Machine Learning and Big Data to Drive Better Health Outcomes

Session 275, March 8, 2018 4pm to 5 pm
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Doug Melton, PhD, Sr. Director, Cigna
Conflict of Interest

• We have no conflicts of interest related to this presentation.
Agenda

• Learning objectives for session
• Overview of customer journey analysis
• Using machine learning and big data to increase engagement
  – Health coaching
  – Case Management
• Questions
Learning Objectives

• Recognize opportunities to use big data and machine learning to increase patient/consumer engagement

• Analyze customer interaction data to identify ways to reduce total medical cost

• Apply machine learning and big data techniques to improve health outcomes and lower medical costs for patients and customers
Underlying Premise of this Session

There are *moments that matter* in every *patient/customer healthcare journey* in which a well-informed and well-timed intervention can influence behavior in a way that *lowers total medical cost and improves outcomes*.

**Examples:**

- An in-network surgery
- Adherence to treatment plan
- Use of generic drug
- Engagement in coaching

- An out-of-network surgery
- Lack of adherence to treatment plan
- Missed opportunity for generic drug
- No engagement in coaching
Analytical Vision for Personalization

Goal of this presentation is to talk about how we will be able to better “Anticipate & Engage” and “Sense & Respond”

- **Analyze**: How can past data be analyzed to drive insights and evaluate opportunities?
- **Anticipate**: How can we anticipate customer needs along their journey to drive better outcomes?
- **Sense & Respond**: How can we quickly identify an event and take an action to help the customer?
- **Inform**: What was the impact of our customer engagement?
Why should employers care about health engagement?

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
</table>
| 28%        | Adults who have **diabetes** and don’t know it | [1](#)
| 17%        | Adults who have high blood pressure and don’t know it | [2](#)
| 1 in 5     | Deaths caused by cigarette smoking | [3](#)
| >1/2       | Adults with high LDL cholesterol who get treatment | [4](#)
| 71%        | Total U.S. health care spending that’s related to chronic medical conditions | [5](#)

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Framework for Journey Analysis

**Total # of customers with EVENT in the study period**

**Total POPULATION who meet the inclusion criteria (for ex: 6 Months of continuous medical coverage prior to EVENT, 3 months post)**

**ATTRIBUTES of Various AGENTS**

- **Customer ATTRIBUTES**
  - Ex: Demographics, Conditions, Height, Weight, Risk Score

- **Provider ATTRIBUTES**
  - Ex: Network Status, Treatment Rules Operating Hours, % Correct Treatment

**STEPS leading up to the EVENT**

(for example only)

1. Web Session – PCP search
2. PCP INN Visit
3. Specialist INN Visit
4. Pharmacy – Brand Drug
5. Care Gap
6. Specialist INN Visit
7. Call – Benefits
8. ER Visit

**INN/OON Joint Surgery**

Q: Which are the most frequent journeys? Which journeys lead to most positive outcomes

Q: What kind of customers are having a negative outcome? What kind of providers maybe influencing a negative outcome?

Q: What is the total $ opportunity to move customers from negative to positive outcome?
A “layered” approach to data ...

... allows for automatic anticipation, sense, and response

A new time-based data construct, the “time-sequenced customer journey data lake” allows providers and payers to:

- predict future events and behaviors
- identify signals suggesting changes to expected behaviors
- prescribe interventions to shape the right outcomes.
Journey analytics must be operationalized

Leverage all big data available vs. focus on only “probable” data

Outcome Driver Data Mining
- Identify drivers of outcomes vs. test hypotheses

Test & Learn Pilots
- Run hundreds of tests simultaneously vs. limited manual evaluation

Personalized Actions
- Learn and modify actions continuously vs. retrospective annual tuning

Executive Scorecard
Operations Management Dashboard
Client Reports
Nuts & bolts of journey data creation

**Journey Dataset Process**

1. **Reference Library**
   - Events, Population Criteria, Outcomes, Steps, Attributes and respective SQL logic are maintained in a central reference file

2. **Create population table**
   - Claims
   - Eligibility

3. **Create customer attribute table**
   - Member DIM
   - Eligibility

4. **Create time sequenced journey and attributes of steps**
   - Claims
   - Pre-Auth
   - Provider
   - SOBI (call)
   - Web

**APPLICATIONS**

- Opportunity Sizing and High-Level Journey Visualization (Automated Insights Engine)
- Individual Path Analysis and Rules Engine for Sensing/Responding and Anticipating/Engaging
- Simulation Analysis to Model the Likely Impacts of Cigna Interventions
- Automated Data Mining for New Opportunity Identification
- Ongoing
- Future
Health coaching for chronic conditions

To better predict future customer engagement opportunities, self-learning models automatically tuning results as new data becomes available on individual and specific journey steps and outcomes.

### Machine Learning

### Customer Engagement Results

Outreach drives results, but timing of outreach has even greater impact.

