Stacking Predictive Models to Reduce Readmissions

Session 13, March 6, 2018
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Ben Cleveland, Data Scientist, UnityPoint Health
Conflict of Interest

Ben Cleveland
Rhiannon Harms

Have no real or apparent conflicts of interest to report.
Agenda

• Introduction
• Our Readmission Story
• Tools & Tech
• Ongoing Challenges
• Q&A
Learning Objectives

• Describe applicable predictive models useful in reducing 30-day readmissions

• Describe elements of a successful readmissions reduction strategy in an integrated health system

• Describe common obstacles faced in the adoption of analytical tools and how to overcome them
In Nine Regions

- **19** UnityPoint Health Hospitals
- Communities served by **280+** Clinics
- **18** Community Network Hospitals
- **15** UnityPoint at Home Locations
- **4** Accredited UnityPoint Health Colleges
- **10** Affiliated Partners
- Insurance presence across all UnityPoint Health markets
Analytics: Our Purpose

• To lead UnityPoint Health’s quest to become a *data-driven organization* by *embedding* analytics into the strategic planning process, *enabling* clinicians and business leaders to use data to make decisions, *identifying* areas of opportunity to improve patient care and *developing* models deployed to predict population health and financial trends.

The real promise of analytics lies in its ability to transform healthcare into a truly data-driven culture.

**We Are**

• Change agents
• Innovators
• Researchers
• Enablers
• Strategic Thinkers
Readmissions Success
All-Cause Rolling Readmission Rate
January 2014 – June 2017

January ’14: 10.0%

June ’17: 7.5%
Our Readmissions Journey

2013
Established readmissions focus

2014
Which patients are readmitting? Why are patients readmitting?

2015
Use data to identify groups at risk for readmission

2016
- Multi-disciplinary team involvement
- Strategy for care coordination to prevent readmissions
- Proactive and routine use of data

2017

Move from reactive to **proactive** readmissions prevention
Our Readmissions Journey

2013
- A3 Readmissions Process
- Daily Readmissions Report
- Tracking readmissions rate
- Managers gathering data

2014
- Setting readmissions goals
- Condition-specific focus areas
- Readmitted patient interviews

2015
- Analytics develops Readmissions Dashboard
- Readmission Risk Tool (heat map)
- Physician outreach

2016
- Proactive use of Readmissions Dashboard
- Daily Huddles
- Chronic Disease Navigator
- Readmissions awareness expands to all staff

2017

Move from reactive to proactive readmissions prevention
Multi-Disciplinary Approach

Readmission Risk Tool
(RN Managers Identify High-Risk Patients)

Daily Huddle
(Unit Team)

Case Management & Chronic Disease Navigators
(Post-Discharge Planning & Follow-Up)

Daily Readmissions Meeting
(Discuss Readmitted Patients)

Ongoing Data Analysis
(Readmissions Dashboard)

PCP, Home Health & SNF
(Data, Outreach, Partnerships)
Patients Who Readmit

What led to the readmission?
- Investigate caregiver concerns
- Check attendance at follow-up appointments
- Look for medication issues
- Review if prior authorization obtained
- Check for errors
Tools & Tech
Analytics

• Analytics in a Consultative role
  - Available data
  - Metric selection
  - Simple visuals

• Provide actionable data through exploratory analysis
  - Hospital Units
  - PCP/Attending
  - Diagnosis/DRG

• Success of data use supported by organizational culture
The Big 3

• Which patients do we focus on?

• What do we do?

• When do we do it?
The Big 3

• Which patients do we focus on?

• What do we do?

• When do we do it?
The Heat Map

UnityPoint Health 30-Day Readmissions Risk Dashboard

Overall and Daily Readmission Risk Heat Map

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#HIMSS18
### Post Discharge View

**Patient Summary**

<table>
<thead>
<tr>
<th>Pat Name</th>
<th>Readmission Risk</th>
<th>Future No Show Risk</th>
<th>Missed Appointments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patient at high risk of readmission with a risk probability of 27%.</td>
<td>Patient is at high risk for not showing up to 6 UPH future appointments.</td>
<td>Patient has missed 4 previously scheduled UPH appointments.</td>
</tr>
</tbody>
</table>

**Overall and Daily Readmission Risk Heat Map**

<table>
<thead>
<tr>
<th>Pat Name</th>
<th>Discharge Date</th>
<th>Readmit Prob</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2017-07-24</td>
<td>27%</td>
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</tbody>
</table>

