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

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.”

Mona Hanna-Attisha M.D.
Hurley Medical Center, Flint, MI
Inquisitiveness lead to insight and provoked action

Children with elevated blood lead levels in the Flint, Michigan, area

In 2014, Flint’s water source switched from Lake Huron to the Flint River, leading to more lead in drinking water and in children’s blood.

Percentage of children with elevated blood lead levels, by area:

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside of Flint</td>
<td>0.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Inside of Flint</td>
<td>2.4%</td>
<td>4.0%</td>
</tr>
</tbody>
</table>

NOTE: Study includes 2.675 children younger than 5 who had a blood lead level test processed through the Hurley Medical Center’s laboratories.

SOURCE: Dr. Mona Hanna-Attisha, American Journal of Public Health

Who and what is a data scientist?

“Data scientists are everywhere—there’s no skillset that doesn’t involve data and tell a fantastic story via the data.” — DJ Patil

“A data scientist is somebody who is inquisitive, who can work in teams and interpret data. He’s someone that can assemble individualized care plans for patients and bring change to organizations.” — Arvind Kharekhi

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

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.
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 – Groundhog’s Day

Gartner Analytic Ascendancy Model

Why Predictive Analytics?

- Predictive Analytics Drives Predictive Care
  - Knowledge-Based Care
    - Intelligently drives care forward to discharge
    - Shows clinicians what they need to know and when to know it in a novel, patient-centered visual paradigm
    - Predicts patient flow across the enterprise
    - Models staff needs based on likely demand scenarios
    - Incorporates molecular diagnostics and predictive models at the point of care to optimize patient care
    - Expands clinical decision support for complex variables
    - Expands clinical decision support for complex variables
    - Provides personalized lifetime wellness planning
    - Predictive disease for improved prevention and management
    - Provides virtual patient monitoring
    - Predictively identifies condition changes based on biomedical monitoring to enable timely intervention

- Predictive Analytics
  - How can we make it happen?
    - Diagnostic Analytics
      - What happened?
      - What will happen?
      - Why will it happen?
    - Prescriptive Analytics
      - What will it happen?
      - Why did it happen?
    - Descriptive Analytics
      - What happened?
      - What will happen?
      - Why did it happen?
How to Understand and work with Big Data

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.

Big Data provides Pattern Recognition:

*Remember C.A.R.P*

• **Clusters**
• **Associations**
• **Relationships**
• **Predictions**

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
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 time 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)

What are Predictions?

Predictions forecast the future based on past trends

Getting Started Using Predictive Analytics
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.

Access data via an enterprise data warehouse (EDW)

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
Other “must havens”

<table>
<thead>
<tr>
<th>Program Needs</th>
<th>Healthcare Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Support</td>
<td>Executives have to manage organization’s staff to get their cooperation and buy-in.</td>
</tr>
<tr>
<td>Well-Defined Business</td>
<td>Business challenges are everywhere. The real problem is prioritizing which one to address first.</td>
</tr>
<tr>
<td>Challenge</td>
<td></td>
</tr>
<tr>
<td>Lots of Data</td>
<td>There’s lots of data but a lot of it is locked in departmental silos which ultimately makes all the data useless.</td>
</tr>
<tr>
<td>Right Team</td>
<td>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!</td>
</tr>
<tr>
<td>Integral Part of Organization</td>
<td>Everyone must buy in to the results of the analytics program including clinical, finance and operational staff.</td>
</tr>
<tr>
<td>Track Results and Update</td>
<td>With the right team in place this should not be an issue.</td>
</tr>
<tr>
<td>Modes</td>
<td></td>
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</tbody>
</table>

Clinical and Policy Applications

The Learning Health System

National LHS Requirements

- Governance of Policy & Standards
- Interoperable Business and Regulatory Environment
- Individuals are empowered
- Care Providers partner with individuals
- Ubiquitous, secure network infrastructure
- Verifiable identify and authentication
- Consistent representation of permission to collect, share and use identifiable health info

- Consistent representation of authorization to access health information
- Stakeholder Assurance that health IT is interoperable
- Consistent data formats and semantics
- Standard, secure services
- Consistent, secure transport techniques
- Accurate identify matching
- Reliable Resource Location

Patient Centered Outcomes Research

PCOR Data Infrastructure Functions

- Collect
- Store
- Link
- Follow
- Analyze
- Disseminate
- Translate

PCOR Data Infrastructure Elements

- Standards, Policies, Services, Governance, Database Development

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.

Clinical Examples:

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

Deep Vein Thrombosis: Augmenting clinical decision making

Automatically gather relevant clinical and environmental patient data
Generates risk score to inform decision making and appropriate actions, driving optimal outcomes
### Personalized Medicine

**Projecting Best Course of Care**

<table>
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<tr>
<th>Therapy Factors</th>
<th>Therapy</th>
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</table>

**Care algorithms keep a patient’s care on track**

**Some Popular Readmission Reduction Predictive Models**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>LACE</td>
<td>Length of Stay; Acuity; Comorbid condition; ED visits in 6 months</td>
<td>1-19 points. Patients with &gt;10 points singled out for follow up</td>
</tr>
<tr>
<td>STAAR</td>
<td>State Action on Avoidable Re-Hospitalization</td>
<td>H4 initiative – focuses on improved transitions of care</td>
</tr>
<tr>
<td>Project RED</td>
<td>Re-engineered Discharge</td>
<td>Developed at Boston Univ Med Ctr (BUMC). An 11-step nurse-led process</td>
</tr>
<tr>
<td>H2H</td>
<td>Hospital to (2) Home</td>
<td>American College of Cardiology &amp; H4 to reduce readmissions &amp; improve care transitions for cardiovascular patients</td>
</tr>
<tr>
<td>Custom</td>
<td>Develop own predictive model</td>
<td>Tools: Statistica R, Strata, MATLAB, Vensim</td>
</tr>
</tbody>
</table>
Predictive analytics is used to calculate risk scores

Specific Heart Failure Cohort
Regression based, pre-calculated
Current PPV (precision) is 91.9%
Integrated in current workflow

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!