Actionable Analytics: From Predictive Modeling to Workflows
March 1, 2016
Ari Robicsek, MD
Chad Konchak, MBA
Conflict of Interest

Ari Robicsek, MD & Chad Konchak, MBA

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

• Introduction
• A cautionary tale – The Story of Wunderlich
• Getting Analytics into Workflows
• Use Cases
  – MRSA
  – Advance Care Planning
  – Patient Lists And Registries for Population Health
  – What’s Going Around
Learning Objectives

• **Learning Objective 1.** Describe EMR functionality that will allow you to integrate predictive modeling and analytics tools (e.g. dashboards and reports) into clinical workflows

• **Learning Objective 2.** Develop interactive dashboards and analytical tools within the context of workflows that takes advantage of and integrates with existing EMR workflows and functionality

• **Learning Objective 3.** Evaluate different modeling techniques against implementation considerations given the tools available to integrate predictive models into clinical workflows

• **Learning Objective 4.** Plan mechanisms to formalize the processes needed to govern predictive modeling efforts in your organization

• **Learning Objective 5.** Share real life use cases of actionable analytics
Value Summary

**MRSA**

Reducing MRSA Tests

Savings:
$10 per patient
X 50K Admissions
= $500K Per Year!
MRSA infection rate unchanged!

**Readmissions**

Reduction in Readmission rates for AMI

**Population Health**

Automated Outreach
Improve Lab Test Completion

Automated Outreach
Improve Management for Hypertension

Reduction in Utilization for high risk patients
Introduction

NorthShore Key Statistics

- 4 Hospitals
- 950 Beds
- 9000+ Employees
- 2700 Physician Medical Staff
- 850+ Employed Physician Medical Group
- 60,000 Annual Admissions
- 1.8 Million Annual Office Visits
- 125,000 Annual ED Visits
- $100M+ Research Institute
- University of Chicago principal teaching affiliate
A CAUTIONARY TALE
What is a ‘fever’ in the postoperative setting? This tool was designed to help clinicians determine whether their patient’s temperature is 'normal' on a given postoperative day. Enter a patient’s characteristics to see how their temperature compares to that of similar patients undergoing the same procedure; the higher the percentile, the more unusual the temperature. You can learn more here.

*denotes required field
*Type of Surgery: 

*Post Operative Day: 

*Today’s T-Max: 

Temperature Percentile Chart

To view the Temperature Percentile Chart, please input the values on the left and click submit

http://fad.northshore.org/wunderlich/Default.aspx
What is a ‘fever’ in the postoperative setting? This tool was designed to help clinicians determine whether their patient’s temperature is ‘normal’ on a given postoperative day. Enter a patient’s characteristics to see how their temperature compares to that of similar patients undergoing the same procedure; the higher the percentile, the more unusual the temperature. You can learn more here.

Temperature Percentile Chart

To view the Temperature Percentile Chart, please input the values on the left and click submit.
What is a ‘fever’ in the postoperative setting? This tool was designed to help clinicians determine whether their patient’s temperature is ‘normal’ on a given postoperative day. Enter a patient’s characteristics to see how their temperature compares to that of similar patients undergoing the same procedure; the higher the percentile, the more unusual the temperature. You can learn more here.

*denotes required field
*Type of Surgery: Lap Cholecystectomy

*Post Operative Day: 1

*Today’s T-Max: 100.4

*Anti-Pyretic?: Yes

*Blood Transfusion?: Yes

Submit

Percentile: 95%
What is a ‘fever’ in the postoperative setting? This tool was designed to help clinicians determine whether their patient’s temperature is ‘normal’ on a given postoperative day. Enter a patient’s characteristics to see how their temperature compares to that of similar patients undergoing the same procedure; the higher the percentile, the more unusual the temperature. You can learn more here.

*denotes required field
*Type of Surgery: Hip Arthroplasty

*Post Operative Day: 1
*Today’s T-Max: 100.4
Pre-Op T-Max: 45
*Age: 45
*Anti-Pyretic?: Yes

Percentile: 65%
What is a ‘fever’ in the postoperative setting? This tool was designed to help clinicians determine whether their patient’s temperature is ‘normal’ on a given postoperative day. Enter a patient’s characteristics to see how their temperature compares to that of similar patients undergoing the same procedure; the higher the percentile, the more unusual the temperature. You can learn more here.

* denotes required field
*Type of Surgery:
CV Surgery

*Post Operative Day: 1

*Today’s T-Max: 100.4

Pre-Op T-Max: 

*Age: 45

*Female?:

Yes ☐ No ☐

Submit

Reset

Percentile: 80%
What is a ‘fever’ in the postoperative setting? This tool was designed to help clinicians determine whether their patient’s temperature is ‘normal’ on a given postoperative day. Enter a patient’s characteristics to see how their temperature compares to that of similar patients undergoing the same procedure; the higher the percentile, the more unusual the temperature. You can learn more here.

