# OHDSI PeriopPredict

Evan Minty MD MSc
Lichy Han MD PhD
OHDSI Collaborators
Nigam Shah
Stanford University

March 13 2018

# Disclosures

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

- http://statweb.stanford.edu/~naras/stat290/Stat290_Website/Stat_290.html

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

s 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

<u>30-day mortality rate by complication:</u>

Any complication 9.84%

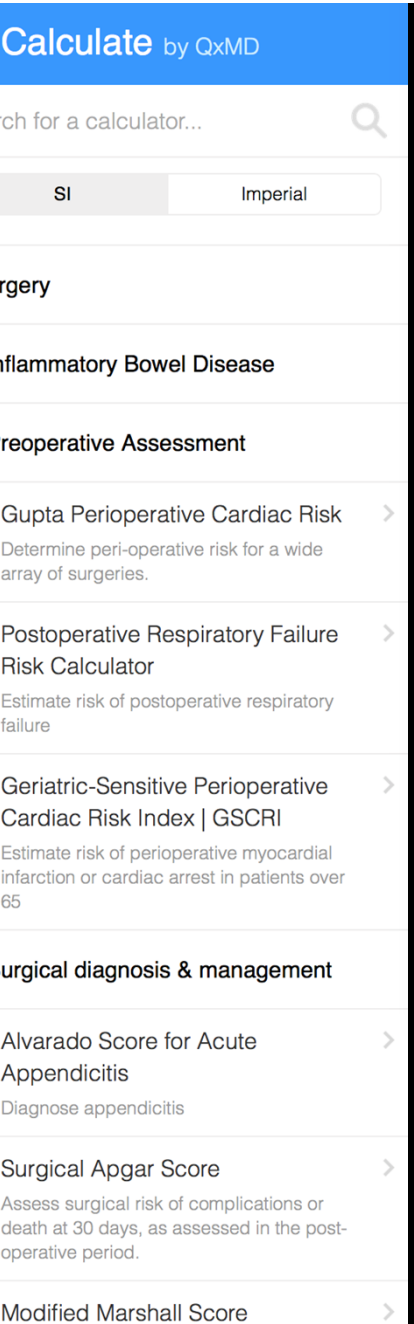
Hospital-acquired pneumonia 7.34%

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

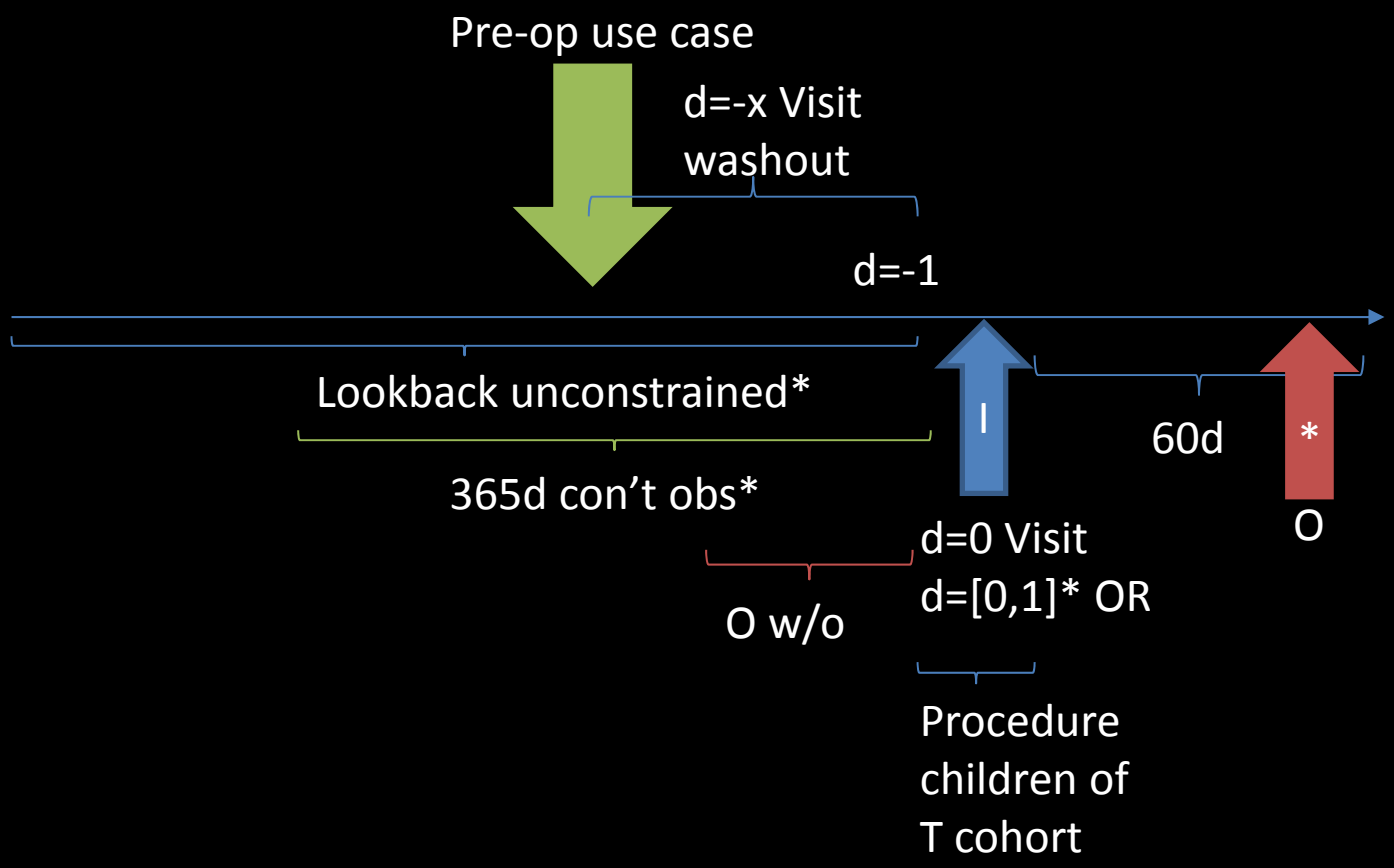
# Controversies

- 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

| result | Risk estimate, % | 95% CI for the risk estimate |
|---|---|---|
| proBNP < 300 ng/L or | 4.9 | 3.9%-6.1% |
| proBNP value ≥ 300 ng/L | 21.8 | 19.0%-24.8% |

