IBM

IBM Advanced Care Insights:

Analytics and Care Management to Reduce Readmissions

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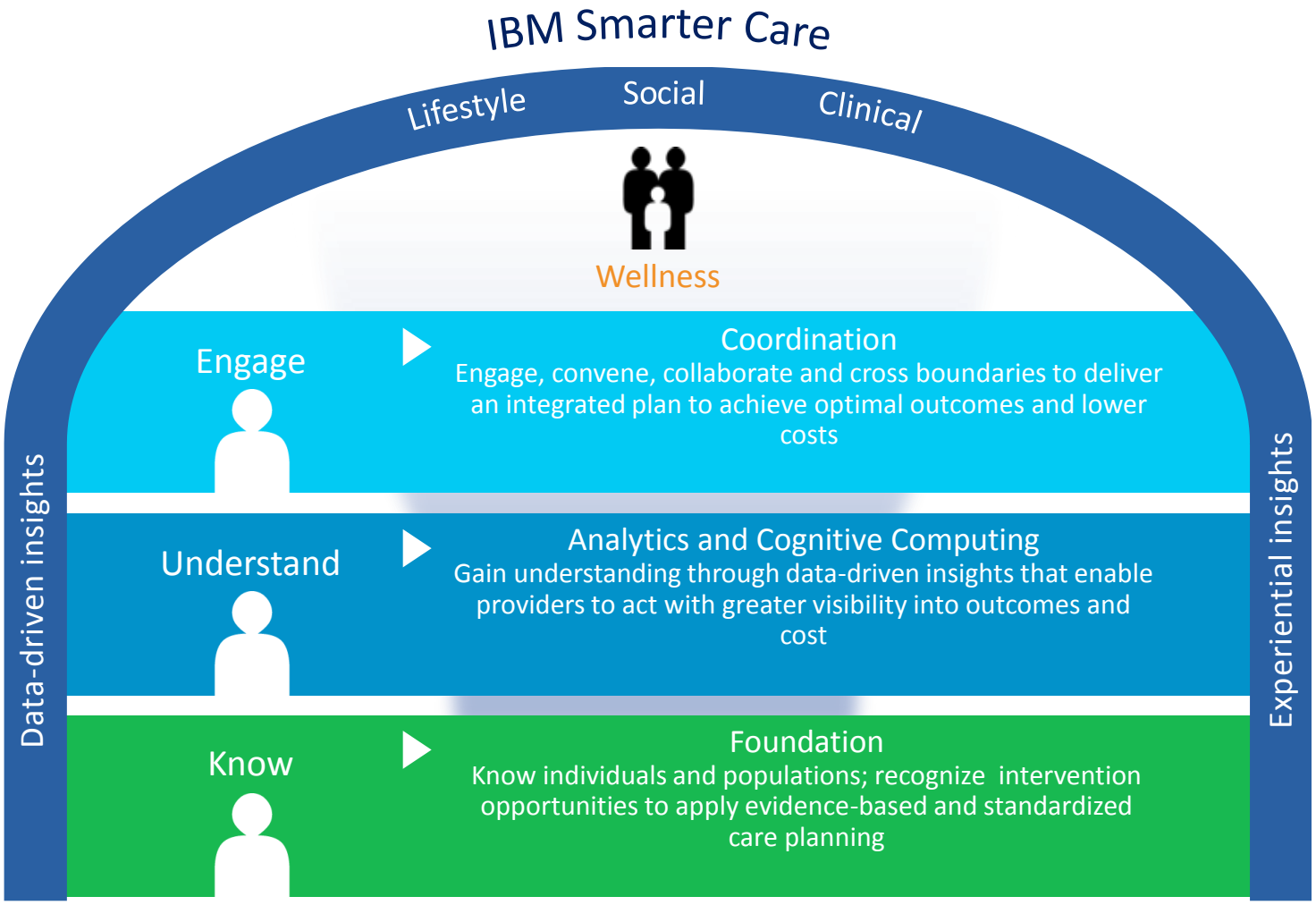
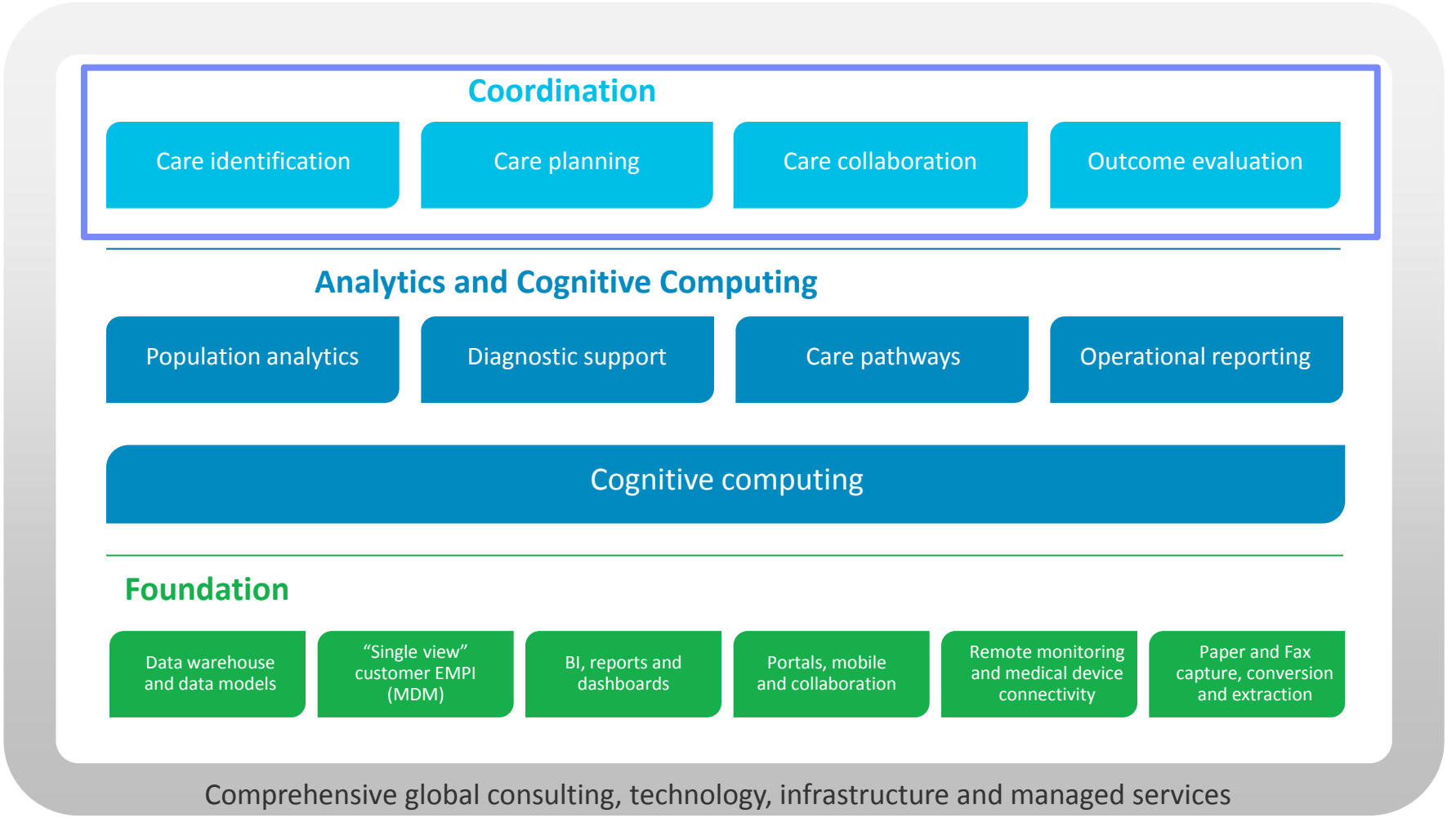
The path forward

