The case for Electronic ICU (eICU)

GROUP 3:
TODD JASCHKE
PETER MAGNUSON
MARC STEARMAN
CHI-ON WONG
Hospital Network Overview

- General Hospital is part of a network that consists of:
  - Five 250 bed regional community hospitals (Our Hospital)
    - Each with 10 ICU beds - mixed medical/surgical
    - Average ICU pt’s: 326 per year
  - One 500 bed tertiary Hospital
    - 25 bed ICU unit
    - Average ICU pt’s: 815 per year
  - Three 25 beds rural critical access hospitals
    - Each with 3 or fewer ICU beds

(Berenson, 2009), (Rufo, 2011), (willmith, 2012), (Zawada, 2009)
ICUs are a key element in hospital care where most fragile and complex patients are treated.

An aging population means more and sicker ICU patients.

Complex ICUs are best managed by intensivists.
Problem

- Our community hospital has no intensivists
- ICU care is delivered by Hospitalists
- Our current ICU severity adjusted mortality and Length of Stay (LOS) rates are trending above historical averages
- Critical need exists to expand our ICU capacity and improve care
eICU offers a new solution to health care reform through a new delivery model that provides a safer patient environment.

Objectives:
- Improve patient care
- Reduce mortality rates
- Reduce ICU patient LOS
- Control and reduce ICU related costs
- Implement best practices at more sites
- Reduce number of patient transfers
Business case

- **Ultimate Goal: Better Medicine**
  - Access to critical care intensivists 24x7
  - Standardization of ICU care delivery
  - Improved quality of care
  - Reduced LOS
  - Reduced total hospital and ICU mortality rates
- **Increased ICU case volume**
- **Increased patient retention rate**
Expected Business Results

- **Expected Business Result Stated in Measurable Terms**
  - Remote-based intensivist or nurse has electronic access to all electronic medical records, physiologic data, EKG waveforms, and lab results for all patients in an eICU monitored bed.
  - Improved clinical outcomes
  - ICU nurses have access to an intensivist nights, weekends, and designated holidays
  - Ten ICU beds will be monitored by eICU
  - Reduce the number of transfers out of General Hospital for ICU care.
  - eICU will assist General Hospital in providing statistics and reports on outcomes. Reports will be provided quarterly.
Our Customers (Stakeholders)

- Clinical Staff
  - Doctors
  - Nurses
  - Clinical Support Staff
    - Pharmacy
    - Labs
    - Radiology
  - Medical Records/HIM
- Administration/Senior Leadership
- IT
- Patients / Families
What Is Important To Them?

- **Clinical Staff**: Workload management/continuity of care, quality of service, minimal technical barriers
  - Doctors
  - Nurses
  - Clinical Support Staff
    - Pharmacy
    - Labs
    - Radiology
  - Medical Records/HIM
- **Administration**: Cost, resource management, best practices (JCAHO audits)
  - Board
  - Management
- **IT Staff**: Seamless technology integration, vendor support, security
  - General IT support (network support)
  - eICU specific staff
- **Patients / Families**: Safety and quality of care
Current state of ICU in our Hospital

- ICU beds - 4% of the total inpatient beds
- ICU cost - 26% of total hospital cost
- Complication rates above national averages for:
  - VAP – Ventilator associated pneumonia
  - Central-line catheter infections
- Mortality Rate
  - 2011 – 17.1%
  - 2010 – 16.8%
  - Historical average – 15.9%
- Average LOS in ICU
  - 2011 – 27.8 days
  - 2010 – 26.9 days
  - Historical average – 23.6 days

(Berenhotz, 2002), (Bernson, 2009), (Zawada, 2009)
• Dedicated remote team of intensivist/CCRN staff for our 10 bed ICU and for our network of 90 ICU beds across hospital network

