Using Predictive Analytics to Save Lives

Presented by Sybil Klaus MD MPH, MITRE, and James Fackler MD, Johns Hopkins University School of Medicine
Outline

- Introduction
- Predictive Analytics Overview
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MITRE Innovation Program

• MITRE focuses its R&D efforts on some of the nation’s biggest problems, from emerging cyber threats and global aviation safety to more effective healthcare programs.
• MITRE and its sponsors believe that serving the public interest means addressing the problems of the future, as well as solving current problems, to ensure a safer world.
• We develop new technologies, or new ways to use existing technologies, that will provide our stakeholders with new capabilities or concepts of operations.
• As a not-for-profit organization focused on solving national problems, we act as a trusted advisor, working across government and industry to pioneer new approaches together.
Predictive Analytics - Overview

- MITRE has proven the effectiveness of using predictive analytics to improve safety in the field of aviation through the ASIAS program.
  - A collaborative government-industry initiative on data sharing and analysis to discover safety concerns before accidents occur
- We are applying these same ideas to several health areas. For example, Johns Hopkins University and MITRE are developing methods and technology -- developed in partnership with doctors and hospitals -- that apply machine learning and predictive analytics to clinical data
  - The goal is to be able to get ahead of adverse events, medication errors, and accelerate identification of mental health and substance abuse (e.g., opioid) risk factors.
Johns Hopkins University and MITRE will discuss new research and technology—developed in partnership with doctors and hospitals—that apply machine learning and predictive analytics on clinical data to identify adverse events, reduce medication errors, and accelerate identification of mental health and substance abuse (e.g., opioid) risk factors.
Four Steps Are Necessary for Predictive Analytics to Save Lives

1. The analytics must be effective.
2. A clinician must respond to an “alert” and decide if the alert is “right.”
3. Prescriber behavior must change to initiate therapy sooner.
4. Team behavior must be optimized to precisely deliver definitive care.
Examples: Three Research Projects

- **Data-Driven Analytics to Help Reduce Drug Misuse and Abuse** - Principal Investigator: Jaya Tripathi: jtripathi@mitre.org

- **Clinical Reasoning and Multi-model Prediction of PTSD and Risk Factors** – Principal Investigator: Qian Hu: qian@mitre.org

- **Sepsis, Traumatic Brain Injury, and Hemorrhagic Shock Solution** - Principal Investigator: Benjamin R. Wellner: wellner@mitre.org
Data-Driven Analytics to Help Reduce Drug Misuse and Abuse

- **Problem**
  - Controlled Substance misuse and abuse costs the US billions of dollars a year, and takes a terrible toll in lives lost. This problem affects state and federal agencies, the healthcare provider community, and businesses and families.

- **Idea/Goal**
  - Apply advanced analytics to millions of longitudinal prescription data to identify novel risk factors and outcomes

- **Solution**
  - Use results to create techniques and tools to spotlight specific problem areas where communities and government sponsors can direct resources.

- **Impact**
  - We have identified risks of Substance Use Disorder at the points of care and points of sale, assessed effectiveness of government policies, and highlighted geographical areas where additional resources should be allocated.
## Data-Driven Analytics to Help Reduce Drug Misuse and Abuse

Advanced analytics were applied to millions of longitudinal prescription data, leading to the development of techniques and tools in the following areas:

<table>
<thead>
<tr>
<th>Fraud Detection</th>
<th>Decision Making</th>
<th>GeoSpatial Maps</th>
<th>Policy Simulator</th>
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</thead>
<tbody>
<tr>
<td><strong>GOAL:</strong> Identify prescriber fraud</td>
<td><strong>GOAL:</strong> Discern risky drug-seeking behavior at the points of care and points of sale</td>
<td><strong>GOAL:</strong> Surveillance to inform policy makers, community outreach, law enforcement, and others, about areas which need additional scrutiny</td>
<td><strong>GOAL:</strong> Assess effectiveness of policies</td>
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<tr>
<td><strong>WHAT WE OFFER:</strong> Tools and techniques to help law enforcement investigations, hospital compliance networks, audits, reports on prescribing behavior, intelligence extraction from indicted news briefs.</td>
<td><strong>WHAT WE OFFER:</strong> Tool with visualizations and risk scoring computations and tools and techniques to aid prescribing and dispensing decision-making</td>
<td><strong>WHAT WE OFFER:</strong> Spatial and temporal maps on distribution of controlled substance prescriptions, patients, prescribers, pharmacies, addressing various modalities</td>
<td><strong>CURRENT RESEARCH:</strong> Simulation models that do what-if analyses on MAT (addiction treatment) access, rural vs. urban studies, patient trajectories</td>
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A Systematic Approach to Help Reduce Drug Misuse and Abuse

