Predictive Analytics Drives Population Health Management
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Conflict of Interest

David Seo, MD
Chitra Raghu

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

• About UHealth
• Drivers Toward Population Health Management
• Data Infrastructure
• Predictive Analytics Solution
• Predictive Analytics Results at the Point of Care
• Predictive Analytics Via User Portal
• Future Directions
• Q/A
Learning Objectives

• Discuss how an integrated health system can leverage technology to focus on chronic disease interventions

• Identify strategies for creating and implementing an adaptable technology platform that enables cost-effective population health management

• Demonstrate the value in delivering risk-stratified information to the point of care as well as to research professionals
Anticipated Benefits of Predictive Analytics Platform

S = A flexible platform that supports the health system’s goal for population health management.

T = Real-time health assessments of their patient population allows clinicians to launch targeted interventions to their most high-risk patients.

E = Secure consolidation of health information from over 60 different healthcare technology systems, provides the necessary data to identify patient’s at risk of developing a chronic disease.

P = Patients are most satisfied when they feel they have more control over their health. Risk assessment tools provide patients with information and allow them to participate in lifestyle changes to improve their health.

S = Potential for significant savings in treatment costs by preventing or delaying the onset of disease and its associated health complications.
About UHealth

- University of Miami Hospital
- Sylvester Comprehensive Cancer Center
- Bascom Palmer Eye Institute
- Affiliated hospitals include:
  - Jackson Memorial Hospital
  - Holtz Children’s Hospital
  - Miami VA Medical Center
- We have 30+ outpatient facilities throughout Miami-Dade, Broward, Palm Beach, and Collier counties, with more than 1,500 physicians and scientists.
UHealth IT Landscape

- Multiple EHRs installed at the various hospitals and clinics
- 450 different technology systems across the organization; exchanging data with 60 of them
- Working to consolidate on a single EHR platform
- Using Content Document Architecture (CDA) as the data transfer vehicle
  - Fully identified CDAs for exchange for patient care
  - De-identified CDAs for exchange for research
Background – The PCMH ACO Population Health Journey
The Big Shift

Payment Models: Moving Risk from Payers to Providers

Care Delivery Models: Trading Volume for Value
Lining Up the Enterprise Pieces

- IT System Infrastructure
- Care Coordination
- Patient Engagement
- Data/Analytics
- Organizational Structure
- Contracting
Data Infrastructure to Support the Journey

- Clinical Results
- Business Intelligence
- Standard/Ad-hoc Reporting
- Risk/Opportunity Identification
- Regulatory Reporting

(Echo, Press Gainey, Payer Claims, Etc.)
Population Health Journey

Part 1 - Doing the Dirty Work

• Decipher then adhere to guidelines
• Gather and analyze the data then argue
• Contracting poker (Texas Hold ‘Em)
Population Health Journey

Part 2 – Shaking Things Up

• Assess the results then argue
• Manage for performance
• Distribute incentives
Population Health Journey

Part 3 – Go for the Gusto

- Population health management
- Reduce care variability
- Change provider behavior
- Maximize patient engagement
Remember the 5/50 and 20/80 Rules

- 2/3 of the sickest folks were healthy the prior year.
- 5% of patients account for 50% of healthcare expenditures
- The sickest 20% of patients account for 80% of costs

Challenge: Build data tools to predict and identify patients who will make this unfortunate health transition and attempt to alter that path.

Solution Infrastructure

- Agnostic architecture for flexibility and growth
- Built on Free and Open Source Software (FOSS) platform
- Easy processing and creation of disease models
- Provide results at the point of care
- Sustainable in an academic medical center IT shop (i.e. limited money)
Predictive Analytics Process

Data Aggregation
- Epic EMR Chronicles
- Epic EMR Clarity
- Meditech EMR
- Genomic Data
- Source System Data

Cogito Data Warehouse → Hadoop

Data Analysis
- Risk Score

Timely Useable Data
- ALERT ENGINE
  - Epic EMR
  - Email
  - SMS
# Technical Alignment of Tools

