Using Predictive Analytics and Machine Learning to Lower Systemwide Readmissions

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Learning Objectives

• Recognize the role of leadership and multidisciplinary collaboration in reducing all-cause readmission rates.

• Describe how to use machine learning and predictive analytics to identify patients at high risk of readmission and guide clinical improvement efforts.

• Indicate how to effectively apply Lean methodology to achieve systemwide improvement.
Poll Question #1

How effective are your organization’s efforts to reduce all-cause readmissions?

1) Not effective
2) Somewhat effective
3) Moderately effective
4) Very effective
5) We are not focusing on it
6) Unsure or not applicable
We believe we must provide patients efficient, value-added, effective, and patient-centered care during and after discharge from the hospital—which in turn, will reduce hospital readmissions and lower costs.
Among Medicare patients, 20% are readmitted within 30 days.*

Total cost: $26 billion annually. Of which $17 billion is considered avoidable.

* Among Medicare patients
Building on a legacy of patient care that began in 1906, the University of Kansas Health System in Kansas City is a world-class academic medical center and destination for complex care and diagnosis.

- Leader in medical research and education.
- 773-bed general medical and surgical facility.
- FY 17 Volumes:
  - 39,000 discharges.
  - 55,000 surgeries.
  - 53,000 emergency department (ED) visits.
  - 950,000 ambulatory encounters.

The University of Kansas Physicians (UKP), the largest multi-specialty group practice in Kansas, are researchers and educators expanding the boundaries of medical knowledge.
High readmission rates:
Affect hospital reimbursement.
Negatively impact the patient experience.

The critical time for intervention for an acute illness:
Is when the patient is in transition between inpatient and outpatient phases of treatment.

Readmission rates have been established as a basis for comparing hospital performance.

Readmissions are expensive, and consume a disproportionate share of expenditures for inpatient hospital care.

A readmission may result from:
Incomplete treatment.
Poor care of the underlying problem.
Poor coordination of services at the time of discharge and afterwards.

Hospital readmissions may result from actions taken or omitted during the initial hospital stay.
Defining Our Readmissions Problem

1. Without a clear understanding of what causes or prevents readmissions, higher readmissions rates occur.

2. Patients were returning to the health system causing overutilization of the acute care setting for repeat care within 30 days of hospitalization.

3. When high-risk and repeat readmissions are not identified it can impact patient outcomes, diagnosis, and treatment plans across the interdisciplinary team.
The Numbers Prove the Case

II. Current Conditions:

Summary Readmissions Trend by Month, CY16 Q1-Q2

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Readmissions</td>
<td>304</td>
<td>240</td>
<td>300</td>
<td>268</td>
<td>288</td>
<td>264</td>
</tr>
<tr>
<td>All Readmissions Rate</td>
<td>13.4%</td>
<td>10.8%</td>
<td>12.2%</td>
<td>11.7%</td>
<td>11.9%</td>
<td>11.7%</td>
</tr>
<tr>
<td>Mult. Readmissions</td>
<td>119</td>
<td>106</td>
<td>138</td>
<td>118</td>
<td>120</td>
<td>103</td>
</tr>
<tr>
<td>Mult. Readmissions Rate</td>
<td>39.1%</td>
<td>44.2%</td>
<td>46.0%</td>
<td>44.0%</td>
<td>41.7%</td>
<td>39.0%</td>
</tr>
</tbody>
</table>

During the most recent 6 months the readmission trend has remained mostly unchanged, however, exceeds hospital targets and expectations.

All-cause readmissions observed and categorized by Case Management drill down. *Not inclusive of CY Quarter 1 2016 from ACMA

- Not a clear process to prevent readmissions and to identify high risk or readmitted patients to guide clinical practice.
- High variability across the units and service providers.
- No specific process for readmitted patients.
- Lack of documentation around education to the patient.
- Documentation system and access does not support transparent interdisciplinary collaboration to facilitate progression of care.
- Standard Work for patient education and discharge developed on Unit 62 test cell has not been spread housewide.
- Challenges in integrity of data capture/inputs.

Using Analytics to Evaluate Individual Variables
Recognized that effective change requires a multi-pronged approach:

- Improvements in the care management process.
- Use of predictive analytics to identify high-risk patients and metrics to document, improve, and sustain readmission outcomes.
- Education and awareness.

