Finding the Data Scientist and Decision Support Expert in Every Anesthesiologist: Sharing Talents Beyond the OR

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Disclosures

None related to this presentation


McCormick PJ et al: Anesthesiology 2016 in press
Anesthesia Proportion of Surgical Mortality

- Lagasse estimate:
  - <2% of surgical mortalities

- IOM estimate:
  - 0.03% of surgical mortalities

The New York Times

“Anesthesia has gotten remarkably safe in recent decades, with roughly one death occurring in every 200,000 to 300,000 cases in which anesthetics are administered during surgery, childbirth or other procedures.”

“From a patient’s point of view, it would seem preferable to have a broadly trained anesthesiologist perform or supervise anesthesia services, but, in truth, the risk is minuscule either way.”

“Who Should Provide Anesthesia Care?” September 6, 2010
The Mount Sinai Hospital: Academic Core of the Mount Sinai Health System | 1852 - 1904

- Founded in 1852, Mount Sinai is one of the oldest and largest not-for-profit hospitals in the United States.
- In 1904, the hospital moved from its founding location at 138 and 140 West 28th Street to its present site between Madison and Fifth Avenues, spanning 98th to 102nd street.

The Mount Sinai Health System: Key Statistics

Health Systems vs. Stand-Alone AMC

Bond Rating Distribution

Health Systems vs. Stand-Alone

Source: S&P U.S. NFP Health Care Sector Outlook, 2013

Ratings as of 07/10/2013
Economic Drivers of Health Care

- Personnel (FTE’s): MD’s RN’s, extenders, support staff
- Expensive resources
  - Hospital care, especially critical care
  - Emergency Departments
  - Post-acute care: SNF, LTACH, Home Care
  - Supplies: Drugs and remainder of supply chain
  - Capital costs of aging infrastructure

Value Metrics

- Observed-to-expected mortality and complication rates better than benchmarks
- Beyond external measures: Infectious complications, length of stay, readmissions
- Controlling costs: ICU and hospital stay; blood, laboratory, radiology, consultations, post-acute care

Why Value?

\[
\text{Value} = \frac{\text{Quality} \times \text{Safety} \times \text{Satisfaction}}{\text{Cost}}
\]
A National Transition to Value-Based Reimbursement

CMS Timeline Expects By 2018, 50% of Payments in Alternative Payment Models:
- Payments linked to alternative payment models
- Fee-for-Service ("FFS") linked to quality
- All Medicare FFS

<table>
<thead>
<tr>
<th>Year</th>
<th>Historical Performance</th>
<th>Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>~70%</td>
<td>30%</td>
</tr>
<tr>
<td>2014</td>
<td>~20%</td>
<td>50%</td>
</tr>
<tr>
<td>2016</td>
<td>&gt;80%</td>
<td>30%</td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td>90%</td>
</tr>
</tbody>
</table>

Goals - 2018:
- ~80% Payments linked to alternative payment models
- >80% Fee-for-Service ("FFS") linked to quality
- 90% All Medicare FFS

Source: Centers for Medicare and Medicaid Innovation ("CMMI") Center, Bundled Payment Summit, June 2015

2017 CMS Programs at Maximum Risk - 6%

Pay-for-Performance Programs
- Affordable Care Act (ACA) mandated
  - Value-Based Purchasing (VBP) Program
  - Hospital Readmissions Reduction Program (HRRP)
  - Hospital Acquired Conditions Reduction Program (HAC/SA)

National programs increase financial risk each year:

Programs Risk

Percentage Revenue at Risk by Commercial Payer:
- Aetna – 2%
- Cigna – 2%
- Emblem Health (currently undetermined)
- Empire QHP – 4%
- HealthFirst – pmpm dollars scaled based on star rating
- United Healthcare – 3%

Percentage Revenue at Risk by CMS:
- VBP – 4%
- HRRP – 3%
- HAC – 1%
2. Data excludes GIP Hospice
3. Includes Principal and Secondary coded diagnosis of sepsis
4. Control Limits Jan 2012 – Dec 2013, UCL & LCL 3 STD

### Palliative Care Enhancement

<table>
<thead>
<tr>
<th>Year</th>
<th>PCU Admits</th>
<th>% of PCU Patients Who Died on PCU</th>
<th>% of all PCU Patients Who are MSVNS Hospice</th>
<th>% of Patients Who Died on KP6 that are Hospice</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>273</td>
<td>66.8%</td>
<td>3.4%</td>
<td>5.3%</td>
</tr>
<tr>
<td>2012</td>
<td>537</td>
<td>63.3%</td>
<td>46.1%</td>
<td>62.3%</td>
</tr>
<tr>
<td>2013</td>
<td>582</td>
<td>73.9%</td>
<td>40.1%</td>
<td>82.7%</td>
</tr>
<tr>
<td>2014</td>
<td>648</td>
<td>74.3%</td>
<td>61.6%</td>
<td></td>
</tr>
</tbody>
</table>
Blood Utilization

External Benchmarking: Society of Thoracic Surgeons

MSH RBC Units per Discharge
Hyperkalemia CDS

Adel Bassily-Marcus, MD
Director of Critical Care Informatics

VoIP Communication Device

- A notification is set to Vocera if no action is taken for 60 minutes after a potassium value of 6.0 or greater has resulted.
- Analyzed time from K+ to treatment for three 9 month periods: No alerts, BPA alerts, BPA + Vocera alerts.

