Data Analytics: Applications in Clinical Settings

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Let's get Started! Objectives and Agenda

- Define data analytics and predictive analytics
- Discuss how to work with and understand Big Data and data patterns
- Describe how to get started with predictive analytics
- Provide an understanding on how to apply and use predictive models in clinical settings
- Describe how ONC contributes to policy on big data and analytics

Florence Nightingale (1820-1910)

- Used data and invented sophisticated predictive analysis tools, such as the polar-area diagram to transform care and save lives

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A practicing physician who was inquisitive…

- *"…if we did not have (electronic medical records), if we were still on paper, it would have taken forever to get these results."*

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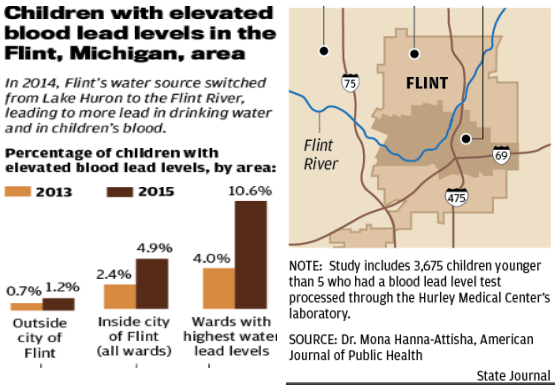
Inquisitiveness lead to insight and provoked action



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Today, who should use data & predictive analytics to transform care?

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Who and what is a data scientist?

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Nursing Transforming Care

- Using nursing data science to address challenges in care delivery
  - » Big data analysis requires interoperable, standardized nursing data sets
    - – Interoperable data contains data elements that are defined, measured, and retrievable in the exact same format.
    - – Work with vendors, standards development organizations to incorporate nursing data into health IT in a standardized and interoperable manner.
  - » Shaping health policy
    - – Nurses advocating for adoption of nursing data standards and making the case for inclusion of nursing data in value based care models.
    - – Demonstrate how nursing data supports clinical decision making that improves clinical outcomes.

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Define Data Analytics

Defining Analytics

- **Analytics** is the discovery and communication of **meaningful patterns** in data using simultaneous application of statistics, computer applications and operations research.

Other important analytic definitions

- **Decision Support –** much more than alerts and reminders! Clinical Decision Support (CDS) includes:
  - **Business Intelligence (BI) –** computerized for managerial decision making
  - **Business Performance Management (BPM) –** combines enterprise information systems (EIS) and BI for decision making. BPM feeds your rapid cycle improvement processes, such as LEAN, Six Sigma, or Plan-Do-Check-Act, which help measure your progress toward improving your **key performance indicators**
  - **Visual analytic tools –** Scorecards, dashboards *(with drill down capabilities)*
  - **Predictive analytics –** Use of tools to determine the probable future outcome or likelihood of a situation occurring.

Building Blocks: Understanding DIKW

- **Data** = vital sign data, static values

- **Information** = electronic medical record

- **Knowledge** = analytics

- **Wisdom =** application

Define the Progression from Descriptive to Prescriptive Analytics

What is predictive analytics?

- Predictive analytics is the practice of extracting information from existing data sets in order to determine patterns and predict future outcomes and trends.
- It does not tell you what will happen in the future.
  - It **forecasts what might happen** in the future with an acceptable level of reliability, and includes what-if scenarios and risk assessment.

Punxsutawney Phil in his movie debut – Goundhog's Day

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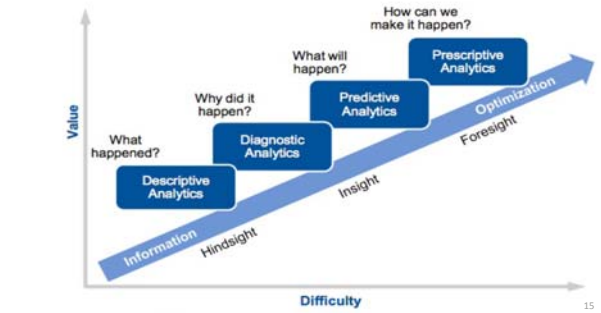
Gartner Analytic Ascendancy Model



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Why Predictive Analytics?