* denotes required field

Type of Surgery: CV Surgery

Post Operative Day: 1

Today’s T-Max: 100.4

Pre-Op T-Max: 

Age: 45

Female?:

[Radio button] Yes [Radio button] No

Submit

Percentile: 85%
What is a ‘fever’ in the postoperative setting? This tool was designed to help clinicians determine whether their patient’s temperature is ‘normal’ on a given postoperative day. Enter a patient’s characteristics to see how their temperature compares to that of similar patients undergoing the same procedure; the higher the percentile, the more unusual the temperature. You can learn more here.

*denotes required field

Type of Surgery: CV Surgery

*Post Operative Day: 1

Today’s T-Max: 100.4

Pre-Op T-Max: 

Age: 85

*Female?: 

Percentile: 94%

Submit

Reset
Getting analytics *into* workflows
1. Data Sources

2. Standardization & Normalization
   - EMPI
   - Security Flags
   - Data Normalization*

3. Data Enrichment
   - Patient Registries (Care Gap Definitions)
   - Predictive Analytics*
     - *Includes Risk Stratification, NLP, & GIS
   - Data Grouping*

4. Workflow
   - EMR & BI agnostic!
     - Point of Care CDS
       - Alerts
       - Banners, etc
     - Physician Portal
       - 1. Embedded within EMR
       - 2. Accessible outside
     - Care/Case Coordinator Portal
       - 1. Embedded within EMR
     - Patient Portal
       - Manage Care Gaps
       - Message care team
     - Automated Outreach
       - Phone
       - Email
       - Text, etc
     - Administrative Portal
       - Quality Scorecards
       - Utilization
       - Productivity / Auditing
       - Practice Variation

**The Data Supply Chain**

Critical step where raw data becomes actionable intelligence
**Stages of Analytics**

**Stage 1:** Bringing Raw Data into EDW from External Sources

**Stage 2:** Enriching Data & Transforming it into Information

**Stage 3:** Development of Actionable Business Intelligence

**Stage 4:** Integrating Intelligence into Business & Clinical Workflows To drive Decision Making

---

**Analytics Factory**

Enriched & Cultivated “Information”

---

**EMR**

- MG &IPA Clinical & Claims Data
- External Claims Data
- External CCD & Point to Point
- External Lab & Pharmacy Fill

**Dashboards**

Quality Scorecards

**Data-driven Workflow Support**

Care Gaps

Utilization Volume & $$$

Risk Stratification

Social Factors

Physician Attribution

GIS Mapping

Predictive Modeling

---
Data Analytics Governance

Process for moving code to analytics server

- **R Programmers**
  - Write, modifies R code
  - Ready for production?
  - No
  - Suggest alternate
  - Approved?
  - Yes
  - New R package Evaluation
  - Yes
  - Trusted Source?
  - Yes
  - Changes Suggested?
  - Engage EDW team (if required)
  - Move Project in Production
  - Create RFC

- **R Code Review**
  - Check template
  - Check error handling
  - Check efficiency and flow
  - Etc.

- **New R Package?**
  - Yes
  - Trusted Source?
  - Yes
  - Changes Suggested?
  - Engage EDW team (if required)
  - Move Project in Production
  - Create RFC

- **Create RFS**
  - Input file(s) and output file(s) details and logic
  - Scheduling details
  - Additional R Packages used (if any)
  - R code
  - Email sample data set to R Admin

- **Pulse**

***RFS will include:
- Input file(s) and Output file(s) details and logic.
- Scheduling details.
- Additional R Packages used (if any).
- R code.
- Email sample data set to R Admin.

---

**R Code review and New R package evaluation will be done by a group of people appointed by mutual consent from all teams.**

---

- Scheduling R code through ETL
- Data mart design changes
- BI changes
- Standard directories, files and granules
- Install packages (if required)
- Etc.
Analytical Standards for Regression-based Predictive Analytics: Methodologies, Naming Conventions and Coding Practices

NorthShore University HealthSystem
Clinical Analytics Team

9th January, 2015

Abstract

This document proposes a set of methodology and programming standards for the Clinical Analytics team. It is intended as a set of guidelines that will be developed over time as the needs of the team evolve. Guidelines include a review of statistics, survival analysis, general programming techniques, naming conventions, R coding practices and a general approach to tackling most common types of applied predictive analysis handled by the team.

Figure 3.1: A generic algorithm for proceeding with an analytical project within the framework of Clinical Analytics.

