Surveillance Monitoring at Dartmouth-Hitchcock

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Disclosures

• Sue McGrath: No disclosures.
• George Blike: No disclosures.
• This presentation includes data from a before-and-after study at Dartmouth-Hitchcock Medical Center, which in December 2007 installed Masimo’s Patient SafetyNet system. Masimo has supported the Hitchcock Foundation, which helped to fund this research.
Value-Based Care:

- **Safe Care** - Eliminating iatrogenic patient harm
- **Appropriate & Effective Care** - Achieving the best outcomes that patients want and need
- **Excellent Experience** - Culture of caring and empathy
- **Cost Effective** - Efficient with no waste
Failure to Rescue—Conceptual Model

Early signs and symptoms of physiological deterioration

Cascading “domino” physiological derangement

Terminal processes of multisystem organ failure and death

Increasing Physiological Instability

Hospitalization → Complication → Arrest → Death

Active Prevention Research → Limited Research → Active Late-Stage Research
Failure to Rescue (FTR)

• *Failure to rescue* – failure to detect and manage a clinically important deterioration, such as death or permanent disability from a complication of an underlying illness (e.g., cardiac arrest in a patient with acute myocardial infarction) or a complication of medical care (e.g., major hemorrhage after thrombolysis for acute myocardial infarction).

• FTR Rate = Death/1000 Complications

• 9 complications considered

Source: AHRQ definition @ http://psnet.ahrq.gov/popup_glossary.aspx?name=failuretoreduce
FTR drives hospital mortality rates

Ghaferi, Birkmeyer et. al.; *Annals of Surgery* • Volume 250, Number 6, December 2009
Environment at DHMC in 2006

Recognition that:

• Risks associated with anesthesia in post-op environment were under-emphasized in relation to potential impact
• Presence of technology was increasing, increasing complexity of the environment (PCA installation)
• Nurse-to-Patient ratios were changing, and more tasks were being added to individual nurse task load
• Prevention of circumstances leading to deterioration is not possible
• Rapid Response Teams were only part of the solution
Prior Work: ARTEMIS Field Triage System

Physiologic monitoring, state determination via triage algorithm, state communication

Soldier or Emergency Responder

Medic or EMT

Assessment, interaction, intervention decision

Processor Unit (Gumstix or PDA)

Pulse Oximeter

Headset

GPS

Wireless Memory

DHMC Lebanon, NH
25,000 Inpatient Discharges
90,000 Inpatient Days
8,500 Intermediate Care Days
24,000 ICU Days
30,000 ED visits
Inpatient Surveillance Model

- Mental model
- Knowledge
- Capacity

Reference Signal → Measured Error → Controller → System Input → System Output

- Interventions
- Devices

- Measurement devices
- Observations
- Algorithms

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Patient Surveillance System Implementation

- Data-based Change Management
- Component selection
  - Pulse oximetry
  - Continuous monitoring
  - All inpatients
- Workflow analysis & integration
- Education
- Rounding
Alarm Design and Management

- Leveraged design approach from other industries
- Wide Default thresholds (airbag settings)
  - SpO2 < 80%
  - PR < 50 BPM
  - PR > 140 BPM
- Averaging, directed notification and delays (e.g., SpO2)
  - 15 sec audible alarm at the bedside
  - + 15 sec for nurse pager annunciation
  - + 1 min sec for buddy/charge nurse pager escalation
- Threshold adjustments
  - +/- 10% by nurse
  - Provider order (condition monitoring)
Alarms

• Typical alarm rates between two and four per patient per 12 hour shift.
• Sample analysis of pager notifications indicates that over 85% of all alarm conditions are resolved within 30 seconds and over 99% before escalation is triggered.
• Observations and alarm duration analysis suggest that the vast majority of audible-only alarms occur with the nurse at the bedside during system set up and sensor application.
• Units where leadership actively encourages staff to incorporate trend analysis and integration of continuous vital signs monitoring into the patient assessment activities tend to have lower overall alarm and pager notification rates.
Alarm Management