• eICU staff model:
  ○ 24 x 7 x 365:
    ▹ 1 dedicated intensivist
    ▹ 3 dedicated critical care nurses
    ▹ 1 dedicated clerical support person
  ○ Available board certified specialty physicians:
    ▹ 6 subspecialists (nephrology, cardiology, pulmonology, trauma /surgery) with ICU experience
  ○ Adjunctive Team members
    ▹ Advanced nurse practitioners
    ▹ Pharmacists
Remote Off campus monitoring with Intensivist physicians and critical care nurses

- **Audio Monitoring**
- **Electronic Monitoring**
- **Video Monitoring**

Alert eICU staff of Possible Complications

eICU Staff Communicates with OnSite Staff members

eICU Staff Provides immediate care instructions until onsite specialists arrive

eICU bridge the information between staff hand-offs and transitions
eICU Technology

- ADT
- Lab
- Pharmacy
- Electronic Critical Care Management System
- CloverLeaf Interface
- 2 way voice streaming
- 1 way video streaming
- Off Campus Monitoring

- PACS
- Bedside Monitor
- EMR
- Archival System for patient data from all hospitals in network
- Smart Alerts
- Hand Written Beside MD notes on dot matrix papers

(Willmitch, 2012)
**eICU Benefits (Medium to Large Hospitals)**

<table>
<thead>
<tr>
<th>Benefits</th>
<th>IOM AIMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fewer transfers translates to higher physicians / nurse to patients ratio</td>
<td>Safety, Patient centric</td>
</tr>
<tr>
<td>Raw mortality rate lowered</td>
<td>Safety</td>
</tr>
<tr>
<td>Adjusted ICU length of stay lowered</td>
<td>Safety</td>
</tr>
<tr>
<td>Additional oversight provided access to expertise and proactive 24x7 monitoring of patients by intensivists</td>
<td>Safety, effective</td>
</tr>
<tr>
<td>Assist with implementation of standardized critical care process</td>
<td>Safety, effective</td>
</tr>
<tr>
<td>Automated performance audits</td>
<td>Timeliness, Efficient</td>
</tr>
<tr>
<td>Oversight by remote team result in more diligent protocol and evidence based medicine tracking by the local team</td>
<td>Effective</td>
</tr>
<tr>
<td>Apply evidence based best practice protocols to improve patient safety and outcomes</td>
<td>Effective</td>
</tr>
<tr>
<td>Local team can spend more time with families, counseling , and other administrative activities</td>
<td>Patient centric</td>
</tr>
</tbody>
</table>

(Berenhotz, 2002), (de vos, 2007), (Zawada, 2009)
# eICU Benefits (Small Rural Hospitals)

<table>
<thead>
<tr>
<th>Benefits</th>
<th>IOM AIMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction in the number of patients requiring transfer</td>
<td>Effective, Efficient</td>
</tr>
<tr>
<td>Families avoid long distance travel</td>
<td>Patient centric</td>
</tr>
<tr>
<td>Patients stay with local community with stronger support system</td>
<td>Patient centric</td>
</tr>
<tr>
<td>Help hospitals to make better triage decision, improved patient safety</td>
<td>Effective, efficient, safety</td>
</tr>
<tr>
<td>Cost savings for patients and payers</td>
<td>Effective</td>
</tr>
<tr>
<td>Physicians and staff are less stressful, enhanced staff comfort</td>
<td>Efficient</td>
</tr>
<tr>
<td>Patients from rural areas have equal access to quality critical care</td>
<td>Equitable</td>
</tr>
<tr>
<td>Patients receive 24x7 ICU monitoring for decrease mortality and length of stay</td>
<td>Timely</td>
</tr>
</tbody>
</table>

