Improving Care Coordination Through Risk Stratification

Dignity Health – SAS Insights Program
SAS Analytics Experience Conference 9/13/16

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No Disclosures
Shifting Workflows
Goals of Readmission Risk Stratification Use Case

• Better understand readmission risk profiles for patients admitted to Dignity Health facilities

• Improve workflow for clinicians, care coordination personnel, social services to reduce readmissions across Dignity Health by 10% or more

• Continuously monitor metrics around patient care and readmissions to sustain continued process improvement

• Improve patient outcome, reduce harm, and reduce needless cost (Triple Aim)
Moving Up the Analytics Frontier

LEVEL OF COMPLEXITY

BUSINESS PROBLEMS

DATA MANAGEMENT
- Extraction, Transformation & Load
- Data Cleaning To Remove Errors
- Building & Maintaining Data Mart
- Data Integration & Transformation

DESCRIPTIVE REPORTING AND MIS
- Transition Existing Reports
- Create Standard & Adhoc Reports
- Automating MIS Reports
- Set Interactive Dashboard
- Prepare Executive Summary By Consolidating Multiple Reports

INQUIsite DATA ANALYSIS
- Rigorous Analysis Of Data To Identify Underlying Patterns In The Data
- Trend Analysis
- Segmentation Analysis
- Validate Hypothesis Based On Results Of Data Analysis
- Deep Dive Analysis & Diagnostics To Support Data Driven Decision Making

PREDICTIVE ADVANCED ANALYTICS
- Development Of Viable Statistical / Mathematical Model
- Validate & Refine The Model
- Track The Model
- Forecast

USE OF STATISTICS

COMPLETE ANALYTICAL SOLUTION

ACTIONABLE INSIGHTS & SOLUTIONS

PRESCRIPTIVE
A Public-Private Partnership Develops and Externally Validates a 30-Day Hospital Readmission Risk Prediction Model
SAS Enterprise Guide Data Modeling
## Model Predictors

<table>
<thead>
<tr>
<th>Model Predictors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of Prior IP Admissions</td>
<td>Time since previous ED visit</td>
</tr>
<tr>
<td>Number of disease risk factors</td>
<td>Time since previous IP visit</td>
</tr>
<tr>
<td>Average lapse time between IP visits</td>
<td>Patient's Urban/Rural Location Class</td>
</tr>
<tr>
<td>Total number of Prior IP Admissions for Respiratory diseases</td>
<td>Marital Status</td>
</tr>
<tr>
<td>RFL (Recency, Frequency, Length of Stay) Score</td>
<td>Length of Stay of previous admit</td>
</tr>
<tr>
<td>Service code of target index admit</td>
<td>Medical Service Line code of previous admit</td>
</tr>
<tr>
<td>Service code of previous admit</td>
<td></td>
</tr>
</tbody>
</table>
What Does This Mean?

**Model Details:** Average ROC achieved on the test data set was **0.79** using Logit Regression with

- Forward Selection
- Variable Transformation and
- Variable Selection

**Model Predictors:** 13 out of the 90 input metrics were selected by the model as important predictors. Majority of predictors related to

- Historical Metrics
- Comorbidities
- Demographics

**Model Output:** Numeric Risk Score from (0-1) Bucketed into High, Medium, Low Groups
What Does This Mean? Cont’d

<table>
<thead>
<tr>
<th>Tier</th>
<th>Predicted Probability Cut offs</th>
<th>Patients with Actual Readmits</th>
<th>Number of Patients</th>
<th>% Actual Readmits</th>
<th>Odds Ratio</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;=0.6</td>
<td>233</td>
<td>293</td>
<td>80%</td>
<td>17.88</td>
<td>(13.273,24.0861)</td>
</tr>
<tr>
<td>Medium</td>
<td>0.4&lt;=Pred_Prob&lt;=0.59</td>
<td>133</td>
<td>269</td>
<td>49%</td>
<td>3.72</td>
<td>(2.8861,4.7948)</td>
</tr>
<tr>
<td>Low</td>
<td>&lt;0.4</td>
<td>433</td>
<td>2903</td>
<td>15%</td>
<td>0.09</td>
<td>(0.0736,0.1101)</td>
</tr>
</tbody>
</table>

Confidence Interval = \( \text{Ln(}\hat{\text{OR}}) \pm Z \sqrt{\frac{1}{a} + \frac{1}{b} + \frac{1}{c} + \frac{1}{d}} \)  
Odds Ratio = \( \frac{a}{b} / \frac{c}{d} \)

The odds of readmission in high risk tier are **17.88** times greater than the odds of readmission in medium or low risk tiers.

We are 95% confident that the true odds ratio is between **13.273** and **24.0861**.

The null value is 1, and because this confidence interval does not include 1, the result indicates a statistically significant difference in the odds of readmission in high risk tier versus other tiers.
Data Scoring Process

Data Flow and Movement Process:

1. **External Data to Dignity Health Insights Environment:**
   - A. Data is collected at the hospital level
   - B. Data is collected in the Cerner environment
   - C. Data movement is managed by integration processes

2. **Data Model Functions in the Dignity Health Insights Environment:**
   - A. Data from Cerner is pulled into the Dignity Health Insights environment
   - B. Data is pushed from MS4 into the Dignity Health Insights environment
   - C. Data is loaded into the Hadoop environment
   - D. The Inpatient registration data is pushed into the Dignity Health environment every 30 minutes
   - E. If the script sees that a new patient has arrived in Cerner, a query to the MS4 historical data in Hadoop is made
   - F. If the patient has historical data in MS4, then the patient is sent to the model. If not, the patient is filtered until the MS4 data is received in next MS4 load (every 12 hours)
   - G. A readmission risk score is derived from the model
# Readmission Dashboard – Version 2