Creation of evidence-based tools

- interviews; gap analysis
  - physicians
  - pharmacists
  - law enforcement
  - federal & state stakeholders

- descriptive data analytics
  - bivariate statistics
  - clustering
  - graph-analysis
  - geo-temporal analysis

- predictive data analytics
  - expert annotation
  - machine learning
  - UI design
  - web development

TOOLS
- actionable
- web-based
- easy integration into workflow
- dynamically generated from agnostic data model
- quick interpretation of charts and scores
Clinical Reasoning and Multi-model Prediction of Post Traumatic Stress Disorder (PTSD) and Risk Factors

- **Problem**
  - Today, PTSD diagnosis relies on a patient’s self-reported symptoms. Physicians need more objective assessment tools to diagnose and treat PTSD. They need tools and methods to identify PTSD indicators and risk factors before the onset.

- **Idea/Goal**
  - Create a new method of diagnosis based on applying natural language processing techniques to audio tapes of the patient interviews conducted by clinicians. For data, used 1,300 psychiatric assessments from consenting veterans.

- **Solution**
  - Created a prototype that objectively identifies diagnostic markers from the interviews. Our algorithms automatically detect words and phrases, speech patterns, and audio characteristics that identify individuals with PTSD.

- **Impact**
  - Testing the new solution today with Veterans Affairs groups. It has been well received and we’re interested in working with more groups.
Effective Analytics for PTSD and Risk Factors

Goal: Research and develop a clinical prediction system that will enable doctors to select predictive models and sets of high-value risk factors to make it a human-machine partnered prediction for the likelihood of PTSD.

<table>
<thead>
<tr>
<th>Feature Sets</th>
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<tbody>
<tr>
<td>PTSD Interview &amp; Diagnosis</td>
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<tr>
<td>Personality Traits</td>
</tr>
<tr>
<td>Extracted Speech Cues</td>
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<tr>
<td>Patient History &amp; Clinical Inf.</td>
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<tr>
<td>Patient Support Network Inf.</td>
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<tr>
<td>Sentiment Analysis</td>
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<tr>
<td>Extracted Vocal Cues</td>
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<tr>
<td>Brain Imaging</td>
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</tbody>
</table>

- Predictive Model #1
- Predictive Model #2
- Predictive Model #3

Optimized Prediction
Predicting Clinical Outcomes: Sepsis, Traumatic Brain Injury and Hemorrhagic Shock

- **Problem**
  - Sepsis, Traumatic Brain Injury, and Hemorrhagic Shock are difficult to recognize and predict.
  - Predicting the risk of these 3 could *dramatically improve health outcomes* given their magnitudes and frequencies of occurrence.

- **Idea**
  - Use machine learning, including deep learning, to forecast outcomes for patients at risk for these 3 based on vitals, laboratory results, medications, and other data.

- **Solution**
  - Work with Johns Hopkins, U. of Maryland, and others to identify clinical outcomes in retrospective data and build prediction models that enable earlier clinical interventions by forecasting/predicting risk factors and adverse outcomes.

- **Impact**
  - Improve accuracies in forecasting outcomes for Sepsis/TBI/HS using better interpretability of prediction models for optimal prospective use in clinical setting.
Findings

- Four steps are necessary if predictive analytics are to save lives
  - The analytics must be effective
  - A clinician must respond to a “alert” and decide if the alert is “right”
    - Role of clinicians in predictive analytics is to move past obfuscation through bias to disambiguation
  - Prescriber behavior must change to initiative therapy sooner
  - Team behavior must be optimized to precisely deliver definitive care
Follow up

To download a copy of this presentation, visit:

https://health.mitre.org/himss18

Data Interoperability to Reduce Clinician Burden

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