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### Outreach to customers has a significant impact on coaching engagement

<table>
<thead>
<tr>
<th>Outreach to customers</th>
<th>Coaching engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>No outreach by Cigna</td>
<td>2%</td>
</tr>
<tr>
<td>At least one outreach by Cigna</td>
<td>19%</td>
</tr>
</tbody>
</table>

### Timing of outreach is EVEN MORE Critical

<table>
<thead>
<tr>
<th>Timing of outreach</th>
<th>Coaching engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outreach before key journey steps</td>
<td>4%</td>
</tr>
<tr>
<td>Outreach after 1 key journey step</td>
<td>83%</td>
</tr>
<tr>
<td>Outreach after 2 key journey steps</td>
<td>78%</td>
</tr>
</tbody>
</table>

20X increase if outreach after specific key journey steps.
Case Management Analysis Background

Current state summary – All case management

114k CM eligible customers

35% Met criteria for study/control group

39K Assessment Attempts

51% Engagement (Assessments Completed)

65% Targeted for initial assessment but did not meet criteria, passed away, not deemed eligible for CM etc. Potential for engagement may exist. Requires deeper dive to estimate the opportunity.

Customer engagement by case management category

<table>
<thead>
<tr>
<th>Service</th>
<th>% Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive Oncology</td>
<td>16%</td>
</tr>
<tr>
<td>Specialty Care Options</td>
<td>18%</td>
</tr>
<tr>
<td>Inpatient CM</td>
<td>20%</td>
</tr>
<tr>
<td>Rehab</td>
<td>27%</td>
</tr>
<tr>
<td>CKD Stage 4</td>
<td>36%</td>
</tr>
<tr>
<td>High Risk Maternity</td>
<td>39%</td>
</tr>
<tr>
<td>NICU</td>
<td>47%</td>
</tr>
<tr>
<td>Oncology</td>
<td>48%</td>
</tr>
<tr>
<td>Healthy Pregnancies, Healthy Babies</td>
<td>73%</td>
</tr>
<tr>
<td>Core CM</td>
<td>76%</td>
</tr>
<tr>
<td>Catastrophic CM</td>
<td>83%</td>
</tr>
<tr>
<td>Core Short-Term CM</td>
<td>86%</td>
</tr>
<tr>
<td>Transplant</td>
<td>88%</td>
</tr>
</tbody>
</table>

Opportunity #1: Increase customer access to best care & patient quality

Opportunity #2: Increase % of customers engaged

Opportunity #3: Increase engagement per outreach
Case Management (CM) journey data

Identifying positive or negative events within a time sequenced view allows for greater insights into opportunities to affect future outcomes.

42,000 Journeys Analyzed
360,000 Million Journey Steps Calculated
43,000 CM Customers Scored on Likelihood to Engage

<table>
<thead>
<tr>
<th>Journey Steps</th>
<th>Details</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialist and PCP Visits</td>
<td>• Provider Specialty</td>
<td>• Visit with a PAR Orthopedic Specialist</td>
</tr>
<tr>
<td></td>
<td>• PAR vs. NONPAR</td>
<td>• Visit with a NONPAR Family Practitioner</td>
</tr>
<tr>
<td>Web Interactions</td>
<td>Actions taken on mycigna.com</td>
<td>• Web - viewed manage claims and balances</td>
</tr>
<tr>
<td>Pharmacy Claims</td>
<td>Generic vs. Branded drug</td>
<td>• Web - provider search</td>
</tr>
<tr>
<td>Facility Visits</td>
<td>• Type of Facility</td>
<td>• Generic drug claim</td>
</tr>
<tr>
<td></td>
<td>• In-Network vs Out of Network</td>
<td>• Acute Inpatient INN visit</td>
</tr>
<tr>
<td>Prior Auths</td>
<td>IP vs. OP</td>
<td>• OON ER visit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Inpatient prior auth</td>
</tr>
</tbody>
</table>
Cigna’s Oncology Case Management program strives to improve the health and well being of individuals by providing services that:

- Help people take action that can prevent cancer or detect it early
- Make good treatment decisions that improve chances for survival and/or improve quality during end of life
- Coordinate care among many providers, which results in more cost effective care and less duplication of services

Customer Outreached
Average expected increase in engagement if we re-target using time sequenced data approach

% of customers outreached based on likelihood to engage score

Average Expected Increase in Engagement:
- 70%
- 79%
- 87%
- 94%
- 100%
- 107%
- 115%
- 125%
- 141%
- 159%

All | Top 90% | Top 80% | Top 70% | Top 60% | Top 50% | Top 40% | Top 30% | Top 20% | Top 10%

Results – comprehensive oncology
Cigna’s Healthy Pregnancy Healthy Babies Case Management program strives to improve the health and well-being of individuals by providing services that:

• Finds more high-risk pregnant individuals and attempts to reduce chances of early delivery through referrals to case managers and education about medication to prevent preterm labor (including how to identify and react appropriately to the signs of preterm labor).

