Using Technology to Improve Patient Safety: Telemedicine, The Electronic Medical Record and CPOE

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Disclosure

Lehigh Valley Hospital has a preferred vendor arrangement with iMDSoft and participates in product development. Dr. Matchett has no personal financial relationship with iMDSoft
- 765 licensed beds
- 3 clinical sites
- 92 Level I ICU beds
  - Trauma
  - Neurosurgical
  - Burn
  - Cardiovascular
  - Med-Surg
- Clinical campus of Penn State University Hershey Medical Center
- 35,000+ inpatient admissions
- MICU named one of top 11 ICUs in the nation
- Level I Trauma Center
- Regional Cancer Center
- Regional Heart Center
- Nationally ranked by US News and World Report in 6 categories
- Named a one of top 10 health networks by Modern Healthcare
- ANA “Magnet” Hospital
Today’s Agenda

- Using Technology to Improve Patient Safety
  - ICU Telemedicine
  - Computer Physician Order Entry
  - The Electronic Medical Record

- The Tele-Intensivist program at LVH
  - The Advanced ICU

- Effectiveness of LVH Tele-Intensivist Program
  - Clinical Outcomes
  - Patient Safety Data

- Lessons Learned
Demand for ICU Services in US

- 8-12% of hospital beds in US are ICU beds
- 4.4 million ICU admissions per year
- 25% of hospitalized adults spend at least 1 day in the ICU
- 1% of US GDP spent on ICU care
Critical Care in the USA

- Demand for ICU care

- Supply of critical care providers
  - Intensivists
  - Critical care nurses

- Patient safety initiatives
**Intensivist Staffing**

- Mandatory Intensivist consultation
  - 18%-38% reduction in hospital mortality
  - 25%-50% reduction in ICU mortality
  - 14%-51% reduction in ICU LOS
    - *Provonost et al. JAMA 2002;288:2151*

- Only 23% of ICU patients in US managed by a full-time intensivist
Intensivists

Projected Hospital RN FTE Supply and Demand (Thousands)

Demand for RNs expected to double across next two decades

Supplies of RNs expected to level off after 2010

Enrollments and Graduations, American Association of Colleges of Nursing 2001
Patient Safety Initiatives
Implementation of Leapfrog Standards

- Survey of 633 hospitals (Sept 2003)
  - 22% met ICU staffing standards
  - 4% fully met CPOE standard

Using Technology to Improve Patient Safety

- ICU Telemedicine
- The Electronic Medical Record (EMR)
- Computer Physician Order Entry (CPOE)
Leapfrog Intensivist Staffing

**Key Requirements**

- Intensivist board certified / board eligible in Critical Care Medicine
- Intensivist present in the medical ICU at least 8 hours per day providing care exclusively to ICU patients
- Returns 95% of pages within 5 minutes
Leapfrog initiatives to drive great leaps in patient safety

Leapfrog purchasers are advancing the three initial methods to improve patient safety:

1. **Computer physician order entry (CPOE)**
2. **Evidence-based hospital referral (EHR)**
3. **ICU physician staffing (IPS)**

These patient safety practices are well suited to purchasing standards because:

1. There is scientific evidence that these standards would significantly reduce avoidable danger.
2. Their implementation by the health industry is feasible in the near term.
3. Consumers can readily appreciate their value.
Leapfrog Tele-Intensivist Standards

- Daily on-site Intensivist rounds
- All remaining hours (24-7) with telemedicine coverage
- Tele-Intensivist has immediate access to:
  - Real time physiologic data
  - Lab results
  - Medications
  - EKG’s, X-rays, notes
ICU Tele-medicine Outcomes

- Surgical ICU
- Two baseline periods, each about 3 months duration
  - Surgical intensivist involved in the care of ~ 30-40% of ICU patients
- Intervention period
  - 3 months
  - Intensivist made daily bedside rounds
  - Telemedicine rounds made on patients ~ every 2 hours except midnight to 6AM when patients were evaluated on an as needed basis

