IBM Advanced Care Insights:

Analytics and Care Management to Reduce Readmissions
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The path forward
... enabling holistic and individualized care to optimize outcomes and lower costs

IBM Smarter Care

Engage, convene, collaborate and cross boundaries to deliver an integrated plan to achieve optimal outcomes and lower costs

Coordinate

Engage

Understand

Know

Data-driven insights

Analytics and Cognitive Computing
Gain understanding through data-driven insights that enable providers to act with greater visibility into outcomes and cost

Foundation
Know individuals and populations; recognize intervention opportunities to apply evidence-based and standardized care planning

Wellness

Lifestyle

Social

Clinical

Experiential insights
IBM integrated portfolio for Smarter Care

**Coordination**
- Care identification
- Care planning
- Care collaboration
- Outcome evaluation

**Analytics and Cognitive Computing**
- Population analytics
- Diagnostic support
- Care pathways
- Operational reporting

**Cognitive computing**

**Foundation**
- Data warehouse and data models
- “Single view” customer EMPI (MDM)
- BI, reports and dashboards
- Portals, mobile and collaboration
- Remote monitoring and medical device connectivity
- Paper and Fax capture, conversion and extraction

Comprehensive global consulting, technology, infrastructure and managed services
The Cost of Disease Progression

20% of People Generate 80% of Costs

Health Status

Healthy
Low Risk

At Risk

High Risk

Early Clinical Symptoms

Active Disease

Health Care Spending

Early Intervention Opportunities Identification

70% of US Deaths from Chronic Diseases
If we could only activate the relevant information to bring insights to the point of care when needed most …

Time once spent manually interpreting data ... becomes time spent healing patients

• Aggregate, activate and enrich relevant patient information beyond what is known
• Surface new data driven insights that enable new intervention opportunities ... earlier
• Adapt to changes and proactively deliver individualized patient centered care
What were the Readmissions Predictors at Seton?

The value of adding unstructured Data

The Data We Thought Would Be Useful … Wasn’t
• Structured data not available, not accurate enough, without the unstructured data - which was more trustworthy

What We Thought Was Causing 30 Day Readmissions … Wasn’t
• 113 possible candidate predictors expanded and changed after mining the data for hidden insights

New Hidden Indicators Emerged … Readmissions is a Highly Predictive Model
• 18 accurate indicators or predictors (see next slide)

<table>
<thead>
<tr>
<th>Predictor Analysis</th>
<th>% Encounters Structured Data</th>
<th>% Encounters Unstructured Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ejection Fraction (LVEF)</td>
<td>2%</td>
<td>74%</td>
</tr>
<tr>
<td>Smoking Indicator</td>
<td>35%</td>
<td>81%</td>
</tr>
<tr>
<td></td>
<td>(65% Accurate)</td>
<td>(95% Accurate)</td>
</tr>
<tr>
<td>Living Arrangements</td>
<td>&lt;1%</td>
<td>73%</td>
</tr>
<tr>
<td></td>
<td>(100% Accurate)</td>
<td></td>
</tr>
<tr>
<td>Drug and Alcohol Abuse</td>
<td>16%</td>
<td>81%</td>
</tr>
<tr>
<td>Assisted Living</td>
<td>0%</td>
<td>13%</td>
</tr>
</tbody>
</table>

97% at 80th percentile
49% at 20th percentile
Readmissions at Seton - Top 18 Indicators

New Insights Uncovered by Combining Content and Predictive Analytics

- Top indicator JVDI not on the original list of 113 - as well as several others
- Assisted Living and Drug and Alcohol Abuse emerged as key predictors - only found in unstructured data
- LVEF and Smoking are significant indicators of CHF but not readmissions
- A combination of actionable and non-actionable factors cause readmissions

1. Jugular Venous Distention Indicator
2. Paid by Medicaid Indicator
3. Immunity Disorder Disease Indicator
4. Cardiac Rehab Admit Diagnosis with CHF Indicator
5. Lack of Emotion Support Indicator
6. Self COPD Moderate Limit Health History Indicator
7. With Genitourinary System and Endocrine Disorders
8. Heart Failure History
9. High BNP Indicator
10. Low Hemoglobin Indicator
11. Low Sodium Level Indicator
12. Assisted Living
13. High Cholesterol History
14. Presence of Blood Diseases in Diagnosis History
15. High Blood Pressure Health History
16. Self Alcohol / Drug Use Indicator
17. Heart Attack History
18. Heart Disease History
The Impact of Readmissions at Seton
CHF Patient X – What Happened?