As mentioned in Section 1, the majority of predictive analytic problems can be solved by employing one of two wide types of forecasting methodologies: regression and classification. Regression\footnote{Or another appropriate fitting technique} should be used when the
ALERTS AND BANNERS
US Legislation

- Illinois (2007)
  - ICU and “high risk”
- New Jersey (2007)
  - ICU and other “high risk” units
- Pennsylvania (2007)
  - LTCF and “high risk” patients
- California (2008)
  - ICU, certain surgical patients, readmits, LTCF residents, dialysis patients
- Washington (2009)
  - ICU and “high risk” patients
Predicted probability of MRSA = $e^\text{LO} / (1 + e^\text{LO})$

where $\text{LO} = -4.655$

+ 0.083 x (Age/10)
+ 0.135(if Male)
+ 0.421(if Black or African-American$^\dagger$)
- 0.229(if other, non-White race$^\dagger$)
+ 1.010(if Nursing Home Resident)
+ 0.267(if Admission Service$^\ddagger$ = Internal Medicine)
+ 0.421(if Admission Service$^\ddagger$ = Psychiatry)
- 0.249(if Admission Service$^\ddagger$ = Surgery)
+ 0.006(if Inpatient within last year)
+ 0.339(if ICU > 2 days within last year)
+ 0.153(if Diarrhea on admission)
+ 0.780(if Feeding Tube on admission)
+ 0.663(if Pressure Ulcer on admission)
+ 0.234(if Microbiology test done on admission or in prior week)
+ 0.480(if Skin or Bone Infection on admission)
+ 0.231(if Albumin < 3)
+ 0.245(if Glucose ≥ 23)
+ 0.355(if Hemoglobin < 8.6)
+ 0.133(if Sodium < 131 or > 143)
- 1.409(if Cephalosporins in past month)
- 0.212(if Fluoroquinolones in past month)
+ 0.316(if Other Antimicrobials in past month)
+ 0.322(if Past VRE or ESBL)
+ 2.146(if Cystic Fibrosis)
+ 0.019(if Diabetes Mellitus)
+ 0.324(if Heart Disease)
- 0.187(if Dialysis past year)
+ 0.479(if Lung Disease)
- 0.135(if Stroke or TIA)
+ 0.175(if Venous Thromboemolism)
Logic

• Alert will “fire” if:
  – Score is high enough ("magic number") OR
  – MRSA on problem list OR
  – ICU admission OR
  – Last digit in Encounter Number is ‘0’
  AND
  – No Staph PCR in past 30 days
<table>
<thead>
<tr>
<th>Unit</th>
<th>Patient</th>
<th>Test needed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 North</td>
<td>Smith, John</td>
<td>🔴</td>
</tr>
<tr>
<td>3 South</td>
<td>Doe, Jane</td>
<td>🔴</td>
</tr>
<tr>
<td>4 East</td>
<td>Duck, Donald</td>
<td>⬜</td>
</tr>
<tr>
<td>3 South</td>
<td>Mouse, Mickey</td>
<td>🔴</td>
</tr>
<tr>
<td>4 North</td>
<td>Of Arendelle, Elsa</td>
<td>⬜</td>
</tr>
<tr>
<td>3 South</td>
<td>Baggins, Frodo</td>
<td>🔴</td>
</tr>
<tr>
<td>4 North</td>
<td>Strike, Cormoran</td>
<td>🟢</td>
</tr>
<tr>
<td>3 South</td>
<td>Hutt, Jabba</td>
<td>⬜</td>
</tr>
<tr>
<td>4 East</td>
<td>Man, Spider</td>
<td>🟢</td>
</tr>
<tr>
<td>3 South</td>
<td>Man, Ant</td>
<td>🟢</td>
</tr>
<tr>
<td>4 North</td>
<td>Man, Super</td>
<td>🟢</td>
</tr>
<tr>
<td>3 South</td>
<td>Man, Bat</td>
<td>🟢</td>
</tr>
<tr>
<td>4 East</td>
<td>Man, Aqua</td>
<td>🔴</td>
</tr>
</tbody>
</table>
Patient meets criteria for MRSA screening

Click here to order test
Real-life prospective validation

- All patients admitted and MRSA tested Sept-Nov 2011 (8899 patients)
- Ranked patients by scoring and determined MRSA ‘capture’ at a spectrum of thresholds
- Layered on additional logic (e.g. test all patients with MRSA history)
148 tests/day

87 tests/day

No increase in MRSA infections
MRSA healthcare-associated infections/10,000 patient-days

Reducing MRSA Tests Savings:
$10 per patient
X 50K Admissions
= $500K Per Year!

MRSA infection rate unchanged!
Advance Care Planning

• Mortality in patients with chronic heart failure is high (~10% annually).
• Many of these patients would benefit from conversations with their cardiologist about advance care planning – especially patients at highest mortality risk.
• Can predictive modeling be used to systematically identify the highest-risk patients?
Heart Failure Mortality Model

Formula

\[
\text{logit}_{HF} = \ln \left( \frac{p_{\text{death}}}{1 - p_{\text{death}}} \right) = 3.31 + 0.06 \times \text{Age (per year)} \\
- 0.51 \times \text{Female} - 0.01 \times \text{sBP (per mmHg)} - 0.11 \times \text{Hb} \\
- 0.05 \times \text{BMI} - 0.04 \times \text{Sodium} + 0.0003 \times \text{BNP} \\
+ 1.61 \times \text{Cancer (active)} \\
+ 0.73 \times \text{Code Status Order Placed} \\
+ 0.51 \times \text{Diabetes Mellitus} + 0.80 \times \text{Dementia} \\
+ 0.41 \times \text{Hypertension} + 0.58 \times \text{Chronic kidney disease} \\
+ 0.98 \times \# \text{ of hospitalizations in the last 30 days} \\
+ 0.15 \times \# \text{ of hospital visits in the last 12 months} \\
- 0.06 \times \# \text{ of cardiological visits in the last 24 months}
\]

\[
p_{\text{death}} = \frac{1}{1 + e^{-\text{logit}_{HF}}}
\]