# ”Planned” Design: Preoperative use case



# Target Cohorts

## Initially: Non Cardiac, Non Maternal Surgeries

## – With other minor surgeries taken out of the CPT

rgery - Minty

ntries

Search:

of 17 entries

Previous 1 Next

| d | Concept Code | Concept Name | Domain | Standard Concept Caption | Exclude | Descendants | Mapped |
|---|---|---|---|---|---|---|---|
| 7 | 1008061 | Surgical Procedures on the Urinary System | Procedure | Classification | ☐ | ☑ | ☑ |
| 6 | 1005690 | Surgical Procedures on the Respiratory System | Procedure | Classification | ☐ | ☑ | ☑ |
| 8 | 1009068 | Surgical Procedures on the Nervous System | Procedure | Classification | ☐ | ☑ | ☑ |
| 2 | 1003679 | Surgical Procedures on the Musculoskeletal System | Procedure | Classification | ☐ | ☑ | ☑ |
| 9 | 1006933 | Surgical Procedures on the Mediastinum and Diaphragm | Procedure | Classification | ☐ | ☑ | ☑ |
| 4 | 1008470 | Surgical Procedures on the Male Genital System | Procedure | Classification | ☐ | ☑ | ☑ |
| 6 | 1003148 | Surgical Procedures on the Integumentary System | Procedure | Classification | ☐ | ☑ | ☑ |
| 6 | 1006843 | Surgical Procedures on the Hemic and Lymphatic Systems | Procedure | Classification | ☐ | ☑ | ☑ |
| 0 | 1008681 | Surgical Procedures on the Female Genital System | Procedure | Classification | ☐ | ☑ | ☑ |
| 6 | 1009727 | Surgical Procedures on the Eye and Ocular Adnexa | Procedure | Classification | ☐ | ☑ | ☑ |
| 1 | 1009024 | Surgical Procedures on the Endocrine System | Procedure | Classification | ☐ | ☑ | ☑ |
| 3 | 1006964 | Surgical Procedures on the Digestive System | Procedure | Classification | ☐ | ☑ | ☑ |
| 8 | 1003614 | Surgical Procedures on the Breast | Procedure | Classification | ☐ | ☑ | ☑ |
| 2 | 1006359 | Surgical Procedures on Arteries and Veins | Procedure | Classification | ☐ | ☑ | ☑ |

# 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

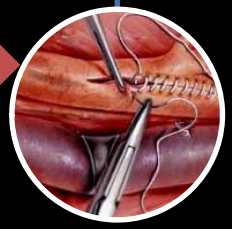
Surgical Procedures on the Cardiovascular System

Surgical Procedures on Arteries and Veins

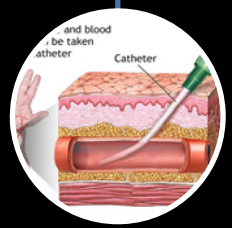
Surgical Procedures on the Heart and Pericardium


