses the following: escalation of care for a deteriorating child and permissions regarding use of medical escalation suspension and parameter amendment.

Recommendation 9

Variances to PEWS parameters or the Escalation Guide may be made by senior clinicians with caution in certain permitted circumstances.

Quality of Evidence: Low

Strength of Recommendation: Conditional

Nursing Variance to PEWS Escalation Guide: Special Situation

A senior nurse may decide against immediate escalation when he/she believes that a child is not deteriorating and that measures to reduce pain, discomfort or distress are likely to reduce the PEWS score over a short period of observation. This is termed a **special situation** and must be clearly documented in the child's notes.

Good practice point

- Transient, readily identifiable cause for PEWS score increase
- Decision not to escalate made in conjunction with senior nurse
- **Engage with the child and family in determining the plan**
- Reassessment must occur within a short and defined timeframe (complete 'reassess within' section) at the discretion of the senior nurse and appropriate to the child's condition and triggering parameter(s)
- Explicit documentation within the child's healthcare record to reflect rationale for decision not to escalate

Medical Variance to PEWS Parameters: Parameter Amendment

A child with a condition that permanently, or for a fixed period, alters their baseline physiological parameters from the expected baseline for age may have a **Parameter Amendment** put in place by a senior doctor, using the Parameter Amendment section on the paediatric observation chart.

Key points:

- Chronic conditions only, not for acute presentation
- Only to be decided by a doctor at registrar level or above (consider discussion with consultant)
- Must be a ranged (upper and lower) value
- Must have an end point or timeframe for review (this may be post-surgery, post specific treatment or for reassessment at the next admission)

Good practice point

- Parameter amendments should only be used for chronic and not acute conditions
- Discussion with the child's specialist consultant should be considered
- Any decision regarding a parameter amendment must be discussed with the child and family as appropriate
- All variances, including clinical rationale and planned review, must be clearly documented in the child's healthcare record

Medical Variance to PEWS Escalation Guide: Medical Escalation Suspension*

*specialist paediatric knowledge, experience and competence are critical for safe use of Medical Escalation Suspension

This may be used to establish an agreed care pathway for children who are experiencing an acute episode of illness with observations that deviate from expected normal limits and triggering high PEWS scores. These children may be considered 'sick but stable' and their increased score reflects their illness as expected. Following assessment they are considered unlikely to deteriorate if they remain stable in this new range. In these circumstances a temporary, conditional **medical escalation suspension** may be ordered.

It is the responsibility of local governance structures to determine if sufficient paediatric experience and support is available to safely use the Medical Escalation Suspension facility. A decision may be made to operate PEWS without the Medical Escalation Suspension option in use. This governance decision must be documented.

Good practice point:

- Child has acute illness and is determined to be 'sick but stable'
- Only to be requested by a doctor of registrar level or above (consider discussion with consultant) following review of an individual child
- Tolerance typically applied to respiratory parameters; caution required if accepting an elevated heart rate for example
- Period of observation is required to determine stability before longer suspensions
- Child is recognised as unlikely to deteriorate if they remain stable in this new range
- Deviations from the agreed parameters should be referred to the senior nurse present
- Child must be reviewed frequently (alert to changes in the child's condition)
- Suspension agreement should be reviewed at least every 24 hours
- Planned review may occur sooner than planned expiry date/time

Temporary adjustment of the escalation guide is overridden at any time where there is clinical concern or changing clinical condition of a child.

Practical guidance for implementation of any variance to parameters or escalation

Engage with the child and family

Document all decisions clearly

Escalate concerns quickly

Monitor closely for complacency/effect /safe use

2.4 Paediatric sepsis

Clinical question 6

In children with suspected sepsis, what additional investigations should be performed?

Evidence for this question was sourced from *National Clinical Guideline No.6 Sepsis management* (DoH, 2014) available at: <http://health.gov.ie/national-patient-safety-office/> and the UK Sepsis Trust Paediatric Sepsis 6 (Version 11, August 2015) available at: http://sepsistrust.org/wp-content/uploads/2015/08/Paediatric-Sepsis-6-version-11_1.pdf

Evidence statement

Recognition of sepsis

The timely recognition of sepsis is a challenge for all paediatric clinicians. Clinical history and physical examination may reveal features in keeping with infection or some of the diagnostic criteria of systemic inflammatory response syndrome (SIRS). Some groups of children have an increased risk of sepsis including:

- children younger than 3 months;
- children with chronic disease;
- children with immune deficiency, immuno-compromise, asplenia, incomplete vaccination record;
- children who have recently had surgery.

Keeping a high index of suspicion of sepsis in all children with signs of infection, risk factors or features of SIRS is the key to early diagnosis. The use of a paediatric early warning system highlights some of these features and facilitates recognition and communication. If sepsis is suspected then tests that may confirm the diagnosis should be performed. In addition, early management should commence as outlined in the 'Paediatric Sepsis 6'. The customised SIRS criteria and further detail on sepsis management are available in *National Clinical Guideline No. 6 Sepsis management*.

Recommendation 10

Once a diagnosis of sepsis has been made, it is recommended that the Paediatric Sepsis 6 is undertaken within one hour. Sepsis is diagnosed by the presence of SIRS criteria due to suspected or proven infection.

Quality of Evidence: High

Strength of Recommendation: Strong

Good practice point

The timely recognition of sepsis is a challenge for all paediatric staff. Clinical history and physical examination may reveal features in keeping with infection or some of the diagnostic criteria of SIRS.

- Recognition of a child at risk:
In a child with suspected or proven infection AND with at least 2 of the following SIRS criteria:
 - Core temperature $<36^{\circ}\text{C}$ or $>38.5^{\circ}\text{C}$
 - Inappropriate tachypnoea
 - Inappropriate tachycardia
 - Reduced peripheral perfusion/prolonged capillary refill time
 - Altered mental state (including: sleepiness/irritability/lethargy/floppiness)
- There should be a lower threshold of suspicion for age <3 months, chronic disease, recent surgery or immunocompromise.
- Not every child with suspected or proven infection has sepsis, however rapid initiation of simple timely treatment following recognition of sepsis is key to improved outcomes.

Practical guidance for implementation

Temperature is an additional, non-scoring parameter in the Irish PEWS. The paediatric observation charts contain a graph for temperature and some clinical prompts for consideration of paediatric sepsis. These are not substitutions for clinical education and training in the management of a child with known or suspected infection/sepsis.

The Paediatric Sepsis 6 is an operational tool to help deliver the initial steps of sepsis treatment in a simple and timely fashion:

Take 3:	1. IV or IO access*	Give 3:	4. High flow oxygen
	2. Urine output measurement		5. IV or IO fluids and consider early inotropic support
	3. Early SENIOR input		6. IV or IO broad spectrum antimicrobials

*IV: intravenous, IO: Intraosseous

This represents the minimum intervention. Other blood tests, cultures or investigations may be required depending on the clinical scenario. Blood tests must be sent marked urgent and must be reviewed and acted upon in a timely fashion. This also applies to any investigations ordered.

2.5 Implementation of the Paediatric Early Warning System

The task of implementing the Paediatric Early Warning System is as important and challenging as operating the system itself. Implementation requires foundational supports including governance, leadership, patient and staff engagement, training and capability in improvement methodology. These supports generate the planning, motivation and culture change necessary to embed new and complex practices. It is well documented in the literature that, despite good intentions by authors of guidelines, implementation remains problematic (Cabana et al., 1999; Pronovost, 2013; Hands et al., 2013).

Hospitals should employ quality improvement methods to enhance stakeholder engagement and support local implementation through the use of testing, measurement and feedback of key interventions. The GDG has made several recommendations that expressly support PEWS implementation from an organisational to clinical level. There may be an impact on resources resulting from these recommendations and this is dealt with further in the budget impact analysis (refer to Appendix 3.1). Where possible, hospitals may allocate resources for PEWS from within existing structures such as risk, quality, patient safety or research divisions so as to minimise additional costs. Larger sites may require the creation of an additional post(s) to support implementation and sustainability, which will have a more significant impact on financial resources.

2.5.1 Governance of the Paediatric Early Warning System

Specific published evidence on the governance structures and organisational supports required for the effective implementation of PEWS is limited. Of the six studies identified that focused specifically on PEWS implementation (Demmel et al., 2010; Lobos et al., 2010; Randhawa et al., 2011; Hayes et al., 2012; McLellan & Connors, 2013; Kukreti et al., 2014) most hospital sites reported having a designated site leader/champion and multidisciplinary PEWS team to drive effective implementation. One of these studies, a pre-and post-implementation survey by Kukreti et al. (2014), reporting on strategies to overcome apparent and potential barriers to assist with PEWS implementation, recommended a six month programme of presentations and question and answer sessions open to every stakeholder group in the hospital (clinicians and managers). A core point across these studies was the cyclical process of implementation over time. Another paper by VanderJagt (2013), reporting on a cross-sectional survey, recommended the following suggestions for PEWS implementation planning:

- Identification of medical and nursing champions (general inpatient, intensive care units, quality/safety leadership),
- Identification of key stakeholders (general inpatient unit nurses, physicians, resident trainees, ICU staff, parents), and
- Establishment of measurable process and outcome objectives (e.g. time between arrests).

Supplementing these research studies were the data extracted from grey literature sources and the consultation process with key experts internationally, both of which strongly emphasised the requisite for leadership to drive the effective implementation of PEWS. An evaluation of the New South Wales, Australia 'Between the Flags' programme states the absolute necessity of governance, strong executive support and the effect of organisational culture for success and sustainability of the programme (Green, 2013).

Similar critical organisational supports for effective PEWS implementation were expressed by participants in the focus groups following the pilot of PEWS (Lambert, 2015). An established hospital PEWS coordinator and PEWS 'champion' on each ward were clearly warranted to ensure sufficient resources and time was available for staff training and ongoing education. Medical champions to assist with training were also discussed. Significant enablers to PEWS implementation were a phased implementation throughout a hospital/unit with supervision and support from management through to ward level (Bullivant and Corbett Nolan, 2013). This evidence is supported in the report of an Irish paediatric early warning score implementation (Ennis, 2014) which notes the significance of the positive leadership roles played by ward managers and senior staff in educating and encouraging staff participation in PEWS. In fact, strong front line nursing leadership is named as a critical component for success. All of these findings are in line with the Improving our Services document (HSE, 2008), which identified organisational leadership and adequate resourcing as key elements when planning a quality improvement initiative. This is further echoed in the UK Department of Health (2009) competency document which advises effective leadership and rigorous change management from "board through to ward".

Thus, the following recommendations in relation to organisational support and governance structures are essential for the effective operation of the PEWS recognition and response system within a wider hospital patient safety culture and commitment to quality improvement practices. Recognition and response systems should be part of standard clinical practice. Nonetheless, the introduction of new systems to optimise care of children whose condition is deteriorating requires organisational support and executive and clinical leadership for success and sustainability. Each paediatric unit should set up a PEWS governance group/committee to consider and agree the processes and stages of implementation for PEWS and the ongoing monitoring of compliance and efficacy.

Recommendation 11

The Chief Executive Officer/General Manager, Clinical Director and Director of Nursing of each hospital or hospital group are accountable for the operation of the Paediatric Early Warning System (PEWS).

A formal governance structure, such as a PEWS group or committee, should oversee and support the local resourcing, implementation, operation, monitoring and assurance of the Paediatric Early Warning System.

Quality of Evidence: High**Strength of Recommendation: Strong**

Practical guidance for implementation

For co-located units, the governance for PEWS implementation may be incorporated into existing early warning score governance structures, and should:

- Include service users, clinicians, managers
- Have appropriate responsibilities delegated and be accountable for its decisions and actions
- Monitor the effectiveness of interventions and training
- Have a role in reviewing performance data and audits
- Provide advice about the allocation of resources.

Recommendation 12

The PEWS governance committee should identify and support a named individual(s) to coordinate local PEWS.

Quality of Evidence: Moderate

Strength of Recommendation: Strong

Practical guidance for implementation

- PEWS nursing and medical implementation leads for each site should be identified.
- The local PEWS coordinator may not be a new role, but should include protected time for PEWS implementation and audit.
- The selection of trainers is important as successful implementation is reflective of the quality of training provided.
- PEWS champions should be named at ward level to facilitate ad hoc questions/queries from colleagues or parents, and continue to promote compliance with completion of the observation charts, PEWS scoring and escalation.

Further information can be found in Appendix 3.4 – Paediatric Early Warning System (PEWS) Implementation toolkit.

2.5.2 Enhancement of the Paediatric Early Warning System and aids to implementation

The PEWS is one facet of a hospital-based paediatric safety system. Brady et al. (2014) believe that a system that improves situation awareness and links it to clear action will enable clinical teams to more rapidly identify, mitigate and when necessary, escalate the recognition of risk in deteriorating children. Reliable escalation could bring more resources in the form of people, equipment and clinical experience to the bedside of the children most in need. However, the process of improving clinical situation awareness is complex; no single solution is effective at bringing significant reduction in morbidity and mortality outcomes (Kodali, 2014). Rather, *“a synergistic combination of interventions that address each stage of clinical deterioration and employ both objective and subjective criteria for identification of these patients will be more effective”* (Kodali, 2014).

Improved situation awareness drives better recognition of early deterioration and is essential in efforts to reduce poor outcomes from significant deterioration or cardiorespiratory arrest outside of the PICU. Additional structures and tools that support a sense of shared situation awareness are available, including:

Briefings

Briefings are team-based updates given at an allocated time. They are focused and structured to cover essential information relating to safety over the following 12-24 hours. This may include current and predicted activity, high risk patients or treatments in use, same name individuals and staffing issues. Briefings are short, usually no longer than 1-2 minutes.

Safety Pause

National Clinical Guideline No.5 Communication (Clinical Handover) in Maternity Services recommends that the 'Safety Pause' (HSE, 2013) is adopted nationally into clinical handover. The safety pause is a very important feature of clinical handover as it provides an opportunity for staff to pause and highlight safety issues which may assist them in being proactive about the challenges they face in providing safe high quality care for patients. Emphasis on the safety pause as part of clinical handover complements the implementation of PEWS in its potential to have a profound effect on patient safety in paediatric care by focussing clinician's attention on priority issues that everyone needs to know to maintain patient safety. It is based on one question 'what patient safety issues do we need to be aware of today?' and results in immediate action.

Huddles

Huddles are short meetings (less than 15 minutes – often shorter) that bring key frontline staff together at fixed times throughout the working day, e.g. morning, evening, night. The purpose of the huddle is to create shared situation awareness amongst groups that work together as a system in order to predict and improve patient flow and safety. Huddles can be adapted to the needs of any team or organisation. Adams et al. (2015) found huddles to be regarded as useful by the vast majority of staff and are an inclusive, empowering, non-hierarchical method of information sharing regarding patient safety.

