OHDSI PeriopPredict

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Disclosures

Lichy Han and Evan Minty are both Stanford BMI graduate students taking Stats 290


project portion of class (to ‘create an R package’)

This is not a class on prediction models

Would like to beta test a working package*
Objectives

To motivate the case for perioperative prediction models
To get some feedback on experimental design
To recruit some OHDSI community members and sites into the study
To produce a publication worthy set of models (to demonstrate a working beta version)
Postoperative mortality is the third leading cause of death in the United States.

- Deaths due to heart disease: n = 631,636
- Deaths due to malignancy: n = 559,888
- Deaths within 30 days of admission for surgery: n = 189,690
- Deaths due to cerebrovascular disease: n = 137,119
1.32% of patients who undergo a surgical procedure die within 30-days

This only included patients who died during the index mission.

6% of post-operative deaths occur after hospital discharge.
Patients who had a complication post-operatively had a higher rate of death

30-day mortality rate by complication:
- Any complication 9.84%
- Hospital-acquired pneumonia 7.34%
- VTE 5.34%
- Shock/cardiac arrest 44.15%
Preoperative risk assessment

Risk-benefit assessment is important for informed consent
Risk assessment may inform surgical strategy*
Risk assessment may inform post-operative monitoring location
Risk assessment may inform type and intensity of post-operative monitoring for complications
Prediction Models in Perioperative Medicine

- Lee (1999)
- Gupta
- NSQIP Surgical Calculator
- Many others
Controversies

General trend towards doing less investigation with imaging, angiography preoperatively

Data suggesting preoperative BNP could be useful

Data suggesting postoperative TnT could help detect patients at >10% 30 day mortality

From Medicine standpoint – addressing the question of ‘who should we follow’?
Risk of death or MI at 30-days post-operative based on pre-operative BNP

<table>
<thead>
<tr>
<th>result</th>
<th>Risk estimate, %</th>
<th>95% CI for the risk estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>proBNP &lt; 300 ng/L or</td>
<td>4.9</td>
<td>3.9%-6.1%</td>
</tr>
<tr>
<td>proBNP value ≥ 300 ng/L</td>
<td>21.8</td>
<td>19.0%-24.8%</td>
</tr>
</tbody>
</table>
"Planned" Design: Preoperative use case

Pre-op use case

\( d = -x \) Visit washout

\( d = -1 \)

Lookback unconstrained*

365d con’t obs*

O w/o

\( d = 0 \) Visit
\( d = [0,1]* \) OR

Procedure children of T cohort

60d

O
Target Cohorts

Initially: Non Cardiac, Non Maternal Surgeries

– With other minor surgeries taken out of the CPT
Target Cohorts

Initially: Non Cardiac, Non Maternal Surgeries
– With other minor surgery parents taken out of the CPT

Realization: the CPT defines “surgical procedures” very loosely
– Index problem: Not confident a procedure occurrence would actually indicate a real surgery took place.
– Prediction Feature Problem
Handling procedures on day of Surgery

Surgical Procedures on the Cardiovascular System

- Surgical Procedures on Arteries and Veins
  - Repair, excision, Revision Arteries and Veins
- Arterial Procedures / Arterial Catheterization for sampling, monitoring...
Handling Procedures on Day of Surgery

Variable Scatterplot: MACE

d=0
Arterial line insertion

arterial line insertion
Handling procedures on day of Surgery

Surgical Procedures on the Abdominal System

Lap Chole $\#!+$ Laparotomy
Rare events

(but so are the outcomes of interest)
Current Design: Perioperative use case

- Periop use case
  - d=-1
  - 365d con’t obs*
  - Lookback unconstrained*
  - 60d
  - d=0 Visit
  - d=[0,1]* OR
  - Procedures in T cohort & Descendents
target cohort T: Visit with Non Cardiac / Maternal Surgery - Minty is defined as:

Special Event Cohort

- people having any of the following:
  - a visit occurrence of Any Visit
    - occurrence start is after 2010-01-01
    - occurrence end is before 2017-10-01

- continuous observation of at least 365 days prior and 60 days after event index date, and limit initial events to: all events per person.

people matching the Primary Events, include:

- meeting all of the following criteria:
  - with the following event criteria:
    - with age > 45
  - and at least 1 occurrences of a procedure of Non Cardiac Surgery - Minty² starting between 0 days After and 1 days After event index date occurring within the same visit

- cohort of initial events to: earliest event per person.
- qualifying cohort to: earliest event per person.

