

# HDR Phenomics - Midlands Update

11/03/2021 | Laura Bravo & George Gkoutos



# Birmingham Phenomics Update

Phenotype Library

ABOUT PHENOTYPES COLLECTIONS SEARCH

Phenomics Portal

Multiple morbidities

Anaphylaxis

Phenotype Library

ABOUT PHENOTYPES COLLECTIONS SEARCH

Metadata

Metadata

Name

Type

Group

Data Sources

Clinical Terminology

Codelists

Valid Event Data

Sex

Authors

Agreement Date

Version (UUID)

Read code

SN50.00

SN50.11

SN50000

SN50100

SN59300

SN59400

14M5.00

ZV1B300

SP24.00

Primary care

Secondary care

Secondary care

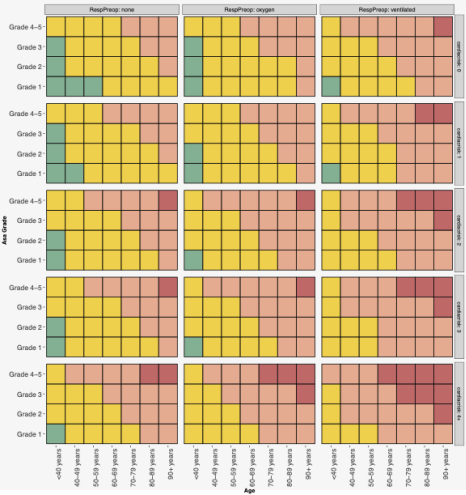
Diagnoses

ICD10code	ICD10codeDescr
T78.0	Anaphylactic shock due to adverse food reaction
T78.1	Other adverse food reactions, not elsewhere classified
T78.2	Anaphylactic shock, unspecified
T80.5	Anaphylactic shock due to serum
T88.6	Anaphylactic shock due to adverse effect of correct drug or medicament properly administered

BACK

-	11.88%	1.56%	7.69%	4.14%	5.03%	-1.78%	5.61%	7.98%	2.45%
-5.04%		-0.76%	6.92%	2.06%	3.22%	-2.65%	4.25%	7.01%	0.46%
0.61%	13.41%		8.71%	2.99%	5.59%	-1.72%	8.33%	8.21%	2.95%
-5.83%	3.22%	-4.75%		-0.66%	2.63%	-4.41%	5.02%	16.14%	-2.21%
3.32%	9.59%	-1.87%	11.64%		8.19%	-3.14%	10.56%	14.17%	3.26%
6.38%	8.36%	2.03%	16.34%	5.76%		-6.06%	11.59%	17.23%	-2.19%
-5.93%	5.20%	-1.22%	3.39%	-0.15%	1.11%		2.11%	3.85%	-4.67%
-4.57%	6.03%	-14.87%	13.89%	-3.21%	8.88%	-4.66%		15.73%	-0.70%
-0.51%	1.42%	-3.97%	8.89%	6.10%	3.78%	-6.71%	8.29%		-2.76%
-2.11%	5.15%	-1.83%	6.52%	3.52%	-0.71%	-23.86%	5.18%	9.61%	
-2.85%	4.68%	-3.97%	5.24%	2.35%	3.11%	-4.09%	6.36%	16.89%	-0.67%
8.25%	10.14%	4.00%	8.97%	5.97%	6.35%	-1.63%	7.49%	9.84%	2.13%
8.53%	8.02%	3.64%	6.49%	4.76%	4.54%	-0.11%	5.25%	7.23%	4.23%
7.17%	8.37%	3.16%	6.45%	3.20%	4.52%	1.53%	4.05%	6.44%	3.47%
7.33%	12.38%	3.32%	9.67%	5.87%	6.55%	-1.30%	7.88%	10.85%	1.10%
-3.65%	17.27%	0.51%	6.66%	1.50%	4.15%	-2.15%	6.79%	3.81%	2.82%
11.54%	8.99%	4.91%	11.10%	6.77%	6.75%	-0.94%	6.67%	10.89%	4.11%
-7.34%	6.30%	-8.21%	9.38%	-8.84%	4.08%	-4.53%	7.14%	12.54%	0.64%

CovidSurg



# Structured Data: Primary , Secondary and UK BioBank Data

Secondary

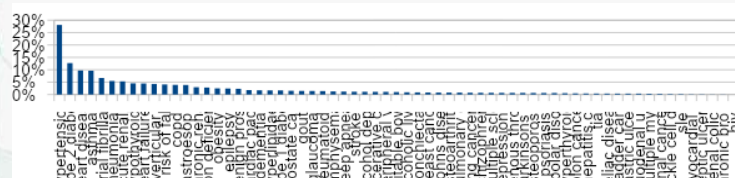
Associations

	hyperte	type 2 diabete s mellitu	heart	acute renal fail	atrial fibrillati	pneum	heart	at risk	chronic renal	hypoth yroidis	divertic ular	gastroe sophag eal	iron deficien cy anaemi	benign prostat ic hyperpl	cardiac pacema	dement	emphys	hyper lipida	epileps
hypertension																			
type 2 diabetes																			
heart disease																			
acute renal fail																			
atrial fibrillation																			
pneumonia																			
asthma																			
heart failure																			
at risk of falls																			
copd																			
chronic renal fail																			
hypothyroidism																			
diverticular disease																			
gastroesophageal reflux																			
iron deficiency																			
obesity																			
benign prostatic hyperplasia																			
cardiac pacemaker																			
dementia																			
emphysema																			
hyperlipidaemia																			
epilepsy																			

