The Children’s Early Warning Tool

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Objective

• To design a suite of tools to meet the needs of bedside clinicians
  • Observation chart
  • Reference ranges for age
  • Early warning score
  • Clinical escalation
  • Tool to assess interventions
  • Triage tool
  • Customisable
Design

• Blank canvas
• What observations predict deterioration?
  • Normal ranges for age?
  • Single point vs. cumulative score? (both…?)
  • Weighting of observations
• What observations – pragmatic
• Human factors approach to design
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<thead>
<tr>
<th>Date</th>
<th>Time</th>
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For children less than 1 year old

<table>
<thead>
<tr>
<th>Respiratory rate</th>
<th>Score</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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Respiratory distress

<table>
<thead>
<tr>
<th>Moderate</th>
<th>Mild</th>
<th>Normal</th>
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<tbody>
<tr>
<td>1</td>
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<td>3</td>
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O₂ (mmHg) | Normal in children (0-1 year) | < 1.3 | 1.3-1.6 |
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SaO₂

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<tr>
<th>Probe change</th>
<th>Normal</th>
<th>&lt; 90</th>
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Temperature

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<th>39.0</th>
<th>39.1</th>
<th>39.2</th>
<th>39.3</th>
<th>39.4</th>
<th>39.5</th>
<th>39.6</th>
<th>39.7</th>
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Heart rate

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<tr>
<th>90-100</th>
<th>101-120</th>
<th>121-150</th>
<th>151-180</th>
<th>181-210</th>
<th>&gt; 210</th>
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Blood pressure

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<tr>
<th>105/65</th>
<th>104/64</th>
<th>103/63</th>
<th>102/62</th>
<th>101/61</th>
<th>100/60</th>
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Score systolic BP

Document mean BP as required

Total CEWT Score

Interventions

Place emergency call if any of the following:
- Clinical concern
- Airway threat
- Bleeding (major)
- Apnea

Place emergency call

Action

CEWT Score

1-3
- Obtain a full CEWT score
- Carry out appropriate interventions as prescribed
- Increase frequency of observations
- Manage anxiety / pain / fever
- Review oxygen
- Consider informing shift coordinator

4-5
- Ward doctor to review
- Notify shift coordinator
- Obtain a full CEWT score after interventions
- Note when review requested over page
- Any reviewing doctor to complete CEWT
- Review over page

6-7
- Registrar to review patient — response within 15 minutes
- Registrar to ensure consultant is notified
- Ward doctor to attend
- Any reviewing doctor to complete CEWT
- Review over page

8+
- Place emergency call
- Registrar to attend
- Ensure consultant is notified
Validation

• **Retrospective**
  - All patients admitted PICU from ward in 2007
  - CEWT detected patients before PICU admission

• **Prospective**
  - Twelve pilot sites (tertiary / regional / rural)
  - Two month trial
  - Phased roll-out

• **Retrieval population**

• **Root Cause Analysis**

• **Semi-qualitative implementation study**
Retrospective validation

ICU admissions

- bronchiolitis n=20
- pneumonia n=5
- reactive airways n=4
- sepsis n=14
CEWT – Bronchiolitis

ICU admissions: bronchiolitis

CEWT score

time (hours)

Bronchiolitis - Controls

Bronchiolitis - Controls

time (hours)
Prospective trial

- Approximately 1900 patients
- Currently analysing data
  - Optimise physiological weighting
  - Optimise action box (for different institutional capabilities)
- Impression is that scoring seems appropriate
- Two critical incidents
  - Patients had respiratory arrests
  - In both cases, CEWT had been overruled by registrar
Bronchiolitis: Index vs. Controls

- **Prospective**
- **Retrospective controls**
- **Retrospective index**

CEWT score vs. time (hours) from 0 to 60 hours.
Can physiological variables and early warning scoring systems allow early recognition of the deteriorating surgical patient?∗

Brian H. Cuthbertson, MD, FRCA; Massoud Boroujerdi, PhD; Laurin McKie, MB, ChB; Lorna Aucott, PhD; Gordon Prescott, PhD

Objective: Early warning scoring systems are widely used in clinical practice to allow early recognition of the deteriorating patient, but they lack validation. We aimed to test the ability of physiologic variables, either alone or in existing early scoring systems, to predict major deterioration in a patient’s condition and attempt to derive functions with superior accuracy.