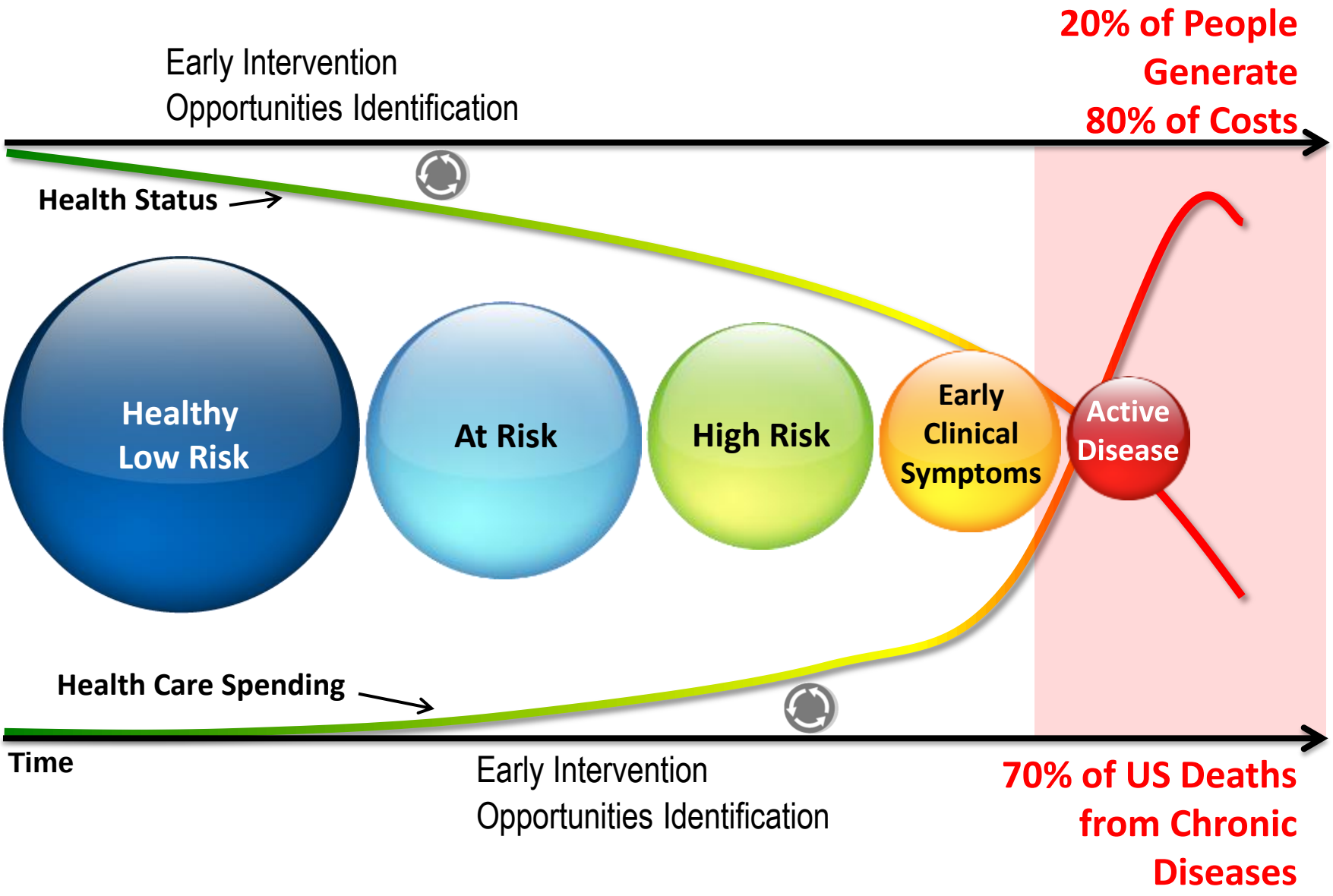
… enabling holistic and individualized care to optimize outcomes and lower costs



