







Can Dynamic Electronic Tracking and Escalation of children in hospital reduce Critical care Transfers?



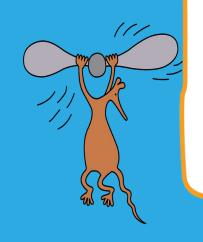




Careflow Vitals & Connect

Single site study to evaluate

- the clinical effectiveness at preventing critical deterioration
- the clinical utility
- the cost-effectiveness







Impact of introducing an electronic physiological surveillance system on adult hospital mortality

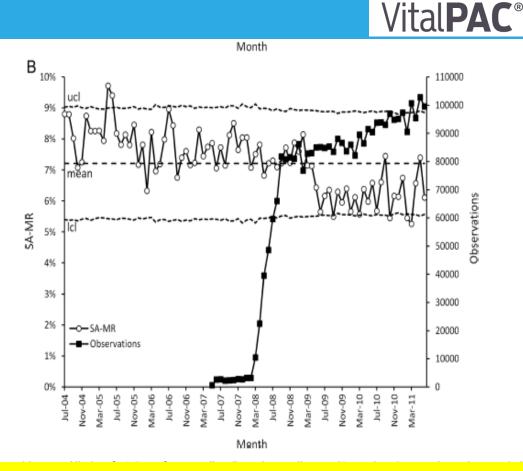
Schmidt et al, BMJ Qual Saf 2014;0:1–11. doi:10.1136/bmjqs-2014-003073

iPods Save 750 Lives During Hospital Trials

08:18, UK, Wednesday 24 September 2014



Video: iPods Save 750 Lives During Trials



This technology has not been robustly evaluated for children in hospital



Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation





500 years of medicine

Clinical paper

ViEWS—Towards a national early warning score for detecting adult inpatient deterioration[☆]

David R. Prytherch^a, Gary B. Smith^{a,b,*}, Paul E. Schmidt^{a,c}, Peter I. Featherstone^{a,c}

- a Portsmouth Hospitals NHS Trust, United Kingdom
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- ^c University of Portsmouth, United Kingdom



Setting higher standards

per-based, aggregate weighted track and trigger system (AWTTS) lational early warning score (EWS) for the detection of patient

knowledge of the relationship between physiological data and

National Early Warning Score (NEWS) 2

Standardising the assessment of acute-illness severity in the NHS

Updated report of a working party **December 2017**



National Early Warning Score (NEWS)

Standardising the assessment of acute-illness severity in the NHS

Recommendations

1 We recommend that the routine clinical assessment of all adult patients (aged 16 years or more) should be standardised across the NHS, with the routine recording of a minimum clinical dataset of physiological parameters resulting in the National Early Warning Score (NEWS).

Report of a working party July 2012

In adults

The NEWS and sepsis

- We recommend that **sepsis** should be considered in any patient with a known infection, signs or symptoms of infection, or in patients at high risk of infection, and a **NEW score of 5 or more** 'think sepsis'.
- We recommend that patients with suspected infection and a NEW score of 5 or more require urgent assessment and intervention by a clinical team competent in the management of sepsis and urgent transfer to hospital or transfer to a higher-dependency clinical area within hospitals, for ongoing clinical care.





Paediatric specific challenges

- Dependent, non-verbal
- Age related variation heart rate, respiratory rate,
 blood pressure
- Limited ability to compensate when seriously ill



Critical deterioration is catastrophic



Failure is not an option

Multicenter cohort study of in-hospital pediatric cardiac arrest*

Kathleen L. Meert, MD, FCCM; Amy Donaldson, MS; Vinay Nadkarni, MD, FCCM; Kelly S. Tieves, DO; Charles L. Schleien, MD, MBA, FCCM; Richard J. Brilli, MD, FCCM; Robert S. B. Clark, MD; Donald H. Shaffner, MD; Fiona Levy, MD; Kimberly Statler, MD; Heidi J. Dalton, MD, FCCM; Elise W. van der Jagt, MD, MPH; Richard Hackbarth, MD; Robert Pretzlaff, MD, MS; Lynn Hernan, MD; J. Michael Dean, MD, MBA, FCCM; Frank W. Moler, MD, MS, FCCM; and for the Pediatric Emergency Care Applied Research Network

Measurements and Main Results: A total of 353 patients met entry criteria; 172 (48.7%) survived to hospital discharge. Among survivors, 132 (76.7%) had good neurologic outcome documented by Pediatric Cerebral Performance Category scores. After adjust-







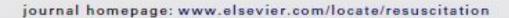
Cost of in-patient cardiac arrest

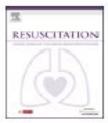
Resuscitation 80 (2009) 529-534



Contents lists available at ScienceDirect

Resuscitation





Clinical paper

Short-term health system costs of paediatric in-hospital acute life-threatening events including cardiac arrest*

H.P. Duncana, E. Frewb

Results: The survival to hospital discharge was 64.4% (65/101), (95% Confidence Intervals 55.02, 73.70) for all acute life-threatening event calls, and 41.3% (12/29), (95% Confidence Intervals 23.45, 59.31) for cardiac arrest. The mean cost of the resuscitation attempt was £3664 for all acute life-threatening event calls, and £3884 for cardiac arrest. The annual cost of cardiopulmonary resuscitation preparedness was £181,565.

