Interoperable information in prediction modeling:
contribution and application to patients

Joshua R Vest, PhD, MPH
Indiana University
Regenstrief Institute
joshvest@iu.edu

Disclosures

Support for this was provided by the Robert Wood Johnson Foundation through the Systems for Action National Coordinating Center, ID 75549.

Work was a collaboration with many colleagues:


Patients’ health depends on factors and experiences outside the context of a single health care encounter.

<table>
<thead>
<tr>
<th>Current triage information</th>
<th>Prior visit history</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Encounters with other providers</th>
<th>Environmental &amp; social contexts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is the contribution of these different data sources in prediction?

**Focus on emergency department re-visits:**
- costly
- use as quality indicator
Predicted 30-day revisit rates among 279,611 adult ED encounters at an Indianapolis safety-net hospital using two class boosted decision trees.

<table>
<thead>
<tr>
<th>Current triage information</th>
<th>Prior visit history</th>
<th>Encounters with other providers</th>
<th>Environmental &amp; Social Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>44 measures</td>
<td>44 measures</td>
<td>30 measures</td>
<td>41 measures</td>
</tr>
<tr>
<td>Data generated at or associated with the ED encounter only</td>
<td>Historical data from the hospital</td>
<td>Data from Indiana Health Information Exchange (statewide)</td>
<td>SES status</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Behaviors</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Built environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Health services</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Social circumstances</td>
</tr>
</tbody>
</table>

Including more contextual information improved model performance
Including more contextual information improved model performance

![Graph showing ROC curves for different information classes with AUC values.]
Including more contextual information improved model performance

Including more contextual information improved model performance
Models using HIE information performed better than models with single information types.

Application of information to patients:

Risk stratification for social services
Delivering social and wraparound services:

- reduces patient utilization
- avoids costs
- meets patients’ needs

However, identifying patients most in need of social services is difficult:

- inherent challenges of screening
- limited service capacity

We implemented machine-learning based risk stratification to identify those in need of social and wraparound services.
Sample & Analyses

- 9 FQHC sites
- 238,087 encounters
- Adult primary care patients
- 12 month stepped-wedge design
- GEE logistics regression models
- Outcomes:
  - Referrals
  - Kept wraparound appointments
Risk stratification was rolled out 3 clinics at a time from July to November 2017

Baseline

3 clinic locations live

Baseline

3 clinic locations live

Baseline

3 clinic locations live

June    July    August    September    October    November    December    January

Interoperable information in prediction modeling

• Strong prediction performance across all performance metrics

• 65% increase in social work referrals when risk scoring went live at primary care clinics

• 48% increase in odds that referred patients will keep their appointments
Potential cost savings: sub-analysis

- Limited data to 6 months pre & post go live
  - 49,835 encounters
- Fixed-effect Poisson models
- Outcomes:
  - hospital admissions
  - emergency department visits
- Applied average HCUP costs to predicted differences in counts of encounters

$1.7 million in estimated cost savings

- 1 year pre-post analysis of ED visits and inpatients admissions after go-live
- $171 cost reduction per patient
Interoperable information in prediction modeling: contribution & application to patients

- Interoperable health information exchange data contributed to prediction models
- Prediction modeling using interoperable data can be successfully applied to health care processes