IBM integrated portfolio for Smarter Care

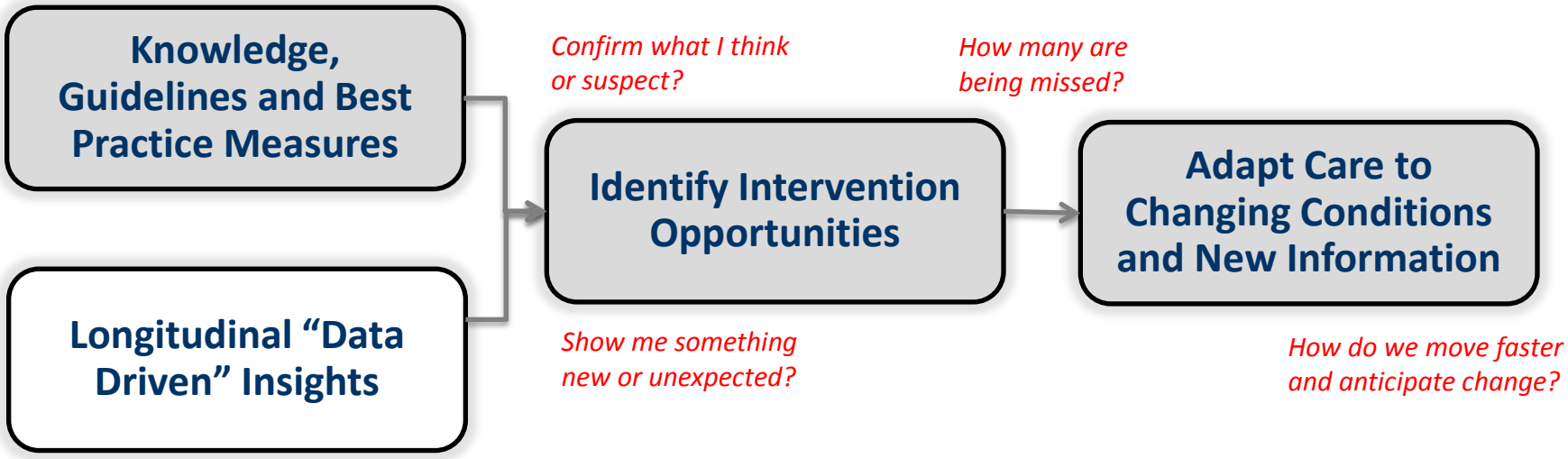


The Cost of Disease Progression



Information Should Aid Us, Not Lie Hidden and Dormant

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

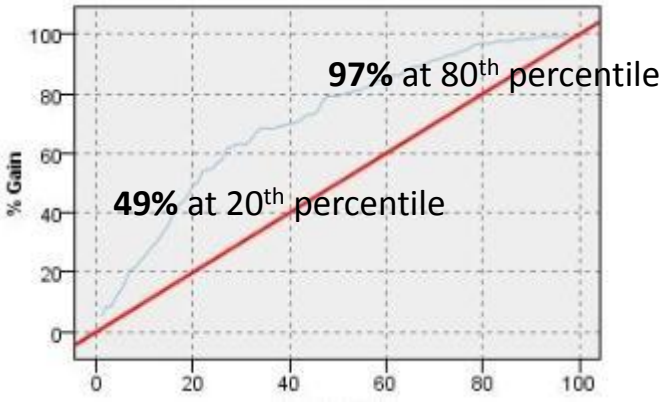
- Structured data not available, not accurate enough, without the unstructured data - which was more trustworthy

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)