Rosenfeld et al. CCM 2000;28:3925
# ICU Tele-medicine Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Baseline 1</th>
<th>Baseline 2</th>
<th>Intervention</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>225</td>
<td>202</td>
<td>2.01</td>
<td>&lt;0.05</td>
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<tr>
<td>Hospital APIII O:P Mortality</td>
<td>1.07</td>
<td>1.02</td>
<td>0.71</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>% Patients with Complication</td>
<td>15.1</td>
<td>18.8</td>
<td>9.5</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>ICU LOS</td>
<td>2.71</td>
<td>3.06</td>
<td>2.0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Hospital LOS</td>
<td>9.18</td>
<td>10.11</td>
<td>9.28</td>
<td>NS</td>
</tr>
<tr>
<td>Total ICU Cost</td>
<td>11,157</td>
<td>12,239</td>
<td>8,417</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>
Effect of a Tele-medicine Program on Clinical and Economic Outcomes

- 10 bed MICU and 8 bed SICU in a 650 bed hospital

- Baseline Intensivist Consultation:
  - MICU-80%
  - SICU-35%

- Pre / post intervention measurements

Effect of a Tele-medicine Program: The Intervention

- Tele-medicine monitoring 19 hours/day (noon-7AM)
- Camera, microphone, speakers in all patient rooms
- Relational database contained clinical information
- All patients reviewed every 1-4 hours
- Monitoring unit responded to emergencies evaluated, new problems and coordinated care

**Effect of a Tele-medicine Program: Outcomes**

<table>
<thead>
<tr>
<th></th>
<th>All Patients</th>
<th>MICU</th>
<th>SICU</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>PRE</td>
<td>POST</td>
<td>PRE</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>1396</td>
<td>744</td>
<td>631</td>
</tr>
<tr>
<td><strong>Hospital Mortality</strong></td>
<td>180</td>
<td>70</td>
<td>125</td>
</tr>
<tr>
<td>(13%)</td>
<td>(9%)*</td>
<td></td>
<td>(20%)</td>
</tr>
<tr>
<td><strong>ICU LOS</strong></td>
<td>4.35</td>
<td>3.63*</td>
<td>5.62</td>
</tr>
<tr>
<td><strong>% LOS &gt;7 Days</strong></td>
<td>14%</td>
<td>15%</td>
<td>14%</td>
</tr>
<tr>
<td><strong>ICU Cost/Day</strong></td>
<td>$1648</td>
<td>$1411</td>
<td>$1303</td>
</tr>
</tbody>
</table>

“Because sometimes getting your car back is simply not enough”
The ICU Electronic Medical Record

- Structured standardized data
- May provide:
  - Interfaces w/ medical devices
  - Interface w/ Lab system
  - CPOE
  - Nursing documentation
  - Note-writing functions
- Foundation for ICU Tele-medicine
Observations During the Registration Phase for Both Intensive Care Information System (ICIS) and Paper Group

<table>
<thead>
<tr>
<th>No. (%) of Observations</th>
<th>Nursing Activity (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ICIS (%)</td>
</tr>
<tr>
<td>Patient care</td>
<td>1633 (61.0)</td>
</tr>
<tr>
<td>Documentation</td>
<td>385 (14.4)</td>
</tr>
<tr>
<td>Unit-related</td>
<td>89 (3.3)</td>
</tr>
<tr>
<td>Personal</td>
<td>568 (21.2)</td>
</tr>
</tbody>
</table>

Observations expressed as proportion of total number of observations in each group. Difference is displayed as ICIS(%) - Paper (%). For the difference between proportions, the 95% confidence interval (CI) is given. To provide an impression of the nursing activity during a shift, the proportions are recalculated to minutes, based on an 8h (480 min) shift.
Computer Physician Order Entry (CPOE)

- Automated medication ordering process
- Standardized, eligible orders
- Clinical decision support
  - Dosing guidelines
  - Allergy checks
  - Drug-lab value checks
  - Corollary orders
Percentage of Medication Orders with Doses Exceeding the Maximum

Data are the percentage of orders for doses exceeding the medication-specific recommended maximal dose according to year after the implementation of a computerized system for order entry by physicians. The application suggested a default dose and displayed only potentially appropriate options, but it did not check for overly high doses. Even so, the percentage of orders exceeding the recommended safe maximum fell by more than 80 percent over a three-year period.