AUC 0.82
Every night, the model is applied to our whole population of HF patients to identify those at highest-risk...

\[
\text{logit}_{HF} = \ln\left(\frac{p_{\text{death}}}{1 - p_{\text{death}}}\right) = 3.31 + 0.06 \times \text{Age (per year)}
- 0.51 \times \text{Female} - 0.01 \times \text{sBP (per mmHg)} - 0.11 \times \text{Hb}
- 0.05 \times \text{BMI} - 0.04 \times \text{Sodium} + 0.0003 \times \text{BNP}
+ 1.61 \times \text{Cancer (active)}
+ 0.73 \times \text{Code Status Order Placed}
+ 0.51 \times \text{Diabetes Mellitus} + 0.80 \times \text{Dementia}
+ 0.41 \times \text{Hypertension} + 0.58 \times \text{Chronic kidney disease}
+ 0.98 \times \# \text{ of hospitalizations in the last 30 days}
+ 0.15 \times \# \text{ of hospital visits in the last 12 months}
- 0.06 \times \# \text{ of cardiological visits in the last 24 months}
\]

\[
p_{\text{death}} = \frac{1}{1 + e^{-\text{logit}_{HF}}}
\]

This high-risk list is then made available to clinical staff in Epic to facilitate Advance Care Planning.
Patient has a high 1-year mortality risk. Click [here](#) for details.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes Mellitus</td>
<td>2008</td>
</tr>
<tr>
<td>Hypertension</td>
<td>2002</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>2009</td>
</tr>
<tr>
<td>COPD</td>
<td>2014</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>2012</td>
</tr>
<tr>
<td>CHF</td>
<td>1998</td>
</tr>
</tbody>
</table>

**History:**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendicitis</td>
<td>1982</td>
</tr>
<tr>
<td>CABG</td>
<td>1999</td>
</tr>
</tbody>
</table>
PATIENT LISTS & REGISTRIES
## Population Health – Disease Management

### Bulk Messaging

<table>
<thead>
<tr>
<th>Unit</th>
<th>Patient</th>
<th>MRN</th>
<th>PCP</th>
<th>Home phone</th>
<th>Due for HbA1c?</th>
<th>Due for lipids?</th>
<th>Due for microalbumin?</th>
<th>Undiagnosed High BP?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 North</td>
<td>Smith, John</td>
<td>12345678</td>
<td>Watson, James</td>
<td>847.555.5555</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>3 South</td>
<td>Doe, Jane</td>
<td>12345678</td>
<td>Watson, James</td>
<td>847.555.5555</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>4 East</td>
<td>Duck, Donald</td>
<td>12345678</td>
<td>Watson, James</td>
<td>847.555.5555</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>3 South</td>
<td>Mouse, Mickey</td>
<td>12345678</td>
<td>Watson, James</td>
<td>847.555.5555</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>4 North</td>
<td>Of Arendelle, Elsa</td>
<td>12345678</td>
<td>Watson, James</td>
<td>847.555.5555</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>3 South</td>
<td>Baggins, Frodo</td>
<td>12345678</td>
<td>Watson, James</td>
<td>847.555.5555</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>4 North</td>
<td>Man, Super</td>
<td>12345678</td>
<td>Moriarty, James</td>
<td>847.555.5555</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 South</td>
<td>Man, Bat</td>
<td>12345678</td>
<td>Moriarty, James</td>
<td>847.555.5555</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 East</td>
<td>Man, Aqua</td>
<td>12345678</td>
<td>Moriarty, James</td>
<td>847.555.5555</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Process Impact

Time to HbA1c Completed

Pilot
- 50% of OFI patients completed in 5.5 weeks

Control
- 50% of OFI patients completed in 11 weeks

p-value < 0.01 : Kaplan-Meier Survival Analysis

Automated Outreach
Improved Lab Test Completion

% of patients still on OFI

# of weeks on OFI

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

0 1 2 3 4 5 6 7 8 9 10 11

-
Clinical Impact

Hypertension Management

Automated Outreach
Improved Management for Hypertension

Percent at goal

30-day Readmissions

- Prospective validation
  - 948 patients discharged from pilot units between Jan 6 and Feb 12 2012

<table>
<thead>
<tr>
<th>Risk Group</th>
<th>Number of Patients</th>
<th>% Readmitted in 30 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>175</td>
<td>33%</td>
</tr>
<tr>
<td>Medium</td>
<td>141</td>
<td>16%</td>
</tr>
<tr>
<td>Low</td>
<td>632</td>
<td>12%</td>
</tr>
</tbody>
</table>
## 30-day Readmissions