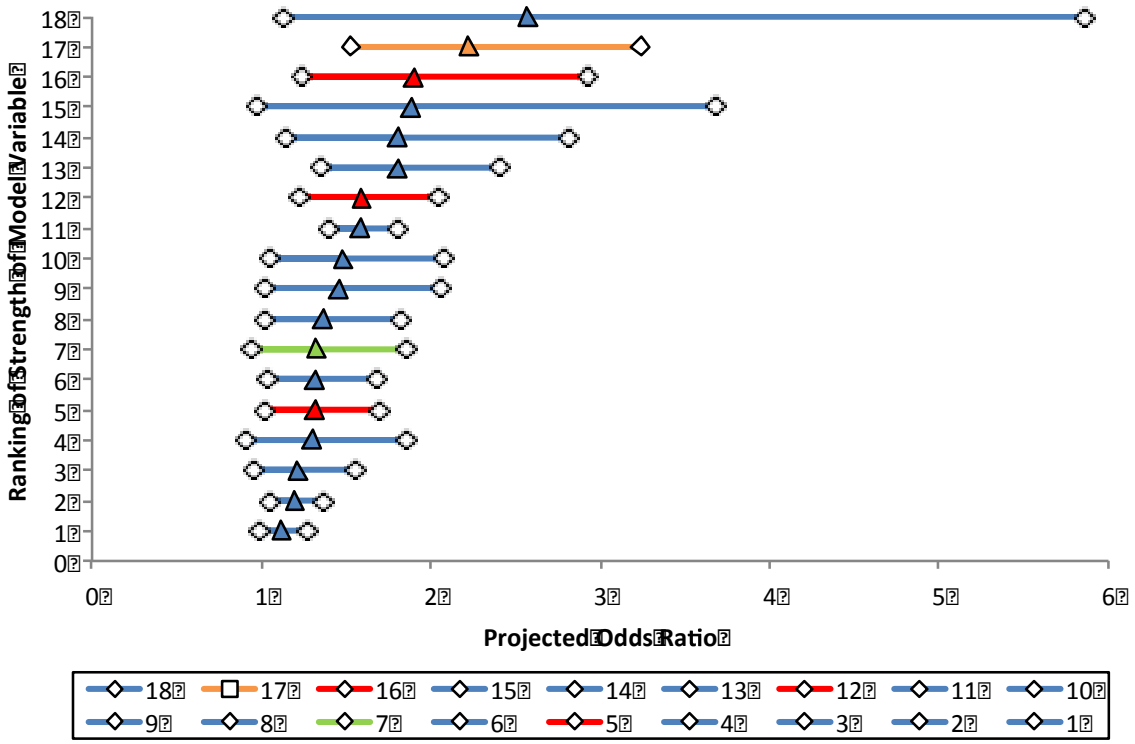


Predictor Analysis	% Encounters Structured Data	% Encounters Unstructured Data
Ejection Fraction (LVEF)	2%	74%
Smoking Indicator	35% (65% Accurate)	81% (95% Accurate)
Living Arrangements	<1%	73% (100% Accurate)
Drug and Alcohol Abuse	16%	81%
Assisted Living	0%	13%

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

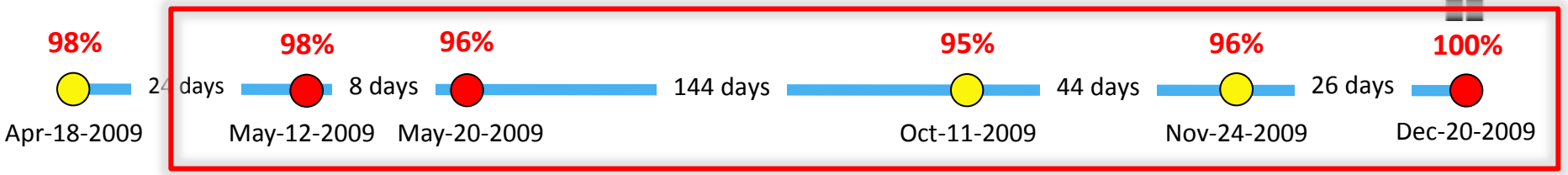
The Impact of Readmissions at Seton

CHF Patient X – What Happened?

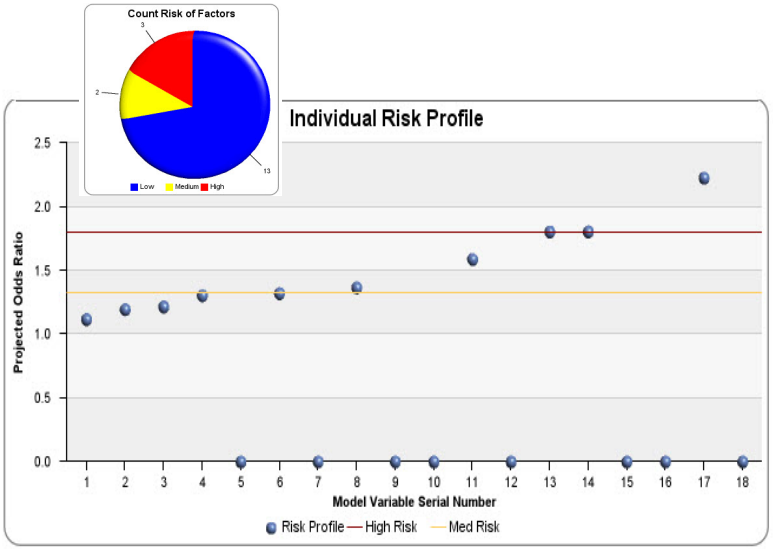
Admit / Readmission

30-Day Readmission

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)