$#!+

Endarterectomy

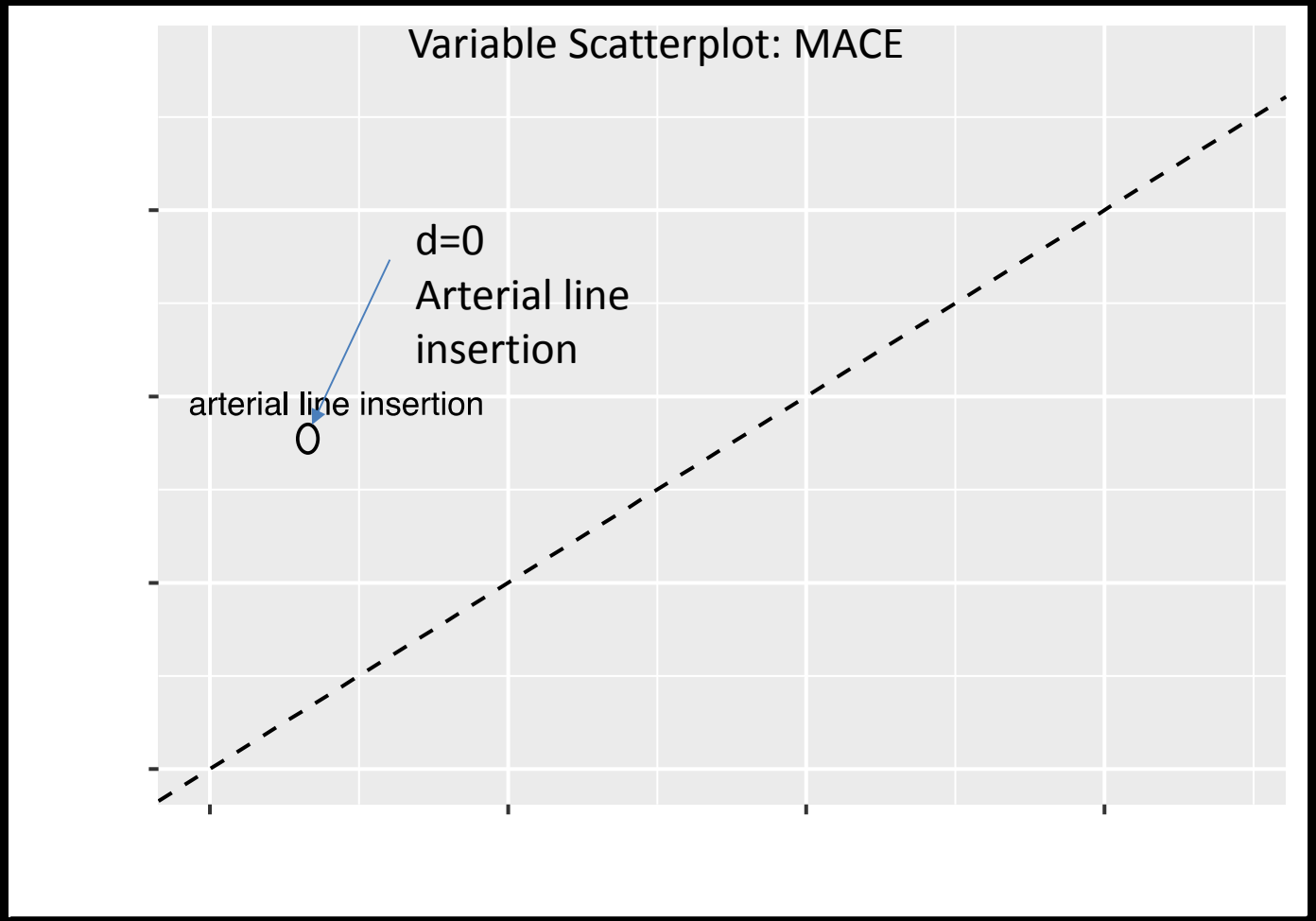


Repair, excision, Revision Arteries and Veins

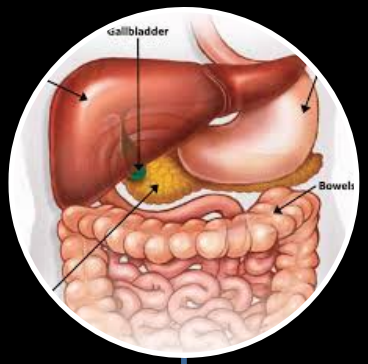



Arterial Procedures / Arterial Catheterization for sampling, monitoring...

# Handling Procedures on Day of Surgery



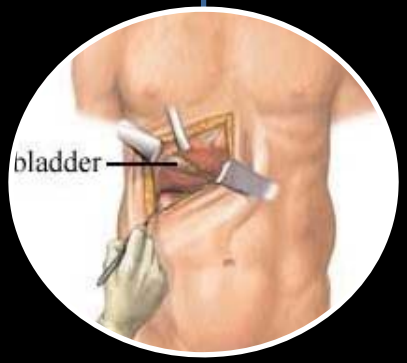
# Handling procedures on day of Surgery




Surgical Procedures on the Abdominal System


Lap Chole

$#!+

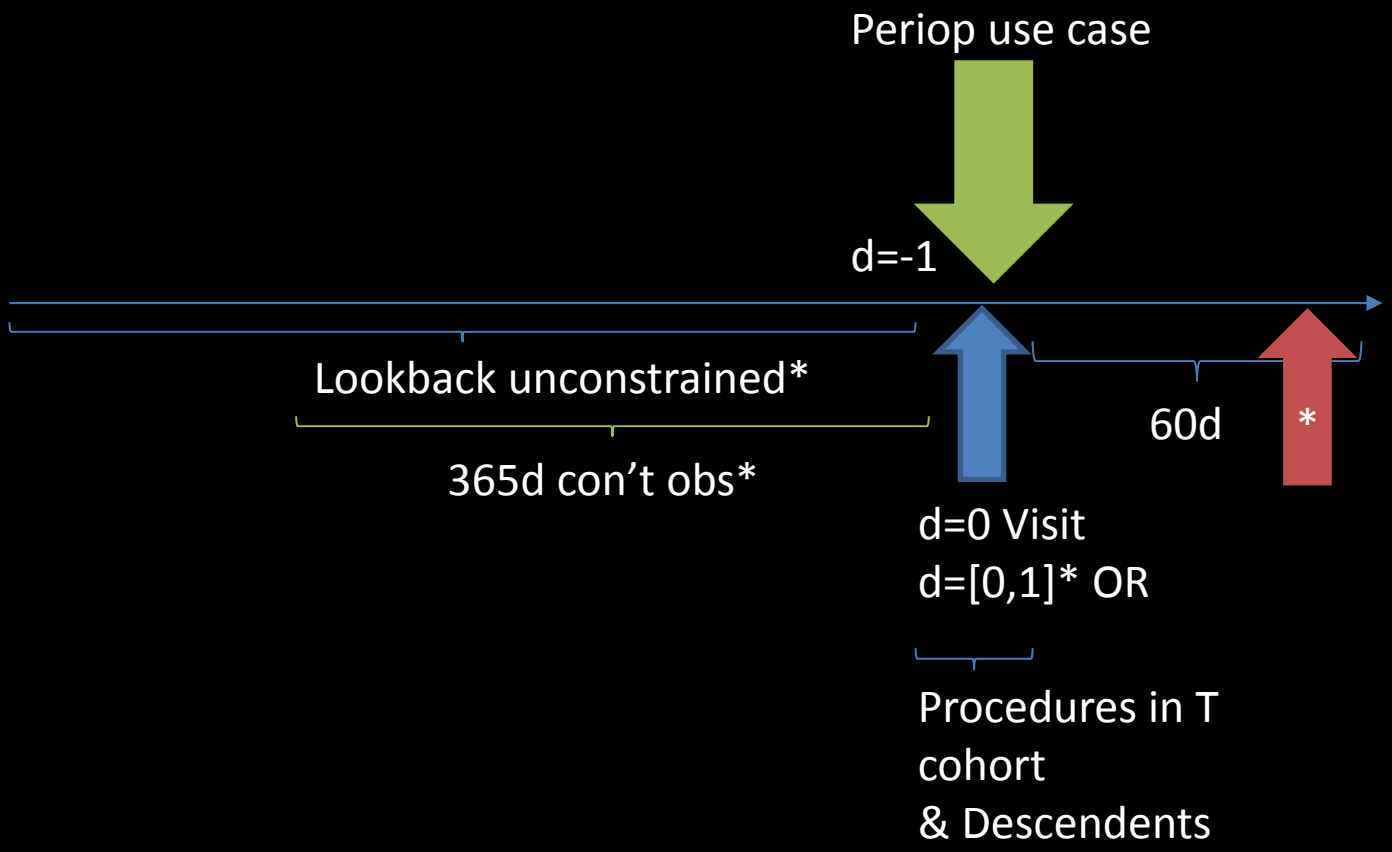



Laparotomy

# Rare events
# (but so are the outcomes of interest)

| | Concept Id | Concept Code | Concept Name | Domain | Standard Concept Caption |
|---|---|---|---|---|---|
| | 2003502 | 54.19 | Other laparotomy | Procedure | Standard |
| | 2003489 | 54.1 | Laparotomy | Procedure | Standard |
| | 4314251 | 86481000 | Laparotomy | Procedure | Standard |
| | 2109428 | 49000 | Exploratory laparotomy, exploratory celiotomy with or without biopsy(s) (separate procedure) | Procedure | Standard |
| | 4047945 | 12324002 | Exploratory laparotomy with biopsy | Procedure | Standard |
| | 4253523 | 74770008 | Exploratory laparotomy | Procedure | Standard |
| | 2003490 | 54.11 | Exploratory laparotomy | Procedure | Standard |