<table>
<thead>
<tr>
<th>Tools Evaluated</th>
<th>HADOOP</th>
<th>ELASTIC SEARCH</th>
<th>MONGO</th>
<th>DDS</th>
<th>MAHOUT</th>
<th>MLib</th>
<th>RATTLE</th>
<th>OPEN SCORING</th>
<th>KIBANA</th>
<th>SHINY</th>
<th>MIRTH</th>
<th>CAMEL</th>
<th>MULE</th>
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<tbody>
<tr>
<td>Data Aggregation</td>
<td>X</td>
<td>X</td>
<td></td>
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<td>Pattern Recognition</td>
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<tr>
<td>Visualization &amp; Actuators</td>
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<td>Integration</td>
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</table>

**Standards:** CDA, PMML, HL7 V2, DICES

**Security**
Architecture Overview

UMiami Enterprise (Virtualized)

Researchers

Model Development & Validation Consoles (e.g. RStudio)

Predictive Model Evaluation (Custom/PMML)

Development & Validation Hadoop Cluster (Ambari/Ri/hadoop)

Workflow Automation (Custom/Activiti)

HL7 Interface Engine (Mirth Connect)

New

Enterprise Service Bus (Oracle JCAPS / SOA Suite)

Honest Broker De/Reidentification (Custom)

Existing

Administrators

Administrator Consoles (e.g. Custom/Ambari/Activiti)

Physicians

Clinician Portal (UChart)

Order Management (EpicCare)

Clinical Document Exchange (Epic Care Anywhere)

Data Warehouse (Epic Cogito)

Patients

Patient Portal (MyUHealthChart)

UM EPIC System

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Model Promotion Process

1. Identify event to be predicted.
2. Survey existing models.
3. Compare models to existing data.
4. Identify model to promote.
5. Develop selection criteria.
6. Write algorithm for model.
7. Encode model in PMML.
8. Test model using patient data.
9. Develop practical criteria.
10. Deploy and integrate model.
11. Evaluate efficacy.
12. Finish.
Development and Validation of a Patient Self-assessment Diabetes Risk

Heejung Bang, PhD; Alison M. Edwards, MStat; Andrew S. Bomback, MD, MPH; Christie M. Ballantyne, MD; David Mark A. Callahan, MD; Steven M. Teutsch, MD, MPH; Alvin I. Mushlin, MD, ScM; and Lisa M. Kern, MD, MPH

Table 1. Risk Factors for Undiagnosed Diabetes*

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
<th>Log (Odds Ratio)</th>
<th>Score Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;40 y</td>
<td>Reference</td>
<td>–</td>
<td>–</td>
<td>0</td>
</tr>
<tr>
<td>40–49 y</td>
<td>2.6 (1.3–5.0)</td>
<td>0.004</td>
<td>0.95</td>
<td>1</td>
</tr>
<tr>
<td>50–59 y</td>
<td>4.8 (2.2–10.6)</td>
<td>&lt;0.001</td>
<td>1.57</td>
<td>2</td>
</tr>
<tr>
<td>≥60 y</td>
<td>8.1 (3.9–16.9)</td>
<td>&lt;0.001</td>
<td>2.09</td>
<td>3</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Reference</td>
<td>–</td>
<td>–</td>
<td>0</td>
</tr>
<tr>
<td>Male</td>
<td>2.6 (1.8–3.7)</td>
<td>&lt;0.001</td>
<td>0.96</td>
<td>1</td>
</tr>
<tr>
<td>Family history of diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Reference</td>
<td>–</td>
<td>–</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>2.0 (1.5–2.6)</td>
<td>&lt;0.001</td>
<td>0.67</td>
<td>1</td>
</tr>
<tr>
<td>History of hypertension</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Reference</td>
<td>–</td>
<td>–</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>1.9 (1.2–2.9)</td>
<td>0.004</td>
<td>0.64</td>
<td>1</td>
</tr>
<tr>
<td>Obesity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not overweight or obese</td>
<td>Reference</td>
<td>–</td>
<td>–</td>
<td>0</td>
</tr>
<tr>
<td>Overweight</td>
<td>1.3 (0.6–2.8)</td>
<td>0.47</td>
<td>0.27</td>
<td>1</td>
</tr>
<tr>
<td>Obese</td>
<td>3.1 (1.6–5.8)</td>
<td>&lt;0.001</td>
<td>1.12</td>
<td>2</td>
</tr>
<tr>
<td>Extremely obese</td>
<td>7.3 (4.0–13.4)</td>
<td>&lt;0.001</td>
<td>1.99</td>
<td>3</td>
</tr>
<tr>
<td>Physically active</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Reference</td>
<td>–</td>
<td>–</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>0.7 (0.5–1.0)</td>
<td>0.06</td>
<td>−0.34</td>
<td>−1</td>
</tr>
</tbody>
</table>
## Data Quality Analysis