Predictive Analytics Drives Predictive Care

Knowledge-Based Care
- Intelligently drives care forward to discharge
- Shows clinicians what they ***want*** to know and ***need*** to know in a novel, patient-centered visual paradigm

Patient Flow Management
- Predicts patient flow across the enterprise
- Models staff needs based on likely demand scenarios

Personalized Medicine
- Incorporates molecular diagnostics and predictive models at the point of care to optimize clinical outcomes
- Expands clinical decision support for complex variables

Monitored Care
- Provides virtual patient monitoring
- Predictively identifies condition changes based on biomedical monitoring to enable timely intervention

Lifetime Care
- Provides personalized lifetime wellness planning
- Predicts disease for improved prevention and management

How to Understand and work with Big Data

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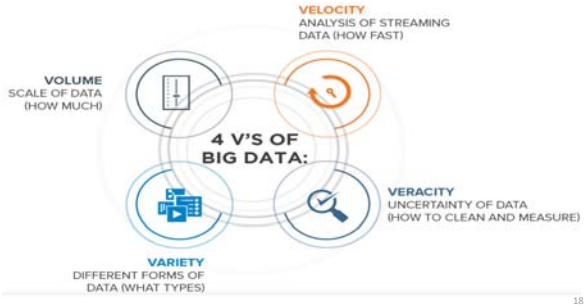
Big Data definition: the 4 Vs

- **Big data** is high volume, velocity, variety & veracity information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization.



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Big Data provides Pattern Recognition:

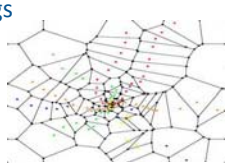
Remember C.A.R.P

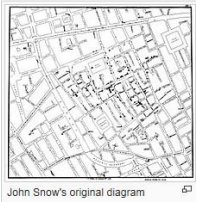
- **C**lusters
- **A**ssociations
- **R**elationships
- **P**redictions

What is a Cluster?

Clusters identify natural groupings based on known characteristics

- Use optimization techniques
  - K-means (statistics) – cluster to the nearest mean & data portioning using Voroni cells
  - Self organizing maps
- Examples:
  - Defining catchment areas for a new hospital or stroke clinic based on population health needs
  - Epidemiology – 1854 Snow's map of cholera outbreaks mapped to contaminated water pumps

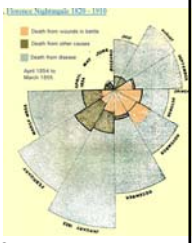




John Snow's original diagram

What is an Association?

- Commonly occurring groupings
  - Apriori – identifies the frequent individual items in the database and extends them to larger items in the database.
  - FP-Growth, OneR, ZeroR and Eclat (frequent item mining set), Polar Area Diagrams
- Examples:
  - "Beer and Diapers"
  - Amazon – people who bought "x" also bought "y"
  - Florence Nightingale's association between unsanitary clinical practices and mortality – demonstrating the value of prevention in saving lives

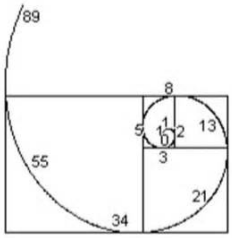


What are sequential relationships?

Sequential relationships discover tim ordered events

- » Fibonacci Sequence
- » Apriori algorithm

- Examples:
  - Population growth (F)
  - Clinical trials and chemotherapy -- oncology trials follow a modified dose escalation (F)
  - Triggers for adverse events for proactive interventions i.e. MI (A)



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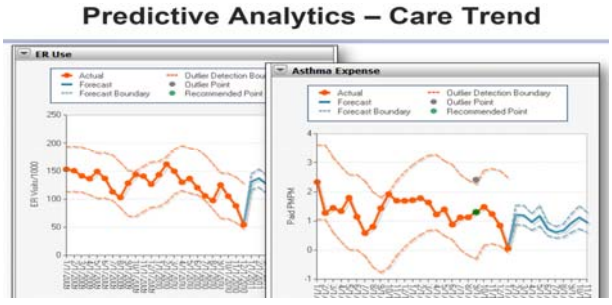
What are Predictions?

Predictions forecast the future based on past trends



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Getting Started Using Predictive Analytics

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What is Predictive Modeling?

- Predictive modeling is a commonly used statistical technique to predict future behavior.
- Predictive modeling solutions are a form of data-mining technology that work by analyzing historical and current data and generating a model to help predict future outcomes.
- In predictive modeling, data is collected, a statistical model is formulated, predictions are made, and the model is validated (or revised) as additional data becomes available
- Example: identifying a patient's risk of readmission through the use of predictive models using data abstracted from the EHR

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Access data via an enterprise data warehouse (EDW)

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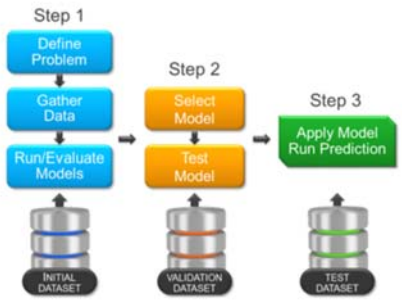
Sources for Analytics

Assembling the data -- putting it all together:

- Clinical billing going to or claims data coming from the payer
- Pharmacy
- Biometric data
- EHRs
- Ancillary claims
- Hospital cost & use data (ADT, patient accounting, GL)