Design: A comparative cohort study.

Setting: A teaching hospital in Scotland.

Patients: Two cohorts of general surgical high-dependency patients. The cohorts are a group of surgical high-dependency care patients who did not require intensive care admission and another group of patients who did require admission.

Interventions: None.

Measurements and Main Results: Prospective physiologic data on consecutive surgical high-dependency unit patients were collected and compared with physiologic data on patients admitted to the intensive care unit from the same surgical high-dependency units. Data were quality checked and summarized, and discriminant analysis and receiver operator curves were used to discriminate between the groups. There were significant physiologic differences between groups with regard to heart rate (p < .001, area under the receiver operating characteristic curve [AUC] 0.7), respiratory rate (p < .001, AUC 0.71), and oxygen saturation (p < .001, AUC 0.78) across time points. This was not present for systolic blood pressure or temperature. Existing early warning scoring systems had good discriminatory power (AUC 0.83–0.86). We derived discriminant functions, which have a high predictive ability to determine differences between groups (p < .0001, AUC 0.86–0.90). We found that heart rate and respiratory rate could detect differences between groups at 6 and 8 hrs before ICU admission, but oxygen saturation and the discriminant function 2 could detect differences 48 hrs before ICU admission.

Conclusions: Some commonly used physiologic variables have reasonable power in determining the difference between patients requiring intensive care unit admission, but others are poor. Existing early warning scores have comparatively good discriminatory power. We have derived functions with excellent predictive power in this derivation cohort. (Crit Care Med 2007; 35:402–409)

Key Words: surgery; early warning scores; scoring systems; intensive care; screening; risk prediction
Retrieval CEWT

- 4 month convenience sample of retrieval referrals
- Evaluate state-wide implementation
- Identify early and late referrers
- Improve objectivity in co-ordination
Retrieval patients - CEWT score

n = 204

51% | 23%
CEWT score by diagnostic group

- Trauma
- Gen Surgery
- Resp infection
- Asthma
- Sepsis
- DKA
- Seizure
Retrieval team composition vs. CEWT
Root Cause Analysis

- Currently reviewing state-wide data in last 3 years
- 20 cases filed (*RCAs not total deaths*)
- 1 late identification spinal injury
- 2 – haemorrhage during / post surgery
- 1 out-of-hospital arrest (discharged that day)
- 1 SUDEP
<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Respiratory Rate</th>
<th>Respiratory distress</th>
<th>Oxygen (F/min)</th>
<th>SaO2</th>
<th>Temperature</th>
<th>Blood Pressure</th>
<th>Score Systolic BP</th>
<th>Non-motion BP</th>
<th>Major co-morbidities</th>
<th>Heart Rate</th>
<th>Capillary refill time</th>
<th>Conscious level</th>
<th>Total CEWT Score</th>
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*Note: The chart shows various vital signs monitored over time, with indicators for respiratory rate, distress, oxygen saturation, temperature, blood pressure, heart rate, and capillary refill time. The total CEWT score is calculated based on these parameters.*
Semi-quantitative implementation study

- Questionnaire at end of prospective trial period
- Evaluation of trial-site experience
  - Staff demographics
  - Impact on perceived ability to care for hospitalised children
  - Ease of use
  - Educational material / support
- Inform design of state-wide implementation strategy
What impact has CEWT had on your ability to care for children in hospital?
How difficult was the CEWT chart to use?

Very easy

Very hard

- Tertiary HDU
- Tertiary Oncology
- Tertiary Medical / Surgical
- Regional 1
- Regional 2
- Regional 3
- Regional 4
- Regional 5
- Rural 1
- Rural 2
- Rural 3
- Rural 4
- Rural 5
How did you rate the educational material and support?
What next…

• Complete prospective analysis
• Optimise CEWT
• Design state-wide implementation
• Work collaboratively across borders
• Further projects
  • Other charts
  • Telemedicine
  • Computers
Acknowledgements

• The staff of the Patient Safety Centre, Brisbane
  • John Wakefield, Jillann Farmer, Rowena Richardson, Hayden Scotter, Lynette Adams

• The other members of the CEWT team
  • Jo-Anne Stephens
  • Ruth McCaffery

• The staff who participated in the prospective trial