Patient X was hospitalized 6 times over an 8 month period. The same basic information was available at each encounter and Patient X’s readmission prediction score never dropped below 95% (out of possible 100%)

Individual Patient Data at Each Encounter (Patient X @ Dec 20, 2009)

Description of Model Serial Number
1. Heart Failure History
2. Heart Attack History
3. Self Alcohol/Drug Use Indicator (Canner + ICA)
4. High Blood Pressure History
5. Presence of diseases of the blood in diagnosis history
6. High Cholesterol History
7. Assisted Living from ICA Extract
8. Low Sodium Level Indicator
9. Low Hemoglobin Indicator
10. High BMP Indicator
11. Heart Failure History
12. With genitourinary system & Endocrine disorders
13. Self COPD Moderate Limit Health History Indicator
14. Lack of Emotion Support Indicator
15. Cardiac Rehab Admit Diagnosis with CHF Indicator
16. Immunity Disorder Disease Indicator
17. Paid by Medicaid Indicator
18. Jugular Venous Distention Indicator

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Illustrative CHF Readmissions Architecture

User Interaction Layer
- Analyst / Research Interfaces
- Operational Systems
  - Admissions, Discharge, Care Planning
- IBM Cognos BI
  - Dashboards - Reports

IPCI Core
- Healthcare Accelerator
- Annotators
  - Custom
- Unstructured Data
  - Clinical notes
  - Discharge Summaries
  - Echocardiogram Report
  - ...
IBM Natural Language Processing Annotator technology ...

- Annotators are used to identify valuable facts in unstructured documents (e.g. clinician notes, consult reports, free text fields in EMRs) and convert to a structured form.
- Annotators execute in a sequence called the UIMA or Unstructured Information Management Architecture pipeline.
- IBM Patient Care and Insights Annotators use UMLS to normalize discovered facts to coding systems.
- Excellent application training services / annotators can be developed in IBM Content Studio.
Healthcare Annotators example

- **Problems**
  - Result of a series of interim annotations that identify diseases, symptoms, and disorders
  - Normalize to standard terms and standard coding systems including SNOMED CT, ICD-9, HCC, CCS
  - Capture timeframes of the problem
    - determine if past or current problem
  - Determine confidence
    - Positive, Negative, Rule Out, etc.
    - Negation example
      - “abdominal pain”
Reducing readmissions - UNC

Risk-stratifying patients
- Focus costly, resource-intense interventions on patients who are at highest risk
- Example: nurse home visits, home tele-monitoring

Risk prediction models
- Performance is generally poor
- Typically only use structured EMR and/or claims data
- Psycho-social determinants of readmission risk usually not in structured data
- Free-text diagnostic test results not included in risk model
**Develop readmission risk model using structured + unstructured data**

<table>
<thead>
<tr>
<th><strong>Structured</strong></th>
<th><strong>Unstructured</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>• Physical exam findings</td>
</tr>
<tr>
<td>Gender</td>
<td>• Diagnostic test results</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td>• Psycho-social factors</td>
</tr>
<tr>
<td>Insurance type</td>
<td>o Lives alone, homeless</td>
</tr>
<tr>
<td>Diagnoses (ICD-9)</td>
<td>o Substance abuse</td>
</tr>
<tr>
<td>Vital signs</td>
<td>o Medication non-compliance</td>
</tr>
<tr>
<td>Laboratory results</td>
<td>o Estrangement from family/friends</td>
</tr>
<tr>
<td># previous readmissions</td>
<td>o Depression</td>
</tr>
<tr>
<td>LOS on previous hospitalizations</td>
<td># Medications</td>
</tr>
</tbody>
</table>
Admission note (social history)

SOCIAL HISTORY: Current smoker - pipe, as well as 10 cigarettes to 1/2 pack per day at present (2ppd since 14). Occasional alcohol use, but history of heavy alcohol use "up to a gallon per day until 1975" per the patient. Denies illicit drug use. Lives alone near Haw River.