Apply the 3 steps of predictive modeling



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Other "must haves"

Program Needs	Healthcare Challenge
Executive Support	Executives have to manage organization's staff to get their cooperation and buy-in.
Well-Defined Business Challenge	Business challenges are everywhere. The real problem is prioritizing which one to address first.
Lots of Data	There's lots of data but a lot of it is locked in departmental silos which ultimately makes all the data useless.
Right Team	The challenge will be finding qualified people in an already scarce resource pool and getting them to accept the lower wage healthcare may pay. Outsourcing might need to be an option. Bottom Line: GET HELP!
Integral Part of Organization	Everyone must buy-in to the results of the analytics program including clinical, finance and operational staff.
Track Results and Update Models	With the right team in place this should not be an issue.

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Clinical and Policy Applications

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The Learning Health System

National LHS Requirements

A. Governance of Policy & Standards
B. Interoperable Business and Regulatory Environment
C. Individuals are empowered
D. Care Providers partner with individuals
E. Ubiquitous, secure network infrastructure
F. Verifiable identify and authentication
G. Consistent representation of permission to collect, share and use identifiable health info
H. Consistent representation of authorization to access health information
I. Stakeholder Assurance that health IT is interoperable
J. Consistent data formats and semantics
K. Standard, secure services
L. Consistent, secure transport techniques
M. Accurate identify matching
N. Reliable Resource Location

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Patient Centered Outcomes Research

PCOR Data Infrastructure Functions

Collect – Extract
Link – Follow
Analyze
Disseminate – Translate

PCOR Data Infrastructure Elements

Standards, Policies, Services, Governance, Database Development

https://www.healthit.gov/policy-researchers-implementers/building-data-infrastructure-support-patient-centered-outcomes

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PMI

- **The Precision Medicine Initiative** -- An approach for disease prevention and treatment that takes into account both the population and individual variations in genes, environment, lifestyle, etc.
  - » Creates a research cohort of **>1 million American volunteers** who will share genetic data, biological samples, and diet/lifestyle information, all linked to their electronic health records if they choose.
  - » Pioneers **a new model for doing science** that emphasizes **engaged participants, responsible data sharing, and privacy protection**.
  - » Tests whether **mobile devices** can encourage healthy behaviors.
  - » Lays **scientific foundation** for precision medicine for **many diseases**.

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Treatment, Research and Population Health Developments

- Clinical Data Registries
  - » Analyzing data from multiple sources to improve care
    - – Developing new practice guidelines
- Zika Response
  - » EHR's and public health response plan
    - – Developing algorithms, vocabulary sets, order sets
  - » Global response - OpenZika
- Precision medicine vs. traditional medicine
  - » Treatment protocols that involve precision medicine and personalized approaches tend to lead to improved patient wellness and prolonged periods of remission (University of California San Diego)

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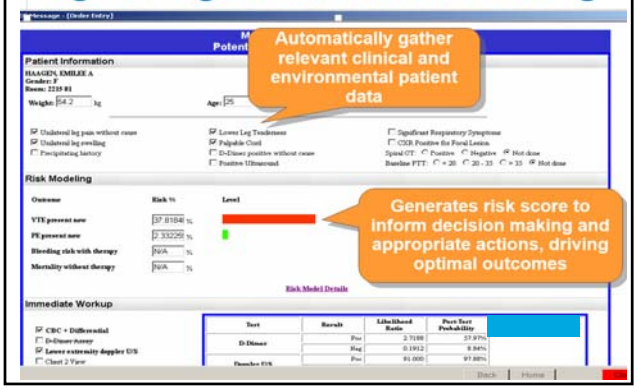
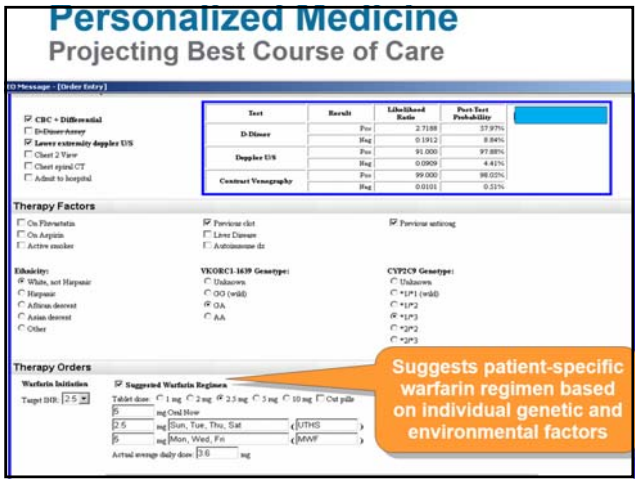
Clinical Examples:

