Patients at Risk of Critical Illness

and

The Observation Chart
Back to Basics
Patients at Risk of Critical Illness

Underlying issue
• Inadequate oxygen delivery to the tissues for their metabolic demand leading multiple organ dysfunction.

Solution to patients at risk
• Identify early the cause of inadequacy, treat and monitor response to therapy

Improved outcome
• Dependent upon treatment
Patients at Risk of Critical Illness

Oxygen Delivery

Cardiac Output x Arterial Oxygen Content

Provides \( O_2 \) for oxidative phosphorylation to provide energy (ATP)
Patients at Risk of Critical Illness

Oxygen Delivery

• Inability to measure in the ward setting
• Unable to delineate absolute number (needs to match metabolic demand)
• Optimising oxygen delivery has only improved outcome in specific settings
• Surrogate markers in the ward setting: “vital signs”
DO₂, Vital Signs

**Pulse**
\[
DO₂ = (SV \times HR) \times ([Hb] \times SaO₂ \times 1.39) + PaO₂ \times 0.003
\]

**Blood pressure**
\[
DO₂ = \frac{BP}{TPR} \times ([Hb] \times SaO₂ \times 1.39) + PaO₂ \times 0.003
\]

**Respiratory rate**
- Neurogenic factors: 
- Chemical Factors: \(H^+, P_{O₂}\)

**Temperature**
- Indication of infection
Observation of Vital Signs

- Determine cause of inadequacy of oxygen delivery
- Trend of observations: response to treatment
detect early derangement
- Trigger a response to derangement
- Tells a story:
  important as we are shift workers and poor at handover/communication
- Observation chart is a place for measurement (not only vital signs)
Observations and Florence Nightingale

- But if you cannot get the habit of observation one way or other, you had better give up the [idea of] being a nurse.

- There are a great many observations, of much importance, both physiologically and practically, which might be made by nurses, if they were educated to observation, and, indeed, can only be made by nurses or those who are always with the sick.*

- To make strict observations of the sick in the following particulars: The state of secretions, expectoration, pulse, skin, appetite, intelligence, as delirium or stupor; breathing, sleep, state of wounds, eruptions, formation of matter, effect of diet, or of stimulants and of medications.*

*Notes on Nursing What It Is, and What It Is Not. Florence Nightingale 1898.
Patients at Risk of Critical Illness

Vital Signs reflect Tissue Oxygenation

Vital Signs Interpreted

Timely and Appropriate Medical Management

Vital Signs Performed

Timely, Appropriate Medical Review

Vital Signs Interpreted

Vital Signs Communicated
Patients at Risk of Critical Illness

Vital Signs reflect Tissue Oxygenation?

• Surrogate marker
• Relationship between pressure and flow
• Relationship between $DO_2$ and cellular production ATP
Patients at Risk of Critical Illness

Vital Signs Performed?

62 patients, 1600 observations

Vital sign frequency (readings/day; IQR)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Frequency</th>
<th>IQR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>4.0</td>
<td>(2.0, 5.5)</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>5.0</td>
<td>(3.5, 6.7)</td>
</tr>
<tr>
<td>Heart rate</td>
<td>4.5</td>
<td>(3.2, 5.8)</td>
</tr>
<tr>
<td><strong>Respiratory rate</strong></td>
<td>1.0</td>
<td>(0.0, 1.6)*</td>
</tr>
<tr>
<td>Temperature</td>
<td>4.5</td>
<td>(3.0, 5.5)</td>
</tr>
</tbody>
</table>

*p < 0.0001
Patients at Risk of Critical Illness

Vital Signs Interpreted?
- Long delays before doctors contacted
- 40% MET calls preceded by MET criteria but not acted upon
Patients at Risk of Critical Illness

Timely, Appropriate Medical Review?