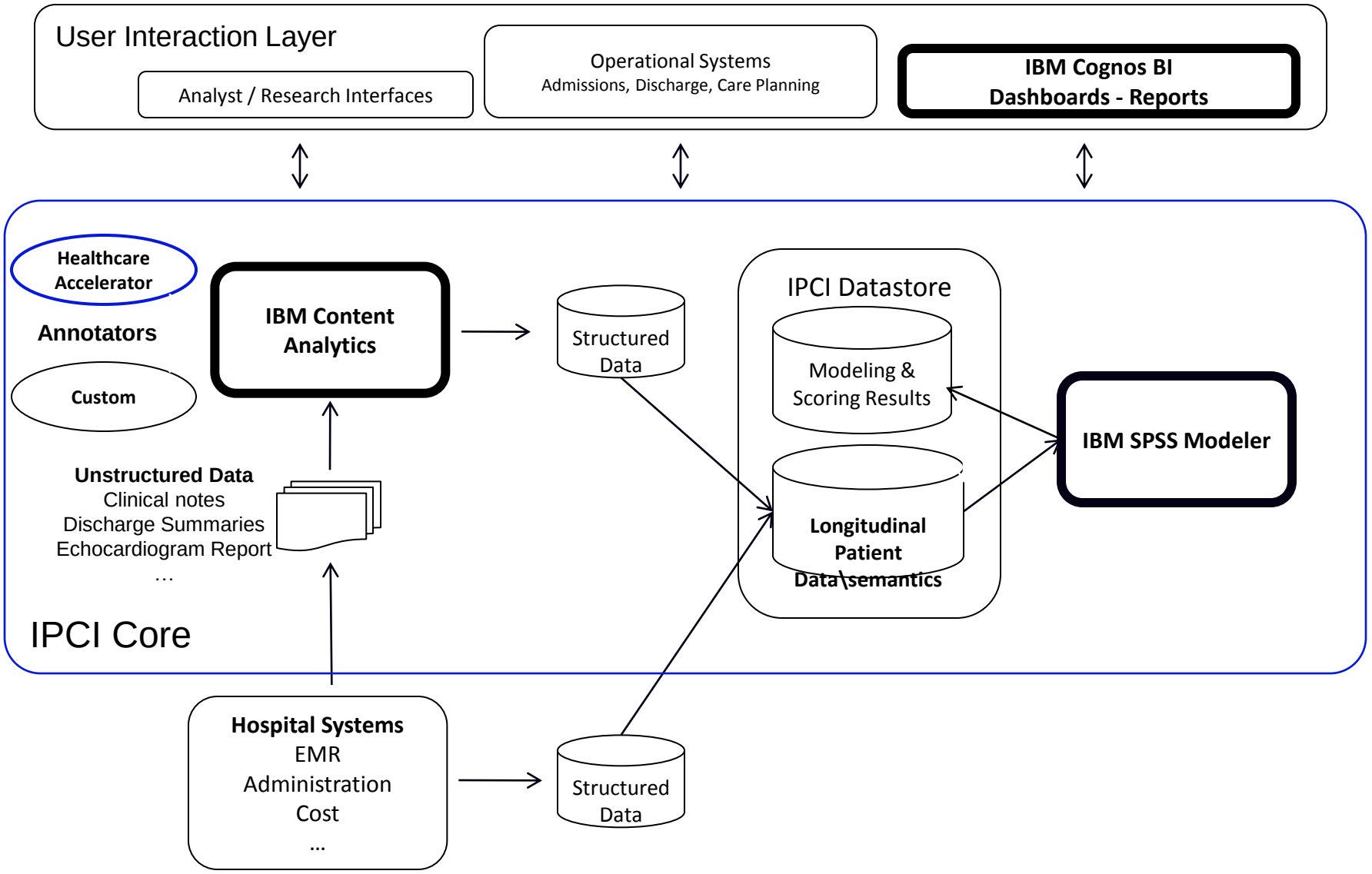


Description of Model Serial Number

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

Patient Population Monitoring
Clinical and Operational Data

Illustrative CHF Readmissions Architecture

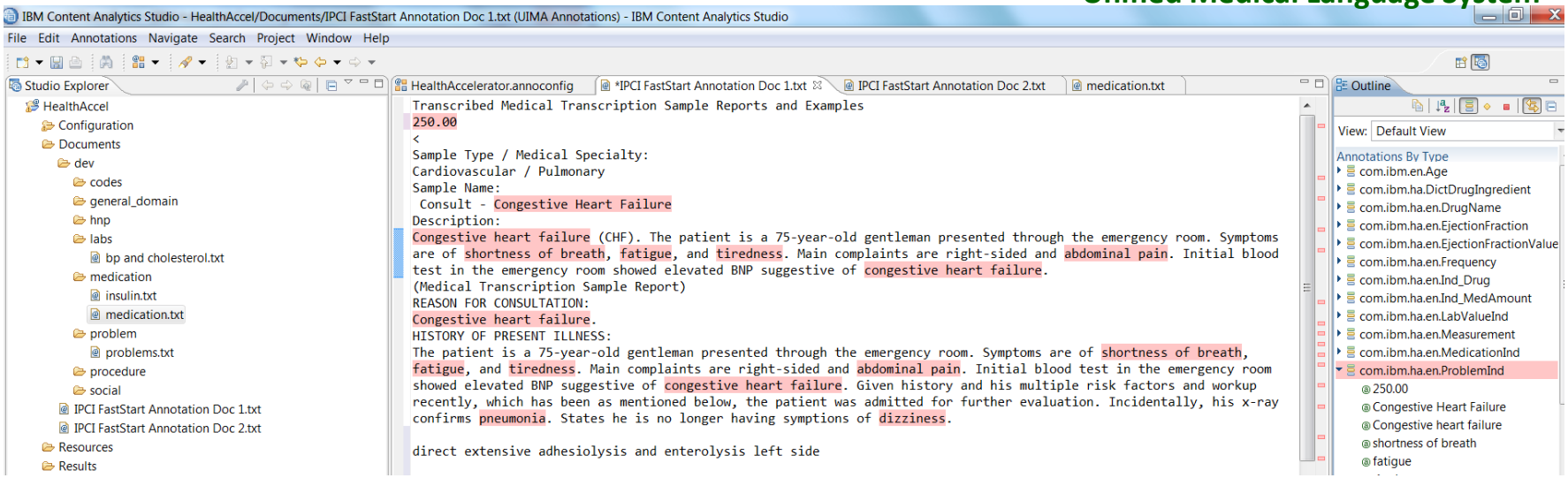


IBM Natural Language Processing Annotator technology …

- 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

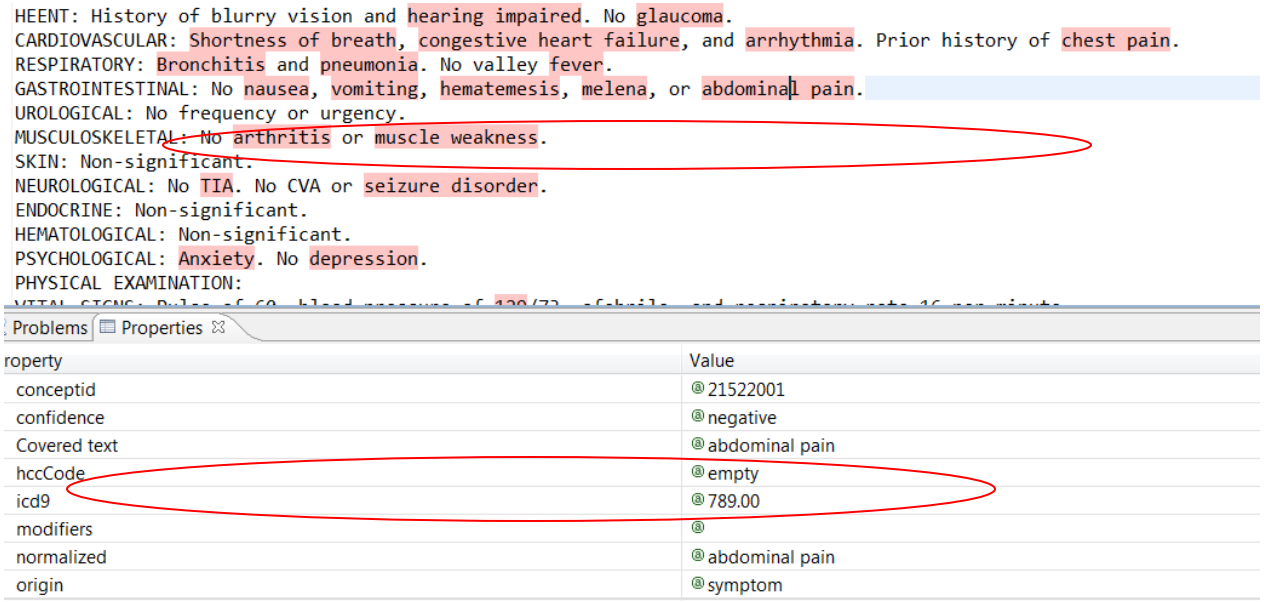
Unstructured Information Management Architecture
An Apache Project

Unified Medical Language System



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 clams 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

Structured

Age
Gender
Race/ethnicity
Insurance type
Diagnoses (ICD-9)
Vital signs
Laboratory results
previous readmissions
LOS on previous hospitalizations
Medications

Unstructured

- Physical exam findings
- Diagnostic test results
- Psycho-social factors
  - Lives alone, homeless
  - Substance abuse
  - Medication non-compliance
  - Estrangement from family/friends
  - Depression

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 tequilla 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:

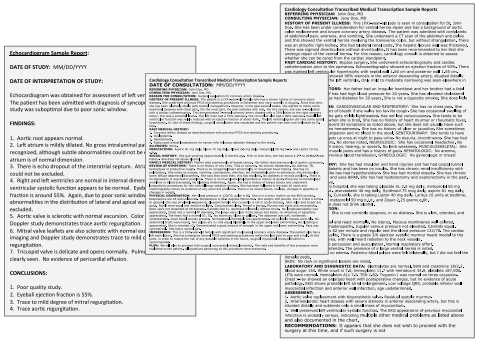
Clinical Diagnoses and Echocardiographic Findings

- 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)

What Have We Learned So Far?