The mean cost of the post-event length of stay in hospital was £22,562 for cardiac arrest, £26,335 for other acute life-threatening events, and £26,138 for urgent PIC admissions. The cost per survivor to hospital discharge was £53,289.

Conclusion: The short-term costs of paediatric in-hospital acute life-threatening events, including cardiac

Confidential Enquiry into Maternal and Child Health



REPORT OF THE CHILDREN AND YOUNG PEOPLE'S HEALTH **OUTCOMES FORUM**

Why Children Die:

A Pilot Study 2006

957 deaths dataset

126 detailed analysis

91 of these in hospital

21% avoidable factors

49% potentially avoidable factors







Royal College of Paediatrics and Child Health

Leading the way in Children's Health





May 2008

England (South West, Wales and Northern Irel Hospitals should use scoring system to spot serious illness in children, report says





UK critical deteriorations => PICU

Roland et al 2014 ADC

- 85% hospitals admitting children use PEWS
- More than 30 different PEWS in use.
- Most unpublished and unvalidated

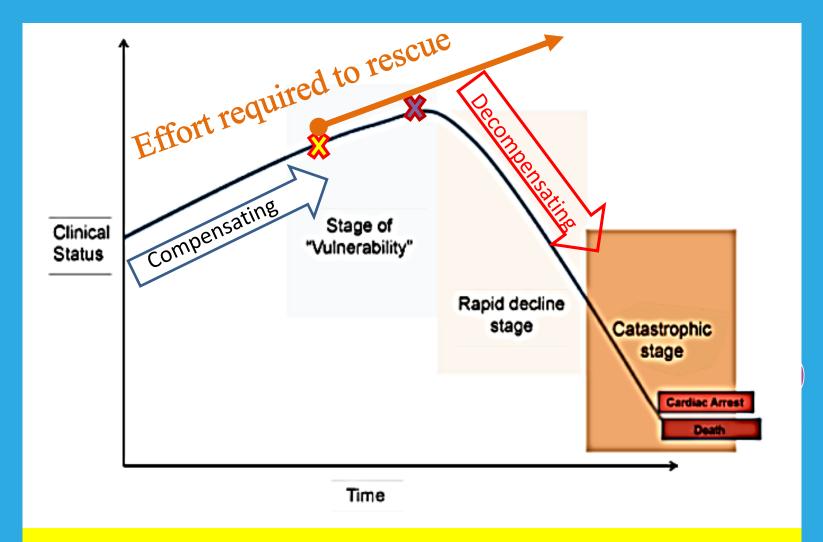
2,123 patients/yr same hospital Similar number from DGHs (2018)



PICU Mortality unplanned admission doubles (Odetola et al 2006)

Morbidity: 22% disability in PICU survivors (Namachivayam 2010)

Trajectory of deterioration



PEWS: Paediatric Early Warning of SHOCK

Chain of prevention [Smith 2010]



Studies struggle to achieve good implementation fidelity.
This intervention aims to be an end-to-end 'solution'



Critical deterioration is a problem, but why are we so far behind adults?

...It's complex





Paper based documentation

Bespoke development of PEWS

Significant heterogeneity

Limited evidence

Lack of consensus re components

Focus on score not the system



Validity and effectiveness of paediatric early warning systems and track and trigger tools for identifying and reducing clinical deterioration in hospitalised children: a systematic review BMJ open 2019

Rob Trubey, ⁰ ¹ Chao Huang, ² Fiona V Lugg-Widger, ⁰ ¹ Kerenza Hood, ¹ Davina Allen, ³ Dawn Edwards, ⁴ David Lacy, ⁵ Amy Lloyd, ¹ Mala Mann, ⁶ Brendan Mason, ⁷ Alison Oliver, ⁸ Damian Roland, ^{9,10} Gerri Sefton, ¹¹ Richard Skone, ⁸ Emma Thomas-Jones, ¹ Lyvonne N Tume, ¹² Colin Powell ^{13,14}

Paediatric early warning systems for detecting and responding to clinical deterioration in children: a systematic review BMJ open 2017

