EMR Surveillance Intervenes to Reduce Risk Adjusted Mortality

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Conflict of Interest

Katherine E. Walsh, MS, DrPH, RN, NEA-BC

Has no real or apparent conflicts of interest to report.
Conflict of Interest

Michael Rothman, PhD

Salary: PeraHealth
Ownership Interest: Equity owner in PeraHealth
Agenda

• Origins and Development of an Early Warning System (EWS)
• Science behind one EWS
• Potential Applications of the EWS
• Implementation at Houston Methodist Hospital
• Clinical Outcomes
• Next Steps
Learning Objectives

• Analyze existing EMR data, including vital signs, labs and nursing assessments, to identify patient deterioration and identify actions to reduce adverse outcomes

• Create consistent communication mechanisms to obviate handoff lapses and manage patient care over the course of multiple shifts

• Develop and formalize surveillance protocols to assure patients get appropriate attention and care

• Describe implementation practices to maximize the utilization of the data
An Introduction of How Benefits Were Realized for the Value of Health IT

Value Steps Implemented Were:

Satisfaction
-Precise risk scoring alerts prevent alarm fatigue
-Nurse satisfaction is improved as data empowers them to take actions to keep patients safe

Treatment/Clinical
-EWS utilization improved responsiveness and reduced mortality
-EWS provided early interventions by Nurse Practitioner team

Electronic Information/Data
-EWS derives the full potential of data
-Complex algorithm creates output that is user friendly, real time and trended over time

http://www.himss.org/ValueSuite

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Origin of the Rothman Index (RI)

“Our measure of success has always been... preventing what happened to my mother from happening to one other person.”
Science – the Heart of the Model

- Nursing Assessments
- Estimating Risk
- All on a Common Scale
Nursing Assessments – Simplified

• “Head-to-toe” assessments - part of standard nursing school curricula

• Simplified... “charting by exception”... the patient has either “met” or “not met” a minimum standard
  
  – GI standard - Abdomen soft and non-tender. Bowel sounds present. No nausea or vomiting. Continent.

• Nursing assessments are recorded twice each day

• Every hospital records essentially the same data
Nursing Assessment – Data for the Study

• 42,302 patient visits from two 1-year periods at an 805-bed community hospital

• Excluded data from patients under age 18, as well as psychiatric and maternity
Nursing Assessments – In-hospital Mortality

Odds Ratios – First Assessment

<table>
<thead>
<tr>
<th>Category</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurological</td>
<td>9.4</td>
</tr>
<tr>
<td>Respiratory</td>
<td>8.1</td>
</tr>
<tr>
<td>Food</td>
<td>7</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>6.9</td>
</tr>
<tr>
<td>Psychosocial</td>
<td>6.7</td>
</tr>
<tr>
<td>Safety</td>
<td>5.6</td>
</tr>
<tr>
<td>Skin</td>
<td>5.2</td>
</tr>
<tr>
<td>Peripheral...</td>
<td>3.9</td>
</tr>
<tr>
<td>Genitourinary</td>
<td>3</td>
</tr>
<tr>
<td>Cardiac</td>
<td>2.8</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>2.3</td>
</tr>
<tr>
<td>Pain</td>
<td>1.1</td>
</tr>
</tbody>
</table>
## Nursing Assessments – 1-Year Mortality

<table>
<thead>
<tr>
<th>Nursing Assessment</th>
<th>1-Year Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>6.7</td>
</tr>
<tr>
<td>Neurological</td>
<td>6.5</td>
</tr>
<tr>
<td>Psychosocial</td>
<td>5.3</td>
</tr>
<tr>
<td>Cardiac</td>
<td>2.3</td>
</tr>
<tr>
<td>Pain</td>
<td>0.8</td>
</tr>
</tbody>
</table>

All p-values < 0.001, except for pain, with a p-value of 0.474
Nursing Assessments – Clinical Implications

• If the first nursing assessments taken upon admission correlate with in-hospital mortality... and

• The last nursing assessments taken prior to discharge correlate with post-discharge mortality... then

• It is reasonable to infer that all nursing assessments gathered throughout the patient’s stay contain significant clinical information

Clinical Implications and Validity of Nursing Assessments: A Longitudinal Measure of Patient Condition from Analysis of the Electronic Medical Record – Michael J. Rothman, Alan B. Solinger, Steven I. Rothman, G. Duncan Finlay, BMJ Open 2(4) 2012.
Science – the Heart of the Model

• Nursing Assessments
• Estimating Risk
• All on a Common Scale
Estimating Risk – Population Norms

Creatinine

Normal Range = 0.5-1.2 (mg/dl)

Lower 5%, Normal 64%, Upper 30%... 87,000 readings... mean=1.33 s.d=1.31

Creatinine Transform

(caps... Low end < .37 then TR=.2, high end > 2.5 then TR=.3)

-10%
-5%
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%

Δ 1st Year Mortality

act-base
calc
Estimating Risk – Expert Opinion

Placing clinical variables on a common linear scale of empirically-based risk as a step toward construction of a general patient acuity score from the Electronic Health Record: A modeling study – Steven I. Rothman, Michael J. Rothman, Alan B. Solinger, BMJ Open 3(5) 2013.
Estimating Risk – Underlying Physiology

Drop in Hemoglobin saturation from 100% to 85% results in a critical fall in pO₂ from 120 mmHg to 60 mmHg... and corresponds to a sharp rise in excess risk

Science – the Heart of the Model

• Nursing Assessments
• Estimating Risk
• All on a Common Scale
## A Common Scale – Rothman Index Core Variables

