Risk Stratification

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Disclosure

• I, Kevin Bain, declare to not have any real or apparent conflicts of interest or financial interests with any pharmaceutical manufacturers, medical device company, or in any product or service, including grants, employment, gifts, stock holdings, and honoraria related to the content of this presentation.

• Each of the planning committee members have listed no financial interest/arrangement or affiliation that would be considered a conflict of interest.

Objectives

• Define the concepts of risk stratification
• Discuss the advantages of utilizing risk stratification models
• Distinguish how risk stratification models are used as predictive tools
• Compare different risk scoring systems currently utilized in the healthcare system
• Provide examples of “success stories” from PACE

Risk Stratification

Background
Risk Stratification Concepts

- Populations are comprised of a mixture of patients with low risk to high risk... for utilization of the healthcare system
- High-risk patients tend to utilize the most healthcare services & drive up expenditures
- Healthcare providers have finite resources to care for all of these patients
- Risk stratification models allow providers to identify the highest risk patients to appropriately allocate resources

Risk Stratification Assumptions

- One can assume that there is a relationship between a Risk Score and Medical Expenditures
Risk Stratification Assumptions

- One can *assume* an overlaying distribution of Members

![Graph showing distribution of Members against Total Expenditure ($)].

Risk Stratification Assumptions

- One can *assume* an intersection between Risk Score, Medical Expenditures, and Members

![Graph showing intersection between Risk Score, Medical Expenditures, and Members].

Risk Stratification Utilities

- Predict
  - [Adverse] health care outcomes
    - Risk of readmission, and/or
    - Risk of death
  - Medical care utilization & costs
    - Physician office visits
    - Expenditures

- Identify
  - Patients who might benefit from more intensive care or services
    - e.g., post-discharge care, pharmacist services

Additional Utilities

- Advantages:
  - Cost avoidances / savings
    - Allocate resources
    - Preventative therapies
    - Avoid penalties (e.g., high readmission rates)
  - Cost gains
    - Obtain rewards (e.g., low readmission rates)

Usually directed by clinical judgement, although this alone is suboptimal
Risk Stratification Utilities

Focus on ADEs

- ADEs are avoidable with proper recognition of contributing drug factors & appropriate actions
  - Multidrug interactions are a leading cause of ADEs
- Prescribers & pharmacists can intervene to mitigate dangerous drug combinations & other medication-related problems
- Mitigating these risks is relatively quick & easy for trained clinicians
- However, identifying which patients require these types of interventions within populations has been a much more difficult task

The probability of >1 clinically relevant DDI is 50% in geriatric patients taking 5-9 medications, 81% with 10-14 medications, 92% with 15-19 medications, and 100% with >20 medications.

The risk of an adverse drug event (ADE) is 81% with ten or more medications. 82% of patients taking >8 drugs use at least one potentially inappropriate medication (PIM).


Risk Stratification Methods

- Vary in their target population(s) & exclusion(s)
  - e.g., medical & surgical wards vs. internal medicine wards, cognitively intact vs. cognitively impaired, general disease vs. disease-specific
- Vary in their methodology (i.e., derivation)
  - Types of variables included in the model
    - Patient- and/or system-level (e.g., sociodemographic, health status, past health care utilization, medical care, length of stay, etc.)
    - Number of variables included in the model
      - Complex outcomes can sometimes be predicted with a few simple factors
- Vary in their predictability (i.e., validation)
  - Positive predictive value
  - Sensitivity & specificity

Risk Stratification Methods Examples

- LACE Index
  - Length of stay, Acuity of admission, Comorbidity of the patient (Charlson Comorbidity Index), and Emergency department visits
- PEARL Score
  - Previous admissions, eMRCD score, Age, Right-sided heart failure, and Left-sided heart failure
- FAM-FACE-SG Score
  - Furosemide IV >40 mg, Admissions in the past one year, Medifund, Frequent emergency department use >3 in the past six months, Antidepressants in past one year, Charlson Comorbidity Index, End-stage renal failure on dialysis, Subsidized ward stay, and Geriatric
Risk Stratification Methods **Examples**

- Adjusted Clinical Groups (ACG®)
- Clinical Risk Groups (CRGs)
- Clinically-Detailed Risk Information System for Cost (CD-RISC)
- Diagnostic Cost Group, Hierarchical Condition Category (DCG/HCC)

**What do they all have in common?**
Largely based on diagnostic claims / codes

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Risk Stratification Methods **Limitations**

- Diagnostic coding is not always reliable
  - Hierarchies are often imposed, such that only one diagnostic code (e.g., most severe) can be processed for medical billing purposes
  - Multiple comorbidities can go underreported in coding, which can have a large impact on the identification of truly high-risk patients
- Timely diagnostic coding is not always available
  - Significant lag times (months or even years) can be observed in some claims data files
- Some methods use limited lists of disease codes
  - This can lead to unrecognized medical conditions
- Some methods are very detailed & complex
  - Not easily implemented in clinical practice
- Information generated by these methods are not immediately actionable
- When drug information is included, drug categories rather than actual drugs are used
  - There are numerous indications across drug classes, which limits the ability to use drugs as a proxy to define diagnostic codes
  - This method assumes drug class effects rather than the characteristics of individual drugs
- The consideration for multi-drug interactions & the significant risk of adverse drug events is rather absent or omitted
Our Strategy