### Hospital System List

<table>
<thead>
<tr>
<th>Unit</th>
<th>Patient</th>
<th>Readmission Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 North</td>
<td>Smith, John</td>
<td>●</td>
</tr>
<tr>
<td>3 South</td>
<td>Doe, Jane</td>
<td>●</td>
</tr>
<tr>
<td>4 East</td>
<td>Duck, Donald</td>
<td>○</td>
</tr>
<tr>
<td>3 South</td>
<td>Mouse, Mickey</td>
<td>●</td>
</tr>
<tr>
<td>4 North</td>
<td>Of Arendelle, Elsa</td>
<td>○</td>
</tr>
<tr>
<td>3 South</td>
<td>Baggins, Frodo</td>
<td>●</td>
</tr>
<tr>
<td>4 North</td>
<td>Strike, Cormoran</td>
<td>●</td>
</tr>
<tr>
<td>3 South</td>
<td>Hutt, Jabba</td>
<td>○</td>
</tr>
<tr>
<td>4 East</td>
<td>Man, Spider</td>
<td>●</td>
</tr>
<tr>
<td>3 South</td>
<td>Man, Ant</td>
<td>●</td>
</tr>
<tr>
<td>4 North</td>
<td>Man, Super</td>
<td>●</td>
</tr>
<tr>
<td>3 South</td>
<td>Man, Bat</td>
<td>●</td>
</tr>
<tr>
<td>4 East</td>
<td>Man, Aqua</td>
<td>●</td>
</tr>
</tbody>
</table>
### Patients Discharged in Past 30 days or Currently Admitted: NorthShore Hospitals

<table>
<thead>
<tr>
<th>Service</th>
<th>Discharged / In Hospital</th>
<th>Readmission Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient EPIC MRN</th>
<th>Patient Name</th>
<th>Patient Type</th>
<th>Service</th>
<th>Admit Date</th>
<th>Discharge Date</th>
<th>Admission Pavilion</th>
<th>Readmission Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient</td>
<td>Medical</td>
<td>Medical</td>
<td>01/03/2016</td>
<td>01/08/2016</td>
<td>Skokie Hospital</td>
<td>HIGH</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Medical</td>
<td>Medical</td>
<td>01/06/2016</td>
<td>01/11/2016</td>
<td>Evanston Hospital</td>
<td>HIGH</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Medical</td>
<td>Medical</td>
<td>12/14/2015</td>
<td>12/20/2015</td>
<td>Evanston Hospital</td>
<td>HIGH</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Medical</td>
<td>Medical</td>
<td>12/24/2015</td>
<td>01/10/2016</td>
<td>Evanston Hospital</td>
<td>HIGH</td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>Medical</td>
<td>Medical</td>
<td>12/27/2015</td>
<td>12/28/2015</td>
<td>Skokie Hospital</td>
<td>INTERMEDIATE</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Surgical</td>
<td>Surgical</td>
<td>12/23/2015</td>
<td>12/28/2015</td>
<td>Glenbrook Hospital</td>
<td>INTERMEDIATE</td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>Surgical</td>
<td>Surgical</td>
<td>12/16/2015</td>
<td>12/17/2015</td>
<td>Skokie Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Medical</td>
<td>Medical</td>
<td>01/07/2016</td>
<td>01/08/2016</td>
<td>Glenbrook Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Medical</td>
<td>Medical</td>
<td>01/11/2016</td>
<td>In Hospital</td>
<td>Skokie Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>Surgical</td>
<td>Surgical</td>
<td>12/15/2015</td>
<td>12/16/2015</td>
<td>Highland Park Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>Medical</td>
<td>Medical</td>
<td>12/20/2015</td>
<td>12/22/2015</td>
<td>Skokie Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>Medical</td>
<td>Medical</td>
<td>01/07/2016</td>
<td>01/08/2016</td>
<td>Glenbrook Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Medical</td>
<td>Medical</td>
<td>12/26/2015</td>
<td>12/29/2015</td>
<td>Skokie Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Medical</td>
<td>Medical</td>
<td>01/04/2016</td>
<td>01/09/2016</td>
<td>Highland Park Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Medical</td>
<td>Medical</td>
<td>12/11/2015</td>
<td>12/18/2015</td>
<td>Evanston Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>Surgical</td>
<td>Surgical</td>
<td>12/28/2015</td>
<td>12/29/2015</td>
<td>Highland Park Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Surgical</td>
<td>Surgical</td>
<td>01/03/2016</td>
<td>01/07/2016</td>
<td>Evanston Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>OB</td>
<td>OB</td>
<td>01/07/2016</td>
<td>01/07/2016</td>
<td>Evanston Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Surgical</td>
<td>Surgical</td>
<td>01/06/2016</td>
<td>01/09/2016</td>
<td>Skokie Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Surgical</td>
<td>Surgical</td>
<td>12/17/2015</td>
<td>12/19/2015</td>
<td>Glenbrook Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Inpatient</td>
<td>Surgical</td>
<td>Surgical</td>
<td>01/10/2015</td>
<td>In Hospital</td>
<td>Glenbrook Hospital</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>Observation</td>
<td>Medical</td>
<td>Medical</td>
<td>01/07/2016</td>
<td>01/09/2016</td>
<td>Skokie Hospital</td>
<td>LOW</td>
<td></td>
</tr>
</tbody>
</table>
30-day Readmissions