Team training

It is important to recognise that PEWS is dependent on foundational elements of patient safety. Team training and simulation are important methods to enhance team work. There are many examples of successful programmes such as the United States (US) Agency for Healthcare Research and Quality TeamSTEPPS (Team Strategies and Tools to Enhance Performance and Patient Safety). This evidence-based patient safety toolkit addresses leading causes of medical errors and helps organisations improve the quality, safety and efficiency of health care delivery. TeamSTEPPS is specifically designed as a resource for health care providers to improve patient safety through effective communication and teamwork skills.

Neily et al. (2010) demonstrated the benefit of team training on surgical related mortality across the Veterans Healthcare Administration in the US with an 18% decrease in annual mortality at centres providing training versus 7% at those where team training had yet to be provided. In a recent review article, Cheng et al. (2015) examined the potential of simulation training in paediatrics moving from its use purely as an educational resource to one that provides system level integration for patient safety. Developing and providing access to simulation training over coming years will ensure that the benefits of PEWS will continue to accrue well into the future.

Use of quality improvement methodology

The Irish Paediatric Early Warning System is a complex intervention made up of multiple components. Many of these components have been studied individually, often as quality improvement projects. A small number of PEWS have been evaluated as whole system interventions with many of these applying quality improvement methods to support implementation. This highlights the need to appreciate the support provided for the successful implementation of complex interventions in published studies. It is likely, therefore, that quality improvement methods are required to support the introduction of PEWS in different contexts – both its individual components and the system as a whole.

Quality improvement methodology facilitates successful implementation by:

- Adapting effective interventions for new contexts
- Helping to formulate theories of change
- Identifying, understanding and mobilising stakeholders
- Providing clarity of goals
- Breaking down large tasks to key components
- Using measurement to drive change

- Testing ways to perform key processes reliably
- Supporting innovation and frontline ownership.

Hayes et al. (2012) reported a multidisciplinary improvement collaborative of 20 children's hospitals through the Child Health Corporation of America. The study implemented a suite of prevention, detection and correction strategies on targeted inpatient units with the aim of reducing the number of inpatient paediatric cardiopulmonary arrests by 50% and improving the culture of patient safety scores by five percentage points in three key domains. The study applied the Institute of Healthcare Improvement's Collaborative Model that uses shared learning between sites as they apply improvement methods, testing and measurement locally. Kukreti et al. (2014) describe the implementation of a rapid response system at the Hospital for Sick Children, Toronto. The study suggested a blueprint for implementing a complex intervention such as this based on quality improvement ideas and methods.

There is evidence from the evaluation of other patient safety interventions that emphasise the need to manage a change of context. For example, Dixon-Woods et al. (2013) describe the importance of understanding the non-technical and programme elements of improvement efforts, separate to the actual intervention (the insertion and care of central venous lines in this case), for successful implementation. In a recent opinion article in *Pediatrics*, Lannon et al. (2015) emphasise the use of quality improvement methods and safety principles to improve child health outcomes and reduce harm. They acknowledge that multi-institution collaboratives have achieved improved results by identifying and implementing best practices and by using rigorous improvement methodology. They recommend the need to create sufficient capability and competence in paediatrics to match the demands of safety.

Recommendation 13

Hospitals should support additional safety practices that enhance the Paediatric Early Warning System and lead to greater situation awareness among clinicians and multidisciplinary teams, such as incorporating briefings, safety pause and huddles into practice and implementation of:

- *National Clinical Guideline No. 11; Communication (Clinical Handover) in Acute and Children's Hospital Services*
- *National Clinical Guideline No. 6; Sepsis Management.*

Quality of Evidence: Moderate

Strength of Recommendation: Strong

Recommendation 14

The Paediatric Early Warning System should be supported through the application of quality improvement methods, such as engagement strategies, testing and measurement to ensure successful implementation, sustainability and future progress.

Quality of Evidence: Moderate

Strength of Recommendation: Strong

Good practice point

- Shared learning and a need for quality improvement capability will be required by all early warning system and safety intervention teams.
- Collaboratives between hospitals should be considered, such as the SAFE programme run by the Royal College of Paediatrics and Child Health (RCPCH) in the UK, which aims to decrease deterioration of children by using interventions such as the huddle developed at Cincinnati Children's Hospital and other safety supports. Early results demonstrate that the system of care to decrease deterioration is essential. A paediatric early warning score is a component of the changes required. See <http://www.rcpch.ac.uk/safe> for more information.

2.5.3 Training for the Paediatric Early Warning System

Within the PEWS systematic literature review, only three studies were identified which principally investigated educational interventions related to paediatric early warning detection and/or response systems (McCrorry et al., 2012; Tume et al., 2013; McKay et al., 2013). Two studies used prospective pre-and post-intervention designs (McCrorry et al., 2012; McKay et al., 2013) and two studies employed surveys (Tume et al., 2013; McKay et al., 2013). Tume et al. (2013) and McKay et al. (2013) sought to evaluate the development and impact of newly designed education courses (Compass, RESPOND) for recognising child clinical deterioration. Other studies, nominally those reporting on paediatric early warning response systems, may have incidentally mentioned various aspects of education for PEWS. For instance, limited data was reported on training modes, timing, trainers, trainees, evaluation and costs. The data that were reported were also variable with no standardised training process identified and no educational outcomes reported.

Of the evidence available that specifically focused on the educational aspect of paediatric early warning systems, there was broad agreement that the implementation of PEWS did have implications for educating and training health care professionals in relation to the completion of the PEWS scoring tool, activation of the escalation processes and knowledge and understanding of child clinical deterioration. There was also consensus on the value of a multi-faceted, multi-professional education programme with inbuilt patient case scenarios. In their evaluation survey following the Recognising Signs of Paediatric Hospital Inpatients Deterioration (RESPOND) course, Tume et al. (2013) found that the two most useful aspects of the course were the discussion of real life cases and learning to use the Situation, Background, Assessment, Recommendation (SBAR) communication process. Also, the authors commented that the multi-professional approach to course delivery improved the understanding amongst each professional group when dealing with cases of possible deterioration. While these interventions/packages report favourable results such as improved teamwork, communication and improved documentation of vital signs, these results are largely based on self-completed evaluation surveys following participation in the training programmes. Of the studies that did examine clinical data, no significant differences in hospital mortality or unplanned admissions to critical care areas were identified.

These findings were echoed in the focus groups held following the pilot of the Irish PEWS, which also highlighted the value of formal, structured, practical, scenario-based education sessions, multi-disciplinary teaching and the need for on-going informal and refresher training opportunities. Focus group participants also highlighted training already in existence, such as resuscitation courses and how this might complement PEWS education. This is in keeping with the UK Resuscitation Council's (2010) published strategies for prevention of in-hospital cardiac arrest, including a responsibility of hospitals to use an early warning system, mandate a clearly identified response to critical illness and to ensure that all clinical staff are trained in the recognition, monitoring and management of the critically ill patient and that they know their role in the rapid response system.

Effective staff education and training has been identified as a key facilitator to early warning system implementation in the Irish context (Lambert, 2015). Existing National Clinical Guidelines for NEWS and IMEWS recommend that senior managers ensure their staff undertake the education programme as appropriate. The recent Why Children Die report (RCPCH, 2014b) recommends that all frontline health professionals involved in the acute assessment of children and young people utilise learning resources and complete relevant professional development so they are confident and competent to recognise a sick child. The NHS NEWS report (RCP, 2012) recommends clinicians involved in the early warning system should be trained in its use, and clinical responders should have the appropriate skills and competencies in the assessment and clinical management of acute illness.

Ennis (2014) describes implementation of a paediatric early warning score on a children's ward in an Irish hospital. The education programme devised included a communication strategy (ISBAR), familiarisation with the paediatric early warning score and provided refresher training for staff in assessment and monitoring of inpatient children. The objective of the Irish PEWS training is to familiarise clinicians with the tools and resources for use of the Irish PEWS, to increase their understanding of the systems-based approach and to relate the system to existing knowledge and practices. Paediatric assessment and resuscitation training remains a core mandatory requirement and is not replaced by PEWS training.

Recommendation 15

The PEWS governance committee in each hospital must ensure that PEWS training is provided to all clinicians.

Quality of Evidence: Moderate**Strength of Recommendation: Strong****Good practice point**

Classroom-based multidisciplinary training is recommended during PEWS implementation and for new staff members that have not had previous experience with PEWS. Ongoing targeted training at team, ward or unit level is recommended to help embed good practices.

Recommendation 16

Clinicians working with paediatric patients should maintain knowledge and skills in paediatric life support in line with mandatory or certification standards.

Quality of Evidence: Moderate**Strength of Recommendation: Strong****Practical guidance for implementation**

The PEWS training toolkit is available at <http://www.hse.ie/pews>.

Good practice point

- Hospitals and PEWS governance committees should ensure that all frontline clinicians involved in the acute assessment of children and young people have access to educational resources and complete relevant professional development so that they are confident and competent to recognise a sick child.
- Resources such as Spotting the Sick Child (<https://www.spottingthesickchild.com/>), which has been endorsed by the UK National Patient Safety Agency (2009), or the following other accredited teaching aids may be used to provide or augment this minimum standard of teaching in hospitals: <https://www.resus.org.uk/resuscitation-guidelines/a-systematic-approach-to-the-acutely-ill-patient-abcde/>
NHS ReACT (Response to ailing children tool) <http://www.england.nhs.uk/ourwork/patientsafety/re-act/>

Practical guidance for implementation

All clinicians should be able to:

- Systematically assess a child
- Understand and interpret abnormal physiological parameters and other abnormal observations
- Understand and follow the PEWS guide for escalation of care
- Initiate appropriate early interventions for patients who are deteriorating
- Respond with life-sustaining measures in the event of severe or rapid deterioration pending the arrival of emergency assistance
- Communicate information about clinical deterioration in a structured and effective way to the primary medical practitioner or team, to clinicians providing emergency assistance and to patients, families and carers
- Undertake tasks required to properly care for patients who are deteriorating such as developing a clinical management plan, writing plans and actions in the healthcare record and organising appropriate follow up.

PEWS training is designed to complement existing paediatric life support courses. All clinicians should attend mandatory training in Cardiopulmonary Resuscitation (CPR)/Basic Life Support (BLS) and the systematic approach to paediatric assessment in addition to completion of PEWS training.

2.5.4 Audit and assurance of the Paediatric Early Warning System

There was consensus across the anecdotal evidence that regular auditing of PEWS should be conducted. For instance, in Starship Hospital, Auckland, New Zealand, monthly PEWS audits have become part of nursing metrics. Eight of eleven local clinical paediatric early warning guidelines examined for the systematic literature review specified audit procedures, monitoring of compliance and/or key performance indicators (Mid-Essex Hospital Service – NHS Trust Guideline for using Children's Early Warning Tool (CEWT); Central Manchester University Hospital – Manchester Children's Early Warning Score (ManchEWS²) Policy; Worcestershire NHS Trust – Paediatric Early Warning Score Clinical Guideline; Royal Cornwell Hospitals NHS Trust Policy for Patient Observation and Monitoring in Child Health; University Hospital Bristol NHS Foundation Trust Clinical Protocol for Recording and Acting Upon Physiological Observations in Paediatric Inpatient Areas; East Cheshire NHS Trust Procedure for Assessing and Measuring Vital Signs on Paediatric Patients and Using the Paediatric Early Warning Score; Thameside Hospital – NHS Trust Paediatric Early Warning Scoring Policy; Hillingdon Hospital Trust NHS – Monitoring Newborn Babies At Risk of Neonatal Illness In The Maternity Unit).

This is in keeping with evidence-based healthcare practices where audit is the final step recognised as an effective mechanism for improving the quality of care (HSE, 2008). Consequently, regular audit needs to be a strategic priority for healthcare institutions as part of their clinical governance strategy. It is the policy of the HSE that healthcare audit is undertaken to develop and sustain a culture of best practice, enable staff to evaluate and measure practice and standards and to establish structures and processes to monitor and evaluate the effectiveness of healthcare audit (HSE, 2008). The value and importance of an ongoing process of audit was acknowledged by the participants who took part in pilot site focus groups, both in terms of completion of the scoring tool and for training and learning purposes to reflect on child cases.

Existing Irish National Clinical Guidelines have highlighted the importance of audit to ensure both guideline implementation and positive impact on patient care through audit of patient outcomes. The NHS NEWS Report (RCP, 2012) also recommends that an evaluation of the system in practice should be carried out to determine if the recommended scoring template and trigger thresholds are optimal and enable refinement if needed. Future research should be directed towards evaluating the effectiveness of the NEWS in improving clinical response times and clinical outcomes in patients with acute illness. A recently published Irish paediatric early warning score implementation report (Ennis, 2014) noted as target objectives full concordance

with the use of paediatric early warning tools, agreed standards for assessment, monitoring, recognition, referral and response and a concurrent reduction in unplanned admissions to critical care.

The PEWS systematic literature review (Lambert et al., 2014) revealed some empirical evidence on methods for monitoring the effectiveness of PEWS implementation and some mixed evidence on potential clinical and process outcomes to analyse the impact of PEWS on patient care. The most commonly reported clinical outcomes were rates of cardio-respiratory arrest, mortality rates, unplanned transfers to PICU and invasive interventions required such as intubation, mechanical ventilation and vasopressors. Process outcomes measured included rates of MET utilisation/calls and code blue activations. Drawing consensus on the evidence was difficult because for any study that reported statistically significant findings there was an equal counterbalance of another study of which findings were non-significant. Challenges were also encountered in deciphering whether studies were adopting the same or different terms/definitions for outcomes measured.

A number of on-going studies, not yet published, are expected to provide some recommendations regarding national audit of processes and clinical outcomes including:

- European Union Network Patient Safety and Quality of Care (PaSQ), a pan-European project on paediatric early warning scores.
- Evaluating Processes of Care & the Outcomes of Children in Hospital (EPOCH) study to evaluate the impact of the Bedside Paediatric Early Warning System on early identification of children at risk for near and actual cardiopulmonary arrest, hospital mortality, processes of care and PICU resource utilisation. This is a 22 centre, international randomised controlled trial with data collection due for completion in July 2015 and study completion expected in October 2015. Results will not be available prior to publication of this national clinical guideline. At the time of guideline update, (November 2016), there has been no publication of findings.
- A National Institute for Health Research funded study in England and Wales, Review of Paediatric Early Warning Systems (PEWS) and scores for clinical deterioration of children in hospital: their development and validation, effectiveness and factors associated with implementation and generative mechanisms, is due for publication in 2017.