CPOE and Timeliness of Service

- Med-surg ICU
- All timed urgent or STAT orders
- Median time interval between order and reported
  - Pre: 148 min
  - Post: 74 min
  - P<0.001

Thompson et al. CCM 2004;32:1306
Tele-Intensivist Program at Lehigh Valley Hospital

Why we chose MetaVision
What LVH Needed

- A critical care-specific electronic bedside medical record that supported CPOE
- Full integration of bedside devices with interfaces to other information systems
- Multi-variable monitoring algorithms
- Tele-medicine system
LVH Tele-Intensivist Program Infrastructure

- **MetaVision: ICU EMR**
  - Bedside EMR documentation
    - *Nursing, RT, Nutrition, MD Notes*
  - Interfaced data entry for
    - *Bedside devices*
    - *CPOE / Medications*
    - *Labs*
    - *ADT*
LVH Tele-Intensivist Program

Infrastructure

- MetaVision: Event Manager
  - Monitoring algorithms
    - *Physiologic*
    - *Process of care*

- Tele-medicine Overlay
  - digital video
  - full duplex audio
AICU Tour
AICU Operational Details

- Intensivist / ICU Nurse / Unit Clerk:
  - 7PM - 7AM, seven days a week

- LVH contracts with independent physician group
  - Medical Director
  - All physician shifts at an hourly rate
  - All AICU physicians must be board-certified critical care specialists

- No clinician works full time in AICU
  - Splits time between AICU & hands-on patient care
AICU Operational Issues, cont.

- **Current Service Area**
  - 72 patients in 7 ICUs in two hospitals
  - High acuity beds in 2 EDs
  - LTACH coverage

- **No professional fee revenue collected**
Return on Investment: A Broader Perspective
Return on Investment: A Broader Perspective

- Improved Clinical Outcomes
- Enhanced Clinical Operations
- Regional Considerations
- Patient Safety Initiatives
- Graduate Medical Education
- Recruitment / Retention
- Clinical Research
- Patient / Family Satisfaction
Nursing Telemedicine Survey
Reduction in Mortality

Pre-Implementation
Post-Implementation

Disagree Completely
Disagree Somewhat
No Opinion
Agree Somewhat
Agree Completely

N=57
Reduction in Complication Rates

- Pre-Implementation
- Post-Implementation

N=57
Improve Patient Safety

- Pre-Implementation
- Post-Implementation

Disagree Completely
Disagree Somewhat
No Opinion
Agree Somewhat
Agree Completely

N=57
Improve Treatment Response Time

- **Pre-Implementation**
- **Post-Implementation**

<table>
<thead>
<tr>
<th>Opinion</th>
<th>Pre-Implementation</th>
<th>Post-Implementation</th>
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<tbody>
<tr>
<td>Agree Completely</td>
<td>0</td>
<td>57</td>
</tr>
<tr>
<td>Agree Somewhat</td>
<td>0</td>
<td>12</td>
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<td>No Opinion</td>
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<tr>
<td>Disagree Somewhat</td>
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<td>0</td>
</tr>
<tr>
<td>Disagree Completely</td>
<td>0</td>
<td>0</td>
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</table>
Helpful to Practice

Pre-Implementation
Post-Implementation

Disagree Completely
Disagree Somewhat
No Opinion
Agree Somewhat
Agree Completely

N=57
Improved Clinical Outcomes

- Morbidity and Mortality
- Complications
- Time to Effective Treatment
Effect of ICU Telemedicine: Mortality

*Denotes statistical significance with $p < 0.05$

Pre: Nov 03 – Feb 04
Pre 2: July 04 – Oct 04
Post: Nov 04 – Feb 05
**Effect of ICU Telemedicine: Outcomes by Severity of Illness**