We do not focus on sensitivity, specificity and predictive value calculations

- Time intensive data collection
- True/False Positive/Negative characterizations are highly subjective due to complexity of tasks, feedback loops, nurse experience, perception of alarms, and many other factors
- Context is critical- in a review of reported safety events (2012-2014) there were twice as many reports indicating that the “sensor off” alarm provided helpful patient state information as for any other category of report related to the surveillance system.
Alarm Management

Instead we focus on understanding the benefit/burden considerations and focus on using our limited resources on broad tactics such as:

- Ensuring standardization of configurations and practices via policies and procedures
- Providing bedside education around device operation and troubleshooting
- Encouraging education around appropriate integration of monitors for patient state assessment
FTR System Development Timeline

2006  Rapid Response Team
Jan 2007  Institutional Outcome Data
Dec 2007  PSS on Orthopedics (Pilot unit)
Feb 2009  PSS on all Surgical Units
Apr 2010  PSS on all Medical Units
Feb 2012  PSS on Pediatrics
Mar-Apr 2012  PSS with acoustic respiratory sensors

PSS: Patient Surveillance System – the Dartmouth implementation of Patient Safey Net™
Pilot Performance

In a comparison of 11 months prior to and 10 months after implementation in a 36-bed orthopedic unit:

- 50% reduction in transfers to higher levels of care
- 60% reduction in rescue events

There was no significant difference in these metrics in either of 2 comparison units during the same time period.

Pediatric Implementation

Pilot Unit 8 Years Later

**HERT Activations**
per 1,000 patient days

**Code Activations**
per 1,000 patient days

**Life Safety Consults**
per 1,000 patient days

**Transfers to Critical Care**
Life Safety Consults and Rescue Team Calls Associated with Opioid Reversals in Surveillance Units, 2009-2015 YTD
Hospital-wide Code Distributions and Trends

% Arrests by Type

- Not Assigned
- Hemorrhaged leading to hypotension and arrest
- Not On List - Other
- Respiratory
- Brady
- VF
- VT
- Asystole/PEA

Codes

- 0.37/1000 pt days medicine units
- 0.11/1000 pt days surgical units

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Risk Assessment and Population Differences

Post Event Patient Disposition

COUNT OF RESCUE EVENTS

UNIT

1 East 1 West 2 East 2 West 3 East 3 West 4 West 5 West Pedi/Adol

- Step Down
- Critica Care
- Stayed in Room
- Not On List - Other/Blank
- Died

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Building on FTR research at D-H

Impact of Pulse Oximetry Surveillance on Rescue Events and Intensive Care Unit Transfers

A Before-and-After Concurrence Study

Andreas H. Taenzer, M.D., F.A.A.P.,* Joshua B. Pyke, B.E.,† Susan P. McGrath, Ph.D.,‡ George T. Blika, M.D.§

Postoperative Monitoring—The Dartmouth Experience

By Andreas H. Taenzer and George T. Blika

for the Dartmouth Patient Surveillance Group, with contributions by Susan McGrath, PhD, Joshua Pyke, BE, Michael Herrick, MD, CMH

A Review of Current and Emerging Approaches to Address Failure-to-Rescue

Andreas H. Taenzer, M.D., M.S.,* Joshua B. Pyke, B.E.,† Susan P. McGrath, Ph.D.‡
FTR Learning Lab—Rapid Learning/Innovation

Candidate Solutions

- **Tech-Early Detection**
- **People-Action Teams**
- **Integrated System-Resilience Engineering Principles**

1—Initial evaluation of solutions
2—Prototyping and sim-based testing
3—Element ready for integration and field testing

Ideal Rescue System

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Summary

• Continuous monitoring with pulse oximetry in general care settings has a positive impact on patient safety and is not cost prohibitive
• Benefit-burden analysis with respect to nursing tasks and cognitive impact remains positive
• Standardization and continuing education are key elements to maintaining results
• More work is needed to increase understanding of the socio-technical aspects of patient state assessment and response systems
Questions and Discussion