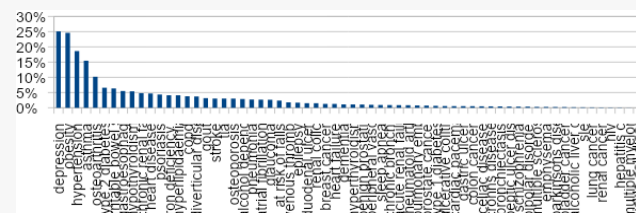
Primary

UK BioBank

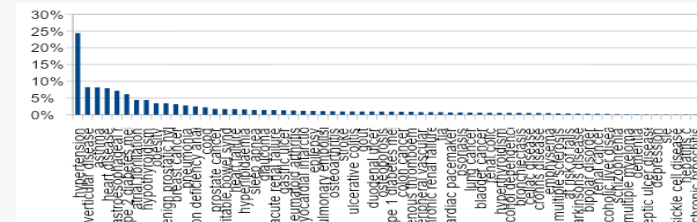
Occurrences



Secondary



Primary



UK BioBank



# Differences in multi-morbidity associations

## Secondary vs UK Biobank

	hyperten sion	type 2 diabetes mellitus	heart disease	acute renal failure	atrial fibrillati on	pneumo nia	asthma	heart failure	at risk of falls	copd	chronic renal failure	hypothy roidism	diverticu lar disease	gastroes ophagea l reflux	iron deficien cy anaemia	obesity	benign prostatic hyperpla sia	cardiac pacemak er	dementi a	emphyse ma	depressi on
hypertension	-	11.9%	1.6%	7.7%	4.1%	5.0%	-1.8%	5.6%	8.0%	2.4%	5.3%	0.5%	-6.1%	-5.1%	0.7%	-3.6%	-1.8%	1.9%	3.2%	1.1%	0.5%
type 2 diabetes mellitus	-5.0%	-	-0.8%	6.9%	2.1%	3.2%	-2.6%	4.2%	7.0%	0.5%	4.8%	-0.7%	-8.0%	-5.8%	-0.6%	-6.6%	-3.2%	1.5%	2.9%	0.6%	0.4%
heart disease	0.6%	13.4%	-	8.7%	3.0%	5.6%	-1.7%	8.3%	8.2%	2.9%	6.7%	0.7%	-6.1%	-5.7%	0.6%	-3.9%	-2.4%	3.5%	3.5%	1.6%	0.3%
acute renal failure	-5.8%	3.2%	-4.8%	-	-0.7%	2.6%	-4.4%	5.0%	16.1%	-2.2%	2.6%	0.7%	-8.6%	-5.9%	-2.7%	-8.6%	-3.3%	1.5%	7.5%	0.4%	0.5%
atrial fibrillation	3.3%	9.6%	-1.9%	11.6%	-	8.2%	-3.1%	10.6%	14.2%	3.3%	7.6%	1.5%	-5.6%	-4.7%	1.2%	-4.3%	-2.4%	3.1%	5.8%	1.6%	0.4%
pneumonia	6.4%	8.4%	2.0%	16.3%	5.8%	-	-6.1%	11.6%	17.2%	-2.2%	7.3%	1.4%	-6.5%	-6.2%	0.3%	-3.7%	-1.6%	2.3%	7.9%	2.1%	0.8%
asthma	-5.9%	5.2%	-1.2%	3.4%	-0.2%	1.1%	-	2.1%	3.9%	-4.7%	2.2%	-1.8%	-7.3%	-6.7%	-0.6%	-3.8%	-2.0%	0.7%	1.3%	-0.1%	1.1%
heart failure	-4.6%	6.0%	-14.9%	13.9%	-3.2%	8.9%	-4.7%	-	15.7%	-0.7%	9.0%	1.9%	-6.4%	-5.9%	-0.1%	-6.9%	-2.9%	2.7%	6.0%	1.3%	0.5%
at risk of falls	-0.5%	1.4%	-4.0%	8.9%	6.1%	3.8%	-6.7%	8.3%	-	-2.8%	6.8%	0.5%	-8.6%	-7.2%	-1.9%	-7.6%	-3.3%	2.5%	10.3%	0.5%	0.1%
copd	-2.1%	5.2%	-1.8%	6.5%	3.5%	-0.7%	-23.9%	5.2%	9.6%	-	4.7%	-1.4%	-9.1%	-8.8%	-1.9%	-5.3%	-2.8%	1.8%	3.2%	-0.6%	0.6%
chronic renal failure	-2.9%	4.7%	-4.0%	5.2%	2.4%	3.1%	-4.1%	6.4%	16.9%	-0.7%	-	0.0%	-7.9%	-7.4%	-4.7%	-8.1%	-3.9%	1.8%	8.0%	0.2%	0.2%
hypothyroidism	8.2%	10.1%	4.0%	9.0%	6.0%	6.3%	-1.6%	7.5%	9.8%	2.1%	6.1%	-	-5.2%	-5.5%	-0.1%	-3.1%	-0.4%	2.2%	4.2%	1.0%	1.0%
diverticular disease	8.5%	8.0%	3.6%	6.5%	4.8%	4.5%	-0.1%	5.3%	7.2%	4.2%	5.0%	1.1%	-	-4.7%	3.2%	-2.8%	-1.0%	2.0%	2.7%	2.1%	0.6%
gastroesophageal reflux	7.2%	8.4%	3.2%	6.5%	3.2%	4.5%	1.5%	4.0%	6.4%	3.5%	4.0%	0.2%	-5.7%	-	1.2%	-2.0%	-1.4%	1.1%	1.9%	2.1%	1.4%
iron deficiency anaemia	7.3%	12.4%	3.3%	9.7%	5.9%	6.5%	-1.3%	7.9%	10.8%	1.1%	5.5%	-1.1%	-6.7%	-6.9%	-	-3.6%	-0.6%	2.4%	3.9%	1.1%	0.5%
obesity	-3.6%	17.3%	0.5%	6.7%	1.5%	4.2%	-2.1%	6.8%	3.8%	2.8%	4.9%	-1.2%	-8.9%	-7.1%	-0.7%	-	-2.3%	0.6%	0.7%	0.6%	1.3%
benign prostatic hyperplasia	11.5%	9.0%	4.9%	11.1%	6.8%	6.8%	-0.9%	6.7%	10.9%	4.1%	7.2%	0.9%	-5.0%	-4.5%	1.5%	-2.1%	-	3.8%	4.4%	2.5%	0.1%
cardiac pacemaker	-7.3%	6.3%	-8.2%	9.4%	-8.8%	4.1%	-4.5%	7.1%	12.5%	0.6%	6.8%	-0.8%	-6.5%	-7.2%	0.0%	-7.4%	-3.0%	-	5.1%	0.8%	0.1%
dementia	2.0%	3.4%	-3.6%	14.0%	8.0%	10.9%	-4.9%	7.5%	23.2%	0.3%	9.9%	2.2%	-5.5%	-8.4%	-1.8%	-3.7%	-5.7%	1.9%	-	0.1%	-0.1%
emphysema	-2.6%	3.8%	-1.4%	6.9%	1.8%	2.6%	-14.5%	5.3%	10.1%	-17.0%	2.9%	-0.5%	-7.4%	-6.2%	-1.7%	-4.7%	-2.1%	1.3%	2.6%	-	1.3%
depression	-10.9%	-0.7%	-8.1%	2.0%	-0.4%	1.6%	1.8%	1.4%	5.1%	-2.9%	0.0%	-3.5%	-8.0%	-5.9%	-4.4%	-5.0%	-3.8%	-0.9%	1.2%	1.5%	-