<table>
<thead>
<tr>
<th>Low Severity of Illness</th>
<th>Mortality Rate</th>
<th>ICU LOS</th>
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<tbody>
<tr>
<td>Pre 1</td>
<td>2/63 (3%)</td>
<td>1.85</td>
</tr>
<tr>
<td>Pre 2</td>
<td>1/61 (1%)</td>
<td>1.80</td>
</tr>
<tr>
<td>Post</td>
<td>0/70 (0%)</td>
<td>1.35</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Medium Severity of Illness</th>
<th>Mortality Rate</th>
<th>ICU LOS</th>
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</thead>
<tbody>
<tr>
<td>Pre 1</td>
<td>11/73 (15%)</td>
<td>2.1</td>
</tr>
<tr>
<td>Pre 2</td>
<td>12/75 (16%)</td>
<td>1.9</td>
</tr>
<tr>
<td>Post</td>
<td>5/72 (5%)*</td>
<td>2.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High Severity of Illness</th>
<th>Mortality Rate</th>
<th>ICU LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre 1</td>
<td>9/18 (50%)</td>
<td>1.5</td>
</tr>
<tr>
<td>Pre 2</td>
<td>5/18 (27%)</td>
<td>2.7</td>
</tr>
<tr>
<td>Post</td>
<td>11/21 (52%)</td>
<td>4.9</td>
</tr>
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*p=0.07*
Effect of ICU EMR, CPOE and Telemedicine on Nursing Workflow

Minutes per Nurse per 12 Hour Shift

+95
-20
-11
-20
-8
-36

Direct Care
Indirect Care
Administrative
Documentation
Housekeeping
Other

Computer Physician Order Entry
CPOE in the ICU
The LVH Experience

![Bar chart showing time to antibiotics before and after CPOE implementation. The chart indicates a statistically significant decrease in time to antibiotics post-CPOE implementation, with a p-value less than 0.01.]
Enhanced Clinical Operations

- Improved Bedside Workflow
- 24 / 7 Physician Triage of ICU Beds
- Increased surgical volume at LVH-M
  - The Vascular Surgery Experience
- Case Study: The Neurosurgical Program
  - A Model for the Future
Regional Considerations

- Regional Provider of Critical Care Services
  - Tele-Intensivist Outreach
  - ICU Management Services
  - Referral of Critically Ill Patients

- Regional Clinical Services
  - Non- ICU Referral Pattern
  - Other Tele-Medicine Services
Patient Safety Initiatives

- Network-Wide Leapfrog Compliance
- JCAHO Core Measures
- Compliance w/ Literature-Based Protocols
- Improved Response Time
  - Immediate Intensivist Availability
  - Monitoring Algorithms
The Risk Management Top 10

1) “Failure to Rescue”
2) “Change in Blood Pressure” events
3) Critical Lab Values
4) Medication errors
5) Antibiotics - Time to delivery
6) Electrolyte imbalance - Time to Rx
7) Notification of Physicians - documentation
8) Documentation of pulses
9) Incomplete nursing forms
10) Airway management supervision
Graduate Medical Education

- Supervised Clinical Decision-Making
- Expert Resource
- Patient Safety Implications
Recruitment / Retention

- Critical Care Nursing
  - mentoring of less experienced nurses
  - improved job satisfaction
- Respiratory Therapy
  - expanding scope of practice at night
- Intensivists
  - short term:
    - “This is cool”
  - long-term:
    - “How am I gonna do this for 25 years???”
Clinical Research

- Case Finding
  - Monitoring algorithms
- Enrollment / Consent
- Research Subject Safety
- Protocol Compliance
Patient / Family Satisfaction

- Better Care / Safer Environment
- Improved Communication
- Peace of Mind

- Press-Ganey
- Critical care Family Satisfaction Survey
Lessons Learned

- Clinical Infrastructure
- Information Technology Considerations
- Metrics
- Clinical Workflow
- Network / Regional Considerations
- Trust

“How can I help you?”
Questions?
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