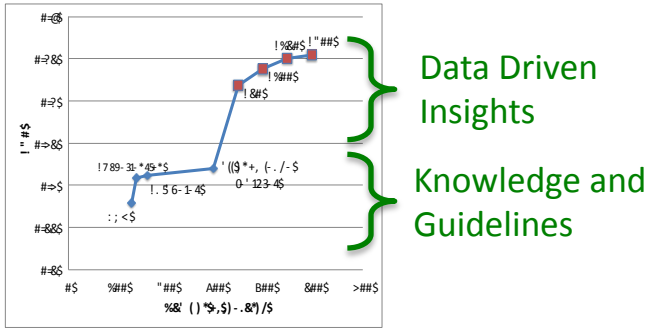
Structured Data is Not Enough

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



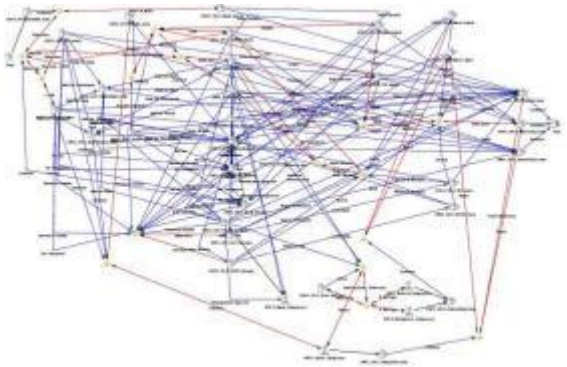
Today's Care Guidelines Only Get You So Far

- 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]



1. Dijun Luo, Fie Wang, Jimeng Sun, Marianthi Markatou, Jianying Hu,Shahram Ebadollahi, SOR: ScalableOrthogonal Regression for Low-Redundancy Feature Selection and its Healthcare Applications. SDM'12
2. Jimeng Sun, Jianying Hu, Dijun Luo, Marianthi Markatou, Fei Wang, Shahram Edabollahi, Steven E. Steinhubl, Zahra Daar, Walter F. Stewart. Combining Knowledge and Data Driven Insights for Identifying Risk Factors using Electronic Health Records. Under submission at AMIA'12
3. Blind Surgeon Metaphor Problem - W.M.P. van der Aalst, M. Weske, and D. Grünbauer. Case Handling: A New Paradigm for Business Process Support. Data and Knowledge Engineering, 53(2):129-162, 2005

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

Spain's most prosperous region

- 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

Catalonia: Care Management Key Drivers

To achieve the main objectives, care systems must **focus on areas of highest impact**

Improve **quality** of care

Lower **costs** of care

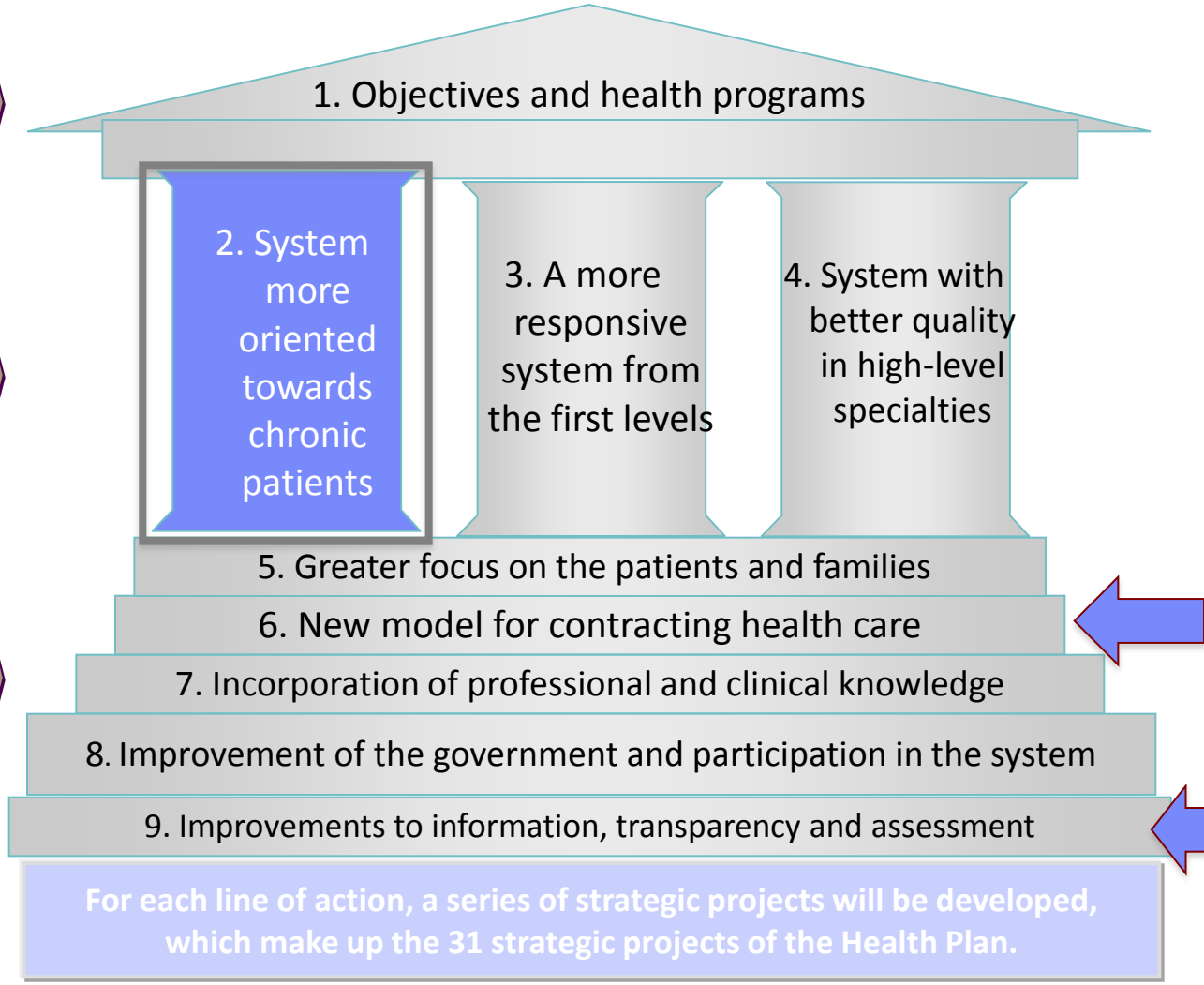
- **25% of population over 65 years,** 60% have chronic diseases and consume 70% of healthcare resources
- Complex needs require care by **providers across disciplines, acting as a team**
- Over time, progress must be tracked and care plans refined **to achieve desired outcomes**