## Secondary vs Primary (THIN)

	hyperten sion	type 2 diabetes mellitus	heart disease	acute renal failure	atrial fibrillati on	pneumo nia	asthma	heart failure	at risk of falls	copd	chronic renal failure	hypothy roidism	diverticu lar disease	gastroe sophag eal reflux	iron deficien cy anaemia	obesity	benign prostat ic hyperpl asia	cardiac pacemak er	dement ia	emphys ema	depressi on
hypertension	-	8.16%	9.56%	8.88%	6.09%	6.19%	-3.54%	6.51%	3.04%	-0.94%	-10.74%	-2.52%	-2.69%	-3.00%	-1.75%	-39.56%	1.93%	2.12%	0.19%	1.61%	-27.76%
type 2 diabetes mellitus	4.78%	-	7.13%	10.32%	4.35%	5.99%	-4.40%	6.27%	2.47%	-1.79%	-10.23%	-3.62%	-3.74%	-3.99%	-1.29%	-49.34%	0.97%	2.15%	-0.14%	1.23%	-32.05%
heart disease	12.38%	7.49%	-	10.90%	5.44%	6.46%	-5.27%	7.08%	1.79%	-3.33%	-15.11%	-4.07%	-7.16%	-5.26%	-3.23%	-33.54%	0.73%	3.71%	-1.38%	2.05%	-30.53%
acute renal failure	3.58%	7.33%	8.33%	-	12.58%	23.71%	-5.50%	17.87%	13.63%	-1.29%	-7.62%	-2.36%	-1.58%	-1.97%	0.77%	-29.89%	3.90%	4.01%	3.86%	3.25%	-33.56%
atrial fibrillation	1.27%	3.16%	3.09%	15.76%	-	12.19%	-5.85%	7.56%	5.78%	-2.26%	-17.08%	-3.74%	-7.16%	-4.07%	-2.31%	-32.99%	1.09%	2.13%	0.03%	2.40%	-24.72%
pneumonia	24.49%	13.40%	11.77%	28.52%	16.79%	-	-13.65%	19.27%	14.72%	-1.12%	2.18%	1.04%	-0.38%	-1.55%	0.46%	-24.70%	2.71%	3.77%	5.63%	6.10%	-32.73%
asthma	15.64%	9.45%	6.43%	5.10%	4.19%	3.09%	-	4.06%	1.70%	-5.55%	-1.11%	0.27%	1.17%	-0.78%	-0.95%	-24.99%	1.12%	1.34%	0.54%	0.77%	-30.80%
heart failure	7.34%	4.55%	-6.39%	25.92%	-0.73%	19.06%	-6.29%	-	7.82%	-5.03%	-19.31%	-2.54%	-7.21%	-4.22%	-3.29%	-34.92%	0.33%	4.66%	1.07%	3.24%	-28.03%
at risk of falls	15.38%	9.84%	7.43%	25.16%	14.80%	20.98%	-8.52%	14.56%	-	0.67%	-5.63%	-0.97%	-4.86%	-3.58%	-1.23%	-30.02%	3.66%	3.99%	6.07%	3.18%	-37.59%
copd	13.30%	8.56%	10.42%	11.93%	9.74%	8.15%	-31.83%	10.26%	5.28%	-	-5.57%	-2.12%	-2.04%	-2.12%	-1.54%	-27.97%	2.32%	2.93%	0.38%	4.30%	-38.61%
chronic renal failure	2.33%	13.76%	9.77%	37.58%	11.08%	18.77%	-3.45%	20.53%	10.79%	0.53%	-	-4.13%	-5.25%	-3.34%	-1.10%	-32.03%	3.85%	5.67%	2.19%	2.41%	-28.05%
hypothyroidism	13.67%	8.05%	6.45%	9.99%	7.47%	7.22%	-3.87%	7.82%	5.15%	-0.17%	-6.67%	-	-1.57%	-2.88%	-4.18%	-34.25%	1.30%	2.45%	1.45%	1.44%	-35.93%
diverticular disease	-1.93%	0.92%	-1.72%	7.12%	1.26%	3.66%	-5.96%	3.04%	-0.44%	-3.20%	-12.61%	-5.24%	-	-6.32%	-1.45%	-34.33%	0.37%	0.90%	-1.62%	2.18%	-34.20%
gastroesophageal reflux	14.32%	6.74%	6.76%	7.56%	4.86%	5.46%	-4.31%	4.50%	2.73%	1.43%	-3.67%	-1.61%	-0.67%	-	-0.47%	-29.12%	1.49%	1.31%	0.35%	2.65%	-35.84%
iron deficiency anaemia	19.07%	17.55%	9.53%	14.35%	9.31%	9.99%	-5.01%	10.17%	6.80%	1.26%	-2.42%	-3.86%	4.58%	-0.44%	-	-26.08%	2.52%	3.15%	1.75%	2.07%	-37.48%
obesity	24.81%	29.30%	15.96%	11.32%	9.29%	8.06%	-0.76%	11.87%	1.83%	5.41%	0.72%	0.71%	-0.13%	0.56%	0.10%	-	1.55%	2.16%	-0.15%	1.51%	-31.41%
benign prostatic hyperplasia	8.67%	3.34%	2.19%	12.97%	5.22%	5.98%	-5.67%	4.58%	4.98%	-2.44%	-7.45%	-0.16%	-6.21%	-5.86%	-0.57%	-28.17%	-	2.82%	0.90%	2.95%	-22.86%
cardiac pacemaker	2.11%	5.30%	5.69%	15.59%	-2.64%	8.40%	-6.04%	12.97%	3.46%	-2.59%	-18.43%	-4.62%	-8.12%	-5.31%	-1.84%	-29.23%	1.49%	-	-1.46%	1.58%	-26.90%
dementia	2.51%	4.58%	0.15%	24.19%	9.78%	20.51%	-4.88%	11.53%	17.30%	-2.88%	-14.13%	-2.91%	-7.77%	-4.03%	-2.55%	-21.53%	2.83%	2.82%	-	1.60%	-34.08%
emphysema	11.83%	4.83%	4.28%	14.56%	8.51%	18.21%	-27.17%	10.03%	6.64%	-53.50%	-6.53%	-1.64%	-3.12%	-2.01%	-2.20%	-22.69%	3.71%	1.77%	0.16%	-	-39.41%
depression	8.74%	5.78%	3.38%	7.39%	3.74%	5.90%	-0.49%	3.46%	5.69%	1.14%	-1.86%	1.69%	0.00%	1.77%	-2.54%	-26.06%	0.08%	0.84%	0.85%	2.93%	-



