Using IT to control variability in practice and improve outcomes

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Disclosures: I am a co-inventor of two patient medical record products — one licensed to McKesson, Inc., and one licensed to Informatics Corporation of America — from which I receive royalties through Vanderbilt University. I am a director of HealthStream, a public company, compensated by an annual option grant.
One of the nation’s largest, fully integrated research intensive health systems on a university campus

- annual operating budget > $3.5B
- 4 Hospitals (1000 beds) – Children’s, Adult, Psychiatric, Rehabilitation
- 20,000 faculty and staff – largest private employer of Tennessee citizens
- 3000 faculty (MDs, PhDs) – all medical disciplines and sub-sub-sub specialties
  - 53,000 inpatient discharges
  - 2 M ambulatory visits
  - 50,000 surgeries
- NCI-Designated Comprehensive Cancer Center, National Centers of Excellence for Heart, Trauma, Neurosurgery, Diabetes, Transplant, Children’s care, many others…

- Discovery is Core. One of 10 largest NIH-funded biomedical research programs. Grants from government, industry exceed $0.5 B/yr
- University leader in HIT, nation’s largest Informatics faculty (70) and over 500 staff
- Coordinating Center for $0.5 Billion NIH CTSA clinical research network (60 universities)
Outline

- Getting the care right
  - Gap between “point” improvement & “whole system” performance
  - Building blocks of a “systems approach to care”
  - Case study - Vanderbilt’s approach to ventilator management
  - Applying systems engineering to healthcare

- Getting the technology right
  - Today’s healthcare IT expectation gap
  - Matching computational approach to complexity of data
  - Using improvement science to adapt technology

- Take home messages
The Healthcare Non-system

Experts Practice by Working around Systems

System Development
If a unit performs each of 7 practices 90% of the time, what is the probability that they will perform all 7 for a patient?

A. 90%
B. 75%
C. 50%
D. 25%
Systems Approach to Care

People + Process + Informatics = Systems

People:
- Compassion
- Pattern Recognition
- Judgment

Process:
- Simplification
- Standardization

Informatics:
- ↓ Memory Dependence
- ↑ Forcing Function

Systems:
- Reproducible Performance
Burning Platform: Overwhelming Complexity

Sets of Facts per Decision vs Human Cognitive Capacity

- Structural Genetics: e.g. SNPs, haplotypes
- Functional Genetics: Gene expression profiles
- Proteomics and other effector molecules
- Decisions by Clinical Phenotype

Systems Approach to Care

- Evidence-based Medicine
- Consistent Process
- Visualization of Results vs. Plan
- Iterative Improvement
- Outcomes
Mechanical Ventilation Orders

1. VENTILATOR SETTINGS CONTIN
   + NURSING: initiate ventilator associated pneumonia (VAP) weaning protocol (daily assessment of readiness to extubate)
2. DVT PROPHYLAXIS
3. ICU Stress Ulcer Prophylaxis orders
4. SPECIFY TARGET RASS
5. ICU SEDATION PROTOCOL

Nursing

6. ELEVATE HOB 30 degrees or greater
7. mouth care q2h per VAP protocol q2h per vap protocol
   + NURSING: Brush teeth q shift; oral suction swabs q2h; apply water-soluble mouth moisturizer PRN
Ventilator Mgmt Redesign (Draft Ideal Process) 1/27/07 Retreat

Orders
1. Physician orders Vent Mode and Settings
2. Physician orders "Standard Ventilator Practices"

Implementation of Bundle
1. Elevate head of bed
2. Place sign on bed
3. Document in HED vs notes

Stress Ulcer Prophylaxis
Oral: TPN, IV
DVT Prophylaxis
Pharm &/or Mechanical

Oral Care
1. Brush teeth
2. Hyposaline漱洗
3. Swabbing

Sedation mgmt
Seal Directed RASS vs. ventilation

Yellow Alert: Vent. Order Placed with out "Standard Ventilator Practices Orders" in place
Orange Alert: Patient started on Vent without "Standard Ventilator Practices Orders" in place

Real-time dashboard for all ventilator pts. in all ICUs
(with alerts to Unit Mgrs)

Outcomes
Iterative Improvement
Visualization of Results vs. Plan
Consistent Process
Evidence-based Medicine
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Intermediate Outcomes

Bundle Compliance vs VAP Rate

VAP Rate  z100  AVG Compliance
1. Number of Ventilator Acquired Pneumonia (VAP) Cases/Year at Vanderbilt

2. Impact on Results

<table>
<thead>
<tr>
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<th>Fiscal Year 2009 Results c/w 2008</th>
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<tbody>
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<td>VAPs Prevented</td>
<td>108</td>
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<tr>
<td>Deaths Avoided</td>
<td>16</td>
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<tr>
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<td>$4.3M</td>
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<tr>
<td>Hospital Days Avoided</td>
<td>1055</td>
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<tr>
<td>ICU Days Avoided</td>
<td>431</td>
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3. Mortality for Vanderbilt Ventilator Patients Compare to all the other Hospitals – Best in the U.S.
Continuous Improvement

Number of Ventilator-Associated Pneumonia (VAP) Cases/Year at Vanderbilt University Hospital

VAP Events

- Standard Order Set: 302 → 269 → 240
- Visual Cue: 146 → 141 → 99 → 55 → 24

Mortality compared to all other University Hospitals – Best in the U.S.

