Using Predictive Modeling To Reduce Readmissions At Park Nicollet Methodist Hospital

Gregg Teeter, MBA
Lead Analytics Advisor
Office Of Population Health
Park Nicollet Health Services

Sixth National Predictive Modeling Summit
Washington, DC
December 6th, 2012
Agenda

- About Park Nicollet
- Business Case
- Steps Taken To Develop Model
- Validation & Automation
- Connecting Model To Operational Efforts
- Next Steps
- Questions
About Park Nicollet Health Services

- Non-profit, integrated healthcare system located in the west metro of Minneapolis/Saint Paul
- Over $1 billion in annual revenue
- Employs 8,300 people, including over 1,300 clinicians
- Serves ~500,000 unique patients per year
- Methodist Hospital: 426 beds, ~22K inpatient admissions/yr
- Park Nicollet Clinics: 26 clinic locations, with 55+ medical specialties, serving ~2.2M ambulatory visits/yr
- One of 32 Pioneer ACOs
Business Case To Reduce Readmissions

- In October, 2012 the Center for Medicare Services (CMS) began reducing payments to hospitals with excess 30 day readmission ratios for Acute Myocardial Infarction, Heart Failure, and Pneumonia.
- Hospital readmissions are increasingly being viewed by health care payers and policy makers as potentially preventable sources of health care utilization and costs, and an indicator of health care quality.
- Healthcare reimbursement moving from volume to value (higher quality, lower total cost of care).
- Park Nicollet, through the Pioneer ACO Program, is “at risk” for Medicare FFS population costs and quality measures.
- Park Nicollet embraces the “Triple Aim” of balancing quality, the patient experience and total cost of care.
- Organizational objective to reduce readmissions.
- Doing well by doing right.
Initial Analysis

- I’m not a statistician, I just want to play one on TV
- Hierarchical Condition Categories (HCC): a relative risk score, created by the Centers for Medicare & Medicaid Services (CMS), used to predict future costs...and is free to download!
- Examined the correlation between patient HCC score and readmissions within 30, 60, 90 days for patients (all ages and aged 65+) discharged with Heart Failure and Pneumonia
- Correlation results
  - Heart Failure: (.12 to .42)
  - Pneumonia: (.23 to .40)
Initial Analysis

- Only used Park Nicollet electronic medical record (EMR) diagnosis/utilization data in the analysis
- Ran a pretty simple analysis that showed some (low) correlation, but results were encouraging
- Was there a better model out there, or a more rigorous analysis I could perform?
- Approached Dr. John Schousboe, MD, practicing physician and health services researcher in the Park Nicollet Institute for a statistical “consult”
Can We Build A Better Model?

Question:
- What if we could predict which patients have a high probability of being readmitted?
- If we could, what could we do, while that patient is under our care, to decrease that risk?

Challenge:
- Which combination of variables are key drivers for risk of readmission?
Steps Taken To Develop Model

• Literature review to identify classes of predictors:
  – **Utilization** (e.g. admissions, ER visits, current length of stay)
  – **Health status** (e.g. diagnoses, lab/test results, PHQ9)
  – **Physical mobility** (e.g. falls risk, assistive devices)
  – **Medication complexity** (e.g. number & changes in medications)
  – **Cognitive function** (e.g. confusion assessment method (CAM) score)
  – **Social support** (e.g. marital status, family support)
  – **Medical support** (e.g. PCP status, insurance, medical home site)
Analysis Approach

- **Objective:** To develop a predictive model (c-stat > 0.7) that could be universally applied to all current inpatients
- **Methodist Hospital adult medical and surgical discharges 2007-2010**
- **Data source:** Park Nicollet enterprise data warehouse (EDW) of EMR data
- **Created a large data set of 121 possible variables**
- **Used Stata® statistical package to create & evaluate models**
Readmission Model Variables Evaluated

- Patient demographic variables
- Patient type
- Admit source
- Admit status
- Admit service
- Discharge disposition
- Length of stay
- Infection control status
- High risk diagnoses within past year
- High risk diagnoses during index admission
- HCC score
- Admits in past 3yrs, 2yrs, 1yr, 6mo, 3mo, 1mo
  - # days since last admit
- EC visits in past 3yrs, 2yrs, 1yr, 6mo, 3mo, 1mo
  - # days since last EC visit
- UC visits in past 3yrs, 2yrs, 1yr, 6mo, 3mo, 1mo
  - # days since last UC visit
- PC visits in past 3yrs, 2yrs, 1yr, 6mo, 3mo, 1mo
  - # days since last PC visit
- CAM scores (# of positive scores, most recent result during admission, most recent result prior to index admission)
- PHQ9 score (max score during admission, most recent score prior to admission)
- Systolic BP (highest, lowest, most recent during admission)
- Pulse (highest, lowest, most recent during admission)
- BMI
- Bun/Creatinine lab values (count, min, max, std dev, most recent)
- Glucose values (count, min, max, std dev, most recent)
- Hemoglobin A1c values (count, min, max, std dev, most recent)
- Serum albumin values (count, min, max, std dev, most recent)
- Braden score
- Falls risk score
- Number of medications at Discharge
- Times per Day Rx Needed
- Medication changes
- Homecare in past 6-12 months
- Assistive devices during index admission
- Level of assist during index admission
Prediction Model Performance

For everything you love.

