Exploring Temporal Patterns in Hypertensive Drug Therapy

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3. Assistant Prof, School of Pharmacy
4. Research Scientist, HCIL
5. Ph.D student in Computer Science
INTRODUCTION

Patients’ Adherence to Medication

- Great importance as non-adherence can lead to worsening of conditions and health decline.

Medication Possession Ratio (MPR)

\[
\text{Sum (days supply for all claims during a defined period of time)} \div \text{# of days elapsed during the period}
\]

- Does not adequately capture different adherence patterns of patients, which vary widely.
Observe and Summarize Common Patterns in Hypertensive Drug Therapy
DATA DESCRIPTION

Pharmacy claims of 493,022 individuals

Angiotension-Converting Enzyme-Inhibitors (Ace)
Angiotension II Receptor Blockers (ARB)
Calcium Channel Blockers (CCB)
Beta blockers (Beta)
Diuretics

5 Drug Classes
IDEAL DRUG USAGE PATTERN

Days

30 30 30 30 30 30 30 30 30 30

ACE
IDEAL DRUG USAGE PATTERN

Days

30 30 30 30 30 30 30 30 30 30

ACE

Beta
IDEAL DRUG USAGE PATTERN

ACE

Beta

Days
What does the whole picture look like?
Randomly selected 5000 events (180 individuals)
What if we narrow down a little bit?
MATCH

WEIR

1000638

108406

Diur  Beta  Ace  CCB
What is a good pattern?
<table>
<thead>
<tr>
<th>Compelling Indication</th>
<th>DIURETIC</th>
<th>BB</th>
<th>ACEI</th>
<th>ARB</th>
<th>CCB</th>
<th>ALDO ANTS</th>
<th>Clinical Trial Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart failure</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>ACC/AHA Heart Failure Guideline,40 MERIT-HF,41 COPERNICUS,42 CIBIS,43 SOLVD,44 AIRE,45 TRACE,46 ValHEFT,47 RALES48</td>
</tr>
<tr>
<td>Postmyocardial infarction</td>
<td></td>
<td>•</td>
<td>•</td>
<td></td>
<td></td>
<td>•</td>
<td>ACC/AHA Post-MI Guideline,49 BHA,50 SAVE,51 Capricorn,52 EPHESUS53</td>
</tr>
<tr>
<td>High coronary disease risk</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td></td>
<td>•</td>
<td>•</td>
<td>ALLHAT,33 HOPE,34 ANBP2,36 LIFE,32 CONVINCE31</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>NKF-ADA Guideline,21,22 UKPDS,54 ALLHAT33</td>
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<tr>
<td>Chronic kidney disease</td>
<td></td>
<td></td>
<td>•</td>
<td></td>
<td></td>
<td>•</td>
<td>NFK Guideline,22 Captopril Trial,55 RENAA,56 IDNT,57 REIN,58 AASK59</td>
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<tr>
<td>Recurrent stroke prevention</td>
<td>•</td>
<td></td>
<td></td>
<td></td>
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<td>PROGRESS35</td>
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NHLBI (2003), JNC 7 Express
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NHLBI (2003), JNC 7 Express
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<th>Compelling Indication*</th>
<th>Recommended Drugs†</th>
<th>Clinical Trial Basis‡</th>
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NHLBI (2003), JNC 7 Express
Drug usages and medical records for heart failure patients with ICD9 4289

Search HF_4289 occurring during the CCB
Why are Those Heart Failure Patients Given CCB?
CCB

Non-dihydropyridines (Good)

Dihydropyridines (Bad)
CCB

Non-dihydropyridines (Good)

Dihydropyridines (Bad)
Are there any heart failure patients on bad CCB?
HF_any

Bad CCB
Drug usages & medical records for heart failure patients on Bad CCB

Search HF_any occurring during the Bad CCB

Matching Records
28 records 0 selected All | None

Non-Matching Records
89 records 0 selected All | None
MEDICAL STUDY

CCB

Non-dihydropyridines (good)

Dihydropyridines (bad)

Atrial Fibrillation (AF)
Do those heart failure patients on bad CCB have AF?
Drug usages & medical records for heart failure patients on Bad CCB

Search AF_any not occurring

Matching Records

Non-Matching Records
37454: Heart failure patients in total

416: Heart failure patients on CCB

89: Heart failure on bad CCB without AF
37454: Heart failure patients in total

416: Heart failure patients on CCB

89: Heart failure on bad CCB without AF

0.24% among the heart failure Individuals
37454: Heart failure patients in total

416: Heart failure patients on CCB

89: Heart failure on bad CCB without AF

0.24% among the heart failure Individuals

21% among the heart failure on CCB
CRITICAL FINDING

- It is not compliant with medical guideline.
CRITICAL FINDING

- It is not compliant with medical guideline.

Doctor’s mistake
CRITICAL FINDING

- It is not compliant with medical guideline.

Doctor’s mistake
What does the pattern look like before and after 1st heart failure inpatient visit?
Aggregating HF claims into 5 categories
<table>
<thead>
<tr>
<th>Category</th>
<th>Place of Services Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>inpatient</td>
<td>21, 51, 56, 61</td>
</tr>
<tr>
<td>outpatient</td>
<td>all others</td>
</tr>
<tr>
<td>urgent</td>
<td>20, 23, 41, 42</td>
</tr>
<tr>
<td>hospice</td>
<td>34</td>
</tr>
<tr>
<td>SNF (skilled nursing facility)</td>
<td>31, 32, 33</td>
</tr>
</tbody>
</table>
Cleaning multiple records of inpatient visit on the same day

Aggregating HF claims into 5 categories

Robert H. Smith School of Business
Search → Add Constraint
Replace Event Sequence

Search:

Replace:

New Sequence Name: <hf_inpatient>

- Replace All
- Allow Overlap of Matched Sequences

Replace: 1st Match
Cleaning multiple records of inpatient visit on the same day

Aligning by the first HF inpatient visit

Aggregating HF claims into 5 categories
Drug usages and medical records for heart failure patients on Bad CCB
Patients with AF claims: started by taking good CCB and ACE → not long after first heart failure inpatient visit, dropped good CCB but took bad CCB instead.

Patients without AF claims: started to take hypertensive drugs after first heart failure inpatient visit → dropped bad CCB

Patients without AF claims: started to take hypertensive drugs after first heart failure inpatient visit → continued to take bad CCB for some periods of time
CONCLUSION

- Patterns are far from ideal

- Doctors may have given wrong prescriptions (use of bad CCB)

- EventFlow:
  - visualization reveals limitations of Medical Possession Ratio
  - detect common patterns & specific cases
FUTURE AVENUES

- **Clustering:** discovering underlying patterns of behavior of patients taking medicine, then analyzing the different clusters in EventFlow

- **Statistic Analysis:** logistic regression, including Charlson Comorbidity Index (CCI), to quantify drug impacts on outcomes

- **EventFlow:**
  - Generating hypothesis
    (eg. Patient on bad CCB may have higher readmission rate)
  - Supporting the statistic analysis findings
THANK YOU

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Website: http://www.cs.umd.edu/hcil/eventflow