(Berenhotz, 2002), (de vos, 2007), (Zawada, 2009)
• "Soft" eICU Benefits
  ○ eICU monitoring equipment tracks and trends patient data and outcomes, the data can be retrieved and used for educational purposes, helping to disseminate best practices.
  ○ eICU staff can pull outcomes from patient charts and compile them into a format that can be presented to JC or CMS for quality reports.
  ○ Improved nurse satisfaction
    ▷ Most nurses report improvements in job satisfaction, because they can be certain another set of eyes is monitoring their patients. Younger nurses in particular appreciate the eICU because they can rely on the team’s expertise in situations where they are uncertain of what to do.
### eICU Performance Metrics

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Process Measures</th>
<th>Complication Measures</th>
<th>Access Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU Mortality Rate</td>
<td>S,F</td>
<td>Effective assessment of pain</td>
<td>P,F,T</td>
</tr>
<tr>
<td>% of ICU Patients with ICU LOS &gt; 7 days</td>
<td>S,F,E,T</td>
<td>Appropriate use of blood transfusions</td>
<td>S,F,E</td>
</tr>
<tr>
<td>Average ICU LOS</td>
<td>S,F,E,T</td>
<td>Prevention of ventilator associated pneumonia</td>
<td>S,F,E</td>
</tr>
<tr>
<td>Average days on mechanical ventilation</td>
<td>S,F,E,T</td>
<td>Appropriate sedation</td>
<td>S,F,E,P</td>
</tr>
<tr>
<td>Suboptimal management of pain</td>
<td>P,F,S</td>
<td>Appropriate peptic ulcer disease prophylaxis</td>
<td>S,F,E</td>
</tr>
<tr>
<td>Patient / family satisfaction</td>
<td>P</td>
<td>Appropriate deep venous thrombosis prophylaxis</td>
<td>S,F,E</td>
</tr>
<tr>
<td>Average costs per ICU day</td>
<td>E,T</td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

IOM AIMS: S=Safety, F=Effectiveness, P=Patient Centric, T=Timely, E=Efficient, Q=Equitable

(Berentwotz, 2002), (de vos, 2007)
## Selected Metrics Detail

<table>
<thead>
<tr>
<th>Structure Metrics</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of intensivists (per hour)</td>
<td>The average couple of hours per day that an intensivist is available within 5 minutes at the ICU,</td>
</tr>
<tr>
<td>Patient-to-nurse ratio (measured 3 times daily)</td>
<td>Number of ICU patients present compared to the number of qualified ICU nurses that are available</td>
</tr>
<tr>
<td>Strategy to prevent medication errors</td>
<td>Strategy to prevent medication errors measured by 10 items, yes or no</td>
</tr>
<tr>
<td>Measurement of patient/family satisfaction</td>
<td>Whether or not a registration of patient/family satisfaction is present</td>
</tr>
<tr>
<td>Suboptimal management of pain</td>
<td>Appropriate peptic ulcer disease prophylaxis</td>
</tr>
<tr>
<td>Patient / family satisfaction</td>
<td>Appropriate deep venous thrombosis prophylaxis</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Measures</td>
<td></td>
</tr>
<tr>
<td>Length of ICU stay</td>
<td>Days of ICU stay in a particular period compared to the total number of discharged patients</td>
</tr>
<tr>
<td>Duration of mechanical ventilation</td>
<td>Days of mechanical ventilation of the ICU patients compared to the total number of mechanical ventilated patients</td>
</tr>
<tr>
<td>Absolute number of interclinical transport</td>
<td>Total number of interclinical transported patients connected to capacity problems</td>
</tr>
<tr>
<td>Percent of days with all ICU beds occupied</td>
<td>Days of 100% bed occupation compared to the total number of days in the same period</td>
</tr>
<tr>
<td>Outcome Measures</td>
<td></td>
</tr>
<tr>
<td>Standardized mortality</td>
<td>A) Mortality rate in the ICU compared to the total number of ICU patients</td>
</tr>
<tr>
<td>Number of unplanned extubations</td>
<td>Number of unplanned extubations (per 100 ventilation days) in a period compared to the total days of mechanical ventilation in the same period</td>
</tr>
<tr>
<td>Incidence of decubitus</td>
<td>Number of ICU patients with incidence of decubitus, level 3 or 4 compared to the total number of treated patients in the same period</td>
</tr>
</tbody>
</table>
eICU Comparative Measures of Success