SH: Currently unemployed but not on disability. Lives in Henderson, NC with his mother and father. Originally from Mexico, moved to US about 7-9 years ago. Previously smoked cigarettes, ~1 pack per week x10 years, quit age 22. Previously drank heavily in Mexico, ~2 bottles tequila on each weekend night x3 years, quit age 16. Prior marijuana use in high school. Used cocaine once.

Social History:
He quit smoking 22 years ago, prior to this, smoked 10 cigarettes per day since his teenage years. Denies any alcohol or other drug use. He has been married for 29 years and lives with his wife.
Diagnostic tests (example: echocardiogram)

Interpretation:

Clinical Diagnoses and Echocardiographic Findings

- Inferoposterior myocardial infarction
- Anteroseptal and apical myocardial infarction
- **Decreased left ventricular ejection fraction (35-40%)**
- Dilated left ventricle
- Diastolic left ventricular dysfunction
- Elevated left ventricular filling pressures
- Degenerative mitral valve disease
- Mitral annular calcification
- Mitral regurgitation (mild)
- Dilated left atrium
- Aortic sclerosis
- Aortic regurgitation (trivial)
- Pulmonary hypertension (moderate to severe - see detail below)
- Segmental right ventricular contractile dysfunction (see detail below)
- Tricuspid regurgitation (mild)
- Elevated central venous and right atrial pressures (see detail below)
Structured Data is Not Enough

- Unstructured data significantly increases the richness and accuracy of analysis and decision making ... including paper / faxes

Today’s Care Guidelines Only Get You So Far

- Not granular enough to deliver on the promise of personalized medicine with data driven insights $^1,^2$

Manual Processes and Traditional Workflow Approaches Don’t Work

- Process complexity increases with disease complexity ... changing conditions require process adaptability $^3$
IBM Advanced Care Insights and Care Management

A **Configurable Solution** designed to surface evidence based insights from longitudinal data that enables advanced population analysis, personalized interventions and proactive care delivery in complex and costly disease scenarios. Supporting doctors treating patients in collaborative care models with process complexity, interventions and care transitions.

**Configurable Solution Options**

**Advanced Care Insights** Solution Models
- Readmission Prediction and Prevention
- Condition Onset or Deterioration Prediction and Prevention
- Drug Treatment Efficacy and Effectiveness
- Physician, Care Team or Resource Matching
- Resource Utilization Pattern and Anomaly Detection
- Risk Adjusted Scoring Improvement
- Care Pathways Adherence and Deviation

**Care Management** Solution Plans
- Disease and Scenario Specific Care Plans and Templates

**Visualizations**
- Care Pathway Flows
- Custom Population Analysis

**User Experience, Dashboards and Reporting**
- Case Performance Analysis and Monitoring
- Semantic Powered Search

**Advanced Care Insights**
- Similarity Analytics
- Predictive Analytics
- Population Evidence Based Semantic Insights
- Pathway Analytics
- Case Analytics
- Content Analytics

**Care Management**
- Care Management Solution
  - Assess
  - Plan
  - Deliver
  - Monitor
  - Audit
  - Analyze

**Care Management Platform**
Reducing Readmissions with targeted care management – Catalonia Region in Spain

- Nationalized Healthcare – Government Payor
- Healthcare Provider for the region of Catalonia
- ~7 million residents served
- $4 Billion annual budget
- 8 Hospitals, 4500 beds, 130 OR, 450 primary care centers

- Existing IBM customer since 2005
  - SAP implementation for clinical healthcare and financial (8 ICS Hospitals)
- Smarter Care proof-of-concept delivered Dec’2012
- Phase 1 live March’2013
  - 300 patients, 10-20 Care Coordinators, 30-40 Doctors and others
  - Developed in 8 weeks