In compliance with national *Standards for Safer Better Healthcare* (HIQA 2012), it is the responsibility of local clinical governance structures to ensure that PEWS audit data is collected using national audit tools. Data should be used initially to enhance implementation and thereafter to assure quality of the system. All sites should collect and store the standard dataset for future national data analysis.

Recommendation 17

The national PEWS audit toolkit should be used to aid implementation and to regularly quality assure the Paediatric Early Warning System.

Quality of Evidence: High

Strength of Recommendation: Strong

Good practice point

Data regarding clinical outcomes for children should be collated nationally. Until a structure for national data collection and reporting exists, hospitals should use local data to inform improvement practices.

Practical guidance for implementation

- Audit must be undertaken to aid PEWS implementation in each clinical area

3 Appendices and References

Appendix 3.1: Budget impact analysis for the Irish Paediatric Early Warning System

Key Message

This budget impact analysis supports the clinical guideline recommendations.

Economic literature review results

Alongside the clinical literature review (summarised in Appendix 3.2), a systematic search for evidence of economic evaluations of paediatric early warning systems including cost-effectiveness, cost impact and resource impact was conducted in August 2014. To identify economic literature, initial searches of the electronic databases, PUBMED, MEDLINE, CINAHL, and EMBASE were expanded using PEWS search terms with various combinations of controlled vocabulary and free text words for economics. The following economic databases were also searched:

- NHS Economic Evaluation Database (NHSEED)
- Health Technology Assessment Database (HTAD)
- Centre for Reviews and Dissemination (CRD) Database, University of York/ NHS National Institute for Health Research (including DARE, NHS EED, HTA)

Details on the search strings are contained in the literature review that can be viewed on the clinical effectiveness website: <http://health.gov.ie/national-patient-safety-office/>.

The search terms used were:

Economic outcomes

Costs and results

- Healthcare resource use
- Training/Education costs
- Staff time costs
- ICU outreach costs/additional referrals
- Results e.g. number of unplanned ICU admissions; number of cardiopulmonary arrests; on-going care costs, hospital mortality
- Immediate call to resuscitation team/MET (medical emergency team)/CCRT (Critical Care Response Team)
- Cost savings
- Cost-effectiveness measures (e.g. ICER)

The search found no economic evaluations on the resource implications of a complete PEW system (detection, response, implementation, education etc.). Studies on the detection and response components of a PEW system provide results using a variety of clinical and process outcome data (e.g. cardiac arrest, unplanned transfer to PICU, length of stay in PICU) which could potentially be costed, but none of those papers estimated those costs/savings. Bonafide et al. (2014b) identified that patients who have clinical deterioration cost more to care for overall while they are in an intensive care environment and for the remaining hospital stay. This study examined the cost-effectiveness of a MET in a tertiary hospital setting, representing just one option as part of the response arm of a EWS. METs have not been introduced as part of the adult early warning score in Ireland. It is unlikely that apart from the two tertiary children's hospitals in Dublin (and eventually the new national children's hospital), that a paediatric MET would be established and even in those sites, existing teams may more likely be involved in the response arm of the PEWS. In their economic analysis of paediatric in-hospital life threatening events, Duncan and Frew (2009) found evidence that '*by identifying clinical deterioration early, the frequency of life threatening events in hospital cardiac arrest and hospital mortality can be decreased in children*'. Therefore, by preventing such events, there is potential to improve clinical outcomes and cost effectiveness.

Budget impact of National Clinical Guideline

The principal cost in implementing this guideline at a national level is the requirement for a national nurse coordinator to oversee implementation in all units. Costs at institutional level outlined here relate to structured initial, and on-going, education and training for clinicians in local, regional and tertiary hospitals caring for paediatric patients. There are also costs associated with local coordinator resources, ongoing audit and assurance of the system, and there should be investment in programmes that support the introduction of additional safety strategies.

National PEWS Nurse Coordinator Costs

A national PEWS nurse coordinator was appointed in August 2014 to oversee the development and implementation of the Irish PEWS. For 2016, this post has been costed based on 1WTE as set out below.

Profession	Grade costed (DoH 2013, pre-2010 scales chosen)	Annual salary (taken as top of scale)	Full labour cost (pay + employer PRSI salary costs of 10.75% + 4% imputed cost on pay + overheads of 25% on pay)
1WTE National PEWS Nurse Coordinator	CNM3	€61,491	€85,934

Initial Phase Education and Material Costs

Education Package	The National PEWS Steering Group has developed a PEWS Education Programme for use in the Irish paediatric setting. The costs for individual units should be minimal, e.g. printing of educational manuals, sample observation charts for training sessions, etc. All slide presentations for use in education sessions are provided.
Savings	It is likely that there will be no savings on existing education costs in those units that have already implemented an early warning score/system.
Costs for existing staff to attend PEWS Training	<p>These were calculated based on existing approximate staff numbers of 2,000 nurses, 205 paediatric consultants, and 405 non-consultant hospital doctors.</p> <p>Staff numbers collected in 2013 reported 1,605 registered children's nurses, while other surveys have reported different numbers of nurses working in the paediatric context so it was taken that 2,000 nurses would represent an average of all sources. In contrast to other early warning systems, the National PEWS Steering Group recommends that 100% of doctors attend training on PEWS. Other paediatric inpatient settings that will need to implement PEWS, e.g. units providing elective paediatric surgery and rehabilitation services. It is recognised that there will be extra costs associated for PEWS education in these settings. It is likely that there will be an opportunity for collaborative provision of education between sites within the same hospital group, helping to minimise costs.</p> <p>A 'train the trainer' model for education has been adopted by the National PEWS Steering Group, whereby the national PEWS nurse coordinator will train a number of key trainers in each hospital. These trainers will then be responsible for training additional local trainers and champions, and together delivering education sessions within their units. Each 'train the trainer' education programme takes 4.5 contact hours. The number of education programme sessions required in each individual unit will be dependent on the total number of staff employed, and the number of staff members attending each session. Each education programme will take 3.5 contact hours of trainer time and 1 hour pre- and post-course organisation. For the purposes of this analysis, the trainer time has been costed at CNM2 grade which is the equivalent grade of a clinical nurse educator.</p> <p>Delivery of the full PEWS Education Programme is estimated to take 3.5 contact hours, and 1 hour for the condensed medical programme. The recommended training ratio is one facilitator per six candidates for the practical elements, however one facilitator may deliver the overview lecture to a larger group. There will be a requirement for protected time for trainers that may be covered by creation of new roles or by judicious rostering within existing roles.</p> <p>Additional nursing resources may be required to oversee the local implementation and audit processes in each unit. The time required for implementation support will depend on the size of the unit/hospital, and therefore cannot be assigned a set cost. The time commitment for audit has been estimated (based on pilot site experience) at 4 hours per week to collect and enter data, and has been costed at CNM2 grade for the purpose of this analysis. There will be a greater time commitment required in the first six months of implementation, and thereafter the requirement will be to oversee audit and on-going education.</p> <p>A summary of these costs is detailed below in Table 3.2.1.</p>
Material Costs	Resources to support PEWS (posters, quick reference guides, etc.), in addition to the paediatric observation chart templates for five age categories, will be provided in electronic format to all units. There will be a cost implication for colour printing of these materials, which is dependent on the individual printer used and volume printed as the unit cost will reduce as the number ordered increases. It is recommended that printing is organised at a hospital group level as this will result in economies of scale. This cost will be offset against the cost of other local observation charts which will no longer need to be printed.

Table 3.2.1: Calculation of initial training costs

Profession	Grade costed (DoH 2013, pre-2010 scales chosen)	Annual salary	Full labour cost (pay + employer PRSI salary costs of 10.75% + 4% imputed cost on pay + overheads of 25% on pay)	Hourly cost	Cost per individual	TOTAL COST
Trainer	CNM2 – point 5 on 9 point scale	€50,874	€71,096	€35.06	€157.77 (train the trainer attendance) + €157.77 (trainer time per session delivered)*	€157.77 x number of trainers nationally + €157.77 x number of sessions delivered.
Nurse	Staff nurse (RCN)- point 6 on 11 point scale	€34,666	€48,446	€23.89	€83.62	€83.62 X 2000 = €167,230
Doctor	Registrar- point 4 on 6 point scale	€60,010	€83,864	€41.35	€41.35 - €144.73 (depending on attendance at full or condensed medical programme)	€41.35 - €144.73 x 610 = €25,223.50 - €88,282.25**
Audit time	CNM2 – point 5 on 9 point scale	€50,874	€71,096	€35.06	€140.24 per paediatric unit per week	€140.24 x number of units that implement PEWS***

* This is based on 4.5hrs per trainer per session, including 1 hour for pre- and post-education session administration.

** Hospitals are advised to incorporate PEWS into existing medical educational structures, such as induction programmes, grand rounds and planned education / teaching sessions in order to minimise these costs.

*** This is audit data collection and entry time only, additional time will be required locally for implementation support including feedback of audit results and targeted reinforcement of learning.

Ongoing Education and Material Costs

Staff Costs	<p>There will be an ongoing resource requirement to oversee audit and education in each unit/hospital.</p> <p>The plan for PEWS retraining is in development. Staff costs may be further reduced by the development of e-learning training resources for PEWS.</p>
Material Costs	<p>As with the initial phase, there will be a cost associated with printing of paediatric observation charts, which will however be offset by no longer needing to print a number of other charts that may have been in use.</p>
Cost Savings from Improved Outcomes	<p>As stated previously, no economic evaluations of a PEWS in its entirety have been identified. Research cited in the systematic literature review has suggested improved clinical outcomes and savings associated with a MET, where critical deterioration is prevented, such as shorter PICU stay and shorter overall hospital stay (post-event). Other studies have shown improved clinical outcomes associated with detection and response systems. While the trend is towards better outcomes for children and fewer invasive interventions (implying less cost) where a component of PEWS has been studied, the available limited data on costs are less clear and somewhat contradictory. Therefore, it is not possible to identify the estimate savings to the health service which are linked with improved outcomes. As with other early warning systems, it is acknowledged that these will not amount to financial savings but to a freeing up of resources much needed in the paediatric healthcare system.</p> <p>A national evaluation of the Irish Paediatric Early Warning System should be undertaken to provide evidence of effectiveness.</p>

Situation Awareness for Everyone (SAFE) Programme

The cost of delivering one SAFE programme in Ireland has been estimated at €20,000. This is for eight teams with 4-6 members per team, and will cover the cost of trainers from the UK, travel expenses, four one-day engagements and a site visit per team.

Appendix 3.2: Literature review summary

The systematic literature review to support the development of this National Clinical Guideline is available on the Clinical effectiveness website.

Background

Many paediatric deaths are identified as either avoidable or potentially avoidable (CEMACH, 2008), with evident deterioration of symptoms (physiological and behavioural) often present in the 24 hours preceding an arrest (Robson *et al.*, 2013; McLellan *et al.*, 2013). This provides a solid foundation for an increased attention to prevention; early detection through implementation of early warning scores and appropriate timely responses to the clinically deteriorating child. Paediatric Early Warning Systems (PEWS) include bedside tools which help alert staff to clinically deteriorating children by periodic observation of physiological parameters and predetermined criteria for escalating urgent assistance. The requirement for a robust system specifically for identification of the clinically deteriorating child is important because the application of early warning scoring systems to paediatric patients is more complex than to adults. There are several reasons for this: variation in age specific thresholds for normal and abnormal physiology; children's inability or difficulty in articulating how or what they feel; children's compensatory mechanisms; staff training issues and the need for more focused attention on respiratory deterioration (Haines *et al.* 2006). While many systems have been developed and tested uncertainty remains as to which system is most useful for paediatric patients.

The purpose of this review was to assess the evidence on the use, validation, education and cost-effectiveness of early warning, or track and trigger systems used in paediatric patients in acute healthcare settings, including emergency departments, for the detection and/or timely identification of deterioration in children aged 0-16 years. The methodology for this systematic review followed the Centre for Reviews and Dissemination guidance (2008) for undertaking systematic reviews in healthcare and the National Clinical Effectiveness Committee Guideline Development Manual (2013).

Research questions

The following questions guided the review;

1. What neonatal and paediatric early warning or track and trigger systems (including escalation protocols and communication tools) are currently in use internationally for the detection of deterioration and/or timely identification of deterioration in children aged 0-16 years? This included a review of early warning scores for the emergency department.
2. What was the level of clinical validation of these neonatal and paediatric scoring systems including escalation protocols and communication tools?
3. What education programmes have been established to train healthcare professionals in the delivery of neonatal and paediatric early warning scoring systems?
4. What level of evaluation has been used for these education programmes?
5. What are the findings in the economic literature of cost effectiveness, cost impact and resources involved with early warning or track and trigger systems in the detection and/or timely identification of deterioration in paediatric patients, including implementation costs? This included the conduct of a budget impact analysis on the implementation of PEWS.

Criteria for considering studies for the review

The criteria for considering studies for inclusion in this review were guided by predetermined PICO's (Table 1).

The overarching PICO question was: is the use of PEWS effective in the timely identification of clinical deterioration in acutely ill children (0-16 years)?

Table 3.2.1: Population, Intervention, Comparison, Outcomes (PICO)

PICO	Indicative Terms
Population	<ul style="list-style-type: none"> • Newborn/neonate/infant/child/adolescent/young person patient • Newborn/neonate/child/adolescent/young person acute patient • Critically ill/deteriorating paediatric/pediatric patient • Sepsis/septic infection/shock in newborn/neonate/infant/child/adolescent/young person patient
Intervention	<ul style="list-style-type: none"> • Neonatal/Paediatric/Pediatric Early Warning Score/System/Tool/Chart • Neonatal/Paediatric/Pediatric Modified Early Warning Score/System/Tool/Chart • Bedside PEWS/BPEWS • Parent Activated Early Warning Systems • Sepsis Six • Track and Trigger Systems/Tools • Instrument Validity/Reliability/Evaluation • Calling Criteria/Rapid Response/Escalation Protocols/ Communication Tools/Situation Awareness • Education/Training/ALERT™/COMPASS®
Comparison	<ul style="list-style-type: none"> • Neonatal/Paediatric/Pediatric Early Warning Score/System/Tool/Chart • Neonatal/Paediatric/Pediatric Modified Early Warning Score/System/Tool/Chart • Bedside PEWS/BPEWS • Parent Activated Early Warning Systems • Sepsis Six • Track and Trigger Systems/Tools • Validity/Reliability/Evaluation • Calling Criteria/Rapid Response/Escalation Protocols/ Communication Tools/Situation Awareness • Education/Training/ALERT™/COMPASS® (comparison against each other or with no intervention)
Outcome	<p>Clinical outcomes Detection, and/or timely identification, of clinical deterioration of the newborn/neonate/child/adolescent/young person patient and all relevant sequelae; and diagnostic accuracy Instrument sensitivity/specificity</p> <p>Economic outcomes Costs and results</p> <ul style="list-style-type: none"> • Healthcare resource use • Training/Education costs • Staff time costs • ICU outreach costs/additional referrals • Results e.g. number of unplanned ICU admissions; number of cardio-pulmonary arrests; ongoing care costs, hospital mortality • Immediate call to resuscitation team/MET (medical emergency team) team/CCRT (Critical Care Response Team) • Cost savings • Cost-effectiveness measures (e.g. ICER)

Search strategy

A comprehensive strategy was developed to search a variety of resources to retrieve published and unpublished evidence nationally and internationally (English language only); including electronic databases, grey literature, clinical guidelines resources and consultation process with international experts in the field of paediatric early warning systems.