- The purpose of our research was to develop a tool that can predict risk of drug-related adverse reactions and events using drug claims as the source of information (e.g., PACE, EMTM, health plans)

- Specifically, we are trying to predict:
  - Drug-related adverse reactions and events (ADRs / ADEs)
  - Healthcare outcomes (e.g., re-hospitalizations)
  - Costs (medical expenditures)

- But more importantly, the purpose of predicting these variables is to determine which patients should receive interventions to avoid negative outcomes by optimizing drug regimens

Our Approach

- We currently look at 5 medication risk mitigation (MRM) factors:
  - Adverse event risk score
  - Aggregated anticholinergic burden
  - Aggregated sedative burden
  - Aggregated long QT syndrome
  - Competitive inhibition burden

- Once algorithms for all 5 factors were developed, they were combined into one comprehensive algorithm

Our Validation

- We analyzed the MRS in a population of 573,459 members
- We removed all members with a negative medical expenditure
  - 151 members
- We removed all members without medical expenditure data
  - 7,340 members
- We removed all members with a MRS of “0”
  - 143 members

The final population was 565,825 members
Our Validation

- We used a **Power Transformation** in order to further normalize the data because our residual plot did not meet our assumptions for normality.

- Power Transform function in R uses the following formula to transform data:

\[ Z = \frac{Y^{\lambda} - 1}{\lambda} \]

where \( Z \) is the transformed Expenditure and \( Y \) is the actual Expenditure.

The function uses the Box & Cox method to find the best value of \( \lambda \) on the interval \([-3,3]\) to best normalize the dataset.

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Our Validation

- Additional results are presented below:

<table>
<thead>
<tr>
<th>Exclusion</th>
<th>MPE ± SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>No exclusions</td>
<td>5.88 ± .54</td>
</tr>
<tr>
<td>1% quantile</td>
<td>5.44 ± .51</td>
</tr>
<tr>
<td>2% quantile</td>
<td>5.54 ± .55</td>
</tr>
<tr>
<td>5% quantile</td>
<td>5.42 ± .57</td>
</tr>
<tr>
<td>&lt; 5 Drugs</td>
<td>7.04 ± .90</td>
</tr>
<tr>
<td>5% and &lt; 5 Drugs</td>
<td>6.21 ± .98</td>
</tr>
<tr>
<td>MRS &lt; 3</td>
<td>6.03 ± .91</td>
</tr>
<tr>
<td>MRS &lt; 3 and 1%</td>
<td>5.29 ± .85</td>
</tr>
<tr>
<td>MRS &lt; 3 and 2%</td>
<td>5.42 ± .86</td>
</tr>
<tr>
<td>MRS &lt; 3 and 5%</td>
<td>6.03 ± .75</td>
</tr>
</tbody>
</table>

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Our Validation

- The residual plots are presented below:
Our Validation

- The final distribution of MRS & Expenditure is depicted below:

![Graph showing MRS vs Medical Expenditure](image)

Sub-Group Analyses

Targeted Drug Classes

- **Opioids**
  - Patients taking >1 opioid
  - Patients taking >1 CYP2D6 metabolized opioid
  - Patients taking >1 CYP2D6 metabolized opioid + multidrug interactions
    - Reduces its activation
    - Reduction in analgesic response +/- potential toxicity

- **Antiplatelets**
  - Patients taking clopidogrel
  - Patients taking clopidogrel with >1 CYP2C19 interacting medication
    - Reduces its activation
    - Reduction in antiplatelet efficacy

Risk Stratification Applications to PACE
Utility in PACE

• PACE participants frequently have multiple comorbidities & take multiple medications

• PACE providers are fully at risk for the financial burdens incurred by its participants’ health issues & medical care costs

• By identifying high-risk PACE participants for various actionable risk factors, PACE providers can act quickly & efficiently to mitigate medication risks
  – Prevent other costly medical interventions (e.g., ED visits, hospitalizations) and improve quality of life of participants
Take-Away Points

• We developed a risk stratification method that utilizes only drug claims data, thereby eliminating the reliance on diagnostic coding
  – Nearly all traditional risk stratification methods rely on diagnostic coding for accurate results, which is fraught with limitations

• Our method also identifies actionable risks
  – Identifying high-risk patients is only half of the puzzle
  – How to mitigate those risks is just as vital as being able to identify them

• PACE providers can utilize the MRS to efficiently & effectively allocate resources to participants in most need
  – Can fluctuate over time (i.e., agile / dynamic)

Questions?