# Current Design: Perioperative use case



# Model Configuration (prelim)

target cohort **T: Visit with Non Cardiac / Maternal Surgery - Minty** is defined as:

tial Event Cohort

ple 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

n 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:
ing 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 - Minty[2]
  starting between 0 days After and 1 days After event index date
  **occurring within the same visit**

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

te Offset Exit Criteria

s cohort defintion end date will be the index event's start date plus 60 days

# Model Configuration (prelim)

e outcome **MACE or Death - Minty** is defined as:

itial Event Cohort

ople 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

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

nit 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)

## 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.

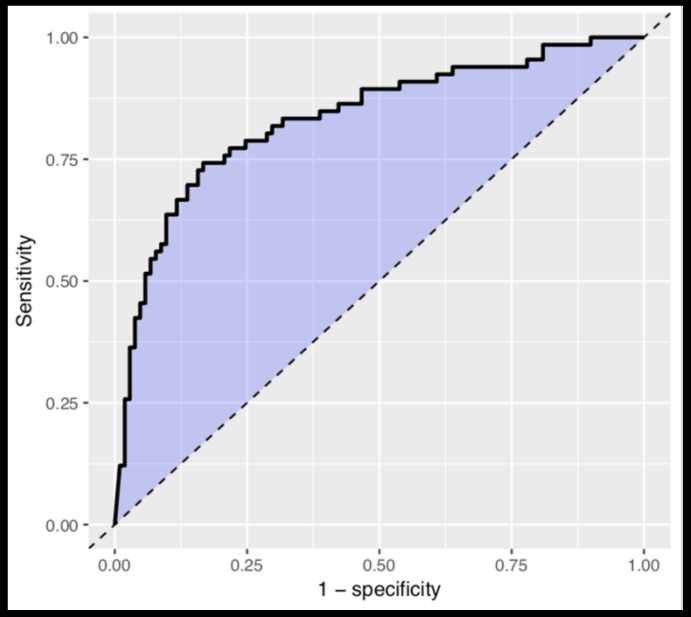
# Results (prelim)

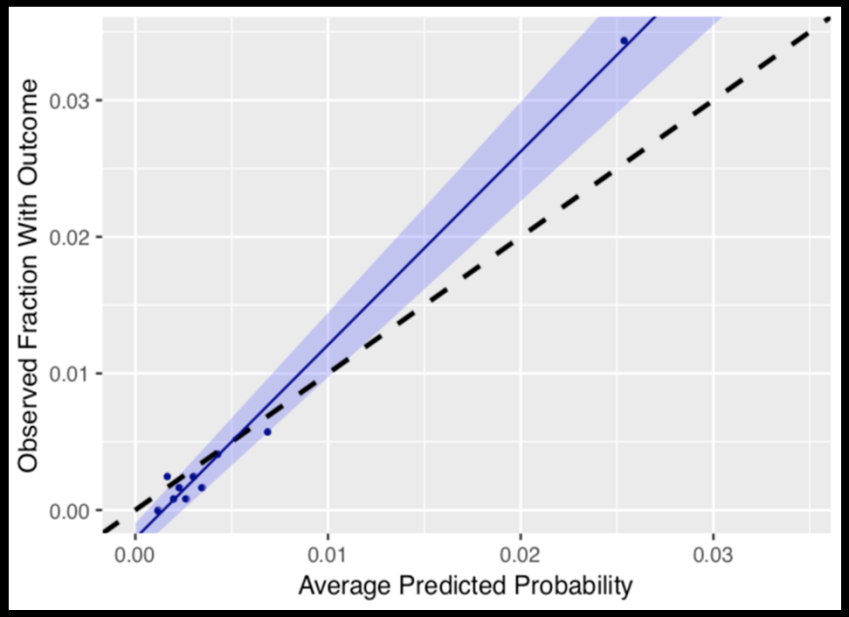
AUCs across outcomes go from ~70% to 80-85% when day=[0,1] procedures are added.

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

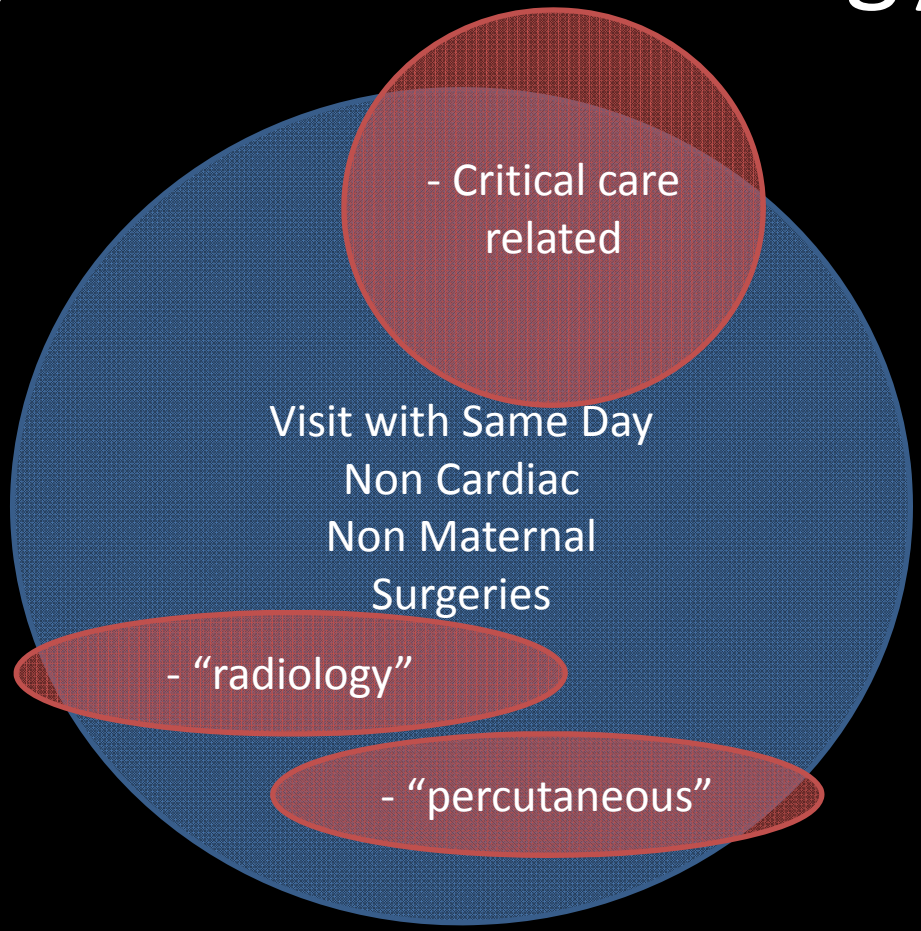
Possibility: Code by code warfare in the CPT to identify real surgeries