Electronic databases

Comprehensive search strategies were developed for each electronic database using various combinations of controlled vocabulary and free text words. These search strategies emanated following mapping of PICOs, scoping searches of the databases, a review of key words from previous research studies in the field and engagement with a subject librarian. The electronic databases searched in June 2014 were;

- Medical Literature Analysis and Retrieval System Online (MEDLINE) and PubMed
- Cumulative Index to Nursing and Allied Health Literature (CINAHL)
- Excerpta Medica Database (EMBASE)
- Cochrane Database of Systematic Reviews (CDSR)
- Cochrane Central Register of Controlled Trials (CENTRAL)
- Database of Abstracts of Reviews of Effect (DARE)

Economic evidence

The search for economic evaluations was augmented by searches of the following databases;

- NHS Economic Evaluation Database (NHSEED)
- Health Technology Assessment Database (HTAD)
- Centre for Reviews and Dissemination (CRD) Database, University of York/ NHS National Institute for Health Research (including DARE, NHS EED, HTA)

Grey literature

The grey literature sources searched were:

- Grey literature databases
 - Research Inventory for Child Health in Europe (RICHE)
 - Agency for Healthcare Research and Quality (AHRQ)
 - UK Clinical Research Network (UKCRN)
 - Open Grey
 - PsycEXTRA
- Trial registers
 - International Standard RCT number register (ISRCTN)
 - MetaRegister of Controlled Trials
 - clinicaltrials.gov
 - UK Clinical Trials Gateway
 - National Research Register (NRR) Archives Search
 - Australian New Zealand Clinical Trials Register (ANZCTR)
 - WHO International Clinical Trials Registry Platform
- Professional organisations and association websites
 - Royal College of Paediatrics and Child Health
 - Paediatric Nursing Association Europe
 - European Federation of Critical Care Nursing Associations
 - Association of Anaesthetists of Great Britain and Ireland
 - American Society of Anesthesiologists
 - American Academy of Pediatrics
 - European Association for Children in Hospital
 - Action for Sick Children UK
 - Children's Hospital Association US
 - Royal College of Physicians (inclusive of National Clinical Guideline Centre)

Evidence based clinical guidelines

The electronic guideline clearinghouses searched were:

- United States National Guideline Clearinghouse (USNGC)
- National Institute for Health and Care Excellence (NICE)
- Scottish Intercollegiate Guidelines Network (SIGN)
- Guidelines International Network (GIN)

Scoping searches of Google and Bing were also performed.

Consultation with paediatric experts internationally

To complement all searches a consultation process was undertaken with key paediatric experts (e.g. paediatricians, advanced nurse specialists) and paediatric hospitals internationally, in the field of paediatric early warning systems, in an attempt to gather data on grey literature and more specifically on evidence based clinical guidelines. This was achieved by two routes; an online survey and telephone discussions. Prior to commencing this consultation process ethical approval was granted by the Research Ethics Committee at Dublin City University.

Screening and selection process

For stage 1 screening, two reviewers independently assessed each title and abstract against the inclusion/exclusion criteria (Box 1) for relevance. Any discrepancies were resolved by discussion and consensus with a third reviewer. For stage 2 screening, full text papers were independently assessed by two reviewers and any discrepancies were resolved by discussion and consensus with a third reviewer before a final decision regarding inclusion was confirmed. Any discrepancies were resolved by discussion and consensus with a third reviewer.

Box 1: Inclusion and exclusion criteria

Inclusion Criteria

- Neonatal and/or paediatric early warning score systems; inclusive of rapid medical response systems and teams
- Outcomes specific to the identification of and/or response to clinical deterioration
- Child patients aged 0-16 years
- Neonatal and paediatric hospital settings (including emergency departments)
- All study designs (i.e. qualitative, quantitative, mixed methods, case reports)

Exclusion Criteria

- Neonatal or paediatric community health settings
- PEWS specific to intra and/or inter- hospital transfer and/or transport of critically ill children
- Trigger tools for identification of adverse events and/or harm caused by medical treatments/interventions
- Severity of illness scales and patient classification systems which focus solely on illness acuity and mortality identification as opposed to early warning and response to child clinical deterioration (except in cases where such studies include PEWS/RRT systems as comparative severity of illness interventions)
- Studies which include both child and adult populations where child data could not be exclusively extracted

Assessment of Methodological Quality/Level of Evidence

Two independent reviewers assessed and classified the methodological level of evidence of the included studies in accordance with the Scottish Intercollegiate Guidelines Network (SIGN) (2014) criteria for assignment of levels of evidence. Any discrepancies were resolved by discussion and consensus with a third reviewer. Assessing comparative quality across the eligible studies proved difficult due to the heterogeneous methodologies employed (e.g. disparate research designs; different ranges of time-period for collecting data over months/years; localised small cases and comparative group selections; and diverse clinical contexts ranging from general medical and

surgical units to specialised settings such as oncology, cardiac, endocrine, rehabilitation units). To appraise clinical guidelines the NCEC (2013) Guideline Development Manual was followed including use of the 'rigour of development' domain of the AGREE II Instrument as outlined in the National Quality Assessment Criteria for Clinical Guidelines by HIQA (2011). Unpublished grey literature was evaluated using a checklist from Flinder's University – AACODS (authority, accuracy, coverage, objectivity, date and significance) (Tyndall 2010).

Data Extraction, Analysis and Synthesis

Two reviewers independently extracted and managed data from included studies. Discrepancies were resolved through consultation with a third reviewer. A data extraction table was developed to retrieve information pertaining to each study purpose; design; setting and/or participant details; intervention and comparison features (if appropriate); clinical data collection/analysis; and outcomes measures/results. Due to the diversity of studies investigating different components of PEW systems, data extraction tables were catalogued according to papers focusing on (i) PEW detection systems (including neonates and emergency departments); (ii) PEW response systems (including family activated response systems) and (iii) PEW implementation/governance factors (including education, cultural issues, and economic evaluations). This classification also formed the basis for the narrative summary of the review results as due to study heterogeneity it was not possible to conduct a meta-analysis or meta-synthesis.

Results

Figure 3.2.1, an adapted PRISMA flow diagram, visually displays the stages of the search and selection process. The search strategy identified 2434 papers as potentially eligible for inclusion in the review. Following the first screening of titles and abstracts, 2328 papers were excluded. On the second screening of 106 full text papers, a further 52 papers were excluded because they were adult focused, both child and adult focused in which it was not possible to segregate child and adult data, not specifically focused on the outcome of clinical deterioration, concentrated on clinical deterioration at point of transportation, examined illness severity or acuity and were discussion papers, commentaries or conference abstracts. A further 16 papers were sourced through secondary citations, personal communications and web-resources. This resulted in a total of 70 papers identified for inclusion in the review. These 70 papers were classified into five main categories according to study type and the specific PEW component the paper focused on; such as PEW detection systems, response mechanisms and implementation/governance factors including, education, cultural issues and economic evaluations (Table 3.2.2).

Table 3.2.2: Classification of included studies

Classification of included studies	No. included
Review papers <ul style="list-style-type: none"> Review of paediatric alert criteria (defined as early warning scores/systems or rapid response team trigger/activation criteria) (n=1) Reviews of rapid response teams/systems (n=3) 	4
Cross-sectional surveys <ul style="list-style-type: none"> Survey of paediatric early warning systems and rapid response teams (n=1) Survey of rapid response systems (n=3) 	4
Primary research studies related to PEW detection systems <ul style="list-style-type: none"> Used in paediatric medical and surgical settings (n=19) Used with neonatal populations (n=2) Used in paediatric emergency departments (n=4) 	25
Primary research studies related to PEW response systems <ul style="list-style-type: none"> Paediatric Rapid Response/Medical Emergency Teams (n=17) Family activated response systems (n=4) 	21
Primary research studies related to PEWS implementation <ul style="list-style-type: none"> Implementation process (n=6) Educational interventions (n=3) Cultural, socio-technical and organisational issues (n=5) Economic evaluations (n=2) 	16
Total	70

Figure 3.2.1: Flowchart of search and selection process

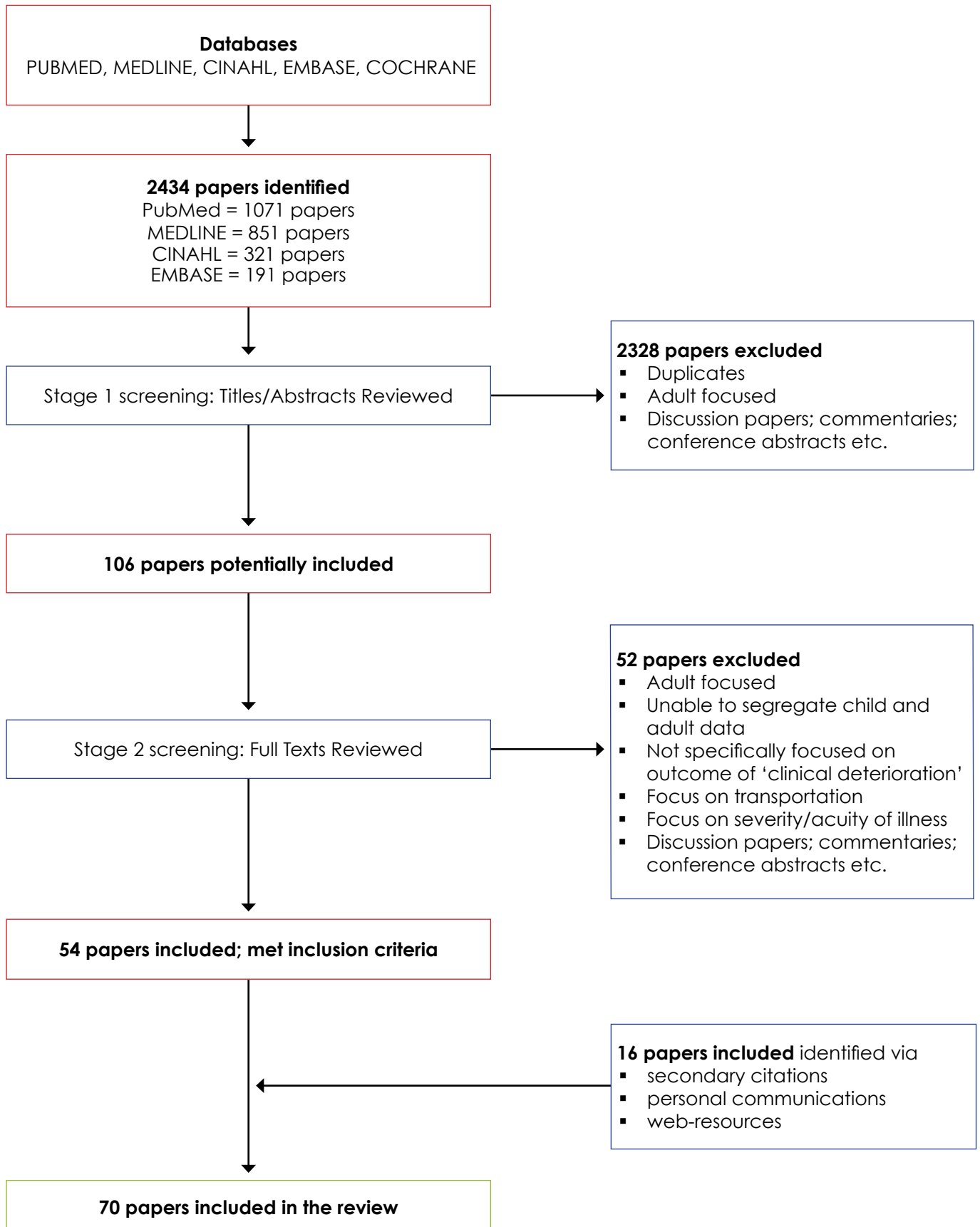


Table 3.2.3: Systematic Review Levels of Evidence (P = prospective; R = retrospective)

Author	Study type	PEW System	Level of evidence	Judgement	Rationale for judgement (see data extraction tables in supporting literature review for further study details)
Chan 2010	Review	Response	2++	High quality systematic review of observational/ quasi-experimental studies	Search strategy detailed, 5 child specific studies of varying quality; all before/after studies with one time series study; results analysed at study not patient-level data; meta-analysis limited by extensive heterogeneity in reported outcomes and variation in research designs
Chapman 2010	Review	Detection	2++	High quality systematic review of observational/ quasi-experimental studies	Detailed description of search strategy and of evidence reviewed; quality assessment in accordance with research design criteria and results summarised narratively
Parshuram 2011a	Case control	Detection	2++	High quality case control study	Large multi-centre international, prospective, 1:2 frequency matched case control design (acc. to clusters of similar inpatient units and stratified patient age categories), clinical data abstraction + nurse interview/ recall of observations (+ retrospective survey global rating)
Duncan 2006	Case control	Detection	2+	Well-conducted case control	Frequency matched case control design, retrospective, 87 cases/128 controls
Edwards 2009	Cohort	Detection	2+	Well-conducted cohort study	Prospective, to test predictability of PEW system, all children admitted in a time period were eligible to participate, data collected on 1,000 children; follow-up across admission
Edwards 2011	Cohort	Detection	2+	Well-conducted cohort study	Prospective, to test predictability of activation system, all admissions to paediatric wards over 12 month period
Fuijkschoot 2014	Cohort	Detection	2+	Well-conducted cohort study	Three cohort studies, appropriate sample and follow-up duration – two described as retrospective, one prospective
Holmes 2013	Case cohort	Detection	2+	Well-conducted cohort study	Retrospective, 2 groups - 1 classed as 'unwell' and 1 classed as 'well'
McLellan 2013	Cohort	Detection	2+	Well-conducted cohort study	Retrospective, a specific high risk population, convenience comparison group