NIHR Global Health Research Unit on  
**Global Surgery**



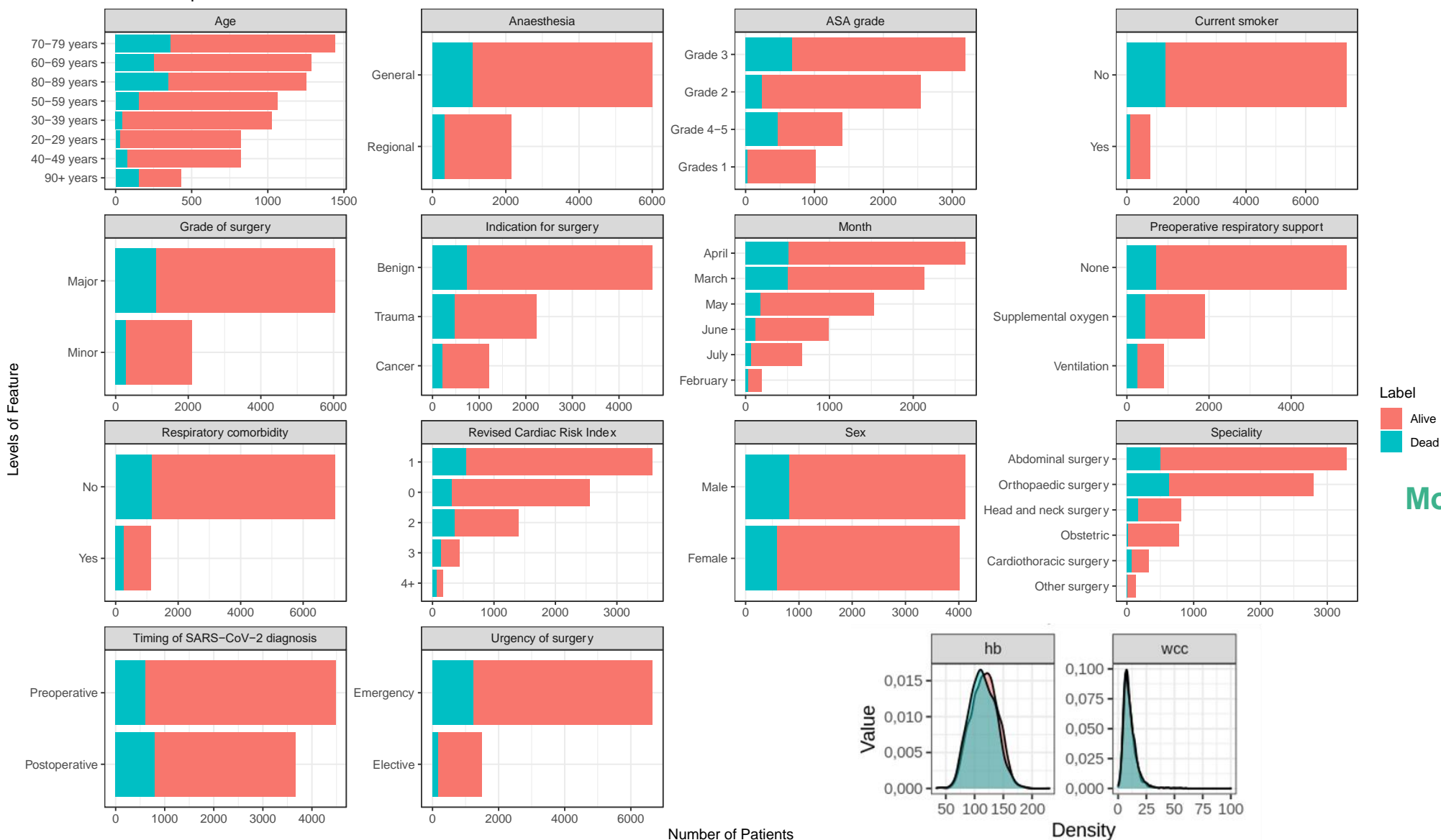
**HDRUK**  
Health Data Research UK

- **CovidSurg**: 122 countries, 1677 centres
- ~10,000 patients from all over the world (Feb-July)
- Surgery
- Had covid