- **Mortality reduction**
  - Maine Medical Center – 20%
  - Sentara Healthcare – 27%
  - Avera Health System – 37%
  - University of Pennsylvania Health System – 46%
  - Lehigh Valley Health System – all cause mortality 5%

- **Length of Stay (LOS)**
  - Sentara Healthcare
    - medical ICU 5.62 → 4.64 days
    - surgical ICU 3.30 → 2.59 days
Risks and Issues with eICU

- Interoperability with existing health system
  - Advanced features such as smart pumps dependent on interoperability
  - Clinical data not accessible for outcomes and quality improvements
- Potential benefits may not justify the substantial upfront and ongoing operating costs
- Lack of third party reimbursement

- Onsite more preferable to offsite staff
- Bedside staff could provide better quality of care than remote staff
- Some study reports increase LOS because of additional inputs from eICU result in additional tests or consultations

(Berenhotz, 2002), (Morrison, 2010)
Despite the introduction of the eICU the attending physician still has ultimate control of patient management.

Success depends on the extent to which the eICU staff are allowed to intervene in the patient care.

More proactive eICU participation results in improved outcomes.

Takes time to build trust and coordination with the remote team.

Physicians need to see the remote team that can assist and facilitate with broader application of evidence based best practice medicine.
Solution Alternatives

• Hire additional Staff
  o Physicians → Board Certified intensivists
    ▪ Current shortage – < 15% of ICUs are able to provide intensivist care
  o Competing for resources – nationwide high demand
• Partner with competing hospitals to pool resources
Financial investment

- Capital, one-time operating and annual operating costs

Projected capital costs:

Expenses:

- Software licensing and implementation fees - $220K
- ICU equipment - $115K
- Network and infrastructure - $35K
- Non-licensing and implementation software - $25K
- Project management and consultants - $20K

= Total one-time capital cost - $415K

Ongoing operating cost - $40K/per ICU bed/yr (10 bed) = $400K
Payback ROI calculation

ROI will be seen from multiple improved financial, clinical & operational results:

- Increased patient volume, retention rates, and ICU patient severity
- The ability to retain patients that would have otherwise been transferred to tertiary care facility will increase ICU volume and severity of cases
- Decrease in overall hospital and ICU mortality
- Adherence to best practice, incidence of complications
- Decrease hospital and ICU Length of stay (LOS)
- Reduced high cost of ICU pt days – average 3:1 cost ratio
- Enable more accurate documentation and thus billing which increase collection for ICU services
Comparative ROI examples

- **Financial performance**
  - Avera Health System
    - $1.25 million – reduction in patient transfers
    - $8 million – reduction of ICU and hospital days
  - Maine Medical Center
    - $1,090,909 – savings/yr in RN turnover reduction
  - Resurrection Health Care
    - $11,200 – 7% reduction in blood transfusions
    - $3 million – 38% reduction in ICU L.O.S. over 6 months
  - Via Christi Health System
    - $240,000 – est avoidance in nonreimbursable patient care costs
  - University of Massachusetts Memorial Center
    - $5,000 – cost savings per patient
# Projected 3yr ROI Estimates