Author	Study type	PEW System	Level of evidence	Judgement	Rationale for judgement (see data extraction tables in supporting literature review for further study details)
Parshuram 2009	Case control	Detection	2+	Well-conducted case control study	Prospective, frequency matched case control design (+ retrospective survey interview), risk recall bias, data abstraction not verified
Robson 2013	Case control	Detection	2+	Well-conducted case control	Matched case control, on age, diagnosis and gender; retrospective
Sefton 2014	Before & after cohort	Detection	2-	High risk of confounding or bias	Cohort, prospective, before 12 month period and after 12 month period, 'in-house' cohort emergency admissions to PICU, comparative group 'external' admissions transferred from DGH (without PEWS)
Seiger 2013	Cohort	Detection	2+	Well-conducted cohort study	Prospective collected data during triage assessments, all admissions to ED, 10 different PEWS evaluated
Sharek 2007	Cohort	Response	2+	Well-conducted cohort study	Described as before and after, uses historic data as 'control', cannot definitively say clinical outcome changes were as a result of RRT intervention. Potential variance between pre and post intervention populations
Skaletzky 2012	Case control	Detection	2+	Well-conducted case control	Retrospective, 1:3 matching controls for each case, matched for age, ward of admission, month of admission, admitting diagnosis
Theillen 2013	Cohort	Response	2+	Well-conducted cohort study	Prospective, audit, all admissions to ICU, 1 year period, before & after MET & concurrent team training, uncontrolled, Hawthorne effect bias
Winberg 2008	Review	Response	2+	Review reporting on observational/quasi-experimental studies	Outline of search strategy provided; quality assessment not reported; results reported narratively on non-controlled non-randomised studies
Bonafide 2012	Cohort	Response	2-	High risk of confounding or bias	Retrospective, review of MET activations, chart and unit review
Bonafide 2014b	Cohort	Economic	2-	High risk of confounding or bias	Retrospective review

Author	Study type	PEW System	Level of evidence	Judgement	Rationale for judgement (see data extraction tables in supporting literature review for further study details)
Haines 2006	Cohort	Detection	2-	High risk of confounding or bias	Prospective, with a random control sample on day of data collection. Sample generated by nurse identification of previous high-dependency nursing needs
Lobos 2014	Cohort	Response	2-	High risk of confounding or bias	Retrospective, MET activations reviewed
Bonafide 2014a	Interrupted time series	Response	2-	High risk of non-causal relationships	Retrospective, historical records, potential exposure to unmeasured confounding
Brady 2013	Time series	Cultural	2-	High risk of non-causal relationships	Retrospective, potential exposure to unmeasured confounding, no measure for situation awareness
Hanson 2010	Interrupted time series	Response	2-	High risk of non-causal relationships	Retrospective (+ chart review); potential exposure to unmeasured confounding
Hunt 2008	Before & after	Response	2-	High risk of confounding or bias	No control group, retrospective & prospective
Kotsakis 2011	Before & after	Response	2-	High risk of confounding or bias	Interdisciplinary multi-centre study, no control group; retrospective & prospective
McCrory 2012	Pre-post design	Education	2-	High risk of confounding or bias	No control group, simulated environment not patient care environment
McKay 2013	Before & after	Education	2-	High risk of confounding or bias	Prospective, controlled, potential selection bias at one site and potential for Hawthorne effect (sustainability unknown)
Parshuram 2011b	Before & after	Detection	2-	High risk of confounding or bias	No control group, prospective, 9-month period, small number of events, self-report subjective responses

Author	Study type	PEW System	Level of evidence	Judgement	Rationale for judgement (see data extraction tables in supporting literature review for further study details)
VanderJagt 2013	Review	Response	2-	Narrative review of components of RRS; unsure risk of bias	Methodology (i.e. search strategy, screening process, quality assessment, data synthesis) underpinning the review not reported
Zenker 2007	Pre-post design	Response	2-	High risk of confounding or bias	No control group, retrospective & prospective
Akre 2010	Chart review	Detection	3	Non-analytic, case reviews	Retrospective, descriptive
Avent 2010	Case report	Response	3	Non-analytic, case report	Case report on one patient case presenting to outpatient department
Bell 2013	Chart review	Detection	3	Non-analytic, case reviews	Retrospective, descriptive, 6 month period, 150 charts (reflected 0.7% of population)
Bradman 2008	Chart review	Detection	3	Non-analytic, case reviews	Retrospective audit of patients who attended ED over 2 week period
Breslin 2014	Chart review	Detection	3	Non-analytic, case reviews	Prospective data, 10 month period, convenience sample (based on availability of study team member)
Brilli 2007	Chart review	Response	3	Non-analytic, case reviews	Described as a performance improvement project, pre-post chart review + a staff performance assessment survey
Demmel 2010	Chart reviews	Implementation	3	Non-analytic, case reviews	Describes implementation of PEWS tool & action algorithm, prospective and retrospective data, ongoing cycles using plan-do-study-act
Duncan & Frew 2009	Cost analysis exercise	Economic	3	Non-analytic, case reviews	Prospective
Haque 2010	Chart review	Response	3	Non-analytic, case reviews	Audit, retrospective data, before and after, 9 month post-implementation period, all children admitted, data form completed by RRT and later collected by one investigator for review

Author	Study type	PEW System	Level of evidence	Judgement	Rationale for judgement (see data extraction tables in supporting literature review for further study details)
McLellan & Connors 2013	Chart reviews	Implementation	3	Non-analytic, case reviews	Describes modification and implementation of a PEWS tool and escalation of care algorithm for cardiac patients, processes implemented over course of 3 pilot studies which incorporated retrospective chart reviews/audits + clinician interviews
Monaghan 2005	Chart review	Detection	3	Non-analytic, case reviews	Descriptive pilot (of PEWS for 3 month period), followed by patient audit – retrospective
Panesar 2014	Database review	Response	3	Non-analytic, case reviews	Quality assessment project, retrospective RRT database review, > 2 year period, before and after implementation
Tibballs 2005	Chart review	Response	3	Non-analytic, case reviews	Quality assurance exercise, preliminary results, before & after, compared retrospective data pre-MET (41 month period) with prospective data post-MET (12 month period)
Tibballs & Kinney 2009	Chart review	Response	3	Non-analytic, case reviews	Before & after, compared retrospective data pre-MET (41 month period) with prospective data post-MET (48 month period)
Roland 2010	Chart Review	Detection	3	Non-analytic, case reviews	2 chart review audits, 1 retrospective and 1 prospective (+ qualitative survey)
Solevag 2013	Chart review	Detection	3	Non-analytic, case reviews	Quality improvement project, retrospective data (3 month period – 761 PEWS forms)
Tucker 2009	Chart review	Detection	3	Non-analytic, case reviews	Prospective, descriptive, all patients admitted to one unit over 12 month period, data recorded by charge nurse using localised tool
Tume 2013	Chart review	Detection	3	Non-analytic, case reviews	Prospective audit, 4 month period, descriptive analysis, child physiological data retrospectively matched against two PEW tools
Wang 2010	Database review	Response	3	Non-analytic, case reviews	Descriptive retrospective, database of ERT activations, 13 year period,
VanVoorhis & Willis 2009	Case examples	Response	3	Non-analytic, case reviews	Descriptive presentation of case examples from 2 US hospitals
Bonafide 2013a	Qualitative study	Cultural	4	Expert opinion	Semi-structured interviews, expert opinion of nurses and physicians in one context, potential social desirability response bias

Author	Study type	PEW System	Level of evidence	Judgement	Rationale for judgement (see data extraction tables in supporting literature review for further study details)
Brady & Goldenhar 2013	Qualitative study	Cultural	4	Expert opinion	Localised focus group interviews with nurses, respiratory therapists and physicians; potential for group think bias & presentation of beliefs and opinions rather than actual behaviours/actions
Chen 2012	Cross-sectional survey	Response	4	Expert opinion	Surveys (designed by investigators & piloted) distributed online and via mail, targeted selected US hospitals with PICU only, surveyed PICU physicians – data self-reported practices and beliefs, potential for non-response bias
Dean 2008	Quality improvement initiative	Family	4	Expert opinion	Descriptive account of 2 year analysis of Condition Help
Hayes 2012	Quality improvement initiative	Implementation	4	Expert opinion	Multi-centre multi-disciplinary collaborative based on Model for Improvement (plan-do-study-act); monthly data submissions over 12 month study period and preceding 12 month period as baseline data, + safety culture survey at 3 time points
Hueckel 2012	Quality improvement initiative	Family	4	Expert opinion	Describes education process for teaching families about Condition Help & follow up survey to evaluate family understanding
Kukrefi 2014	Quality improvement initiative	Implementation	4	Expert opinion	Describes local experience of implementing RRT, presented some data on pre-post implementation survey and MET activity
Lobos 2014	Quality improvement initiative	Implementation	4	Expert opinion	Multi-centre study on standardised implementation of RRS, based on Social Marketing principles, phases of implementation described
Paciotti 2014	Qualitative study	Family	4	Expert opinion	Semi-structured interviews based on expert opinions of 30 physicians selected purposively, single site, constant comparative analysis
Randhawa 2011	Quality improvement initiative	Implementation	4	Expert opinion	Single site, description of 3 cycles of change related to the process and outcome implementation of PEWS, underpinned by plan-do-check-act methodology

Author	Study type	PEW System	Level of evidence	Judgement	Rationale for judgement (see data extraction tables in supporting literature review for further study details)
Ray 2009	Quality improvement	Family	4	Expert opinion	Descriptive localised account of implementing a family activated Paediatric RRS, random in-person surveys with families
Roland 2013	Cross-sectional survey	Detect/Respond	4	Expert opinion	Electronic survey based on 2005 PEWS survey (+ follow up telephone survey for non-responders) of identified hospitals providing inpatient paediatric services in Great Britain, self-report data
Sen 2013	Cross-sectional survey	Response	4	Expert opinion	Telephone survey, focused on prominent academic paediatric hospitals in US, self-report data
Tume 2013	Course evaluation survey	Education	4	Expert opinion	Small preliminary evaluation of a training course, post-course paper evaluation form and 3-month post-course electronic survey (low response rate – non-response bias); descriptive
VandenBerg 2007	Cross-sectional survey	Response	4	Expert opinion	Telephone survey (designed by investigators), of selected Canadian/American hospitals ≥ 50 paediatric acute care beds or ≥ 2 paediatric wards, self-report data – accuracy not verified

Appendix 3.3: SIGN principles for use of GRADE methodology for recommendations available at <http://sign.ac.uk> (reproduced with permission), and GRADE tables for decisions related to the strength of recommendations.



Applying the GRADE methodology to SIGN guidelines: core principles

In 2009, SIGN took the decision to implement the GRADE approach within its guideline development methodology. This work is currently in process. There is, however, scope for variation in what people mean when they say they are “applying the GRADE system”. For clarity, this statement sets out the principles that SIGN will be applying when implementing GRADE.

We believe these principles are in line with the criteria set out by the GRADE Working Group, as they stood in June 2010.

1. All guideline recommendations will be based on a systematic review of the available evidence, and an assessment of the quality of that evidence. **Quality of evidence** is defined as the extent to which confidence in an estimate of the effect is adequate to support recommendations.
2. Assessment of quality of evidence will be carried out in the context of its relevance to the NHS in Scotland. Criteria for establishing the overall quality of evidence will include all factors for increasing or decreasing the quality of evidence identified by the GRADE Working Group.
3. Evidence identified in a systematic review will be summarised in an evidence table listing key characteristics of individual studies. Each table will in turn be summarised in relation to the overall quality of evidence for each critical or important outcome identified by the guideline development group (GDG). These summaries will form the basis for all decisions regarding the **quality of evidence** or **strength of recommendations**. Summaries will be produced either using Gradepro software or by recording decisions made by the GDG relating to each quality factor in a considered judgement form specific to this stage of the process.
4. Quality of evidence will be rated in one of four categories (ranging from low to high) as defined by the GRADE working group.
5. **Strength of recommendation** will be established on the basis of explicit consideration of each of the criteria established by the GRADE Working Group, and recorded in a considered judgement form specific to this stage of the process.
6. **Recommendations** will either be **unconditional** (strong evidence, no important drawbacks) or **conditional** (weaker evidence, serious potential drawbacks).