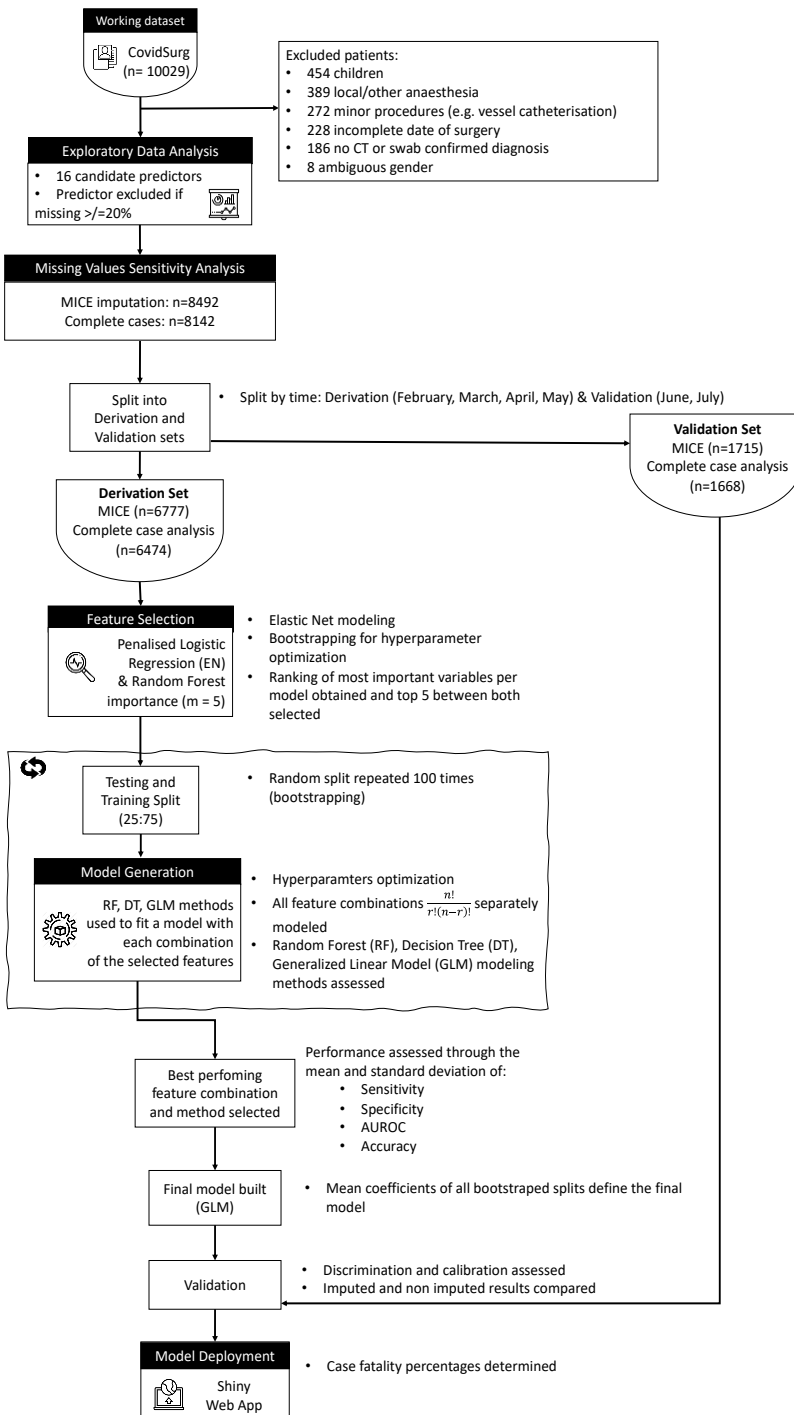
**Understand** which patients are at higher risk of dying to then **guide** the scheduling of surgeries.

**Objective: to build a prognostic model for mortality after 30 days of COVID-19 patients undergoing surgery.**

## Relationship of Variables and Outcome



Mortality: ~17%



## Prediction models for covid-19 outcomes

Reasons to be cautious

Matthew Sperrin,<sup>1</sup> Brian McMillan<sup>2</sup>

EDA +  
Preprocessing

Feature  
Selection

Derivation and Validation Split

- Based on time
- Derivation: training/testing (75/25)