Model We Chose
Building A Better Mousetrap

• Concurrent to our model development efforts, the Methodist Hospital Readmission Task Force built and implemented a readmission risk score into our EMR (Model 1.0)
  – Developed in the Spring, 2012
  – Design based on variables identified from literature review
  – Subjective weighting and scoring of the variables added up to a total score
  – Originally scored on paper, then converted to an EMR screen where the variables were aggregated
  – Banner on the inpatient EMR record
  – Most important: the tool became part of a process

• Our Model (Model 2.0)
  – Developed in parallel with the original model (Model 1.0)
  – Identified the drivers of readmissions from an analysis of historical data to develop a regression equation that has actual predictive power
  – Park Nicollet changed EMR systems in July, 2011
  – Validated model with new EMR data (3 month retrospective analysis)
## Model Differences

<table>
<thead>
<tr>
<th>Original Model (1.0) Variables</th>
<th>Current Model (2.0) Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Age</td>
</tr>
<tr>
<td>Living arrangements</td>
<td>Race</td>
</tr>
<tr>
<td>Type of residence</td>
<td>Marital status</td>
</tr>
<tr>
<td>Readmit or ER visit w/in past 2 weeks</td>
<td>Gender</td>
</tr>
<tr>
<td>Multiple medical problems</td>
<td>HCC score</td>
</tr>
<tr>
<td>Falls risk score</td>
<td>Length of current stay</td>
</tr>
<tr>
<td>CAM score</td>
<td># of admits in past 6 months</td>
</tr>
<tr>
<td>Braden score</td>
<td># of ED visits in past 6 months</td>
</tr>
<tr>
<td></td>
<td>Patient type (medical or surgical)</td>
</tr>
</tbody>
</table>

Analysis suggested that the prior model’s predictive power was low, while Model 2.0’s predictive power was significantly better.

**Model Limitations:**
- Variables in the prior model were dependent nurse input
- Model 2.0 dependent on patient having prior utilization data
Discrimination of 30 Day Readmissions After Index Medical & Surgical Admissions

Area under ROC curve = 0.7152
Model Calibration

The graph illustrates the model calibration for predicting the proportion of patients re-admitted within 30 days. The x-axis represents the observed proportion re-admitted within 30 days, while the y-axis shows the predicted proportion. The reference line indicates perfect calibration, where predicted and observed values align. The linearity of the data points along the reference line suggests good model calibration.
Model 2.0 c-stat: 0.7152

JAMA article
- Authors evaluated 26 models
- 14 used claims data
- 9 had “poor discriminative ability” (c-stat 0.55 - 0.65)
- 7 could identify high risk patients during hospitalization (c-stat 0.56 - 0.72)
- 5 could be used at discharge (c-stat 0.68 - 0.83)
Patient Risk Distribution
Connecting Model To Operations

• Readmission risk predictive model (2.0) went live in mid-October, 2012
• RN Care Coordinators updating EMR inpatient record
• Care Model Enhancements
  – Inpatient
    • RN Care Coordinators paired with Hospitalists
    • Consults as needed: pharmacy, nutrition, CDE, PT, OT, spiritual care
  – Post-Discharge
    • Post discharge phone calls
    • Discharge appointments – 3-5 days for high risk
    • Home visits to all high risk patients
    • Transition call to NH, TCU
    • Outpatient care consultant assigned as needed
Connecting Model To Operations

High Risk Flag
For everything you love.

Data Flow

Epic

EDW

Nightly SQL program run generating a readmission risk probability score for all currently admitted adult medical & surgical patients

Park Nicollet
For everything you love.
Next Steps

- **Operations**
  - Visibility of the high risk banner post-discharge
  - Automated communication back to Primary Care

- **Measures & Models**
  - Analyze and track the impact of the change
  - Expand / Fine tune model
    - Analyze additional variables
    - Evaluate the creation of condition specific models
    - Evaluate the value of expanding a model to Observation and EC patients
  - Automate the transfer of risk score into the EMR
  - Validate model in another facility
Questions?

Gregg Teeter - Lead Analytics Advisor
Office Of Population Health
Park Nicollet Health Services
Gregg.Teeter@parknicollet.com