Summary tables of considered judgement by GDG, using an adapted GRADE process

Recommendation 1: The Paediatric Early Warning System (PEWS) should be used in any inpatient setting where children are admitted and observations are routinely required.	
Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Standardisation, quality of care, safety is enhanced.</p> <p><u>Harm</u> None foreseen.</p>
<i>Quality of evidence</i>	<p>No concrete evidence to state what system is the most beneficial or conclusive, measurable improvement in outcomes but definite positive directional trends in outcomes and clinician support.</p> <p>Need for RCTs – awaiting results from EPOCH trial and work ongoing in the UK.</p> <p><u>GRADE Criteria for PEWS:</u> Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.</p> <p>Quality of evidence: Moderate</p>
<i>Values and preferences</i>	Early detection universally supported.
<i>Resource use</i>	<ul style="list-style-type: none"> • Time required to introduce and train adequately to inform the system, not just a new chart. • The PEWS training course is only part of the competency framework. • Additional costs will be incurred by Healthcare Institutions where they must provide additional training in Early Recognition of the Seriously Ill child. • May be a resource required to oversee the process – long-term project to ensure success. • Will be a cost involved in printing the national charts but this may be balanced by the cost of the charts that are being replaced • There will be an audit implication. • All costs are balanced by likelihood that standardisation will lead to improved patient safety and outcome.
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 2:	
Clinician or family concern is a core parameter and an important indicator of the level of illness of a child, which may prompt a greater level of escalation and response than that indicated by the PEWS score alone.	
Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Enhanced clinician/parent relationship, enhanced multi-disciplinary relationship. Promotes situation awareness and clinical judgement because concern carries a single score, the level of escalation and response required is judged by the attending clinician.</p> <p><u>Harm</u> Could arise from misunderstanding on the part of the family or clinician as to the concept of concern or at the expression of concern – address with education and resources to actively engage with the family and promote shared understanding.</p>
<i>Quality of evidence</i>	<p><u>GRADE criteria for CONCERN</u>: Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.</p> <p>Quality of evidence: Moderate</p>
<i>Values and preferences</i>	Some variation discussed at focus groups regarding separation of family and nurse concern but as this may have a potential negative impact on PEWS scoring through communication difficulties/ discrepancies- differences of opinion etc., concern was retained as a single score in the presence of any level of concern on behalf of any party.
<i>Resource use</i>	<p>Requires inclusion in PEWS training.</p> <p>Resources for parents/families – hard copy and conversation/ education/information giving.</p> <p>All costs offset by benefit in genuine engagement with families and recognition of concern.</p>
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 3: The PEWS should complement care, not replace clinical judgement. Any concern about an individual child warrants escalation, irrespective of PEWS score. The level of escalation should be reflective of the degree of clinical concern.	
Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Continuation of good practice.</p> <p>Clinical concern, judgement and impression remain the standard for practice with a PEWS scoring tool to assist good practice and standardise.</p> <p><u>Harm</u> Allowing PEWS to falsely reassure. Not taking into account the full clinical picture.</p> <p>Offset with robust training within a recognised competency framework.</p>
<i>Quality of evidence</i>	<p><u>Consistency</u>: All present regard the education around clinician clinical judgment, concern, impression to be of the utmost importance in maintaining patient safety and this was reflected in the literature.</p> <p><u>Generalisability</u>: No tool can replace the human factors involved with situation awareness.</p> <p><u>Generalisability</u>: Previous study findings possibly impaired owing to studies carried out in different locations with different healthcare systems/ structures in place.</p> <p><u>Applicability</u>: All clinicians should be aware that the tool should never override clinical concern or provide false reassurance due to a low number. Expert opinion absolutely unanimous – concern /judgement should be emphasised.</p> <p><u>Impact</u>: Must be a national standard.</p> <p><u>GRADE Criteria for CLINICAL JUDGEMENT</u>: High quality: Further research is very unlikely to change our confidence in the estimate of effect.</p> <p>Quality of evidence: High</p>
<i>Values and preferences</i>	<p>Universally strongly expressed at all levels, including patient/family representatives.</p> <p>Very strong theme at focus groups.</p>
<i>Resource use</i>	Nil additional.
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 4: The core physiological parameters must be completed and recorded for every set of observations.	
Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Holistic view of the child.</p> <p><u>Harm</u> None foreseen.</p>
<i>Quality of evidence</i>	<p>As discussed in literature review- limited but emerging validity. PEWS parameters harmonised with the best available and most validated data. Tested at pilot and retested following changes.</p> <p>Level 2 evidence for validity of Bedside PEWS – tool most closely utilised as reference point for Irish PEWS.</p> <p><u>GRADE criteria for 6 CORE PARAMETERS</u>: MEDIUM quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate (may be changes in future pending EPOCH and UK results).</p> <p>Quality of evidence: Moderate</p>
<i>Values and preferences</i>	Requires a cultural shift to perform complete assessment therefore a perception of increased workload by nursing staff.
<i>Resource use</i>	May require some minutes additionally at the bedside but this is seen as a benefit overall.
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 5: Observations and monitoring of vital signs should be undertaken in line with recognised, evidence-based standards.	
Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Evidence-based standards of care, quality improvement. Ensures standardisation of clinical guidelines and practices across multiple sites in Ireland.</p> <p><u>Harm</u> None foreseen.</p>
<i>Quality of evidence</i>	<p>Statement of standards from a recognised regulatory or professional body (RCN, UK) high level evidence.</p> <p><u>Impact</u>: Must be a national standard.</p> <p><u>GRADE criteria for STANDARDS FOR OBSERVATION</u>: Level 2 is highest available.</p> <p>Quality of evidence: High</p>
<i>Values and preferences</i>	Unlikely to indicate preference for variation in observation/monitoring standards.
<i>Resource use</i>	Possible equipment costs if changes are required to achieve standardisation required across hospital/unit but this is negligible and benefits of enhanced patient safety more than outweigh any cost.
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 6: The PEWS escalation guideline should be followed in the event of any PEWS trigger.	
Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Increased patient safety, team work, communication, common understanding.</p> <p>Greater situation awareness for nursing team leaders/on call etc. to facilitate prioritisation of care, delegation of duties.</p> <p>Timely response to deterioration with the aim of prevention, not 'fire-fighting'.</p> <p>Benefits of standardised communication are well established. Clear communication, record keeping adhering to mandatory standards.</p> <p><u>Harm</u> Allowing guide to influence clinical judgement in revising actions down based on a lower than expected score and therefore holding off escalation.</p> <p>Unnecessary escalations.</p>
<i>Quality of evidence</i>	<p>Mixed, as highlighted above. Difficult to compare due to variances at all stages: detection systems, activation criteria, activation process, team composition and availability, response measures/outcomes etc. BUT all PEWS have escalation algorithm or care recommendations following a trigger.</p> <p><u>GRADE criteria for ESCALATION:</u> Level 2 evidence for response and detection systems.</p> <p>High quality: Further research is very unlikely to change our confidence in the estimate of effect.</p> <p>Quality of evidence: High</p>
<i>Values and preferences</i>	<p>Some clinicians were concerned in early pilot that PEWS would result in unnecessary increased workload but this did not materialise due to promotion of clinical judgement and permitted variances to parameters or calling criteria in conditional circumstances.</p>
<i>Resource use</i>	<ul style="list-style-type: none"> • Personnel (possibly associated budgetary costs) – additions to a current team, creation of a dedicated response (PEWS) team or increasing remit of individuals. • Tailoring of a bleep system, alert system for rapid response (Urgent PEWS call). • Education. • Time – workload implications for those involved in a response team.
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 7: The ISBAR communication tool should be used when communicating clinical information.	
Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Benefits of standardised communication are well established.</p> <p><u>Harm</u> Nil.</p>
<i>Quality of evidence</i>	<p><u>GRADE criteria for ISBAR</u>: High quality: Further research is very unlikely to change our confidence in the estimate of effect.</p> <p>Quality of evidence: High</p>
<i>Values and preferences</i>	<p>Standardised communication universally supported.</p> <p>ISBAR is the HSE endorsed tool.</p>
<i>Resource use</i>	<p>ISBAR use is governed by HSE endorsement in National Clinical Guidelines. Many hospitals have already put the tool in place. Others will have to comply. For those hospitals there may be costs associated with training, education, culture –bedrock, buy in from all stakeholders and resource support from the top; leadership.</p> <p>All sites will require on-going attention to monitor and evaluate and sustain implementation.</p>
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 8: Management plans following clinical review must be in place and clearly documented as part of the PEWS response.	
Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Clear communication, record keeping adhering to mandatory standards.</p> <p><u>Harm</u> None foreseen.</p>
<i>Quality of evidence</i>	<p>HSE standards for documentation.</p> <p>Supportive experiential findings in pilot.</p> <p><u>GRADE criteria for DOCUMENTATION</u>: High quality: Further research is very unlikely to change our confidence in the estimate of effect.</p> <p>Quality of evidence: High</p>
<i>Values and preferences</i>	-
<i>Resource use</i>	Documentation: mandatory standards – should be current practice though refresher training may be implemented by local units.
<i>Strength of recommendation</i>	Strong.
GDG consensus	Unanimous.

Recommendation 9: Variances to PEWS parameters or Escalation Guide may be made by senior medical personnel with caution in certain permitted circumstances.	
Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Reducing inappropriate calls. Enhances communication with family. Increases specificity. Individualised, patient focused. Enhances clinician understanding of the circumstances of variance use and supports clinical judgement, promotes clinical discussion and engagement with the family to determine acceptable parameters.</p> <p><u>Harm</u> Inappropriate amendments - solved by education and audit – the GDG is aware that greater clarity was required to assist staff in understanding the individual circumstances in which a variance MAY apply. The GDG is also aware that all sites have reported some level of misunderstanding around the application of variance orders and there is a concern at practices such as ‘automatic switch off’ for certain conditions or any trigger may lead to signs of child deterioration being missed. For this reason, the GDG has given greater responsibility to local PEWS Governance Groups to decide the level of permitted variance onsite and to ensure clear escalation SOP and monitoring system in place.</p>
<i>Quality of evidence</i>	<p>There was strong feeling at focus groups and at steering group that the permitted variances are the most important factor in PEWS. It is the piece which firmly entrenches the judgement of the clinician and the individual circumstances of each child as paramount. Variances allow for the child whose baseline is different to the expected range for age and/or whose clinical presentation is as expected though their illness is causing physiological triggers. It is also the part of the system which poses a risk as the triggers or escalation safety net is dampened down. Clear and on-going education is required.</p> <p><u>GRADE criteria for VARIANCES:</u> Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.</p> <p>Quality of evidence: Low</p>
<i>Values and preferences</i>	<p>At focus group, one site had not used variances to PEWS parameters or escalation due to lack of clarity or understanding of the system. Post pilot and following re-education, these sections were used with good effect.</p>

<i>Resource use</i>	<p>Education required pre implementation and focused audit required to monitor and embed.</p> <p>May be cost (time) savings due to reduced inappropriate calls.</p> <p>Training, education, culture – bedrock, buy in from all stakeholders and resource support from the top, leadership.</p> <p>On-going attention to monitor and evaluate and sustain appropriate amendment changes.</p> <p>Audit/monitoring essential to embedding system post implementation. Champions / medical support/ medical case review.</p> <p>The above points still apply at the time of this revision but are strengthened by the rewording of the recommendations themselves and the updated good practice points to reflect the PEWS user manual content, 2016.</p>
<i>Strength of recommendation</i>	Conditional.
<i>GDG consensus</i>	Unanimous.

Recommendation 10:

Once a diagnosis of sepsis has been made, it is recommended that the Paediatric Sepsis 6 is undertaken within one hour.

Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> The burden of sepsis has been well established. The benefit of early detection and timely effective management of sepsis has been well established.</p> <p><u>Harm</u> None foreseen.</p>
<i>Quality of evidence</i>	<p>National Clinical Guideline for sepsis, ministerial endorsement, recently published based on best available evidence.</p> <p><u>GRADE criteria for SEPSIS</u>: High quality: Further research is very unlikely to change our confidence in the estimate of effect.</p> <p>Quality of evidence: High</p>
<i>Values and preferences</i>	No variances predicted.
<i>Resource use</i>	Cost of training time outweighed by clinical benefit to patients, likely reduction in PICU admissions, reduction of level of illness and length of stay, reduced long term sequelae, reduced mortality.
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 11:

The Chief Executive Officer/General Manager and Clinical Director of each hospital or hospital group are accountable for the operation of the Paediatric Early Warning System. A formal governance structure (such as a PEWS group or committee) should oversee and support the local resourcing, implementation, operation, monitoring and assurance of the Paediatric Early Warning System.

Recommendation 12:

The PEWS governance committee should identify and resource a named individual(s) to coordinate local PEWS implementation.

Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Oversight, leadership, real change, supported change, cultural transformation, sustained change. ensures standards and quality, PEWS is the start of a process.</p> <p><u>Harm</u> Nil.</p>
<i>Quality of evidence</i>	<p>Vanderjagt (2013) Level 2, Lobos (2010) Level 2, Kukreti (2014) Level 4, National Clinical Guidelines no.1 NEWS and no.4 IMEWS.</p> <p><u>GRADE criteria for GOVERNANCE</u>: High quality: Further research is very unlikely to change our confidence in the estimate of effect.</p> <p>Quality of evidence: High</p> <p><u>GRADE criteria for LOCAL COORDINATOR</u>: Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.</p> <p>Quality of evidence: Moderate</p>
<i>Values and preferences</i>	Unanimous voicing at focus groups and GDG for strong governance committee with decision making abilities to implement at local level.
<i>Resource use</i>	<p>Clinical governance committee (CGC) should pre-exist (cost neutral). Subcommittee from CGC should be formed to oversee planning and implementation of PEWS locally (time cost).</p> <p>PEWS Coordinator role- may be a new or standalone role but must include dedicated time for PEWS.</p>
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 13:

Hospitals should support additional safety practices that enhance the Paediatric Early Warning System and lead to greater situation awareness among clinicians and multidisciplinary teams.

Recommendation 14:

The Paediatric Early Warning System should be supported through the application of quality improvement methods, such as engagement strategies, testing, and measurement to ensure successful implementation, sustainability and future progress.

Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Enhanced patient safety through greater situation awareness (SA). Shared SA through briefings/huddles/safety pause to prompt and promote safety concerns.</p> <p><u>Harm</u> None foreseen.</p>
<i>Quality of evidence</i>	<p>Strong evidence for human factors significance in healthcare systems. Increasing body of work around SA (esp. Brady, Meuthing) and patient safety/quality of care.</p> <p><u>GRADE criteria for SUPPORTIVE PRACTICES:</u> Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.</p> <p>Quality of evidence: Moderate</p>
<i>Values and preferences</i>	No variances predicted.
<i>Resource use</i>	Time for education and embedding in processes.
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 15:
The PEWS governance committee in each hospital must ensure that PEWS training is provided to all clinicians.

Recommendation 16:
Clinicians working with paediatric patients should maintain knowledge and skills in paediatric life support appropriate to their role and in line with mandatory or certification standards.

Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Quality assurance, more effective implementation, enhanced understanding of the system and therefore compliance.</p> <p><u>Harm</u> None foreseen</p>
<i>Quality of evidence</i>	<p>Existing NCG endorsed guidelines.</p> <p>Known barriers to implementation include lack of formalised training.</p> <p><u>GRADE criteria for EDUCATION:</u> Moderate quality: further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.</p> <p>Quality of evidence: Moderate</p>
<i>Values and preferences</i>	None foreseen.
<i>Resource use</i>	Time for trainers and attendees (medical and nursing) for education.
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Recommendation 17:
The national PEWS audit toolkit should be used to aid implementation and to regularly quality assure the Paediatric Early Warning System.

Factor	Comment
<i>The balance of desirable and undesirable effects</i>	<p><u>Benefit</u> Audit for improvement, real data to inform progress, facilitates targeted education, measure for success.</p> <p><u>Harm</u> None foreseen.</p>
<i>Quality of evidence</i>	<p>Focus groups all expressed the value found through auditing of providing baseline for performance and facilitated targeted ward training.</p> <p><u>GRADE criteria for MONITORING/AUDIT:</u> High quality: Further research is very unlikely to change our confidence in the estimate of effect.</p> <p>Quality of evidence: High</p>
<i>Values and preferences</i>	None predicted.
<i>Resource use</i>	Audit processes time consuming at the intensive stages.
<i>Strength of recommendation</i>	Strong.
<i>GDG consensus</i>	Unanimous.