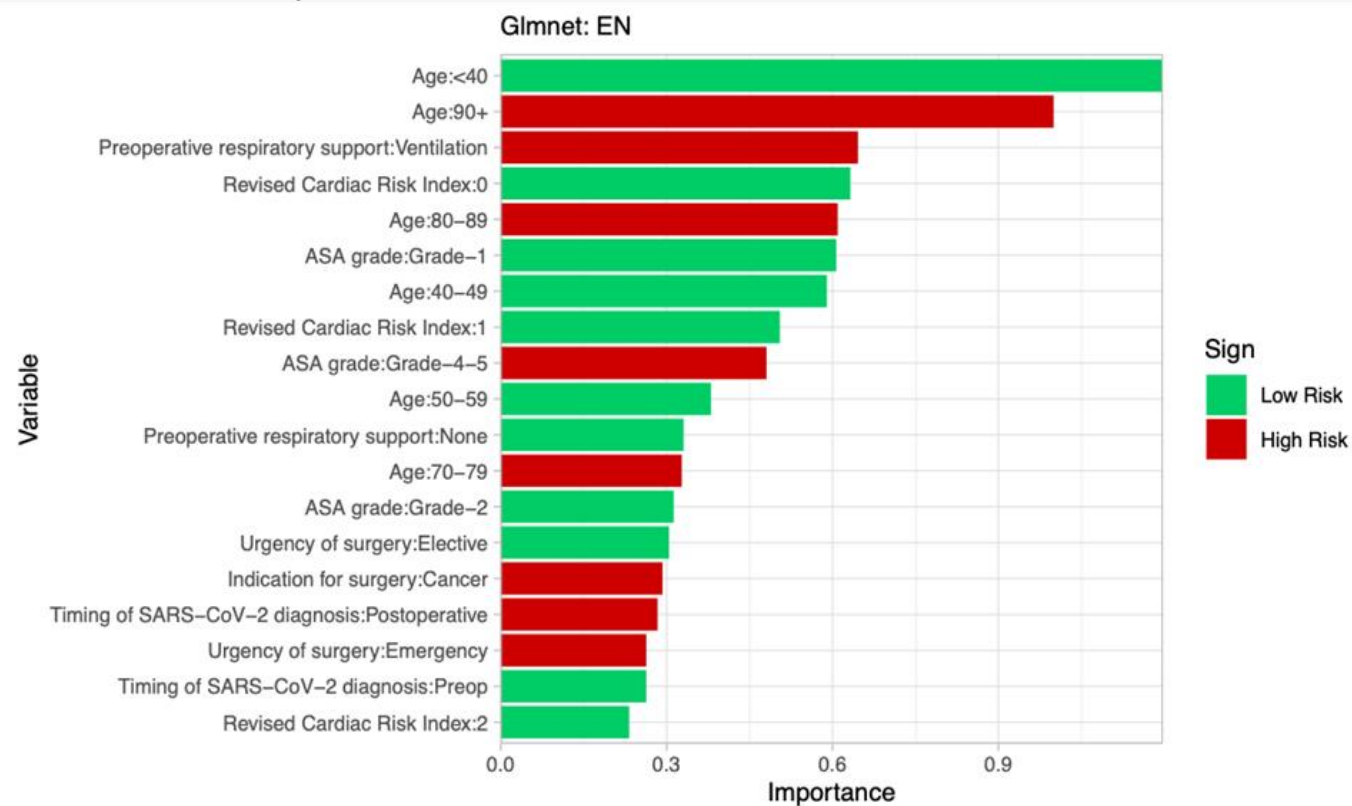
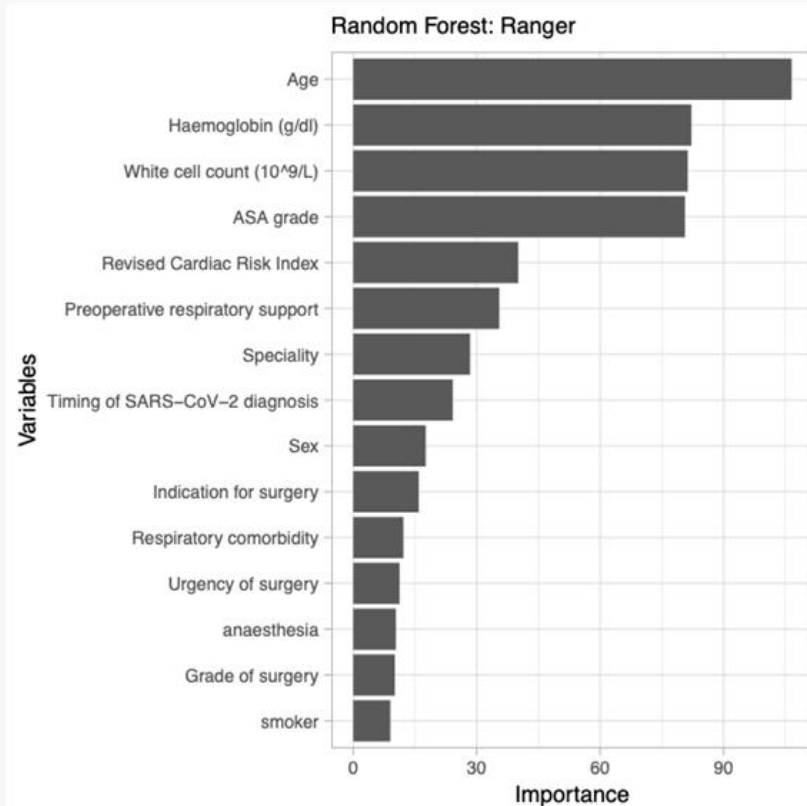
Decision Trees, Logistic Regression,  
Random Forest