- Should run a predictive model on whether this will give you RSI

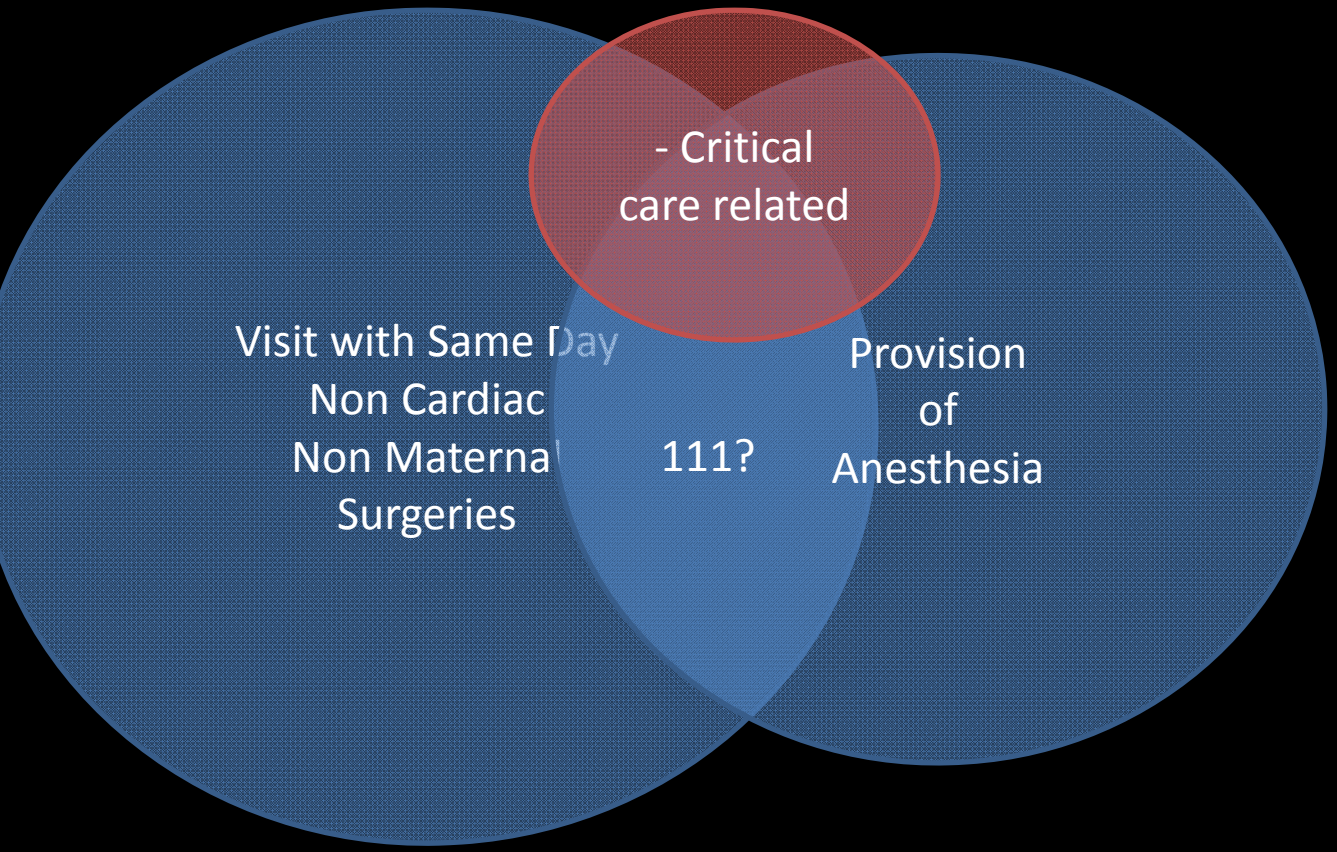
Possibility: use a subset of high risk surgeries