3 pillars of transformation

I Health Programs: *Better health and quality of life for everyone*

II Transformation of the care models: *better quality, accessibility and safety in health procedures*

III Modernize the organizational models: *a more solid and sustainable health system*



Source: Catalan Health Plan 2011-2015.

Catalonia Care Management Functional Objectives

Approach care holistically

- Implement a care management program to effective 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

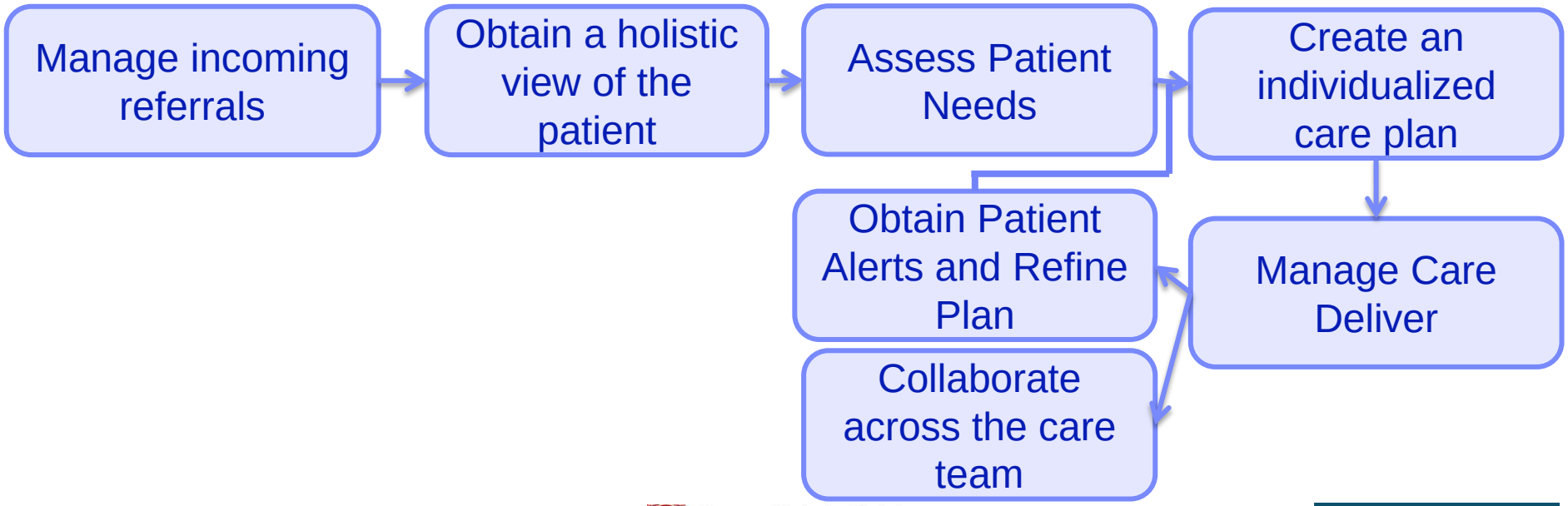
Empower Patients

- **Improve therapeutic adherence**
- **Increase the patient co-responsibility** in his/her care
- **Improve patient satisfaction** with the healthcare system

Project Areas and Process Flow

Institut Català de la Salut IBM

Holistic View of patient	Care Management	Integration
• **Segmentation** & **Stratification** • **MDT portal** • **Same information available for all actors** involved in the patient	• Identification and **referral** inbound process • **Global treatment plan** • **Evaluation** and **Follow-up** • Regional management – **Multidisciplinary Team approach (MDT)**	• **Alerts and warnings in real time** • **Integration of all relevant data** from backend systems • **Access from backend systems**



Generalitat de Catalunya
Programa de prevenció i atenció a la cronicitat

Pla de Salut 2011-2015

Key Project Objectives for Tracking

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

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