Appendix 3.4: Paediatric Early Warning System (PEWS) implementation toolkit

Available at: www.hse.ie/pews. The contents of this webpage will be updated as required. Contents as from November 2016 are below but subject to change:

Toolkit Contents:

1. PEWS Training and Support

The following resources are available to support PEWS implementation and training:

- PEWS Implementation Guidance
- Sample National Age-specific Paediatric Observation Charts
- PEWS User Manual
- Quick Reference Guide
- PEWS Physiological Parameter Tables
- Paediatric Sepsis 6 Poster

PEWS Trainer Toolkit (for leads and trainers only)

- PEWS Training Guidance
- PEWS Training sign in sheet
- PEWS Training slides
- PEWS Training quiz and answer sheet
- PEWS Case Study 1-4
- PEWS Case Study Template
- PEWS Training evaluation sheet
- PEWS Training certificate template

PEWS Audit Toolkit

- Clinical outcome minimum dataset (Excel)
- PEWS Audit for Quality Improvement (word document)
- PEWS Audit for Quality Improvement (excel datasheet)

PEWS Parent/Carer Engagement Toolkit

- Information for staff and parents/carers about PEWS
- Listening to You posters (A3)
- Listening to You leaflet (A5)

2. PEWS National Clinical Guideline

Link to the NCG revised editions, full and summary versions.

3. National PEWS Steering Group

Current membership

4. PEWS Supplemental Resources / Links

- PEWS Systematic Literature Review
- PEWS Focus Group Report

Appendix 3.5: Paediatric early warning system audit toolkit (monitoring mechanism, audit parameters, audit plan and KPI)

The implementation of the Irish PEWS, as shown in other countries, is expected to lead to earlier recognition and timely intervention in clinical deterioration and to improve outcomes such as reduced unplanned PICU admissions, shorter length of stay in PICU or a lesser severity of illness on admission to PICU. Other possible outcome improvements include reduction in incidence of respiratory and cardiopulmonary arrests.

For clinicians, children and families there may be increased satisfaction and enhanced safety culture.

Hospitals must monitor PEWS implementation and compliance at local level and engage with national monitoring initiatives such as Nursing Metrics and the HSE Key Performance Indicators for the Acute Hospitals metadata. The PEWS Steering Group has worked to engage with key stakeholders in these areas to establish helpful audit tools and value driven metrics.

1. PEWS Audit Support tools (audit parameters)

Audit parameters: compliance with documentation standards, recording observations, escalation and safe variance use (further details in section 1.13).

All sites must record the following clinical outcomes on a monthly basis:

- Number of recorded urgent PEWS call triggers (PEWS Score ≥ 7)/MET/emergency team activations including PEWS total score and trigger parameters
- Unplanned admissions to PICU/adult ICU, including readmissions
- Length of stay in PICU/adult ICU
- Incidence and outcomes from in-hospital paediatric cardiac arrest, using a standardised minimum data set such as the UK and Ireland National Cardiac Arrest Audit (NCAA) (2014):
 - Age in years
 - Sex
 - Length of stay in hospital prior to arrest
 - Reason for admission to/attendance at hospital
 - Location of arrest
 - Presenting or first documented rhythm.

The PEWS Audit Toolkit is available at: <http://www.hse.ie/pews>

- Clinical outcome minimum dataset (Excel)
- PEWS Audit for Quality Improvement (word document)
- PEWS Audit for Quality Improvement (excel datasheet)

2. PEWS National Monitoring

The Quality Assurance and Verification Division, Health Services Executive will be undertaking a national PEWS Audit in Q1 2017.

A Dublin City University tendered evaluation of *Hospital safety culture and situation awareness in acute paediatric hospitals in Ireland: service evaluation pre-implementation of the Irish Paediatric Early Warning System (PEWS)* is due for publication in Q4 2016.

The HSE Acute Hospitals Division 2017 Key Performance Indicator (KPI) for PEWS, titled 'Percentage of hospitals with implementation of PEWS (Paediatric Early Warning System)' examines the following parameters:

- Compliance with national PEWS documentation standards (minimum standard of 5 assessed charts per inpatient clinical area per month)
- Governance (named governance group and medical and nursing leads)
- Training (offered to all relevant staff)
- Audit (hospitals are recording the minimum dataset as noted in section 1.13, outcome measures)

As implementation matures, the KPI will be updated accordingly.

References

- Adams J, Conn, R, Gohil, R (2015) "Safety huddles": multidisciplinary views regarding the purpose and effectiveness of a novel paediatric situational awareness tool *Arch Dis Child* 2015;100:A100.
- Akre M, Finkelstein M, Erickson M, Liu M, Vanderbilt L, Billman G. (2010) *Sensitivity of the Pediatric Early Warning Score to Identify Patient Deterioration*. *Pediatrics*. 215:2763-e769.
- An Bord Altranais (2002) *Recording clinical practice: guidance to nurses and midwives*. 1st edition.
- Avent Y, Johnson S, Henderson N, Wilder K, Cresswell J, Elbahlawan L. (2010) *Successful use of a rapid response team in the pediatric oncology outpatient setting*. *The Joint Commission Journal on Quality and Patient Safety*. 36(1):43-45.
- Aylott M (2006) *Developing rigour in observation of the sick child*. *Paediatric Nursing*. 18, 8, 38-44.
- Bonafide CP, Roberts KE, Priestley MA, Tibbetts KM, Huang E, Nadkarni VM, Keren R. (2012) *Development of a Pragmatic Measure for Evaluating and Optimizing Rapid Response Systems*. *Pediatrics*. 129:e874-e881.
- Bonafide CP, Brady PW, Keren R, Conway PH, Marsolo K, Daymont C. (2013b) *Development of Heart and Respiratory Rate Percentile Curves for Hospitalized Children*. *Pediatrics*. 131:e1150.
- Bonafide CP, Localio R, Roberts KE, Nadkarni VM, Weirich CM, Keren R. (2014a) *Impact of Rapid Response System Implementation on Critical Deterioration Events in Children*. *JAMA Pediatrics*. 168(1):25-33.
- Bonafide CP, Localio AR, Song L, Roberts KE, Nadkarni VM, Priestley M, Paine CW, Zander M, Lutts M, Brady PW, Keren R. (2014b) *Cost-benefit analysis of a medical emergency team in a children's hospital*. *Pediatrics*. 134(2): 235-241.
- Bradman K & Maconochie I. (2008) *Can paediatric early warning score be used as a triage tool in paediatric accident and emergency?* *European Journal of Emergency Medicine*. 15:359-360.
- Brady PW & Goldenhar LM (2013) *A qualitative study examining the influences on situation awareness and the identification, mitigation and escalation of recognised patient risk*. *BMJ Quality and Safety*. 2014;23:153-161.
- Brady PW, Muething S, Kotagal U, Ashby M, Gallagher R, Hall D, Goodfriend M, White C, Bracke TM, DeCastro V, Geiser M, Simon J, Tucker KM, Olivea J, Conway PH, Wheeler DS. (2013) *Improving situation awareness to reduce unrecognised clinical deterioration and serious safety events*. *Pediatrics*. 131(1):e298-e308.
- Brady PW, Wheeler DS, Muething SE, Kotagal UR. (2014) *Situation awareness: a new model for predicting and preventing patient deterioration*. *Hosp Pediatr*. 2014 May;4(3):143-6.
- Breslin K, Marx J, Hoffman H, McBeth R, Pavuluri P. (2014) *Pediatric Early Warning Score at Time of Emergency Department Disposition is Associated with Level of Care*. *Pediatric Emergency Care*. 30(2):97-103.

Brilli RJ, Gibson R, Luria JW, Wheeler TA, Shaw J, Linam M, Kheir J, McLain P, Lingsch T, HallHaering A, McBride M. (2007) *Implementation of a medical emergency team in a large pediatric teaching hospital prevents respiratory and cardiopulmonary arrests outside the intensive care unit*. *Pediatric Critical Care Medicine*. 8(3): 236-246.

Bullivant, J. and Corbett-Nolan, A. (2013) *Clinical audit: A simple guide for NHS Boards & partners*. Good Governance Institute, London.

Cabana MD, Rand CS, Powe NR, et al. (1999) *Why Don't Physicians Follow Clinical Practice Guidelines? A Framework for Improvement*. *JAMA*. 1999;282(15):1458-1465.

Centre for Reviews and Dissemination (2008) *Systematic Reviews: CRD's guidance for undertaking reviews in health care*. Centre for Reviews and Dissemination, University of York.

Chan PS, Jain R, Nallmothu BK, Berg RA, Sasson C. (2010) *Rapid response teams: a systematic review and meta-analysis*. *Archives of Internal Medicine*. 170(1):18-26.

Chapman S.M, Grocott M.P.W, Franck L.S. (2010) *Systematic review of paediatric alert criteria for identifying hospitalised children at risk of clinical deterioration*. *Intensive Care Medicine*. 36:600-611.

Chen J.G., Kemper, A. R., Odetola, F., Cheifetz, I. M., & Turner, D. A. (2012). *Prevalence, characteristics, and opinions of pediatric rapid response teams in the United States*. *Hospital pediatrics*, 2(3), 133-140.

Cheng A, Grant V, Auerbach M (2015) *Using simulation to improve patient safety: dawn of a new era*. *JAMA Pediatr*. 2015 May;169(5):419-20.

Confidential Enquiry into Maternal and Child Health (CEMACH). (2008) *Why children die – a pilot study*. CEMACH, London.

Dean BS, Decker MJ, Hupp D, Urbach AH, Lewis E, Benes-Stickle J. (2008) *Condition HELP: A Pediatric Rapid Response Team Triggered by Patients and Parents*. *Journal of Healthcare Quality*. 30 (3): 28-31.

Demmel KM, Williams L, Flesch L. (2010) *Implementation of the Pediatric Early Warning Scoring System on a Pediatric Hematology/Oncology Unit*. *Journal of Pediatric Oncology Nursing*. 27(4):229-240.

Department of Children and Youth Affairs (2012) *State of the Nation's Children: Ireland 2012*. Dublin: Government Publications.

Department of Health (UK) (2009) *Competencies for Recognising and Responding to Acutely Ill patients in Hospital*. London © Crown copyright 2009 Published to DoH website, in electronic PDF format only. <http://www.dh.gov.uk/publications>.

Department of Health (2013) *National Early Warning Score National Clinical Guideline No. 1*. Department of Health, Dublin.

Department of Health (2014) *Irish Maternity Early Warning System National Clinical Guideline No. 4*. Department of Health, Dublin.

Department of Health (2014) *Communication (clinical handover in maternity services) National Clinical Guideline No. 5*. Department of Health, Dublin.

Department of Health (2014) *Sepsis management National Clinical Guideline No. 6*. Department of Health, Dublin.

Dixon-Woods M, Leslie M, Tarrant C, Bion J. (2013) *Explaining Matching Michigan: an ethnographic study of a patient safety program*. *Implement Sci.* Jun 20;8:70.

Douw G, Schoonhoven L, Holwerda T, Huisman-de Waal G, van Zanten A, van Achterberg T, van der hoeven J (2015) *Nurses' worry or concern and early recognition of deteriorating patients on general wards in acute care hospitals: a systematic review*. *Critical Care.* 19:230.

Duncan H, Hutchison J, Parshuram CS. (2006) *The pediatric early warning system score: A severity of illness score to predict urgent medical need in hospitalized children*. *Journal of Critical Care.* 21:271-279.

Duncan HP, Frew E. (2009) *Short-term health system costs of paediatric in-hospital acute life-threatening events including cardiac arrest*. *Resuscitation.* 80(5): 529-534.

Edwards ED, Powell CVE, Mason BW, Oliver A. (2009) *Prospective cohort study to test the predictability of the Cardiff and Vale paediatric early warning system*. *Archives of Diseases in Childhood.* 94:602-606.

Edwards ED, Mason BW, Oliver A, Powell CVE. (2011) *Cohort study to test the predictability of the Melbourne criteria for activation of the medical emergency team*. *Archives of Diseases in Childhood.* 96:174-179.

Ennis, L (2014) *Paediatric early warning scores on a children's ward: a quality improvement initiative*. *Nursing children and young people.* 26(7):25-31.

Fuijkschot J, Vernhout B, Lemson J, Draaisma JMT, Loeffen JLCM. (2014) *Validation of a paediatric early warning score: first results and implications for usage*. *European Journal of Pediatrics.* PMID: 24942238 (Epub ahead of print).

Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, Schünemann HJ, (2008a) *GRADE Working Group. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations*. *BMJ* 2008 Apr 26;336(924-926).

Guyatt GH, Oxman AD, Kunz R, Falck-Ytter Y, Vist GE, Liberati A, Schünemann HJ, (2008b) *GRADE Working Group. Going from evidence to recommendations*. *BMJ* 2008 May 17;336(1049-1051).

Green, M. (2013) *Between the Flags Program Interim Evaluation Report-April 2013* Clinical Excellence Commission New South Wales.

Haines C, Perrott M, Weir P. (2006) *Promoting care for acutely ill children – development and evaluation of a paediatric early warning tool*. *Intensive and Critical Care Nursing.* 22: 73-81.

Hands C, Reid E, and Smith GB et al. (2013) *Patterns in the recording of vital signs and early warning scores: compliance with a clinical escalation protocol*. *BMJ Qual Saf.* 2013 Sep;22(9):719-26.

Hanson CC, Randolph GD, Erickson JA, Mayer CM, Bruckel JT, Harris BD, Willis TS. (2010) *A reduction in cardiac arrests and duration of clinical instability after implementation of a paediatric rapid response system*. *Postgraduate Medicine Journal.* 86:314-318.

Haque A, Saleem AF, Zaidi S, Haider SR. (2010) *Experience of Pediatric Rapid Response Team in a Tertiary Care Hospital in Pakistan*. Indian Journal of Pediatrics. 77(3): 273-276.

Hayes LW, Dobyens EL, DiGiovine B, Brown A, Jacobson S, Randall KH, Wathen B, Richard H, Schwab C, Duncan KD, Thrasher J, Logsdon TR, Hall M, Markovitz B. (2012) *A Multicenter Collaborative Approach to Reducing Pediatric Codes Outside the ICU*. Pediatrics. 129(3): e785-e791.

Health Information and Quality Authority (2015) *Guidance on Budget Impact Analysis of Health Technologies in Ireland*. Published by the Health Information and Quality Authority.

Health Information and Quality Authority (HIQA) (2011) *National Quality Assurance Criteria for Clinical Guidelines*. Dublin: HIQA.

Health Information and Quality Authority (HIQA) (2012) *National Standards for Safer Better Healthcare* Dublin: HIQA.

Health Information and Quality Authority (2013) *Health Patient Safety Investigation report into services at University Hospital Galway (UHG) and as reflected in the care provided to Savita Halappanavar*. Available at: <http://www.hiqa.ie/publications/patient-safety-investigation-report-services-university-hospital-galway-uhgand-reflect>.

Health Service Executive (2008a) *IMPROVING OUR SERVICES. A Users' Guide to Managing Change in the Health Service Executive Developed by the Organisation Development and Design Unit, HSE, with the support of the Strategic Planning, Reform and Implementation (SPRI) Unit, HSE, and in consultation with the Health Services National Partnership Forum*. Published by the Health Service Executive.