AMI Readmission Rate

Reduction in Readmission rates for AMI

Readmission predictive modeling integrated into workflow
Population Health – Case Management

## New Patients

### New Patient Criteria
- All Patients

### Sort Patients By
- Preventable Hospitalization

### Conditions
- All Patients

### Patient Table Filters - copy

<table>
<thead>
<tr>
<th>Pat Mnr Id</th>
<th>Pat Name</th>
<th>Age Yrs</th>
<th>Payor Name</th>
<th>Payer Category</th>
<th>Payer Group</th>
<th>Cur Pcp Phy Name</th>
<th>Admission Date Time</th>
<th>Department Name</th>
<th>Hosp Disch Date</th>
<th>Dx Or Reason</th>
<th>Suggested Call Time</th>
<th>Preventable Hospitalization Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>77</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td>Medicare</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
<td>Preventable Hospitalization Risk</td>
</tr>
<tr>
<td>68</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td>Medicare</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
<td>Preventable Hospitalization Risk</td>
</tr>
<tr>
<td>48</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td>Medicare</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>T 11AM - 3PM</td>
<td>10</td>
<td>Preventable Hospitalization Risk</td>
</tr>
<tr>
<td>36</td>
<td></td>
<td></td>
<td>BLUE CROSS PPO</td>
<td>Other</td>
<td></td>
<td>Other</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>M After 6PM</td>
<td>10</td>
<td>Preventable Hospitalization Risk</td>
</tr>
<tr>
<td>101</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td>Medicare</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
<td>Preventable Hospitalization Risk</td>
</tr>
<tr>
<td>46</td>
<td></td>
<td></td>
<td>ILLINICARE</td>
<td>Medicaid</td>
<td></td>
<td>Non-CCP</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>M After 4PM</td>
<td>10</td>
<td>Preventable Hospitalization Risk</td>
</tr>
<tr>
<td>69</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td>Medicare</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
<td>Preventable Hospitalization Risk</td>
</tr>
<tr>
<td>64</td>
<td></td>
<td></td>
<td>BLUE CROSS PPO</td>
<td>Other</td>
<td></td>
<td>Other</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
<td>Preventable Hospitalization Risk</td>
</tr>
<tr>
<td>62</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td>Medicare</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
<td>Preventable Hospitalization Risk</td>
</tr>
<tr>
<td>74</td>
<td></td>
<td></td>
<td>AETNA MEDICARE OPTION C</td>
<td>Medicare</td>
<td></td>
<td>Medicare</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
<td>Preventable Hospitalization Risk</td>
</tr>
</tbody>
</table>
Population Health – Case Management

Patient Details - Preventable Hospitalization Score

<table>
<thead>
<tr>
<th>MRN:</th>
<th>Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number Of Hospitalizations</th>
<th>Comorbidity Indicators I</th>
<th>Comorbidity Indicators II</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Alcohol Abuse</td>
<td>Lymphoma</td>
</tr>
<tr>
<td></td>
<td>Blood Loss Anemia</td>
<td>Metastatic Cancer</td>
</tr>
<tr>
<td></td>
<td>Cancer</td>
<td>Obesity</td>
</tr>
<tr>
<td></td>
<td>Congestive Heart Failure</td>
<td>Other Neurological Disease</td>
</tr>
<tr>
<td></td>
<td>Complicated Diabetes</td>
<td>Paralysis</td>
</tr>
<tr>
<td></td>
<td>Complicated Hypertension</td>
<td>Psychoses</td>
</tr>
<tr>
<td></td>
<td>COPD</td>
<td>Peripheral Vascular Disease</td>
</tr>
<tr>
<td></td>
<td>Deficiency Anemia</td>
<td>Rheumatoid Arthritis</td>
</tr>
<tr>
<td></td>
<td>Depression</td>
<td>Renal Failure</td>
</tr>
<tr>
<td></td>
<td>Drug Abuse</td>
<td>Tumor Without Metastasis</td>
</tr>
<tr>
<td></td>
<td>Fluid Electrolyte Disorder</td>
<td>Uncomplicated Diabetes</td>
</tr>
<tr>
<td></td>
<td>Hypothyroidism</td>
<td>Uncomplicated Hypertension</td>
</tr>
<tr>
<td></td>
<td>Liver Disease</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>46</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>M</th>
</tr>
</thead>
</table>
# Population Health – Case Management