Interventions identified to reduce readmissions:

- Better identification of high-risk patients and implementation of systemwide change.
- Get upstream of the readmission event, accurately predicting which patients were at greatest risk for readmission, providing the opportunity to intervene.
Results

• Predictive model developed to identify patients at highest risk of readmission.
• Home program developed for highest risk patient population with significant impact on readmissions.

<table>
<thead>
<tr>
<th>Readmission Rates</th>
<th>Fall 2015</th>
<th>Fall 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-cause heart failure (HF)</td>
<td>28-30%</td>
<td>8-11%</td>
</tr>
<tr>
<td>HF</td>
<td>12%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Non-HF</td>
<td>15%</td>
<td>&lt;8%</td>
</tr>
</tbody>
</table>
How We Did It

- Lean approach and supporting organizational design.
- Education and engagement.
- Machine learning and predictive analytics.
Continuum of Care
1. Lean Approach and Supporting Organizational Design

Based on a site visit to Virginia Mason in 2013, our CEO and COO identified that we needed to better manage capacity and throughput.

**Resulting actions:**

- **Organizational commitment to Lean** as our performance improvement framework.
  - Design and deployment of improvement and management systems.

- Creation of a **continuum of care strategic plan** to help guide organization in the development of the infrastructure required to successfully transition the patient through all of the care settings.
  - Continuum of Care Advisory Team.

- **Readmissions Workshop.**
Continuum of Care Advisory Team (CAT)

A multidisciplinary team, supported by executive sponsors, chartered with optimizing the management and transition of patients across the care continuum, improving patient outcomes and experience.

• CAT operationalizes the strategic plan.
  • Identify strategies to align with the overall strategic plan.
  • Remove barriers.
  • Coordinate implementation and spread.

*CAT members include representation from: Ambulatory, Hospital and Post-Acute Care Physicians, Business and Strategic Development, Case Management, Health Informatics, Lean Promotion Office, Nursing, Organizational Improvement, Pharmacy, Quality and Safety, and Rehab Services.
CAT Strategies and Approach

• Align with overall strategic plan and allow for distribution of resources to begin implementation and/or spread of best practices across the system.

• Leads assigned to teams across the system responsible to further assess and develop interventions.
  • Acute/Pre-acute/Post-acute.
  • Foundation.
    • Patient Family Advisory Council.
    • Psychosocial.
    • EMR.

• Improvement efforts driven from ground level with a multidisciplinary approach.
  • Start an improvement project locally based on defined need → prove and stabilize → spread.
CAT Actions to Achieve Goals

Preferred network (Skilled nursing facility, home health, and hospice).
Additional levels of care in process.

Patient Family Advisory Council.

Readmissions workshop.
Implementation of 8 initial countermeasures.

Comorbidity protocols.

Hospital to Home Program.
Multiple readmissions in 30 days (Feb. 2017 – current).
Hospital to Home Program

HF Readmissions

- Primary diagnosis of HF.
- Medicare or Medicare Replacement insurance.
- Follow-up protocol:
  - Follow-up call to patient at 24-48 hours, 7-10 days, and 30 days post-discharge.
  - Home visits are offered to high-risk patients (determined by Lace+ scoring) in Johnson, Wyandotte, Jackson, Leavenworth, Cass, and Clay county.
Hospital to Home Program

Multiple Readmissions

- All patients age 18 or older with more than one readmission in previous 30 days (patients enrolled from daily readmit report).
- All insurance providers.
- Continue current follow-up protocol (calls at 24-48 hours, 7-10 days, and 30 days post-discharge).
- Home visits will not be offered initially.
- Focus on bridging patients to primary care physician (PCP) and other community resources.

Hospital To Home Program - Multiple Readmissions (Feb. 2017 – Apr. 2017)
2. Education and Engagement

Combines use of LLD and Lean process improvement concepts to systematically spread and manage standard work across multiple work groups.

Involves senior through frontline leaders within a specific department structure.

- Hands-on learning in support of transitioning our leaders to the Toyota Management System.

Prepares leaders in the organization to manage Lean improvement work.

Introduces both Lean process improvement and Lean leadership concepts to systemwide leaders who are not directly involved in Lean improvement work.