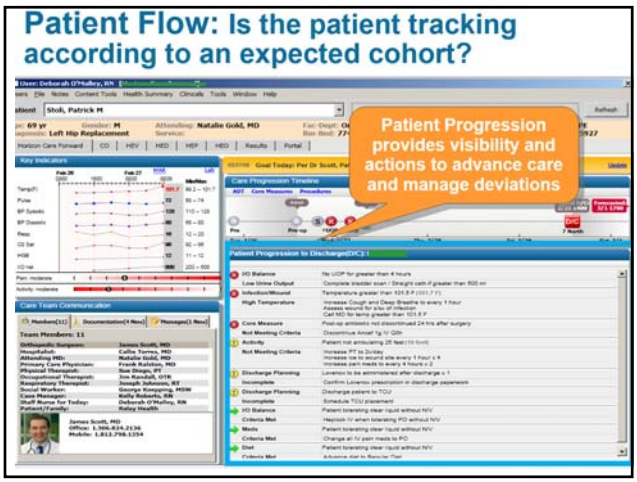
Predicting

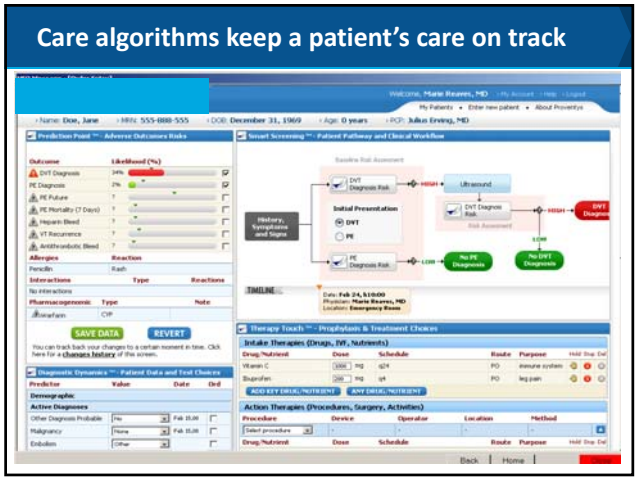
- Deep Vein Thrombosis
- 30-day Readmissions
- Patient Flow
- Disease Outbreaks

Deep Vein Thrombosis: Augmenting clinical decision making





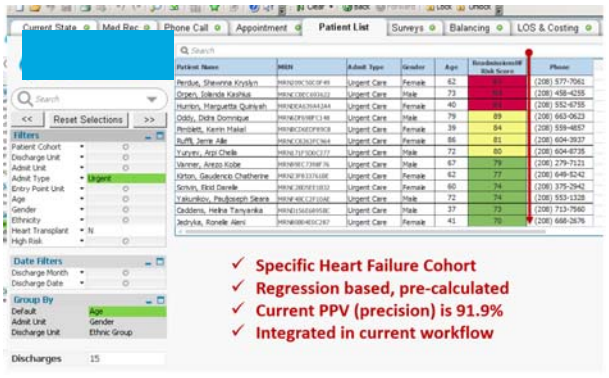




Some Popular Readmission Reduction Predictive Models

Model	Description	Details
LACE	Length of Stay; Acuity; Comorbid condition; ED visits in 6 months	1-19 points. Patients with >10 points singled out for follow up
STAAR	State Action on Avoidable Re-Hospitalization	iHi initiative – focuses on improved transitions of care
Project RED	Re-engineered Discharge	Developed at Boston Univ Med Ctr (BUMC). An 11-step nurse-led process
H2H	Hospital to (2) Home	American College of Cardiology & iHi to reduce readmissions & improve care transitions for cardiovascular patients
BOOST	Better Outcomes by Optimizing Safe Transitions	8-Ps (1. Problems with medications;2. Psychological; 3. Principal diagnosis; 4. Psychosocial limitations; 5. Poor health literacy; 6. Poor social support; 7. Prior hospitalization; 8. Palliative care)
Custom	Develop own predictive model	Tools: Statistica R, Strata, MATLAB, Vensim

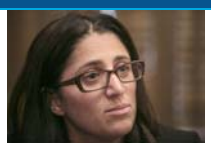
Predictive analytics is used to calculate risk scores



We are at the finish line!

- We defined analytics & predictive analytics
- We talked about Big Data and data patterns
- We talked about how to get started
- We talked about using predictive analytics in the clinical setting
- We described policy efforts

Thoughts to leave you with…



- Who are data scientists? - Clinicians, epidemiologists, public health officials, policy specialists, etc., can work with big data – asking questions, seeking answers, and making a difference
- Data validity begins at the point of data capture. The value and reliability of data are only as good as its validity.
- Use C.A.R.P. to detect patterns
- Data, information, knowledge and wisdom can transform care – as we move from predictive analytics to prescriptive care.

Thank you for:

- Your time,
- Your attention,
- Your role as being inquisitive agents for change, and
- For the work you do everyday!