Risk adjusted time to treatment

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Mean Time (95% CI), min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior BPA</td>
<td>190 (141-258)</td>
</tr>
<tr>
<td>BPA</td>
<td>156 (117-208)</td>
</tr>
<tr>
<td>BPA + Vocera</td>
<td>145 (108-196)</td>
</tr>
</tbody>
</table>

A Real-time Next Generation Health Platform

The MSHS Data Science Team has created a real-time AI platform that:
- Harnesses data flowing through the health system
- Creates actionable outputs delivered directly into the EMR and other standard tools
- Has proven results for 5 use cases in 4 hospitals
Building the AI models

Historical Clinical Data → Prototyping, Development, & Validation → Predictive Engine

Machine Learning Platform

Deployed Predictive Models

- Malnutrition
- Falls
- Delirium
- Deterioration
- Discharge Planning
Malnutrition: Identifying and Evaluating Malnourished Patients

1. Situation – Dieticians were missing patients that were malnourished:
- Patient safety and outcome
- Operational impacts
- Financial impacts

2. Goal – Better identify patients likely to be malnourished and prioritize seeing them.

3. Action – Train a machine learning/AI model to identify malnutrition and deploy in a real-time platform.

4. Result – All patients receive daily malnutrition scores. Dieticians evaluate patients with the highest scores.

Malnutrition: Consistent Performance Across Hospitals

<table>
<thead>
<tr>
<th>Facility</th>
<th>Population Size</th>
<th>Threshold</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>Precision</th>
<th>F1 Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSH</td>
<td>6710</td>
<td>0.53</td>
<td>0.69</td>
<td>0.75</td>
<td>0.47</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td>MSSL</td>
<td>1343</td>
<td>0.44</td>
<td>0.71</td>
<td>0.7</td>
<td>0.53</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>MSW</td>
<td>1513</td>
<td>0.4</td>
<td>0.71</td>
<td>0.64</td>
<td>0.65</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>MSQ</td>
<td>1417</td>
<td>0.5</td>
<td>0.67</td>
<td>0.67</td>
<td>0.5</td>
<td>0.57</td>
<td></td>
</tr>
</tbody>
</table>

Malnutrition: AI Learning Makes the Model Better

AUCPR Curve

AUCROC Curve
1. **Situation** – Patients sometimes deteriorate clinically, resulting in ICU transfer or even death.

2. **Goal** – Better identify patients likely to deteriorate and notify the primary care team and Rapid Response Team accordingly, before they deteriorate.

3. **Action** – Train a machine learning/AI model (MEWS++) to identify clinical deterioration and deploy it on the real-time platform. Send text and voice pages to clinicians.

4. **Result** – Randomized Controlled Trial (ReSCUE-ME, NCT NCT04026555) in progress. 1134 patients enrolled to-date. Estimated enrollment 20,000 patients over 2 years.

**ReSCUE-ME: Preventing Deterioration Before It Happens**

**ReSCUE-ME: Smart Clinician Alerts**
### Potential Annual Value of Current Initiatives

<table>
<thead>
<tr>
<th>Use case</th>
<th>Description</th>
<th>Value drivers</th>
<th>ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malnutrition</td>
<td>Identifies potentially malnourished patients. Directs care to vulnerable patients.</td>
<td>Fewer complications, improved revenue, if diagnosed correctly.</td>
<td>$12M</td>
</tr>
<tr>
<td>Falls</td>
<td>Automated risk assessment tool for risk of inpatient falls</td>
<td>Preventing falls to reduce hospital risk</td>
<td>$3M</td>
</tr>
<tr>
<td>Clinical Deterioration</td>
<td>Predicts which patients are likely to deteriorate in the next 6 hours</td>
<td>Avoided ICU days (cost) ICU backfill (revenue)</td>
<td>$8M/1</td>
</tr>
<tr>
<td>Delirium</td>
<td>Identifies hospitalized patients at greatest risk for acute delirium. Prioritized patients for Hospital Delirium Program</td>
<td>More accurate diagnosis for improved care (revenue)</td>
<td>$8M</td>
</tr>
<tr>
<td>Excess days</td>
<td>Identifies patients likely to be discharged within 48 hours to help prioritize discharge planning activities and reduce excess days</td>
<td>Reduced inpatient days (cost) inpatient backfill (revenue)</td>
<td>$9M</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$40M</td>
</tr>
</tbody>
</table>

The Future: More Data, More ML, More AI

- Imaging reports, physician notes, outpatient data
- Deployment at all MSHS hospitals
- Potential commercialization
- Natural Language Processing (NLP), Neural Nets, Image Analysis
- Learning models with staff engagement
- Cloud computing and hybrid models

Conclusions

- Population Health
  - Decision support for physicians and extenders
  - Precision Medicine
  - Win at the bundles and value-based episodic care
    - Control laboratory, imaging, consultation, and pharmacy costs
    - Positively affect outcome and prevent readmissions
  - Reduce negative outcomes of clinical and financial concern
    - Avoidable harm, including infections
    - Rapid response teams, home hospital, tele-health
  - Moving palliative care upstream
  - Make AI applications relevant to value-based care
Thank You