Model  
Selection

Deployment



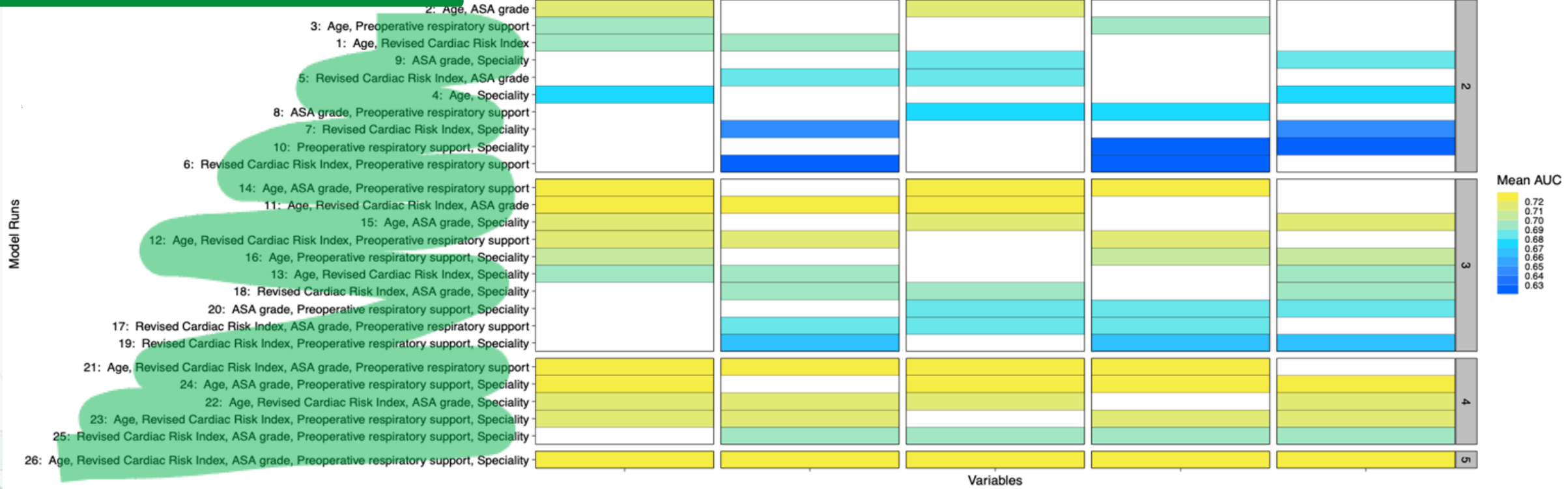
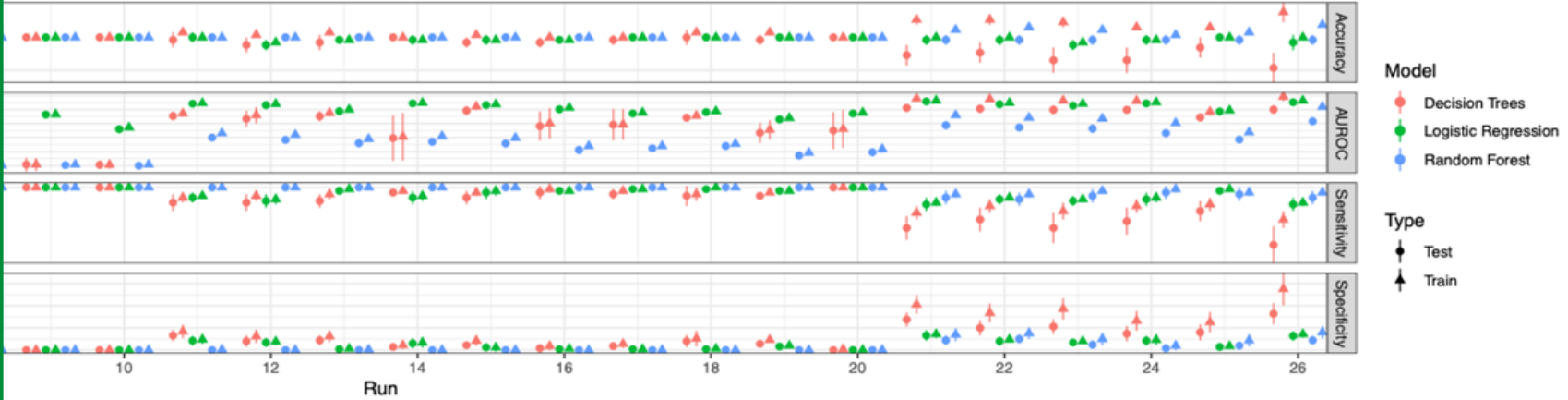
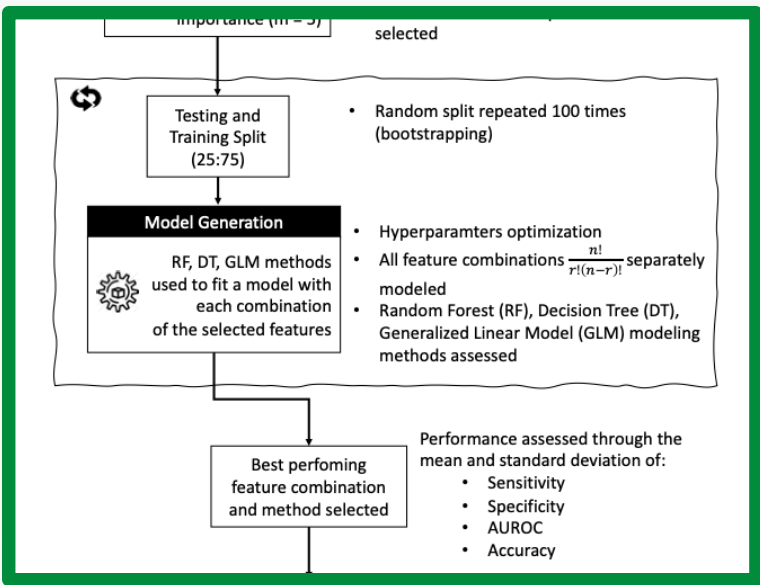
## Variable Importance



## Feature Ranking

Variable Name	Top rank in model	Freq of appearance
Age	1-LASSOEN	8
Revised Cardiac Risk Index	4-LASSOEN	3
ASA grade	4-RF	3
Preoperative respiratory support	3-LASSOEN	2
Speciality	7-RF	2
Haemoglobin (g/dl)	2-RF	1
White cell count (10 <sup>9</sup> /L)	3-RF	1