### Sample One Million Patients:

<table>
<thead>
<tr>
<th>Data Element</th>
<th>% Found in Patient Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>~100%</td>
</tr>
<tr>
<td>Gender</td>
<td>~100%</td>
</tr>
<tr>
<td>Body Mass Index (BMI)</td>
<td>~35%</td>
</tr>
<tr>
<td>History of Hypertension</td>
<td>~41%</td>
</tr>
<tr>
<td><strong>Diabetes Family History</strong></td>
<td>~0.26%</td>
</tr>
<tr>
<td>Physical Activity</td>
<td>~0%</td>
</tr>
</tbody>
</table>

* Unknown ETL issue at the time
Point of Care Predictive Analytics
EHR Order Entry – Ordering the Score
EHR Results – Risk Score Returned

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Units</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. DIABETES RISK SCORE</td>
<td>8.0</td>
<td></td>
<td>H</td>
</tr>
</tbody>
</table>
EHR Result – Risk Scores Stored & Trended
REDCap and EHR – Data Collection

Health and Wellness

Would you like to participate in a University of Miami Health Assessment and see how you score?

If yes, all you need to do is answer questions on your medical history and current lifestyle in this brief online survey Click here to take the assessment survey.

Link to REDCap data instruments and surveys
REDCap Survey Results in the EHR

### Expanded Prostate cancer Index Composite Short Form (EPIC-26) Domain Scores

Report Run Date: 7/31/2015 at 11:31:20AM

<table>
<thead>
<tr>
<th>UMMG MRN Patient Information / Domain Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>9834580</td>
</tr>
<tr>
<td>Date Form Completed</td>
</tr>
<tr>
<td>First name:</td>
</tr>
<tr>
<td>Last name:</td>
</tr>
<tr>
<td>Date of birth:</td>
</tr>
<tr>
<td>Urinary Incontinence</td>
</tr>
</tbody>
</table>
Predictive Analytics via User Portal

Would you like to participate in a University of Miami Health Assessment and see how you score?

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Health Assessment - Are you at risk?

The Diabetes Risk Assessment aims to identify an individual’s risk of developing type 2 diabetes.

Click here to find out your risk for type 2 diabetes.
Health Assessment - Are you at risk?

Based on data collected in your UHealth medical record, you have a risk score of 6.9

A score of 5 or higher means you are at increased risk for having type 2 diabetes. However, only your doctor can tell for sure.

The following factored into your total score:

1. Your Body Mass Index is 30.7
2. You indicated that you are a smoker
3. You show family history of diabetes

You can prevent or delay type 2 diabetes by staying at a healthy weight, not smoking, eating a balanced diet and taking steps to lower your blood pressure. Please speak with your UHealth physician to see if additional testing is needed and for tips on reducing your risk.
Future Directions – Putting It All Together

- Epic EMR Chronicles
- Epic EMR Clarity
- Meditech EMR
- Genomic Data
- Source System Data

Cogito Data Warehouse → Hadoop → Risk Score

Evaluate Response

Algorithm Development and Testing

Business Objects

Alert Engine

Epic EMR
Email
SMS

Clinical Care

Patient Care Intervention

Care Coordination

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Future Directions – Fine Tuning
Future Directions

• Individualized Alerts and Treatment
  - Heart Rate
  - Warfarin
• EHR-based Observational Analysis
  - Complex Clinical Decision Support
  - Population Health is local
• Patient Engagement
Anticipated Benefits of Predictive Analytics Platform

S = A flexible platform that supports the health system’s goal for population health management.

T = Real-time health assessments of their patient population allows clinicians to launch targeted interventions to their most high-risk patients.

E = Secure consolidation of health information from over 60 different healthcare technology systems, provides the necessary data to identify patient’s at risk of developing a chronic disease.

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Questions

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