## New Patients

### Patient Table Filters - copy

<table>
<thead>
<tr>
<th>Pat Mm Id</th>
<th>Pat Name</th>
<th>Age Yrs</th>
<th>Payor Name</th>
<th>Payer Category</th>
<th>Payer Group</th>
<th>Cur Pcp Phy Name</th>
<th>Admission Date Time</th>
<th>Department Name</th>
<th>Hosp Disch Date</th>
<th>Dx Or Reason</th>
<th>Suggested Call Time</th>
<th>Preventable Hospitalization Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>77</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td></td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
</tr>
<tr>
<td>68</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td></td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
</tr>
<tr>
<td>48</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td></td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>T 11AM - 3PM</td>
<td>10</td>
</tr>
<tr>
<td>36</td>
<td></td>
<td></td>
<td>BLUE CROSS PPO</td>
<td>Other</td>
<td></td>
<td></td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>M After 6PM</td>
<td>10</td>
</tr>
<tr>
<td>101</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td></td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
</tr>
<tr>
<td>46</td>
<td></td>
<td></td>
<td>ILLINICARE</td>
<td>Medicaid</td>
<td>Non-CCP</td>
<td></td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>M After 4PM</td>
<td>10</td>
</tr>
<tr>
<td>69</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td></td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
</tr>
<tr>
<td>64</td>
<td></td>
<td></td>
<td>BLUE CROSS PPO</td>
<td>Other</td>
<td></td>
<td></td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
</tr>
<tr>
<td>62</td>
<td></td>
<td></td>
<td>MEDICARE PART A &amp; B</td>
<td>Medicare</td>
<td></td>
<td></td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W Before 4PM</td>
<td>10</td>
</tr>
<tr>
<td>74</td>
<td></td>
<td></td>
<td>AETNA MEDICARE OPTION C</td>
<td>Medicare</td>
<td></td>
<td></td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>Null</td>
<td>W After 2PM</td>
<td>10</td>
</tr>
<tr>
<td>Patient EPIC MRN</td>
<td>Patient Name</td>
<td>Status</td>
<td>Case Manager</td>
<td>Last Outcome Encounter Date</td>
<td>Payer Group</td>
<td>Patient Risk Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
<td>--------</td>
<td>--------------</td>
<td>-----------------------------</td>
<td>------------</td>
<td>-------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active</td>
<td>Torres, Belma</td>
<td>10/20/15</td>
<td>CCP</td>
<td>Very High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active</td>
<td>Wijas, Elaine</td>
<td>04/07/15</td>
<td>Other</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active</td>
<td>Francis, Philip</td>
<td>12/15/15</td>
<td>Other</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active</td>
<td>Corral, Dana</td>
<td>01/06/16</td>
<td>CCP</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Population Health – Case Management

Utilization Rates Per Year and Care Gaps -- Pre and Post Enrollment

<table>
<thead>
<tr>
<th>Category</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-PCP Visits</td>
<td>5.4</td>
<td>6.0</td>
</tr>
<tr>
<td>PCP Visits</td>
<td>3.4</td>
<td>-</td>
</tr>
<tr>
<td>Emergent Admissions</td>
<td>0.9</td>
<td>*</td>
</tr>
<tr>
<td>Other ED Visits</td>
<td>1.2</td>
<td>*</td>
</tr>
</tbody>
</table>

* = statistically significant (p<0.05)
- = not significant

A1C Over 10
Pre: 41%
Post: 17%

DM Lipid Uncont.
Pre: 35%
Post: 35%

NorthShore Charges
Pre: $5,028
Post: $3,800

NorthShore Charges HB
Pre: $4,058
Post: $3,031

Reduction in Utilization for high risk patients

©HIMSS 2016
MyPanel Dashboard - Lakeman, Justin
Physician Scorecard

MMI Score Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMI</td>
<td>74%</td>
</tr>
<tr>
<td>BP Control</td>
<td>82%</td>
</tr>
<tr>
<td>Colon CA Scrn</td>
<td>67%</td>
</tr>
<tr>
<td>DM &amp; CVD - Statin Mgmt</td>
<td>69%</td>
</tr>
<tr>
<td>DM-A1C Control</td>
<td>70%</td>
</tr>
<tr>
<td>Mammo</td>
<td>77%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antipit Therapy</td>
<td>82%</td>
</tr>
<tr>
<td>Asthma Action Plan</td>
<td>65%</td>
</tr>
<tr>
<td>Asthma Control Test</td>
<td>45%</td>
</tr>
<tr>
<td>DM - Nephropathy</td>
<td>91%</td>
</tr>
<tr>
<td>DM - Eye Exam</td>
<td>51%</td>
</tr>
<tr>
<td>HPV (Combined)</td>
<td>18%</td>
</tr>
</tbody>
</table>

Click a bar to filter your patient list. Click it again to remove the filter.