<table>
<thead>
<tr>
<th></th>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total one-time capital cost</strong></td>
<td>$415K</td>
<td></td>
<td></td>
<td></td>
<td>$415K</td>
</tr>
<tr>
<td><strong>Ongoing operating cost - $40,000 per ICU bed x 10 beds</strong></td>
<td></td>
<td>$400K</td>
<td>$400K</td>
<td>$400K</td>
<td>$1.2M</td>
</tr>
<tr>
<td><strong>Total Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$1.615M</td>
</tr>
<tr>
<td><strong>Decrease ICU LOS</strong></td>
<td></td>
<td>$230K</td>
<td>$310K</td>
<td>$390K</td>
<td>$930K</td>
</tr>
<tr>
<td><strong>Decrease non ICU LOS</strong></td>
<td></td>
<td>$180K</td>
<td>$180K</td>
<td>$200K</td>
<td>$560K</td>
</tr>
<tr>
<td><strong>Savings in clinical risk reduction interventions</strong></td>
<td></td>
<td>$80K</td>
<td>$90K</td>
<td>$100K</td>
<td>$270K</td>
</tr>
<tr>
<td><strong>Total Savings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$1.76M</td>
</tr>
<tr>
<td><strong>ROI = (Savings – Costs) / Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8.9%</td>
</tr>
</tbody>
</table>

*Based On Estimates From Similar Hospital Systems

(Rufo, 2011), (Wakefield, 2004), (Zawada, 2009)
Executive Summary

Problem
- ICU key element in hospital care
- ICU growth expected with aging population
- ICUs best managed by intensivists, but shortage limits ICU expansion and quality of care

Goal
- Mortality rates and LOS can be reduced by 24x7 intensivist managed ICUs

Solution
- eICU leverages intensivist coverage over more ICU beds
- eICU can provide valuable resource for hospitals needing to expand capacity and improve quality of care

Key Metrics
- ICU Mortality Rate
- Average ICU LOS
- Patient / family satisfaction
- Average costs per ICU day
- Availability of onsite intensivists (per hour)
- Patient-to-nurse ratio

Financial Cost
- Based on estimates for 10 ICU beds, we estimate a cost of $1.62M in the next 3 years:
  - One time implementation cost – $415K
  - Annual operating cost – $400K

Financial Benefits
- Based on estimates from hospitals of similar size, we an estimate of $1.76M savings in the next 3 years:
  - Decrease ICU LOS – $930K
  - Decrease non ICU LOS – 560K
  - Savings in clinical risk reduction interventions - 270K

Issues / Concerns / Dependencies
- Interoperability with existing health system
- Lack of third party reimbursement
- Bedside staff could provide better quality of care than remote staff
Appendix Slides

- State of ICUs nationwide
- Current state General Hospital
- Project scope
- Core Team
- Implementation options
- Project plan
- eICU monitoring
- References
State of ICUs Nationwide

- **Patients to staff data:**
  - 6 million patients admitted to ICU each year
  - Over 50% ICU beds are in small hospital
  - About 8% of ICU (300,000) annually receive care from remote intensivist
  - 1300 critical access hospitals serves millions of patients who have no access to critical care physicians
  - 40.1 / 100,000 subspecialists to patients in rural areas
  - 134.1 / 100,000 subspecialists to patients in urban areas

- **Beds = 10 % of total inpatient beds**
- **Cost = 30% of total hospital cost**
- **Mortality rates – 10 - 20%**
  - Overall, approximately 500,000 ICU patients die in U.S. each year

(Berenhotz, 2002), (Bernson, 2009), (Rufo, 2011), {Zawada, 2009)
State of ICUs Nationwide (cont)

- Intensivists
  - Increased demand
    - More need for ICU because of aging baby boomer population
  - Decrease supply
    - Teaching hospitals decreasing the size of their programs in critical care for financial reason
    - Working in other areas, ie Emergency Medicine or Burn units
      - Only 10% to 15% of hospital have full time intensivists
    - Reimbursement issues- many intensivists chose not to work in ICU
    - Hospitals with small units lack the economies of scale to support full time intensivists

(Berenson, 2009), (Rufo, 2011)
General Hospital Current State

- Fully integrated and functional components:
  - Fully integrated electronic medical records
  - Computerized Physician order entry
  - Nursing care plan management system
  - Picture archiving and communication system
  - Admission, discharge, and billing (ADT) system
  - Medication ordering system
  - Lab Information System
  - Clinical Decision Support System
eICU Monitoring Process