- Reports of long delays for medical review
- Registrars/Consultants often not contacted
Patients at Risk of Critical Illness

Timely and Appropriate Medical Management

NCEPOD: “An acute problem” 2005

- Reviewed 100 unplanned ICU admissions
- 50 had suboptimal management prior to admission
Early Recognition of the Deteriorating Patient

Aim:
To develop a process that enables the early recognition of the deteriorating patient to potentially improve outcome
Early Recognition of the Deteriorating Patient

Hypothesis
Installing a modified early warning score (MEWS) into a general ward would:

• Reduce unplanned admissions to ICU
• Increase documentation of observations
• Decrease the time for an appropriate medical review

The MEWS would have specific scores triggering a timely appropriate medical review
Early Recognition of the Deteriorating Patient

Study Design
A prospective, controlled, before and after intervention trial
Early Recognition of the Deteriorating Patient

Study population
All patients ≥ 18 years admitted to four general wards during the two study periods

Exclusions
Those admitted for palliative care
Readmissions

Ethics
Waived the need for consent
Early Recognition of the Deteriorating Patient

Three Study Periods

Study of two wards under normal operating conditions
Early Recognition of the Deteriorating Patient

Study Periods


- Focus groups
- Information sessions
- Interdisciplinary education program “COMPASS”
- Design of new general observation
Early Recognition of the Deteriorating Patient

Study Periods

3. Intervention Period: Feb-June 2007
Study of two wards after introduction: Education, observation chart and MEWS
Early Recognition of the Deteriorating Patient

Data Collection

All patients

• Demographic and logistic data
  (age, gender, admission diagnosis, ward, interventional history, planned ICU admission)

• All patients were followed up either to death or hospital discharge

• Outcome data
  (length of hospital stay, survival, and whether an unplanned admission to ICU or call of the medical emergency team cardiac had occurred)
Early Recognition of the Deteriorating Patient

Data Collection

A priori subgroup
25% patients randomly selected
• frequency of observations
• time from when the observations deteriorated to an appropriate medical review
• whether appropriate medical management had been implemented

Power Calculation

Would need 400 patients to detect a 50% increase in documentation rate of respiratory rate
Early Recognition of the Deteriorating Patient

Primary outcome

- The frequency of measurement of vital signs
Early Recognition of the Deteriorating Patient

Secondary Outcome

• Incidence of unplanned ICU admissions
• Incidence of in-hospital deaths
• Incidence of attendance of the MET
• Time for appropriate medical review
• Frequency of appropriate medical management
• Duration of hospital stay.
Intervention

1. **Interdisciplinary Education: COMPASS**
   - DVD, manual, online quiz, 3 hours face-to-face
   - Back to basics physiology & meaning of vital signs
   - Be able to communicate in a succinct manner

2. **Redesign observation chart**

3. **Modified Early Warning Score**
   - **Triggers:**
     - medical review
     - change in frequency of observations
     - who is to escort patient off ward
### General Observation Chart

**Graph:** Pulse vs. X  
**Temperature vs.**  
**Blood Pressure vs.** Systolic  Diastolic

<table>
<thead>
<tr>
<th>Time</th>
<th>Pulse 60-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>40</td>
</tr>
<tr>
<td>160</td>
<td>43</td>
</tr>
<tr>
<td>140</td>
<td>42</td>
</tr>
<tr>
<td>120</td>
<td>41</td>
</tr>
<tr>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>60</td>
<td>39</td>
</tr>
<tr>
<td>50</td>
<td>38</td>
</tr>
<tr>
<td>40</td>
<td>37</td>
</tr>
<tr>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>10</td>
<td>34</td>
</tr>
</tbody>
</table>