**Patient's Risk of Readmission each day of 30 Day Timeline**

- 2017-07-24: 2
- 2017-07-25: 2
- 2017-07-26: 2
- 2017-07-27: 3
- 2017-07-28: 3

**What actually happened with those appointments**

- Completed: 2
- Missed: 2
- Future No Show Risk: 3

**Missed or Likely to Miss Appointment List**

<table>
<thead>
<tr>
<th>Medical Record Number</th>
<th>Pat Name</th>
<th>Date</th>
<th>Scheduled Appointment Location</th>
<th>Pcp Name</th>
<th>Appt Status</th>
<th>No Show %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017-08-04</td>
<td>GREENE, DYLAN C</td>
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<td>2017-08-04</td>
<td>GREENE, DYLAN C</td>
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<td>GREENE, DYLAN C</td>
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### Adjustable definitions of “high risk” for both Readmission and No Show

**Heat map “freezes” once a patient is discharged**

**Future appointments at high risk of no show**

**More detailed info on missed or high no show risk appointments**
Readmission Model Performance

- Regional Performance
  - AUC ranges from 0.75-0.81
  - Brier Score: 0.06-0.09

- Performance in Literature:
  - AUC: 0.7-0.82 (Kansagara, et al. 2011)
  - Brier Score: 0.05-0.1

Data Types

- Healthcare Utilization
  - Number of appointments (Prior 2 Years)
  - Number of providers (Prior 2 Years)
  - Percentage of Appointment No-Shows (Prior 2 Years)
  - Number of late appointment arrivals (Prior 2 Years)
  - Number of ED Visits (Prior 12 Months)
  - Number of Inpatient Visits (Prior 12 Months)

- Demographic/Social
  - Age
  - BMI
  - Sexually Active
  - Hispanic (Yes/No)
  - Single (Yes/No)
  - Insurance Type

- Diagnosis History
  - Age
  - BMI
  - Sexually Active
  - Hispanic (Yes/No)
  - Single (Yes/No)
  - Tobacco User
  - Illegal Drug User
  - Female Partner
  - Male Partner

- Visit-Specific
  - Blood Pressure Diastolic
  - Blood Pressure Systolic
  - Weight
  - Height
  - Pulse
  - Temperature
  - Respirations
  - Patient Pain Score
  - Surgical Procedure
  - LACE Score
  - Length of Stay
  - Admission Type (Emergent/Elective)
  - Weekday

- High Relative Variable Importance
Experience with Social Determinants

• Our internal findings are consistent with recent literature regarding the predictive value of social determinants of health:
  
  – When considered along with clinical data (diagnoses, meds, labs, utilization hx), SDoH in their current form are not significant predictors of readmission risk
    
    • (Logue, et al. 2016)
    • (Jamei, et al. 2017)


Current Batch Scoring Process

1. Patient Admitted to Hospital
2. Extract Patient Data for Modeling
3. Predict patient readmission risk
4. Refresh Dashboard
5. Begin Patient Rounds

Repeat Daily During Inpatient Stay

- 4:00 PM Day 1
- 5:30 AM Day 2
- 6:00 AM Day 2
- 6:30 AM Day 2
- 7:30 AM Day 2
System-Wide Education & Marketing

- Annual Lunch & Learn Webinars
- Group-specific presentations on-site
- Internal Conference Functions
- Comprehensive User Guide
  - Methodology
  - Tool Features & Orientation
  - Onboarding
  - FAQs
- Word of mouth

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Ongoing Challenges
Ideal Future State – Into the EHR

Patient Admitted to Hospital → Extract Patient Data for Modeling → Predict patient readmission risk → Refresh Dashboard → Begin Patient Rounds

Repeat Daily During Inpatient Stay

- 4:00 PM Day 1
- 5:30 AM Day 2
- 6:00 AM Day 2
- 6:30 AM Day 2
- 7:30 AM Day 2
How to Integrate with Other Care Coordination Tools?

Population Management Tools
- Longer prediction time horizon (6-12 months)
- Not triggered by an event
- Not readmission specific

Readmission Tools: Heatmap
30 day time horizon
Triggered by Admission
Readmission Specific

30 Day Readmission Window
7/25/2017 – 8/23/2017
How do you test this after deploying?

- If the care team acts on the prediction, your new training data will be biased

- If we successfully prevent high risk patients from readmitting consistently, theoretically, patients with similar profiles would not be high risk in future models
Closing tips

• Risk scores trigger work lists, risk visualizations trigger conversations

• Conditions for adoption include all of: the right use case, staff involvement in build, ease of workflow, coaching on interpretation, peer success

• Be mindful of silo development efforts involving pop health ‘risk’ – these can contradict and will flow downstream to care managers

• When identifying machine learning use cases, focus on uncertain “decision points”
Questions

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