- eICU nurses monitor vital signs streaming from the bedside monitors
- Vital sign data process by eICU decision support software
- When detected early trends in deterioration, an alert is triggered
- eICU nurses evaluate the reason for the alert
- eICU nurses conduct assessment via the audio and video system, review of laboratory data
- Laboratory abnormalities detection
- Virtual Patient Rounds
- Recommendations on gaps in best practices
- Responding to requests from the bedside nursing and physician staff

Evaluation of Proprietary Alerts For Vital Signs
Project Scope

- eICU vendor evaluation
  - Request For Proposals (RFPs)
  - Evaluate RFPs
- Vendor selection
- Project team assignment
- Implementation Plan/Timeline
- System configuration
- Implementation
- Training
- User Acceptance Testing
- Ongoing evaluation
eICU Implementation Core Team

- Chair: Marc Stearman, CMIO
- Todd Jaschke, CIO
- Peter Magnuson, CFO
- Chi-On Wong, Director of Quality and Informatics

- The implementation is led by the medical office, as we want to build our eICU system based on clinical medicine based outcomes and quality
Possible Implementations Options Recommended From Literatures:

- **Category 1.** Initiate only emergent interventions for life-threatening conditions (e.g., cardiac arrest).
- **Category 2.** As in category 1 plus initiate minor non-emergent therapies (e.g., electrolyte replacement).
- **Category 3.** As in categories 1 and 2 plus maintain therapies in existing patient care plan (e.g., make adjustments in ventilator support and vasoactive regimen).
- **Category 4.** As in categories 1, 2, and 3 plus initiate new therapies as needed (e.g., evaluation and treatment of a new fever).

(Morrison, 2010)
## High Level Project Plan

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Target Begin Date</th>
<th>Target End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements Gathering</td>
<td>6/1/2012</td>
<td>7/1/2012</td>
</tr>
<tr>
<td>RFP Process</td>
<td>7/1/2012</td>
<td>8/1/2012</td>
</tr>
<tr>
<td>Vendor Finalists Site Visit</td>
<td>8/1/2012</td>
<td>8/15/2012</td>
</tr>
<tr>
<td>Vendor Selection</td>
<td>8/16/2012</td>
<td>8/29/2012</td>
</tr>
<tr>
<td>Engineering Requirements Document Signed by vendor and Hospital</td>
<td>9/15/2012</td>
<td>9/30/2012</td>
</tr>
<tr>
<td>Design of the vendor system</td>
<td>9/30/2012</td>
<td>10/10/2012</td>
</tr>
<tr>
<td>Engineering Design document signed by vendor and Hospital</td>
<td>10/10/2012</td>
<td>10/18/2012</td>
</tr>
<tr>
<td>Build implementation</td>
<td>10/18/2012</td>
<td>1/15/2013</td>
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<td>Build QA</td>
<td>1/15/2013</td>
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<td>User Acceptance</td>
<td>2/20/2013</td>
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<td>User Training</td>
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<td>Deployment</td>
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<tr>
<td>First Month Performance Report</td>
<td>4/15/2013</td>
<td>5/15/2013</td>
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<tr>
<td>6th Month Performance Report</td>
<td>9/15/2013</td>
<td>10/15/2013</td>
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<tr>
<td>12th Month Performance Report</td>
<td>3/15/2014</td>
<td>4/15/2014</td>
</tr>
<tr>
<td>Phase 1 Implementation to 5 Community Regional Hospitals</td>
<td>Q3 2012</td>
<td>Q2 2013</td>
</tr>
<tr>
<td>Phase 2 Integration with Tertiary Hospital</td>
<td>Q1 2013</td>
<td>Q3 2013</td>
</tr>
<tr>
<td>Phase 3 Implementation to 3 rural regional hospitals and other affiliated</td>
<td>Q3 2013</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>critical care hospitals</td>
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References