- E.g. Lee ‘High Risk’ Surgery
- ~451 cases, 5 events

# Target Cohorts: Strategy 2

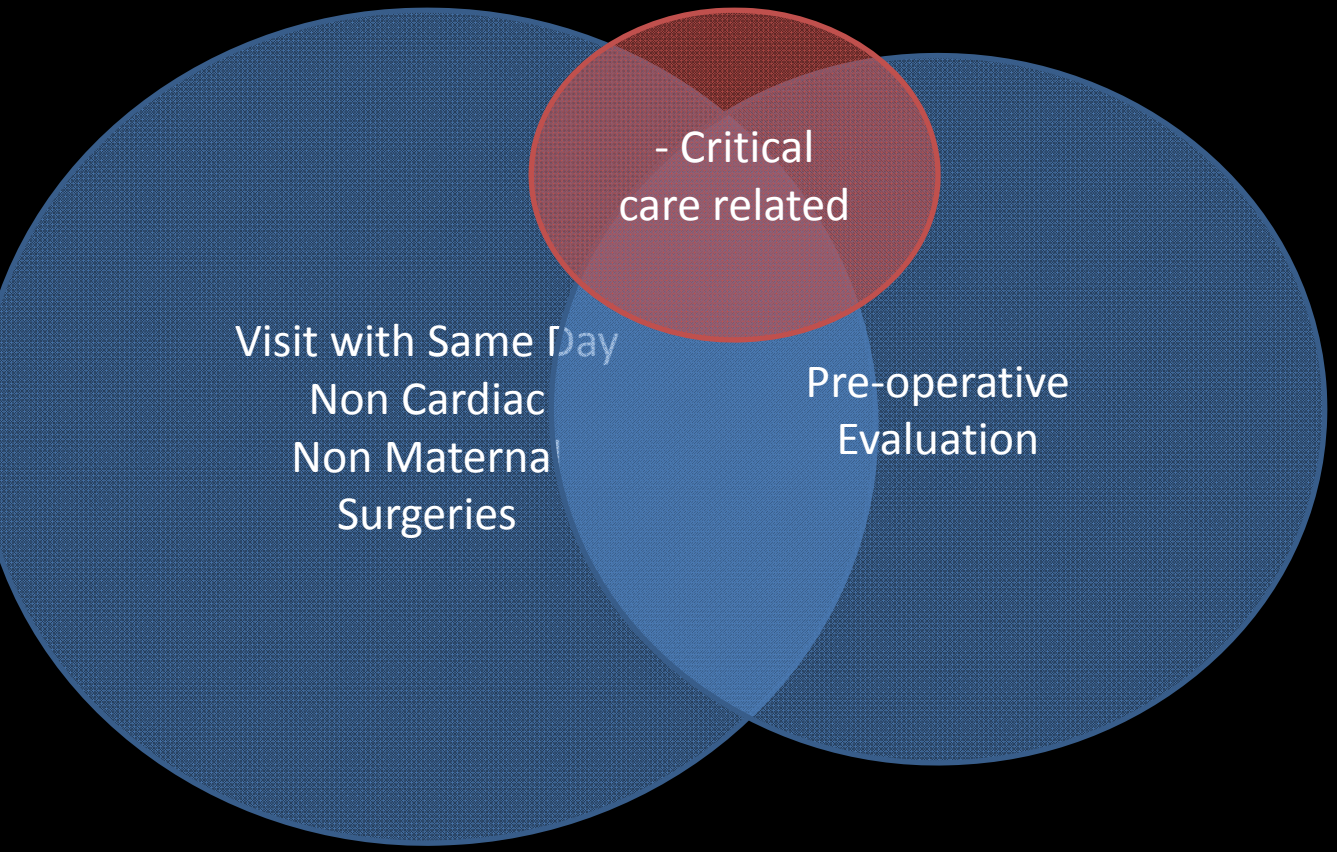


# Target Cohorts: Strategy 3




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

# Target Cohorts: Strategy 4




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

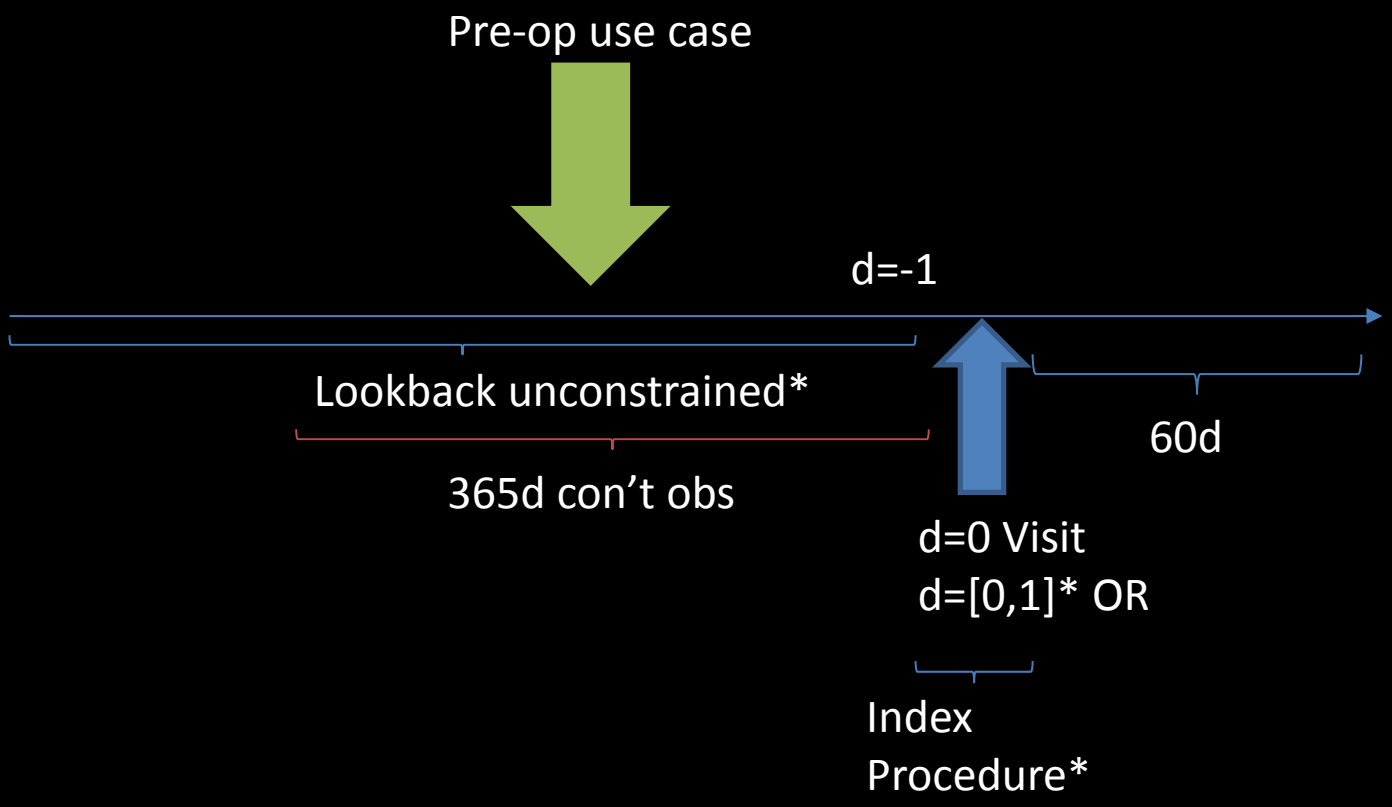
‘Post op infection’