## All Cause Readmission Risk - ACRR

![Dashboard Screenshot](image)

### Records: 89

<table>
<thead>
<tr>
<th>Facility</th>
<th>Location</th>
<th>MRN</th>
<th>Acct #</th>
<th>Name - Age - DOB</th>
<th>Risk</th>
<th>Admit Date</th>
<th>Discharge Disposition</th>
<th>Reason for visit</th>
<th>Admit DX</th>
<th>Discharge DX</th>
<th>Payor</th>
<th>Previous Discharge</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHS</td>
<td>MET 3F</td>
<td></td>
<td></td>
<td></td>
<td>38%</td>
<td>05-24-2016</td>
<td>RT KNEE OSTEOARTH</td>
<td>RT KNEE OSTEOAR</td>
<td>MEDICARE</td>
<td>09-01-2014 HOME</td>
<td>Punjabi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHS</td>
<td>MET 3F</td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
<td>05-24-2016</td>
<td>RESECTION OF RECT</td>
<td>RESECTION OF R</td>
<td>MEDICAL/CAI</td>
<td>12-06-2015 HOME</td>
<td>Vietnamese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHS</td>
<td>MET 3F</td>
<td></td>
<td></td>
<td></td>
<td>9%</td>
<td>05-23-2016</td>
<td>UNSPECIFIED CONDI</td>
<td>UNSPECIFIED CO</td>
<td>BLUE CROSS</td>
<td>04-08-2015 HOME</td>
<td>Russian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHS</td>
<td>MET 3F</td>
<td></td>
<td></td>
<td></td>
<td>13%</td>
<td>05-23-2016</td>
<td>LEFT KNEE OSTEOART</td>
<td>LEFT KNEE OST E</td>
<td>1/ MEDICARE/</td>
<td>05-29-2016 HOME</td>
<td>English</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHS</td>
<td>MET 4F</td>
<td></td>
<td></td>
<td></td>
<td>73%</td>
<td>05-23-2016</td>
<td>SOB COPD EXACERBA</td>
<td>SOB COPD EXAC</td>
<td>MEDICARE/</td>
<td>04-17-2016 HOME</td>
<td>English</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHS</td>
<td>MET EDIP</td>
<td></td>
<td></td>
<td></td>
<td>6%</td>
<td>05-23-2016</td>
<td>ENCEPHALOPATHY</td>
<td>ENCEPHALOPATH</td>
<td>MEDICARE</td>
<td>08-12-2015 DISCHA</td>
<td>Spanish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHS</td>
<td>MET EDIP</td>
<td></td>
<td></td>
<td></td>
<td>34%</td>
<td>05-23-2016</td>
<td>CHF EXCERBATION</td>
<td>CHF EXCERBATIC</td>
<td>MEDICARE/</td>
<td>03-10-2016 HOME</td>
<td>English</td>
<td></td>
<td></td>
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<tr>
<td>MHS</td>
<td>MET EDIP</td>
<td></td>
<td></td>
<td></td>
<td>17%</td>
<td>05-23-2016</td>
<td>SEVERE CONSTIPATI</td>
<td>SEVERE CONSTITI</td>
<td>MEDICARE</td>
<td>02-25-2013 HOME</td>
<td>English</td>
<td></td>
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<tr>
<td>MHS</td>
<td>MET EDIP</td>
<td></td>
<td></td>
<td></td>
<td>7%</td>
<td>05-23-2016</td>
<td>HYPERGLYCEMIA</td>
<td>HYPERGLYCEMIA</td>
<td>MEDICARE</td>
<td>09-12-2015 HOME</td>
<td>English</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Disease risk factors:** 12
- **Average days between visits:** 81
- **Last admit medical service:** MED
- **Days since last ED visit:** 0 - 89 days

**Dignity Health Insights**
Operationalization

- **Change Governance**
  - Model finalized March 2016 and updated in May 2016
  - Stakeholder group formed (working with Care Coordination)
    - Pilot started in Sacramento (April 2016)
  - Workflow integration (Web App vs Cerner)
    - SMART on FHIR
  - Expansion across care continuum
    - Ambulatory Care
    - Pop Health

- **Continued measurement of KPIs**
  - Ongoing readmit rate (stratified by risk, discharge DRG)
  - Average time between re-admits

- **Future Model Back testing and Re-Calibration**
Care Pathways

• Daily, coordinators “hotspot” patients with high risk

• Delegate improved coordination of discharge planning with
  - Current medical team, PCP, outpatient care coordinators, pharmacists, social work, skilled nursing facilities
  - Consider phone calls within 48hrs of discharge
  - PCP appointments within 2-3 days of discharge if warranted
  - Clinical pathway enrollment (ie: monitoring for CHF, COPD)
Managing Patients by Segmentation (Risk x GMLOS)
Metrics Dashboard – Trending over Time

PRELIMINARY DATA
### Data Scoring Process

#### Data Flow and Movement Process

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Summary

- Envision
- Technology is your friend
- Engage personnel to understand your vision
- Maintain stakeholder engagement
  - This is how the “rubber meets the road”
- Create modules (LEGOs)
- Iterate
- Remain sanguine – patients deserve it
Acknowledgements

- Anu Penaganti – SAS Consulting
- Chuck Palmer – SAS Consulting
- Ken Ferrell – Dignity Health Insights
- Alyson D’Andrea – Dignity Health Insights
- Dignity Health Insights IT
  - Sunil Kakade
  - Murali Nandula
  - Gaurav Padiyar
  - Jeromy Randels
  - Joyjit Chowdhury
  - Nilesh Mehta
- Dignity Health Care Coordinators and CHAMPS Program
Questions