Introduces Lean to all Health System employees. Both didactic and hands-on activities are used in this 45 minute session.
3. Machine Learning and Predictive Analytics

- Enterprise data warehouse (EDW) combined data from multiple sources.

- CAT needed to identify high-risk criteria and focus interventions on preventing those readmissions.

- Set out to understand the risk factors that drove readmissions.
  - Built an advanced application to do multi-variant risk analysis to identify key risk factors.
  - Used basic machine learning and predictive analytics but more so data mining techniques to do this—which led to some interesting findings.
Poll Question #2

How effective is your organization’s predictive analytics program in identifying high-risk patients?

1) Not effective
2) Somewhat effective
3) Moderately effective
4) Very effective
5) We do not yet employ predictive analytics
6) Unsure or not applicable
Our Analytics Layer

- **Predictive Analytics Layer**
  - (Predicting and Monitoring)
  - Anesthesia
  - Strategic Planning
  - Org Improvement
  - IT
  - Lean
  - Statistics Tool
  - EHR
  - EDW

- **Advanced Analytics Layer**
  - (Statistics, Forecasting, Prescriptive)
  - Strategic Planning
  - Org Improvement
  - IT
  - Lean
  - EDW

- **Operational Reporting Layer**
  - (Retro-perspective BI and Reporting)
  - Strategic Planning
  - Org Improvement
  - IT
  - Lean
  - EHR
  - Visualization Tool
  - EDW

This is the framework used to align analytics capabilities to technology capabilities.

The key is to have a single foundational data layer to tie in the foundation, advanced, and predictive layers so you are telling an integrated data story.
Machine Learning and Predictive Analytics

Classical statistics and analytics rely on human expertise to formulate and test the relationship between cause and effect.

- Approaches data mining with computational statistics and supervised learning.
- Leverages external published models. (Over 30+ published readmission models were used.)
- Machine learning starts with the outcome and teaches a computer to automatically uncover factors driving outcome.

- Extracts information from existing data sets to identify patterns and predict future outcomes and trends.
- Makes the very best informed prediction for future events.
- Applies advanced statistical/analytic technique or machine learning technique.
The key is to tie the machine learning and predictive work to real improvement effort.

This is our “general process” for machine learning and predictive analytics.
CHF Readmission Predictive Analytics Project

Congestive heart failure (CHF) as principal diagnosis for admission.

CMS inclusion/exclusion criteria.

Admitted between 1/1/2014 and 12/31/2016.

Total 1,862 admissions and 353 readmissions (19%).

Cohort

Interested Risk Factors

Generated based on other scientific research studies.

Demographics, vital signs, insurance, charges, admission/discharge info, laboratory results, comorbidities.

About 170 variables are included in the analysis.
HF Readmission Project Process and Timeline

• The key is to have dedicated and focused business and clinical project SMEs engaged to drive the analytical work.

• This is the actual project process used for our readmission work.
Manual Process or Machine Learning/Modeling Tools?

**Manual Process:**
- Clinical rationale integration.
- Drive analysis direction.
- Understand the data in greater detailed level.
- Time and resource demanding.
- Lower up-front and maintenance cost.
- Need to understand the methods and process.
- Control over detailed level of analysis.

**Machine Learning/Modeling Tools:**
- Let the data tell and decide the story.
- Time and resource saving.
- Higher up-front and maintenance cost.
- Some could be “black box.”
- Limited “fine tuning” capability.
- Requires minimum level of understanding.
- May require additional analysis to understand the data in detailed level.
Machine learning, predictive analytics, and Lean were used to identify patients at high risk of readmission, guide clinical interventions, and redesign care.
Lessons Learned

The appropriate and aligned work of operational leaders, improvement teams, and analytics teams is key to improving any organizational target.

The most prominent bias in understanding problems is thinking we know what drives performance based on our training and experience.

• Such assumptions can lead to wrong conclusions. Data may tell a different story. It is important to be willing to ask questions and challenge existing thinking to understand the problems and generate truly impactful solutions.

When there is an understanding of the problem and performance, a model can be built to identify high-risk criteria and improve care using machine learning and predictive analytics.
Future Plans

Using this type of thinking and approach will help drive improvements in more high impact areas (when using the same framework and methodology).
Thank You