**Other:**
- Height
- Transfer
- Weight
- Bodily Fluids
- Pain
- Breathing
- Pulse
- Respiration
- Systolic
- Diastolic

*901440/109*
<table>
<thead>
<tr>
<th>Modified Early Warning Scores</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Observation chart number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resp</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RR</td>
<td>≥ 36</td>
<td>31 – 36</td>
<td>21 – 30</td>
<td>9 – 20</td>
<td>≤ 9</td>
</tr>
<tr>
<td><strong>Systolic BP (mmHg)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP</td>
<td>≥ 100</td>
<td>90 – 99</td>
<td>80 – 89</td>
<td>70 – 79</td>
<td>≤ 70</td>
</tr>
<tr>
<td>PaO₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arterial Oxygensaturation (%)</td>
<td>≥ 93</td>
<td>90 – 92</td>
<td>85 – 89</td>
<td>80 – 84</td>
<td>≤ 80</td>
</tr>
<tr>
<td>Temp (°C)</td>
<td>≤ 39.5</td>
<td>39.5 – 40.5</td>
<td>38 – 39.5</td>
<td>37 – 38</td>
<td>≥ 38</td>
</tr>
<tr>
<td><strong>Urine Output (ml)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ml/24h</td>
<td>≥ 0.5</td>
<td>0.3 – 0.49</td>
<td>0.2 – 0.29</td>
<td>0.1 – 0.19</td>
<td>≤ 0.09</td>
</tr>
<tr>
<td><strong>Hypothermia (°C)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothermia</td>
<td>≥ 39.5</td>
<td>39.5 – 40.5</td>
<td>38 – 39.5</td>
<td>37 – 38</td>
<td>≥ 38</td>
</tr>
<tr>
<td><strong>Total Score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Score HR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR</td>
<td>≥ 100</td>
<td>90 – 99</td>
<td>80 – 89</td>
<td>70 – 79</td>
<td>≤ 70</td>
</tr>
<tr>
<td></td>
<td><strong>Score BP (see back)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seizure Score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seizure</td>
<td>≥ 200</td>
<td>190 – 199</td>
<td>180 – 179</td>
<td>160 – 159</td>
<td>≤ 150</td>
</tr>
<tr>
<td><strong>Urinary Score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urine</td>
<td>≥ 500</td>
<td>150 – 499</td>
<td>100 – 149</td>
<td>50 – 99</td>
<td>≤ 49</td>
</tr>
<tr>
<td><strong>TOTAL MINUTES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minutes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain</td>
<td>≥ 400</td>
<td>120 – 400</td>
<td>100 – 119</td>
<td>90 – 99</td>
<td>≤ 90</td>
</tr>
<tr>
<td><strong>Bowel</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bowel</td>
<td>≥ 400</td>
<td>120 – 400</td>
<td>100 – 119</td>
<td>90 – 99</td>
<td>≤ 90</td>
</tr>
<tr>
<td><strong>Initial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Medical Review

**MEWS > 4**
- Contact Intern, to review within 30 minutes.
- After 60 mins pt not reviewed & MEWS has not decreased
  - Contact Registrar & Intern, to review in 30 minutes
  - After 60 mins pt not reviewed & MEWS has not decreased
  - Registrar & VMO notified, Registrar to review within 10 minutes. No response from the page or the treatment, the MEWS has not decreased consider MET/ICU consult

**MEWS > 6**
- Contact Registrar & Intern, to review within 30 minutes
- After 60 mins pt not reviewed & MEWS has not decreased
- Registrar & VMO notified, Registrar to review within 10 minutes. No response from the page or the treatment, the MEWS has not decreased consider MET/ICU consult

**MEWS > 8**
Results
## Results

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>1137</td>
<td>975</td>
</tr>
<tr>
<td>Male</td>
<td>631</td>
<td>536</td>
</tr>
<tr>
<td>Age, years</td>
<td>58.2 (19.6)</td>
<td>57.3 (19.7)</td>
</tr>
<tr>
<td>Medical (%)</td>
<td>601 (52.9)</td>
<td>495 (50.8)</td>
</tr>
<tr>
<td>Hosp. Stay, (IQR)</td>
<td>4.0 (1.8-8.3)</td>
<td>4.8 (2.2-9.8)*</td>
</tr>
</tbody>
</table>

*p<0.05*
<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>414</td>
<td>315</td>
</tr>
<tr>
<td>BP</td>
<td>4.5 (3.2, 6.3)</td>
<td>4.8 (3.6, 6.6)*</td>
</tr>
<tr>
<td>HR</td>
<td>4.4 (3.2, 6.2)</td>
<td>4.7 (3.4, 6.4)</td>
</tr>
<tr>
<td>RR</td>
<td>2.5 (0.8, 4.4)</td>
<td>4.8 (3.4, 6.8)**</td>
</tr>
<tr>
<td>Temp</td>
<td>4.2 (3.1, 5.4)</td>
<td>4.7 (3.5, 6.1)**</td>
</tr>
<tr>
<td>SaO₂</td>
<td>4.2 (3.1, 5.7)</td>
<td>4.8 (3.6, 6.8)***</td>
</tr>
</tbody>
</table>