Patients with Care Gaps - All

<table>
<thead>
<tr>
<th>Patient MRN</th>
<th>Patient Name</th>
<th>Last Appt</th>
<th>Next Appt</th>
<th>Last A1c</th>
<th>Last LDL</th>
<th>Last BP</th>
<th># of Care Gaps</th>
<th>Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/3/15</td>
<td></td>
<td></td>
<td></td>
<td>9.6</td>
<td>90</td>
<td>142/80</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>12/21/15</td>
<td></td>
<td></td>
<td></td>
<td>14.3</td>
<td>118</td>
<td>146/86</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5/11/15</td>
<td></td>
<td></td>
<td></td>
<td>8.4</td>
<td>82</td>
<td>150/90</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>10/27/14</td>
<td></td>
<td></td>
<td></td>
<td>6.4</td>
<td>93</td>
<td>130/70</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1/11/16</td>
<td></td>
<td></td>
<td></td>
<td>6.0</td>
<td>132</td>
<td>140/86</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>7/6/15</td>
<td></td>
<td></td>
<td>2/10/16</td>
<td>7.2</td>
<td>126</td>
<td>158/80</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>12/15/15</td>
<td></td>
<td></td>
<td></td>
<td>8.9</td>
<td>38</td>
<td>120/80</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>11/18/15</td>
<td></td>
<td></td>
<td></td>
<td>5.9</td>
<td>95</td>
<td>128/82</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>9/3/15</td>
<td></td>
<td></td>
<td></td>
<td>6.0</td>
<td>62</td>
<td>146/70</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Patient Details

MRN: 
Name: 
Race/Ethnicity: African American
Age: 60
NSconnect Status: Not Active
Payor Name: BLUE CHOICE POS

Patient Stats

Last A1c: 7.2 - 10/1/14  DUE
Last LDL: 126 - 3/18/14
Last BP: 158/80 - 7/9/15
Last BMI: 25.8
Statin Dose: Moderate
Statin Rec: Add high dose

Patient Scorecard

- BP Control: crossed out
- Colon CA Scrn: checked
- DM & CVD - Statin Mgmt: crossed out
- DM- Eye Exam: crossed out
- DM-A1C Control: crossed out
- DM-Nephropathy: checked
- Mammo: checked

Select Measure: BP Control
Select Com.: (All)
Figure 4. Percentage of patients with FRI who received antibiotics based on the number of patients with FRI seen by their physician in the previous week.

FRI = febrile respiratory illness.

What's Going Around Overview
Syndromic Surveillance Across the NorthShore Population

Click a syndrome for details.

- Influenza-Like Illness: MEDIUM
- Pediatric Asthma: MEDIUM
- Strep Throat: LOW
- Gastroenteritis: MEDIUM
- Pertussis: HIGH
What's Going Around
Syndromic Surveillance Across the NorthShore Population

Pertussis as of November 10, 2013
Three-Year Lookback Period

Colors represent the proportion of all patients seen in the Medical Group who had the syndrome of interest. Areas with insufficient data for accurate estimates are not colored.

Sample Maps | Change Location | How WGA Works | Feedback

Sample Low | Sample Medium | Sample High

Below BLUE line = LOW syndromic activity. Above RED line = HIGH syndromic activity.

Age Specific Instances of syndrome. Grey represents 95% confidence intervals.
What's Going Around
Syndromic Surveillance Across the NorthShore Population

Colors represent the proportion of all patients seen in the Medical Group who had the syndrome of interest. Areas with insufficient data for accurate estimates are not colored.
Libertyville
What’s Going Around
Tracking Conditions Across the NorthShore Population

Influenza  Strep Throat  Pertussis  Pediatric Asthma  Gastroenteritis

Pertussis as of October 29, 2013
Three-Year Lookback Period

Colors represent the proportion of all patients seen in the Medical Group who had the syndrome of interest. Areas with insufficient data for accurate estimates are not colored.

Sample Maps  Change Location  How WGA Works  Feedback

Go-live preparation; October 30, 2013
Dear Parents and Guardians,

We have an update to our recent email notification - eight cases of pertussis, also called “whooping cough,” have been reported in our school, with a few more test results pending. Thank you to parents who have informed us of positive cases and concerns. Pertussis is caused by bacteria infecting the mouth, nose and throat. It is spread through the air by coughing.

Symptoms can appear 5 to 21 days after infection. Usually only close contacts of someone with Pertussis may become infected. Pertussis may start with cold-like symptoms (i.e., sneezing/runny nose) followed by a cough that can gradually become worse. Others may develop the cough without any cold symptoms. **Those with Pertussis are most contagious during the beginning, cold-like stage and the first 2 weeks after cough onset.** The cough
Movie

http://vimeo.com/90437195
Value Summary

**MRSA**
Reducing MRSA Tests
Savings:
$10 per patient
X 50K Admissions
= $500K Per Year!
MRSA infection rate unchanged!

**Readmissions**
Reduction in Readmission rates for AMI

**Population Health**
Automated Outreach
Improve Lab Test Completion

Automated Outreach
Improve Management for Hypertension

Reduction in Utilization for high risk patients
THANK YOU!

Ari Robicsek:  arobicsek@northshore.org

Chad Konchak:  ckonchak@northshore.org