- New infection (any)

New Sepsis

Delirium

# Preoperative use case: is it feasible?

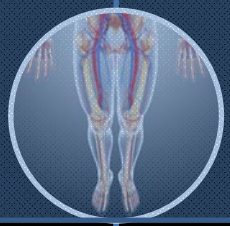


# Model Use cases and Approaches

| odelling consideration | Preoperative | Perioperative |
|---|---|---|
| y 0-1* surgeries | Desire index procedure, or a 'reasonable' aggregate feature | Include |
| her Day 0-1* procedures | Exclude | Include |
| nit to Day 0-1* Surgery | Implement | Include* |
| clude other hospital variates | Exclude | … do we need to exclude? |
| evisit Washout | Implement? | Implement?* |
| tcome washout | Implement | Not needed |

# Modelling the index procedure

Surgical Procedures on the Cardiovascular System

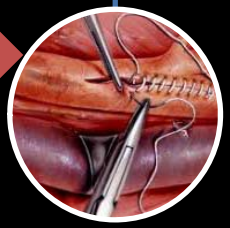


Surgical Procedures on Arteries and Veins

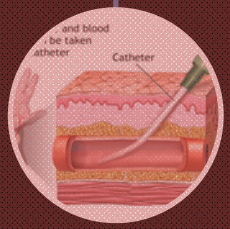
Surgical Procedures on the Heart and Pericardium


@$%!

Endarterectomy



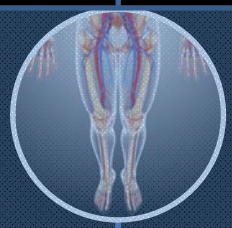
Repair, excision, Revision Arteries and Veins




Arterial Procedures / Arterial Catheterization for sampling, monitoring...

# Does this have the makings of a more broadly useful modelling process?

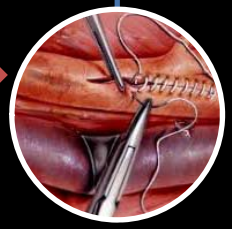
Surgical Procedures on the Cardiovascular System



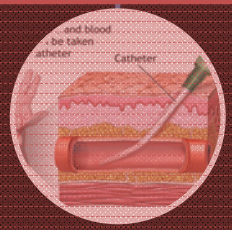
Surgical Procedures on Arteries and Veins

Surgical Procedures on the Heart and Pericardium


@$%!
Endarterectomy



Repair, excision, Revision Arteries and Veins



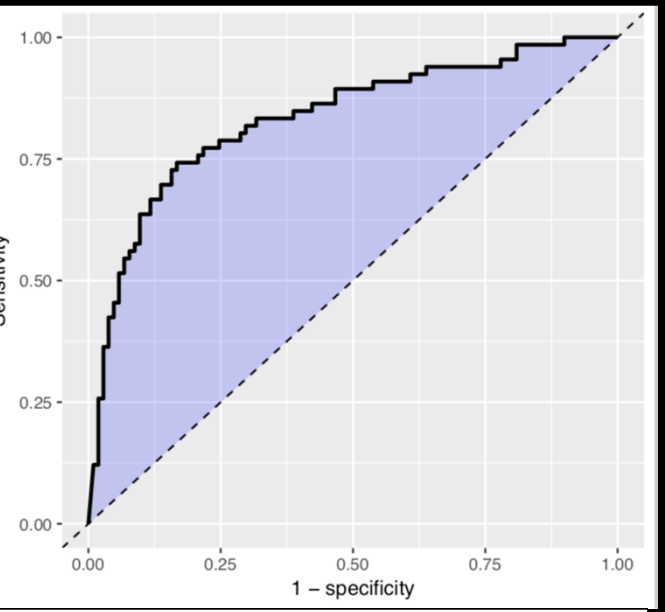

Arterial Procedures / Arterial Catheterization for sampling, monitoring...

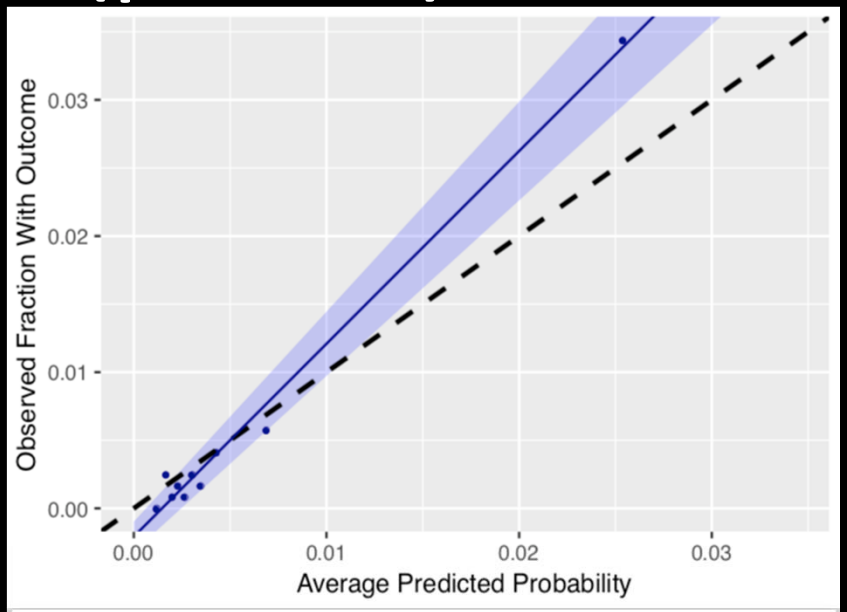
# Thank you!