* p<0.05, **p<0.001, *** p<0.0001
## Results

<table>
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<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>95% CI</th>
</tr>
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<tbody>
<tr>
<td>Patients</td>
<td>1137</td>
<td>975</td>
<td></td>
</tr>
<tr>
<td>ICU admissions (%)</td>
<td>21 (1.9)</td>
<td>4 (0.4)</td>
<td>0.07, 0.64 **</td>
</tr>
<tr>
<td>Hospital Deaths (%)</td>
<td>22 (1.9)</td>
<td>8 (0.8)</td>
<td>0.19, 0.95 *</td>
</tr>
<tr>
<td>MET Calls</td>
<td>24 (2.1)</td>
<td>36 (3.7)</td>
<td>1.05, 3.00 *</td>
</tr>
</tbody>
</table>

*p<0.05 **p<0.001
<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
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</thead>
<tbody>
<tr>
<td>Patients</td>
<td>1137</td>
<td>975</td>
</tr>
<tr>
<td>Cardiac Arrests</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Resp. Failure</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>CVA</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>AMI</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sepsis</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>PE</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Acute Renal Failure</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Early Recognition of the Deteriorating Patient

**Conclusion**

Improved documentation vital signs
Reduction ICU admissions
Improvement hospital outcome
Early Recognition of the Deteriorating Patient

Discussion

• Difficulties interpreting before and after trial
• Matched cohorts, Regression to mean
• Not designed to detect differences in outcome
• Unclear why patients improved
Project to Program

- New Obs Chart/MEWS/COMPASS to all acute clinical areas in ACT Health
- Governance arrangements completed
- Ongoing Data Collection/Review/Reports to Clinical Areas
- Monthly Newsletter
- Continuing support from ACT Health
- Development specific charts/community
COMPASS Roll Out

Nursing staff
• Calvary Hospital: 468
• The Canberra Hospital: 785

Medical Staff
Interns/RMOs: 70

Undergraduates (2008)
University of Canberra/ACU
Nursing students: 164
Australian National University
Medical students: 94
# Ongoing Data Collection*

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET calls</td>
<td>89</td>
<td>136</td>
</tr>
<tr>
<td>Resp rate documentation</td>
<td>65%</td>
<td>94%</td>
</tr>
<tr>
<td>Unplanned crit. care transfers</td>
<td>49</td>
<td>41</td>
</tr>
<tr>
<td>Time to medical review (MEWS&gt;4)</td>
<td>48 mins</td>
<td>12 mins</td>
</tr>
</tbody>
</table>

*3 months for first group of wards ([surgical](#))
## Ongoing Data Collection*

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET Calls</td>
<td>43</td>
<td>50</td>
</tr>
<tr>
<td>Missed METs</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td><strong>Vital Sign Frequency (per day)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>4.1</td>
<td>5.6</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>5.5</td>
<td>6.5</td>
</tr>
<tr>
<td>Resp. Rate</td>
<td>3.8</td>
<td>6.4</td>
</tr>
<tr>
<td>SaO2</td>
<td>5.6</td>
<td>6.9</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>5.8</td>
<td>6.5</td>
</tr>
</tbody>
</table>

*3 months for second group of wards (medical)
Project to Program

- Possible
- Requires ongoing enthusiasm and passion
- Support up and down the food chain
- Does it really make a difference?
- Struggle to get SMOs and JMOs to own the problem (what problem??)
Thanks to...

- Heather McKay
- Chris van Leuvan
- Bronwyn Avard
- Sarah Mamootil
- Sue Hogan
- Bobby Antoniou
- Daryl McGill
- Mark Cormack
- All the ward staff

Nicole Slater
Cath McCutcheon
Robyn Berry
Ross Peake
Paul Lamberth
Judy Gosper
Wayne Ramsey
Tracey Bessell