Health Service Executive (2008b) *Healthcare Audit Criteria and Guidance August 2008 Prepared by the Clinical Audit Criteria and Guidance Working group* http://www.hse.ie/eng/about/Who/qualityandpatientsafety/resourcesintelligence/Quality_and_Patient_Safety_Documents/guid.pdf.

Health Service Executive (2011) *Health Service Executive Standards and Recommended Practices for Healthcare Records Management*. Available at: http://www.hse.ie/eng/about/Who/qualityandpatientsafety/resourcesintelligence/Quality_and_Patient_Safety_Documents/v3.pdf.

Health Service Executive (2013) *The safety pause: information sheet. Helping teams provide safe quality care*. Available at: http://www.hse.ie/eng/about/Who/qualityandpatientsafety/Clinical_Governance/CG_docs/safetypause240513.pdf.

Hueckel RM, Mericle JM, Martin PL, Champagne MT. (2012) *Implementation of Condition Help Family Teaching and Evaluation of Family Understanding*. Journal of Nursing Care Quality. 27(2):176–181.

Holmes H, Bhatt R, Koumettou M, Griffin MAS, Winckworth LC. (2013) *Retrospective evaluation of a new neonatal trigger score*. Pediatrics. 131:e837-e842.

Hunt EA, Zimmer KP, Rinke ML, Shilkofski NA, Matlin C, Garger C, Dickson C, Miller MR. (2008) *Transition from a Traditional Code Team to a Medical Emergency Team and Categorization of Cardiopulmonary Arrests in a Children's Center*. Arch Pediatr Adolesc Med. 162(2):117-122.

Joint Commission (USA) (2007) *Improving America's Hospitals The Joint Commission's Annual Report on Quality and Safety 2007* Published by The Joint Commission http://www.jointcommission.org/assets/1/6/2007_Annual_Report.pdf.

Kleinman M, Romano J. (2010) *Children's Hospital Boston Early Warning Score: early detection + early treatment = better outcomes. FIRST Do No Harm. August 2010.* Available at: <http://www.mass.gov/eohhs/docs/borim/newsletters/qps-august-2010.pdf>.

Kodali,S (2014) *Situational Awareness and Emergent Response Systems in the Context of Stages of Clinical Deterioration in the Hospital* J Nurs Care 2014, 3:4.

Kotsakis A, Lobos AT, Parshuram C, Gilleland J, Gaiteiro R, Mohseni-Bod H, Singh R, Bohn D & on behalf of the Ontario Pediatric Critical Care Response Team Collaborative (2011) *Implementation of a Multicenter Rapid Response System in Pediatric Academic Hospitals is Effective.* Pediatrics. 128: 72-78.

Kukreti V, Gaiteiro R, Mohseni-Bod H, (2014) *Implementation of a Pediatric Rapid Response Team: Experience of the Hospital for Sick Children in Toronto.* Indian Pediatrics. 51:11-15.

Lambert V. (2015) *Baseline research to support the development of a national clinical guideline on PEWS (Paediatric Early Warning System) for the Irish health system.* Commissioned report for the Clinical Effectiveness Unit, Department of Health.

Lambert V, O'Shea MT, Walshe C, Matthews, A, Corbally M, O'Mathuna D, Staines A, O'Connor C. (2014) *A systematic literature review to support the development of a National Clinical Guideline - Paediatric Early Warning System (PEWS).* Commissioned report for the Clinical Effectiveness Unit, Department of Health.

Lannon CM, Levy FH, Moyer VA. (2015) *The need to build capability and capacity in quality improvement and patient safety.* Pediatrics. 2015 Jun;135(6):e1371-3.

Lobos AT, Fernandes R, Ramsay T, McNally JD. (2014) *Team (MET) Activation: Disposition Depends on Who Activates the Team Patient Characteristics and Disposition After Pediatric Medical Emergency.* Hospital Pediatrics. 4(2):99-105.

Lockwood C, Conroy-Hiller T, Page, T (2004) *Vital signs: a systematic review.* Joanna Briggs Institute REPORTS 2004;2:207-230.

McCrary MC, Aboumatar H, Custer JW, Yang CP, Hunt EA. (2012) *"ABC-SBAR" Training improves simulated critical patient hand-off by pediatric interns.* Pediatric Emergency Care. 28 (6): 538-543.

McKay H, Mitchell I, Sinn K, Mugridge H, Lafferty T, VanLeuvan C, Mamootil S, Abdel-Latif ME. (2013) *Effect of a multifaceted intervention on documentation of vital signs and staff communication regarding deteriorating paediatric patients.* Journal of Paediatrics and Child Health. 49; 48-56.

McLellan M & Connors JA. (2013) *The cardiac children's hospital early warning score (CCHEWS).* Journal of Pediatric Nursing. 28: 171-178.

McLellan MC, Gauvreau K, Connor JA. (2013) *Validation of the Cardiac Children's Hospital Early Warning Score: An Early Warning Scoring Tool to Prevent Cardiopulmonary Arrests in Children with Heart Disease.* Congenital Heart Disease. 9:194-202.

Monaghan A. (2005) Detecting and managing deterioration in children. *Paediatric Nursing*. 17(1):32-35.

National Cardiac Arrest Audit (NCAA) *NCAA Dataset overview*. Retrieved from <https://www.icnarc.org/Our-Audit/Audits/Ncaa/Resources/Dataset-Overview> 03/08/15.

NCEPOD (2005, 2012) *Time to intervene: a review of patients who underwent cardiopulmonary resuscitation as a result of in-hospital cardiorespiratory arrest. A report by the National Confidential Enquiry into Patient Outcome and Death (NCEPOD)*(2012).

National Clinical Effectiveness Unit (2013) *Guideline Developer's Manual* Dublin: NCEC.

National Health Service Institute for Innovation and Improvement (2013) *Paediatric Early Warning Scores*. Retrieved from: www.institute.nhs.uk/safer_care/paediatric_safer_care/pews.html on 04/08/15.

National Patient Safety Agency. (2009) *Review of patient safety for children and young people*. London: National Patient Safety Agency.

Neily J, Mills PD, Young-Xu Y, Carney BT, West P, Berger DH, Mazzia LM, Paull DE, Bagian JP. (2010) *Association between implementation of a medical team training program and surgical mortality*. *JAMA*. 2010 Oct 20;304(15):1693-700.

Nursing and Midwifery Board of Ireland (NMBI) (2015, October) *Children's nursing post registration standards and requirements*. NMBI.

O'Leary F, Hayden A, Lockie F & Peat J (2015) *Defining normal ranges and centiles for heart and respiratory rates in infants and children: a cross-sectional study of patients attending an Australian tertiary hospital paediatric emergency department* Downloaded from <http://adc.bmj.com/> on June 24, 2015 - Published by group.bmj.com ADC Online First, published on April 8, 2015 as 10.1136/archdischild-2014-307401.

Paciotti B, Roberts KE, Tibbetts KM, Oaine CW, Keren R, Barg FK, Holmes JH, Bonafide CP. (2014) *Physician Attitudes toward Family-Activated Medical Emergency Teams for Hospitalised Children*. *The Joint Commission Journal on Quality and Patient Safety*. 40(4):187-192.

Panesar R, Polikoff LA, Harris D, Mills B, Messina C, Parker MM. (2014) *Characteristics and outcomes of pediatric rapid response teams before and after mandatory triggering by an elevated pediatric early warning system (PEWS) score*. *Hospital Pediatrics*. 4 (3):135-140.

Parshuram CS, Hutchinson J, Middaugh K. (2009) *Development and initial validation of the Bedside Paediatric Early Warning System score*. *BioMed Central Critical Care*. 13:R135.

Parshuram CS, Duncan HP, Joffe AR, Farrell CA, Lacroix JR, Middaugh KL, Hutchinson JS, Wensley D, Blanchard N, Beyene J, Parkin PC. (2011) *Multicentre validation of the bedside paediatric early warning system score: a severity of illness score to detect evolving critical illness in hospitalised children*. *BioMed Central Critical Care*. 15:R184.

Pronovost PJ. (2013) *Enhancing Physicians' Use of Clinical Guidelines*. *JAMA*. 2013;310(23):2501-2502.

Randhawa S, Roberts-Turner R, Woronick K, DuVal J. (2011) *Implementing and Sustaining Evidence-Based Nursing Practice to Reduce Pediatric Cardiopulmonary Arrest*. *Western Journal of Nursing Research*. 33(3):443-456.

Ray EM, Smith R, Massie S, Erickson J, Hanson C, Harris B, Willis TS. (2009) *Family Alert: implementing direct family activation of a pediatric rapid response team. The Joint Commission Journal on Quality and Patient Safety.* 35(11):575-580.

Resuscitation Council (UK) 2010 *Decisions about CPR UK*: Resuscitation Council.

Robson MJ, Cooper CL, Medicus LA, Quintero MJ, Zuniga SA. (2013) *Comparison of three acute care pediatric early warning scoring tools. Journal of Pediatric Nursing.* 28: e33-e41.

Roland D, Madar J, Connolly G. (2010) *The Newborn Early Warning (NEW) system: development of an at-risk infant intervention system. Infant.* 6(4):116-120.

Roland D, Oliver A, Edwards ED, Mason B, Powell C (2014) *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;99:26–29.

Royal College of Paediatrics and Child Health (May 2014a) *'Why children die: death in infants, children and young people in the UK - part a'* Published by: Royal College of Paediatrics and Child Health.

Royal College of Paediatrics and Child Health (May 2014b) *Why children die: death in infants, children and young people in the UK, Part B a policy response for England to the report why children die: death in infants, children and young people in the UK – part A.* Published by: Royal College of Paediatrics and Child Health.

Royal College of Physicians 2012 *Report of a working party July 2012 National Early Warning Score: Standardising Assessment of acute illness severity in the NHS* <https://www.rcplondon.ac.uk/sites/default/files/documents/national-early-warning-score-standardising-assessment-acute-illness-severity-nhs.pdf>.

Royal College of Nursing, UK (2013) *Standards for assessing, measuring and monitoring vital signs in infants children and young people* (due update Nov 2015) London, Royal College of Nursing.

Sefton G, McGrath C, Tume L, Lane S, Lisboa PJG, Carrol ED. (2014) *What impact did a Paediatric Early Warning system have on emergency admissions to the paediatric intensive care unit? An observational cohort study. Intensive and Critical Care Nursing.*

Seiger N, Maconochie I, Oostenbrink R, Moll HA. (2013) *Validity of different pediatric early warning scores in the emergency department. Pediatrics.* 132(4):e841-e849.

Sen AI, Morgan RW, Morris MC. (2013) *Variability in the Implementation of Rapid Response Teams at Academic American Pediatric Hospitals. Journal of Pediatrics.* 163:1772-1774.

Sharek PJ, Parast LM, Leong K, Coombs J, Earnest K, Sullivan J, Frankel LR, Roth SJ. (2007) *Effect of a Rapid Response Team on Hospital-wide Mortality and Code Rates Outside the ICU in a Children's Hospital. JAMA.* 298(19):2267-2274.

Shilkofski NA, Hunt EA. *Use of a Pediatric Medical Emergency Team (PMET) to manage a complex child with hypoxia and a worried parent. Jt Comm J Qual Patient Saf.* 2007;33(4):236-41, 185.

Shulman, C, Shaul L (2010) *Standards for Frequency of Measurement and Documentation of Vital Signs & Physical Assessments. Critical Care Nurse* 30(3):74-76.

Skaletzky SM, Raszynski A, Totapally BR. (2012) *Validation of a Modified Pediatric Early Warning System Score: A Retrospective Case-Control Study*. *Clinical Pediatrics*. 51(5):431-435.

Theilen U, Leonard P, Jones P, Ardill R, Weitz J, Agrawal D, Simpson D. (2013) *Regular in situ simulation training of paediatric Medical Emergency Team improves hospital response to deteriorating patients*. *Resuscitation*. 84:218-222.

Tibballs J, Kinney S, Duke T, Oakley E, Hennessy M. (2005) *Reduction of paediatric in-patient cardiac arrest and death with a medical emergency team: preliminary results*. *Archives of disease in childhood*. 90(11): 1148-1152.

Tibballs J, Kinney S. (2009) *Reduction of hospital mortality and of preventable cardiac arrest and death on introduction of a pediatric medical emergency team*. *Pediatric Critical Care Medicine*. 10(3): 306-312.

Tucker K, Brewer TL, Baker RB, Demeritt B, Vossmeier MT. (2009) *Prospective evaluation of a pediatric inpatient early warning scoring system*. *Journal for Specialists in Pediatric Nursing*. 14(2):79-85.

Tume LN, Sefton G, Arrowsmith P. (2013) *Teaching paediatric ward teams to recognise and manage the deteriorating child*. *British Association of Critical Care Nurses*. 19 (4): 196-203.

Tyndall J. (2010) *AACODS (Authority, Accuracy, Coverage, Objectivity, Date, Significance) Checklist*. Flinders University, Archived at the Flinders Academic Commons: <http://dspace.flinders.edu.au/dspace/>.

VandenBerg SD, Hutchison JS, Parshuram CS. (2007) *A cross-sectional survey of levels of care and response mechanisms for evolving critical illness in hospitalized children*. *Pediatrics*, 119(4): 940-946.

Van den Breul A, Thompson M, Buntinx F, Mant D. (2012) *Clinicians' gut feeling about serious infections in children: observational study*. *BMJ* 2012;345:e6144.

VanderJagt EW. (2013) *Improving pediatric survival from resuscitation events: the role and organization of hospital-based rapid response systems and code teams*. *Current Pediatric Reviews*. 9:158-174.

Van Voorhis KT, Willis TS. (2009) *Implementing a pediatric rapid response system to improve quality and patient safety*. *Pediatric Clinics of North America*. 56(4): 919-933.

Wang GS, Erwin N, Zuk J, Henry DB, Dobyms EL. (2010) *Retrospective review of emergency response activations during a 13-year period at a tertiary care children's hospital*. *Journal of Hospital Medicine*. 6(3): 131-135.

Winberg H, Nilsson K, Aneman A. (2008) *Paediatric Rapid Response Systems: A literature review*. *Acta Anaesthesiologica Scandinavica*. 52: 890-896.

Zenker P, Schlesinger A, Hauck M, Spencer S, Hellmich T, Finkelstein M, Thygeson MV, Billman G. (2007) *Implementation and Impact of a Rapid Response Team in a Children's Hospital*. *The Joint Commission Journal on Quality and Patient Safety*. 33(7): 418-425.



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