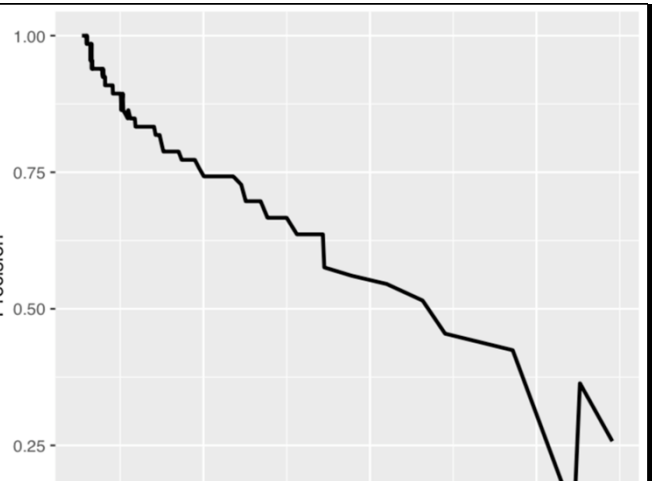
eminty@stanford.edu

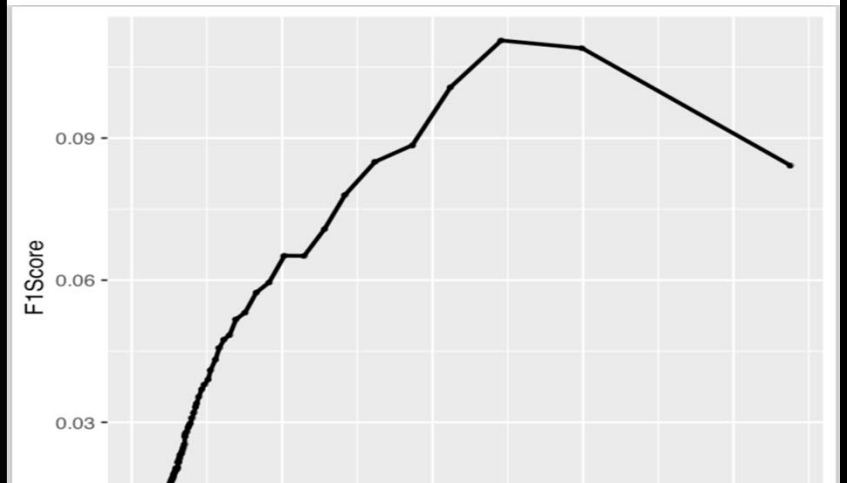
# Extra Slides

# Results (prelim)

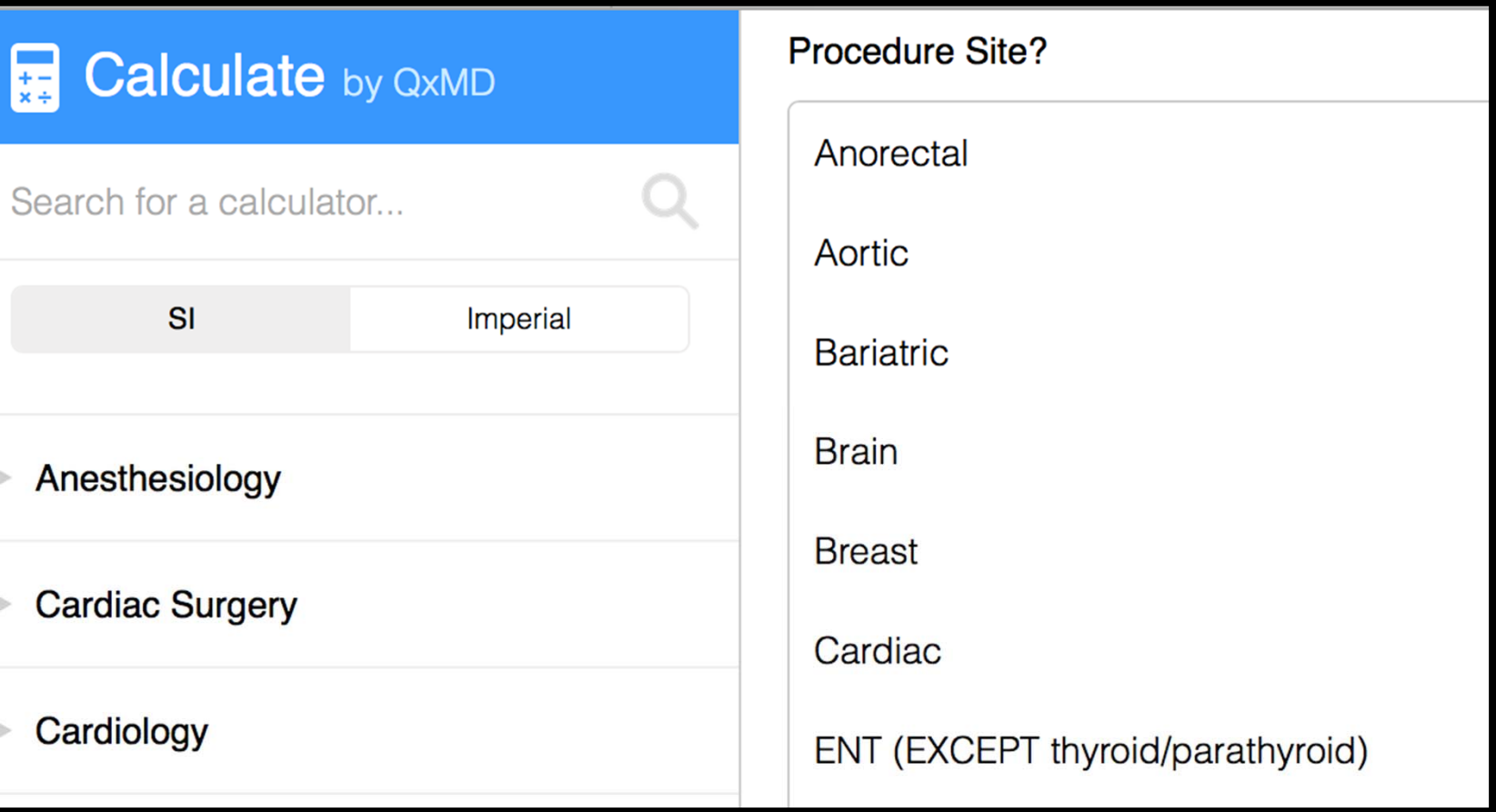


# Custom Aggregating Ontology?



# 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