Veronica Lambert, Anne Matthews, Rachel MacDonell, John Fitzsimons



Thomas-Jones et al. BMC Pediatrics (2018) 18:244 https://doi.org/10.1186/s12887-018-1210-z

BMC Pediatrics

Open Access

2018: 18, 244

STUDY PROTOCOL

A prospective, mixed-methods, before and after study to identify the evidence base for the core components of an effective Paediatric Early Warning System and the development of an implementation package containing those core recommendations for use in the UK: Paediatric early warning system – utilisation and mortality avoidance– the PUMA study protocol Jones, Lloyd, Powell et al

'The Score Matters': wide variations in predictive performance of 18 paediatric track and trigger systems

ADC 2017;102:487–495

Susan M Chapman, ^{1,2,3} Jo Wray, ^{2,4} Kate Oulton, ^{2,4} Christina Pagel, ^{5,6} Samiran Ray, ^{6,7} Mark J Peters ^{6,7}

Systematic review of paediatric track and trigger systems for hospitalised children

Resuscitation 2016; 109

Effect of a Pediatric Early Warning System on All-Cause Mortality in Hospitalized Pediatric Patients The EPOCH Randomized Clinical Trial

Christopher S. Parshuram, MBChB, DPhil; Karen Dryden-Palmer, MScN; Catherine Farrell, MD;
Ronald Gottesman, MD; Martin Gray, MBChB; James S. Hutchison, MD; Mark Helfaer, MD;
Elizabeth A. Hunt, MD, MPH, PhD; Ari R. Joffe, MD; Jacques Lacroix, MD; Michael Alice Moga, MD;
Vinay Nadkarni, MD; Nelly Ninis, MBChB; Patricia C. Parkin, MD; David Wensley, MB, BS; Andrew R. Willan, PhD;
George A. Tomlinson, PhD; for the Canadian Critical Care Trials Group and the EPOCH Investigators

21 centres internationally; 10 intervention & 11 control

No statistically significant reduction in all-cause

mortality

-Anticipated mortality 5.1% Observed mortality 1.7%

Significant Deterioration Events reduced 15.3% v 22%, P<0.03

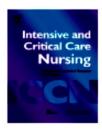
Unplanned PICU admissions OR cardiac arrest on ward pre PICU admission OR death pre PICU admission



Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/iccn



ORIGINAL ARTICLE

What impact did a Paediatric Early Warning system have on emergency admissions to the paediatric intensive care unit? An observational cohort study



G. Sefton^{a,*}, C. McGrath^a, L. Tume^a, S. Lane^b, P.J.G. Lisboa^c, E.D. Carrol^b

Outcomes PIM2 median (IQR)	0.060 (0.078)	0.044 (0.049)
Invasive ventilation (n) (%) Median length of ventilation days (IQR)	118 (75.2) 4 (11)	104 (62.7) 2 (5)
Inotropes (n) (%) Median length of inotropes days (IQR)	50 (31.8) 0 (2)	40 (24.1) 0 (0)
PICU LOS days; median (IQR) PICU mortality (n) (%)	5 (9) 17 (10.8)	3 (5) 14 (8.4)



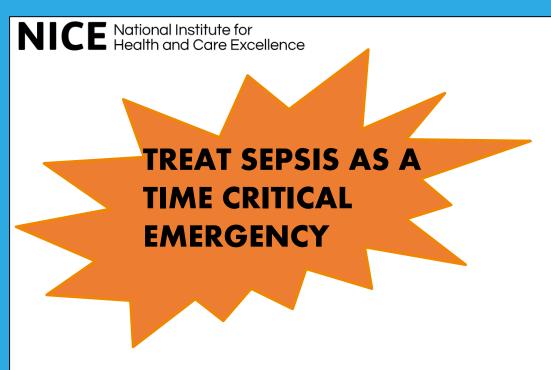
p=0.0152b

p=0.122b

p=0.0021^a p=0.4/2^b

^a Mann Whitney U test.

b Chi-squared test.





Sepsis: recognition, diagnosis and early management

NICE guideline

Published: 13 July 2016 nice.org.uk/guidance/ng51

Sepsis; a time critical emergency

For each hour's delay in administering antibiotics in septic shock, mortality increases by 7.6% Kumar A, Crit Care Med 2006

Pediatric Critical Care

Crit Care Med 2014

Delayed Antimicrobial Therapy Increases Mortality and Organ Dysfunction Duration in Pediatric Sepsis*

Scott L. Weiss, MD¹; Julie C. Fitzgerald, MD, PhD¹; Fran Balamuth, MD, PhD²; Elizabeth R. Alpern, MD, MSCE³; Jane Lavelle, MD²; Marianne Chilutti, MS⁴; Robert Grundmeier, MD^{4,5}; Vinay M. Nadkarni, MD, MS¹; Neal J. Thomas, MD, MSc⁶

Sepsis= Dynamic process; time does not stand still

Time zero = first clinical signs seen by health professional CQUIN time zero = Clinician confirms treat as sepsis





Sepsis is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection.