Spain’s most prosperous region
To achieve the main objectives, care systems must focus on areas of highest impact:

- Improve **quality** of care
- Lower **costs** of care

- **25% of population over 65 years**, 60% have chronic diseases and consume 70% of healthcare resources
- Complex needs require care by **providers across disciplines**, acting as a team
- Over time, progress must be tracked and care plans refined to achieve desired outcomes
The new HEALTH PLAN 2011-2015 in Catalonia

3 pillars of transformation

1. Objectives and health programs
   - Health Programs: Better health and quality of life for everyone

2. System more oriented towards chronic patients
   - Transformation of the care models: better quality, accessibility and safety in health procedures

3. A more responsive system from the first levels
   - Modernize the organizational models: a more solid and sustainable health system

4. System with better quality in high-level specialties

5. Greater focus on the patients and families

6. New model for contracting health care

7. Incorporation of professional and clinical knowledge

8. Improvement of the government and participation in the system

9. Improvements to information, transparency and assessment

For each line of action, a series of strategic projects will be developed, which make up the 31 strategic projects of the Health Plan.

Catalonia Care Management Functional Objectives

Approach care holistically
- Implement a care management program to effectively manage care
- **Overcome fragmented views of health** Physical, mental, nutrition, education, employment & income, safety, family & community, living conditions
- Design care approaches to **address holistic needs** of the patient

Manage care plans for better outcomes
- **Reduce Aggressive Treatments:** Increase homecare, Reduce A&E cases, Reduce inpatient cases
- **Collaborate and coordinate all stakeholders** Care providers, activities, services, medication, equipment
- **Improve adherence** to care management program

Empower Patients
- **Improve therapeutic adherence**
- **Increase the patient co-responsibility** in his/her care
- **Improve patient satisfaction** with the healthcare system
Project Areas and Process Flow

Holistic View of patient
- Segmentation & Stratification
- MDT portal
- Same information available for all actors involved in the patient

Care Management
- Identification and referral inbound process
- Global treatment plan
- Evaluation and Follow-up
- Regional management – Multidisciplinary Team approach (MDT)

Integration
- Alerts and warnings in real time
- Integration of all relevant data from backend systems
- Access from backend systems

Manage incoming referrals ➔ Obtain a holistic view of the patient ➔ Assess Patient Needs
Obtain Patient Alerts and Refine Plan ➔ Collaborate across the care team ➔ Manage Care Deliver
Create an individualized care plan
### Key Project Objectives for Tracking

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prevalence</strong> recruiting Complex Chronic Patients (PCC) and Advanced Chronic Patients (MACA)</td>
<td>At least to double PCC and MACA prevalence comparing with the rest of control territories</td>
</tr>
<tr>
<td>Proportion of PCC/MACA patients with a related activated/reviewed Care Plan</td>
<td>More than 70% patients with a Care Plan</td>
</tr>
<tr>
<td><strong>Avoidable emergency admission</strong>: COPD / Heart failure / “composite”</td>
<td>Decreasing by 10%</td>
</tr>
<tr>
<td><strong>30-day Readmission</strong>: COPD / Heart Failure / “Composite”</td>
<td>Decreasing between 5-10%</td>
</tr>
<tr>
<td>Mean number of contacts with PHC services</td>
<td>Increasing contacts with PHC by 15%</td>
</tr>
<tr>
<td>Patient <strong>Satisfaction</strong></td>
<td>Satisfaction over 85 score</td>
</tr>
<tr>
<td>Introduction of <strong>Quality of Life (Euroqol)</strong> measure</td>
<td>Improvement Euroqol score</td>
</tr>
<tr>
<td>Regular <strong>Medication Plan review</strong></td>
<td>Over 80% medication plan reviewed at least 2 times a year</td>
</tr>
</tbody>
</table>
Key Findings:

1) Predictive Modeling/Risk identification is not enough to reduce readmissions
2) Care Management is equally as important
3) NLP can help augment both
4) Platform approaches integrating all 3 look promising
Thank You