• Helps low and moderate-risk pregnant individuals through education and resources on how to maintain a healthy pregnancy and by re-assessing them often, in case they become high risk.
Increasing engagement for CM overall

Assuming we can outreach to all customers who originally received an outreach, a time sequenced data approach, can provide a **30% increase in engagement**
Right Customers at the Right Time

Journey analysis allows us to prioritize customers based on their likelihood to engage, and inform us when likelihood is the highest so we can outreach at the right time.

Seemingly subtle differences in journeys can have significant impact on engagement.

Examples of % engagement differences based upon customer journey activity leading up to outreach by Cigna

**Oncology**
- 2 PAR Hematologist Visits → Outpatient Prior Auth: 36%
- 2 PAR Oncologist Visits → Outpatient Prior Auth: 67%

**Healthy Pregnancies Healthy Babies**
- PAR OBGYN Visit → 2 Web Sessions (manage claims & balances): 50%
- PAR OBGYN Visit → 2 Inbound Calls: 87%

**Core Short Term CM**
- PCP Pediatric Visit → Acute Inpatient Stay: 65%
- Web session (manage claims & balances) → Acute Inpatient Stay: 91%
Best Candidates for Outreach

Using traditional approach to decide who receives an outreach and when

- 35% Received Cigna Outreach
- 51% Successful Outreach

35% Receive Cigna Outreach
51% Successful Outreach

18% Predicted Overall Engagement

Using likelihood to engage score to pick the top candidates and outreach

- 35% Receive Cigna Outreach
- 88% Successful Outreach

31% Predicted Overall Engagement

If we use likelihood to engage score to pick the top 35% of customers for outreach, we can expect the overall predicted engagement to go up from 18% to 31%
Engagement Potential by CM Category

% increase in engagement when we use likelihood to engage score to prioritize outreach vs. a traditional approach.
Summary of CM Journey Analysis

Each case management category has specific journey steps (selected from a catalog of over 300 unique journey steps) that are more predictive of engagement than others.

<table>
<thead>
<tr>
<th># of Predictive Variables</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive Oncology</td>
<td>IP Facility, PAR Oncology Visit, Viewed Estimate Health Care Costs section on Web</td>
</tr>
<tr>
<td>Core CM</td>
<td>PAR Orthopedic visit, Generic Pharmacy claim, Viewed my coverage on web</td>
</tr>
<tr>
<td>Healthy Pregnancies and Healthy Babies</td>
<td>PAR Reproductive endocrinology/infertility visit, Viewed HW Hub section (CO) on web</td>
</tr>
<tr>
<td>High Risk Maternity</td>
<td>PAR Maternal And Fetal Medicine visit, Call</td>
</tr>
<tr>
<td>Inpatient CM</td>
<td>IP Prior Auth, IP Acute Facility claim</td>
</tr>
<tr>
<td>NICU</td>
<td>PCP Pediatrics visit, Provider search on web</td>
</tr>
<tr>
<td>Oncology</td>
<td>OP Prior auth, PAR Oncology Visit</td>
</tr>
<tr>
<td>Other</td>
<td>PCP Internal Medicine visit, Viewed Manage Claims &amp; Balances section on web</td>
</tr>
<tr>
<td>Transplant</td>
<td>PAR Gastroenterology visit, PAR Cardiology visit</td>
</tr>
</tbody>
</table>
Four phases of CM Journey analysis

Data Collection + Journey Data Creation
- Selected customers identified for CM
- Designed a data robot to query multiple data sources and create a time sequenced journey dataset
- Included details on each journey step such as provider specialty, INN/OON, type of web interaction etc.

Journey Step Importance Test
- Calculated importance of and rank ordered each journey step using Decision Trees and Lasso regression
- Selected the most important journey steps using results

Rules Selection
- Modified journeys to only include the most important journey steps
- Ran Association Rules analysis to identify the most prevalent rules (combinations of journey steps)
- Calculated score (confidence) for each rule as total engaged / total outreached
- Created rule sets to prioritize certain rules over others

Results
- Used the selected rules to score customers by CM Category
- Combined scores at CM category level to determine overall engagement rate

Outcomes
- Detailed journey data for customers identified for CM
- List of most important journey steps by CM category
- Catalog of rules for each CM Category
- Potential engagement and engagement lift by CM Category
Next Best Action BEFORE Health Events

... can lead to more accurate predictions, earlier outreach, better experience & increased in-network utilization
Opportunities and next steps

1. Combine likelihood to engage score with ROI calculation
2. Design a pilot to evaluate the effectiveness of journey analytics approach
3. Add customer attribute metrics to the likelihood to engage analysis
4. Evaluate operational processes and outreach strategy

Conduct pilot to modify engagement and outreach strategy in 2018 - measure and validate insights and opportunities
Questions

• Please feel free to contact us . . .

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• Please remember to complete online session evaluation