Date Offset Exit Criteria

- this cohort definition end date will be the index event’s start date plus 60 days
The outcome **MACE or Death - Minty** is defined as:

**Initial Event Cohort**

People having any of the following:

- a condition occurrence of Acute MI - Minty\(^1\)
- a procedure of Cardiac Revascularization - Minty\(^2\)
- a death occurrence from Any Death

Each continuous observation of at least 0 days prior and 0 days after event index date, and limit initial events to: **all events per person**.

Limit qualifying cohort to: **earliest event per person**.

End date strategy selected. By default, the cohort end date will be the end of the observation period that contains the index event.
Model Configuration (prelim)

Prediction Options

The analysis will use the following options:
  - Prediction Model: Lasso Logistic Regression
    - Starting value for the automatic lambda search: 0.01

We impose a requirement that patients must have at least 365 days of continuous observation prior to cohort entry.

We consider all exposures per subject in the prediction model.

We include people with outcomes who are not observed for the whole at risk period.

This data will split by using 75% of the subjects to train the model and 25% to test.

The hyper-parameter training will be conducted using a 10-fold cross validation.
Model Configuration (prelim)

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Results (prelim)

AUCs across outcomes go from ~70% to 80-85% when day=[0,1] procedures are added. AUC is probably not a good measure given the imbalance in the data set — e.g. MACE: 36K in train (77 events), 12K in test (26 events)
Results (prelim)
Target Cohorts: Strategy 1

Possibility: Code by code warfare in the CPT to identify real surgeries
  – Should run a predictive model on whether this will give you RSI

Possibility: use a subset of high risk surgeries
  – E.g. Lee ‘High Risk’ Surgery
  – ~451 cases, 5 events
Target Cohorts: Strategy 2

- Critical care related

Visit with Same Day
Non Cardiac
Non Maternal Surgeries

- “radiology”

- “percutaneous”
Target Cohorts: Strategy 3

- Critical care related

Visit with Same Day Non Cardiac Non Maternal Surgeries

Provision of Anesthesia

http://www.ohdsi.org/web/atlas/#/cohortdefinition/1734860
Target Cohorts: Strategy 4

Visit with Same Day Non Cardiac Non Maternal Surgeries

Pre-operative Evaluation

- Critical care related

http://www.ohdsi.org/web/atlas/#/cohortdefinition/1734860
Outcome Cohorts

MACE*: Acute Myocardial Infarction, Coronary Revascularization
Congestive Heart Failure
Pneumonia
  – Pneumonia with inpatient or ED encounter
‘Post op infection’
  – New infection (any)
New Sepsis
Delirium
Preoperative use case: is it feasible?

Pre-op use case

365d con’t obs

Lookback unconstrained*

60d

d=0 Visit
d=[0,1]* OR

Index
Procedure*
## Model Use cases and Approaches

<table>
<thead>
<tr>
<th>Modelling consideration</th>
<th>Preoperative</th>
<th>Perioperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0-1* surgeries</td>
<td>Desire index procedure, or a ‘reasonable’ aggregate feature</td>
<td>Include</td>
</tr>
<tr>
<td>Other Day 0-1* procedures</td>
<td>Exclude</td>
<td>Include</td>
</tr>
<tr>
<td>Visit to Day 0-1* Surgery</td>
<td>Implement</td>
<td>Include*</td>
</tr>
<tr>
<td>Include other hospital variates</td>
<td>Exclude</td>
<td>... do we need to exclude?</td>
</tr>
<tr>
<td>Revisits Washout</td>
<td>Implement?</td>
<td>Implement?*</td>
</tr>
<tr>
<td>Outcome washout</td>
<td>Implement</td>
<td>Not needed</td>
</tr>
</tbody>
</table>
Modelling the index procedure

Surgical Procedures on the Cardiovascular System

Surgical Procedures on Arteries and Veins

Endarterectomy

Repair, excision, Revision Arteries and Veins

Arterial Procedures / Arterial Catheterization for sampling, monitoring...
Does this have the makings of a more broadly useful modelling process?
Thank you!

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Extra Slides
Results (prelim)
Custom Aggregating Ontology?
Non-invasive stress testing: Critique

**One third of MIs and deaths** within 30-days of surgery occurred in patients with a **negative** thallium/stress echo

Meta-analysis including over 10,000 patients

Survival benefit study was retrospective

NNT of 221

NNT 38 when only applied to RCRI $\geq 3$ patients