Presumed/confirmed infection & organ dysfunction

Sepsis not present

Sepsis unlikely

Sepsis
unlikely but
possible

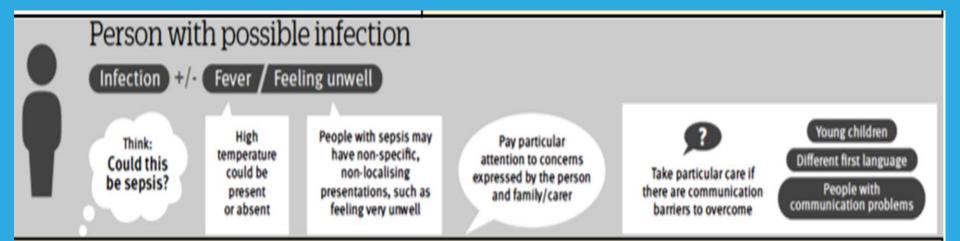
Sepsis probably but not certain

Sepsis highly likely Confirmed sepsis

@damianroland

Sepsis does not appear.....it develops

NICE



Heightened suspicion

- Pre-existing risk factors are present
- if recorded vital signs are abnormal without an obvious cause
- PEWS 3 or more without an obvious cause; NB early sepsis will not score high on PEWS. <u>Vigilance required</u>

Accuracy and Efficiency of Recording Pediatric Early Warning Scores Using an Electronic Physiological Surveillance System Compared With Traditional Paper-Based Documentation

Sefton et al. Computers, Informatics, Nursing. 2017;35(5):228.

Faster vital signs documentation

75 vs 103 seconds [p=0.002]



More accurate vital signs documentation

Mean accuracy 99.2% [SD 0.3] vs 88.4% [SD 0.12] p<0.02

More accurate PEWS calculation

• 95% vs 56%

"This system is likely to yield improved outcomes at a lower overall cost" Independent health economic report



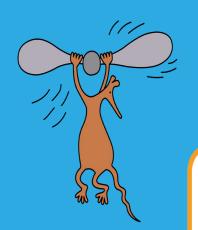


Digital potential-Active Monitoring

- Standardisation
- Real-time data
- Auto-plotting
- Reduce human factor errors
- Clinical decision support







Digital potential-Implementation fidelity

Chain of Prevention

- Monitoring completeness
- Monitoring frequency
- Nurse in Charge role
- Automated alerts
- Chronology
- Safety metrics for regulators







Digital potential-Large data

- Which physiological variables?
- Which clinical assessments?
- What thresholds for concern?
- Weighting per component?
- Trend analysis?





Setting

Tertiary Children's Hospital

General paediatric & specialty case-mix

Deployed across 240 in-patient beds

Change from EPR-PEWS

Large ED, designated trauma centre

24 bed PICU, with ECMO

19 bed HDU, 4 bed LTV

No Rapid Response Team









- Standard Vital Signs, real-time
- Underpinning age-specific PEWS risk model
- NICE Sepsis screening
- Neurological observations
- Glucose Monitoring



- Automated alerts NIC, Clinicians
- Task management
- Push laboratory results
- Bundled sepsis management

Primary outcomes

- In-hospital Critical Care transfers (PICU/HDU)
- Sepsis screening/identification and response

Secondary outcomes:

- Clinical course of patients following critical deterioration
- Hospital Mortality (all cause).
- Critical care activity (elective/emergency)
- Hospital activity (elective/emergency)



Critical Deterioration Events

Impact of Rapid Response System Implementation on Critical Deterioration Events in Children

Christopher P. Bonafide, MD, MSCE; A. Russell Localio, PhD, MPH; Kathryn E. Roberts, RN, MSN; Vinay M. Nadkarni, MD, MS; Christine M. Weirich, MPH; Ron Keren, MD, MPH

13 X increased risk of death

PICU or HDU admission + any of the following within 12hrs:

- Non invasive ventilation
- Mechanical ventilation
- Inotropes

PREVENT
CDE
Stabilise on ward

PROACTIVE MONITORING

Reduce morbidity from CDE by early CC for non responders

Escalation via Nurse in charge



Supervisor role

Automated alerts NIC & Clinical team

High PEWS, Critical PEWS, new sepsis concern

Escalate concerns with/without high PEWS

1st responder



Clinical team response

- In-hours own team/2nd on team
- Target response within 30 minutes
- Senior doctor involvement ST3 & above
- Proactive approach.
- Inform Consultant re deterioration