<table>
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<tr>
<th>VAP Events</th>
<th>Jan 2008 – June 2012</th>
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<tbody>
<tr>
<td>VAPs Prevented</td>
<td>580</td>
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<tr>
<td>Deaths Avoided</td>
<td>87</td>
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<tr>
<td>Hospital Days Avoided</td>
<td>5,675</td>
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<tr>
<td>ICU Days Avoided</td>
<td>2,317</td>
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</table>

Estimated VU Savings: $23,000,000

Source: UHC and Vanderbilt Data
Systems Engineering Methods

- Outcomes
- Spiral Development
- System Control
- System Design & Analysis
- System Definition
Systems Approaches to Care

Pick Population
- Risk
- Cost
- Variability

Evidence
- Research
- Guidelines
- Practice database

Workflow
- People’s roles
- Process
- Technology Tools

System Development

System-supported Practice

Individualize & Act
- Assess
- Plan
- Order

Monitor & Correct

Process
- Sentinel Events
- Process Outcomes
- Clinical Outcomes

Patient
- Status
- Results
- Trends

Challenges to applying systems engineering to healthcare

- **System Development**
  - Evidence
    - Research
    - Guidelines
    - Practice database
  - Workflow
    - People’s roles
    - Process
    - Technology Tools

- **System-supported Practice**
  - Individualize & Act
    - Assess
    - Plan
    - Order
  - Monitor & Correct
    - Process
      - Process Outcomes
    - Patient
      - Status
      - Results
      - Trends

- **Workflow**
  - People’s roles
  - Process
  - Technology Tools

- **System evolves as we learn**
  - Human judgment is in the loop

- **Stratify Population**
  - Risk
  - Cost
  - Variability
Central Conclusions

• Current efforts aimed at nationwide deployment of HCIT will not be sufficient to achieve the vision of 21st century health care, and may even set back the cause…
• Success will require emphasis on providing cognitive support (assistance for thinking about and solving problems).
• In the near term, embrace measureable health care quality improvement as the driving rationale for HCIT adoption efforts.

Principles to Support Change

• Record all available data to drive care, process improvement, and research
• Architect information and workflow systems to accommodate disruptive change
• Archive data for subsequent re-interpretation
• Seek and develop technologies that clarify the context of data
Root cause: Mismatch between Computational Technique & Scale of Problem

Decouple Data from Interpretation

- Work at multiple scales
- Triangulate multiple signals for robustness

Satellite

Rain Gauge

Doppler Radar
<table>
<thead>
<tr>
<th>OLD</th>
<th>NEW</th>
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</thead>
<tbody>
<tr>
<td>One integrated set of data</td>
<td>Sets of data from multiple sources</td>
</tr>
<tr>
<td>Capture data in standardized terminology</td>
<td>Capture raw signal and annotate with standard terminology.</td>
</tr>
<tr>
<td>Single source of truth</td>
<td>Current interpretation of multiple related signals</td>
</tr>
<tr>
<td>Seamless transfer among systems</td>
<td>Visualization of the collective output of relevant systems</td>
</tr>
<tr>
<td>Clinician uses the computer to update the record during the patient visit.</td>
<td>Clinician &amp; patient work together with shared records and information.</td>
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<tr>
<td>The system provides transaction-level data.</td>
<td>The system provides cognitive support.</td>
</tr>
<tr>
<td>Work processes are programmed and adapt through non-systematic work around.</td>
<td>People, process and technology work together as a system.</td>
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</table>

Match Computational Approach to Complexity of Data

Abstraction Generalization

Model

“formal relationship”

Feature Set

“package of related attributes”

Attribute

“structured information”

Data

“raw signal”

Observation

One Instance
Use Improvement Science to Adapt EHRs

- **Ease of Learning**
  - Set of functions a role needs to do, training time, time to peak efficiency

- **Ease of Use**
  - Time to complete & error rate for standard tasks, sensitivity & specificity for standard information-seeking tasks

- **Cognitive Support**
  - % of users handling new information correctly for a set of standard patients

- **Adaptation to Change**
  - Time from issuance of an urgent drug interaction update to its deployment in 80% of operational systems

- **Effectiveness**
  - % of alerts overridden by role, % of ADEs following an alert override, % of ADEs in absence of an alert
Take Home Messages

- Focus on what you need to improve, not external measures
- Use measurement driven, iterative cycles to create self correcting sustained improvement
- Use a common fact base to drive agreement
- Target 100% performance across the set of practices appropriate to a patient
- Combine people, process and technology to get the desired result