<table>
<thead>
<tr>
<th>Vital Signs</th>
<th>Nursing Assessments (Head-to-Toe)</th>
<th>Nursing Assessments (Other)</th>
<th>Laboratory Tests (blood)</th>
<th>Cardiac Rhythm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Cardiac</td>
<td>Braden Score</td>
<td>Creatinine</td>
<td>Asystole</td>
</tr>
<tr>
<td>Diastolic Blood</td>
<td>Respiratory</td>
<td></td>
<td>Sodium</td>
<td>Sinus rhythm</td>
</tr>
<tr>
<td>Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic Blood</td>
<td>Gastrointestinal</td>
<td></td>
<td>Chloride</td>
<td>Sinus bradycardia</td>
</tr>
<tr>
<td>Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse Oximetry</td>
<td>Genitourinary</td>
<td></td>
<td>Potassium</td>
<td>Sinus tachycardia</td>
</tr>
<tr>
<td>Respiration Rate</td>
<td>Neurological</td>
<td></td>
<td>BUN</td>
<td>Atrial fibrillation</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>Skin</td>
<td></td>
<td>WBC</td>
<td>Atrial flutter</td>
</tr>
<tr>
<td>Safety</td>
<td></td>
<td></td>
<td>Hemoglobin</td>
<td>Heart block</td>
</tr>
<tr>
<td>Peripheral Vascular</td>
<td></td>
<td></td>
<td></td>
<td>Junction rhythm</td>
</tr>
<tr>
<td>Food/Nutrition</td>
<td></td>
<td></td>
<td></td>
<td>Paced</td>
</tr>
<tr>
<td>Psychosocial</td>
<td></td>
<td></td>
<td></td>
<td>Ventricular fibrillation</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td></td>
<td></td>
<td></td>
<td>Ventricular tachycardia</td>
</tr>
</tbody>
</table>
Validation – 48-hour Mortality or Discharge to Hospice
Use of RI as an Early Warning System

• RI model has been published in peer-reviewed literature

• The hospital software is commercially available on a subscription basis

• The RI is available for researchers without fee
Implementation at Houston Methodist Hospital

• History of starts and stops
• Used selectively for post event review
• Renewed interest in 2014
• Began as nurse driven initiative with interdisciplinary quality steering committee (July 2014)
• Selected 11 pilot units

• Partnered with vendor of selected EWS
• Staff education and champion support
• Leader driven
• Change management through stories and data
• Daily communications on utilization
• Brought physicians in later
Utilizing the RI as an Early Warning System

• Graphically present a patient’s condition over time using the Rothman Index score. The RI integrates with EHR systems to automate data inputs and visualization.

• The color coded background indicates the RI ranges and adjusts based on rules.
Implementation at Houston Methodist Hospital

- Leveraged the impact of visible data
- EWS reviewed by nurse five times per 24 hour period
  - Bedside handoff at change of shift (in the morning and evening)
  - Care Coordination Rounds
  - Mid-shift (for day and night shift)
Implementation at Houston Methodist Hospital

- Escalation algorithms implemented
  - Call Clinical Emergency Response Team
  - Call Physician
  - Administer medication, O2, treatments
  - Increased surveillance-VS, labs, assessments
- Built momentum through stories and outcomes
- Reported outcomes to Quality Committee of the Board of Trustees, System Quality Council and various nursing and medical staff forums
- 7 additional units implemented in July 2015
- Phase 3, November 2015, remaining units implemented
- Nurse Practitioner oversight implemented
Clinical Outcomes
Jan 2014 - Jun 2015 (9 months pre-RI, 9 months post-RI)

- **30%** decrease in mortality rate (1.34% to 0.93%) in original 11 units before and after implementation
- **32%** lower mortality index (0.70 to 0.48) in original 11 units before and after implementation
- **8%** lower sepsis mortality index (0.77 vs 0.84) when compared to non-Rothman units
Risk-Adjusted Mortality Outcomes

- Risk-adjusted mortality decreased 32% on 11 units after RI implementation (0.70 to 0.48), p-value<0.001
- Non-RI units were unchanged over the same period
- Study analyzed 33,797 encounters

RI Implementation Process Began

<table>
<thead>
<tr>
<th>Period</th>
<th>Rothman Units</th>
<th>Non Rothman Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014 Q1-Q3</td>
<td>0.70</td>
<td>0.71</td>
</tr>
<tr>
<td>2014 Q4</td>
<td>0.49</td>
<td>0.70</td>
</tr>
<tr>
<td>2015 Q1</td>
<td>0.44</td>
<td>0.73</td>
</tr>
<tr>
<td>2015 Q2</td>
<td>0.49</td>
<td>0.62</td>
</tr>
</tbody>
</table>

HMH DataMart, Prepared by HMH Service Line Analytics (pt) ©HIMSS 2016
Clinical Outcomes
Nurse Practitioner Oversight

**PROCESS**
- Nurse Practitioners reviewing Swim Lanes each night
- Nurse Practitioners assessed each risk patient

**OUTCOME**
- Over 2,500 patients identified at risk (6 months)
- 5% of time RN/M.D. not aware of decline (132 patients)
- 4 patients were immediately coded
- 10% required further intervention (266 patients)
77 Lives Saved
over 9 months in 11 Rothman units
Potential Applications

• Patient Assignments
• Level of Care Decisions
  – Transfer from ICU to acute care
  – Transfer to post acute care
  – Discharge home
• Code and Emergency Response Review
• Auto page to Physicians/NP
• Post Event Review
• Patient and Family Education
• End of Life Decision Making
• Patient Risk Models
A Summary of How Benefits Were Realized for the Value of Health IT

Satisfaction
-Nurses highly satisfied, confident and engaged in outcomes

Treatment/Clinical
-Reduction in mortality and mortality index before and after
Questions

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