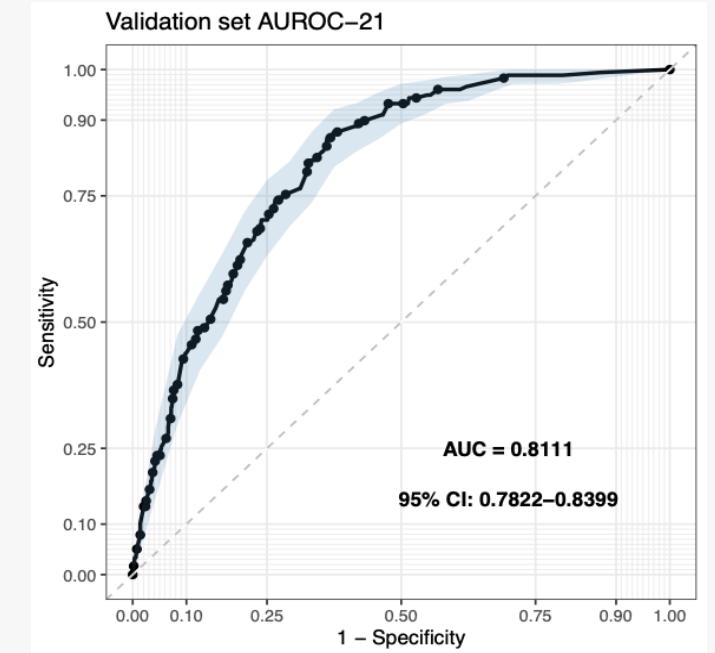
# Model Selection

Model	Run	Mean AUC	Standard Deviation	Names	Number of Variables
Logistic Regression	21	0.729	0.012	Age, Revised Cardiac Risk Index, ASA grade, Preoperative respiratory support	4
Logistic Regression	26	0.726	0.012	Age, Revised Cardiac Risk Index, ASA grade, Preoperative respiratory support, Speciality	5
Logistic Regression	14	0.722	0.011	Age, ASA grade, Preoperative respiratory support	3
Logistic Regression	24	0.722	0.012	Age, ASA grade, Preoperative respiratory support, Speciality	4
Logistic Regression	11	0.721	0.012	Age, Revised Cardiac Risk Index, ASA grade	3
Logistic Regression	22	0.719	0.012	Age, Revised Cardiac Risk Index, ASA grade, Speciality	4
Logistic Regression	2	0.718	0.012	Age, ASA grade	2
Logistic Regression	15	0.716	0.012	Age, ASA grade, Speciality	3
Logistic Regression	12	0.716	0.013	Age, Revised Cardiac Risk Index, Preoperative respiratory support	3
Logistic Regression	23	0.714	0.012	Age, Revised Cardiac Risk Index, Preoperative respiratory support, Speciality	4
Decision Trees	21	0.706	0.012	Age, Revised Cardiac Risk Index, ASA grade, Preoperative respiratory support	4
Decision Trees	22	0.703	0.014	Age, Revised Cardiac Risk Index, ASA grade, Speciality	4

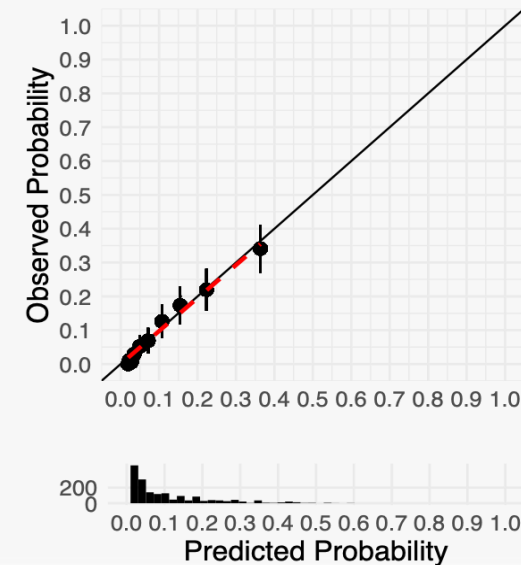
Variables	Mean	Standard Deviation	Odds
(Intercept)	-3.918	0.1094	0.0199
Age:40-49 years	0.695	0.1077	2.0030
Age:50-59 years	0.903	0.0930	2.4679
Age:60-69 years	1.336	0.0959	3.8045
Age:70-79 years	1.648	0.0911	5.1984
Age:80-89 years	1.894	0.0912	6.6488
Age:90+ years	2.247	0.1033	9.4638
ASA grade: Grade 2	0.316	0.1123	1.3719
ASA grade: Grade 3	0.692	0.1089	1.9972
ASA grade: Grade 4-5	1.211	0.1110	3.3582
Revised Cardiac Risk Index1	0.148	0.0503	1.1595
Revised Cardiac Risk Index2	0.456	0.0584	1.5785
Revised Cardiac Risk Index3	0.513	0.0769	1.6706
Revised Cardiac Risk Index4+	0.720	0.1116	2.0545
Preoperative respiratory support: oxygen	0.276	0.0472	1.3172
Preoperative respiratory support: ventilated	0.741	0.0634	2.0987

## Performance evaluation

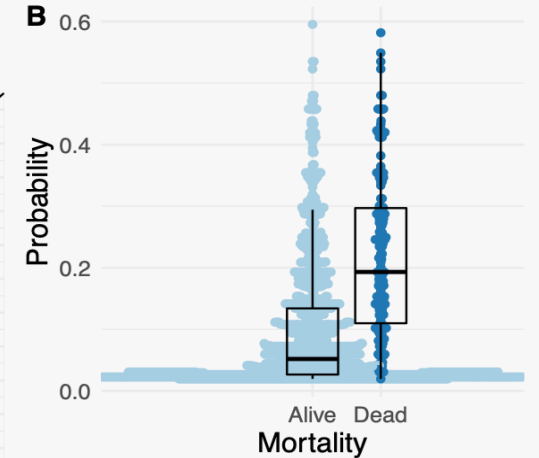
- Discrimination
- Calibration



A



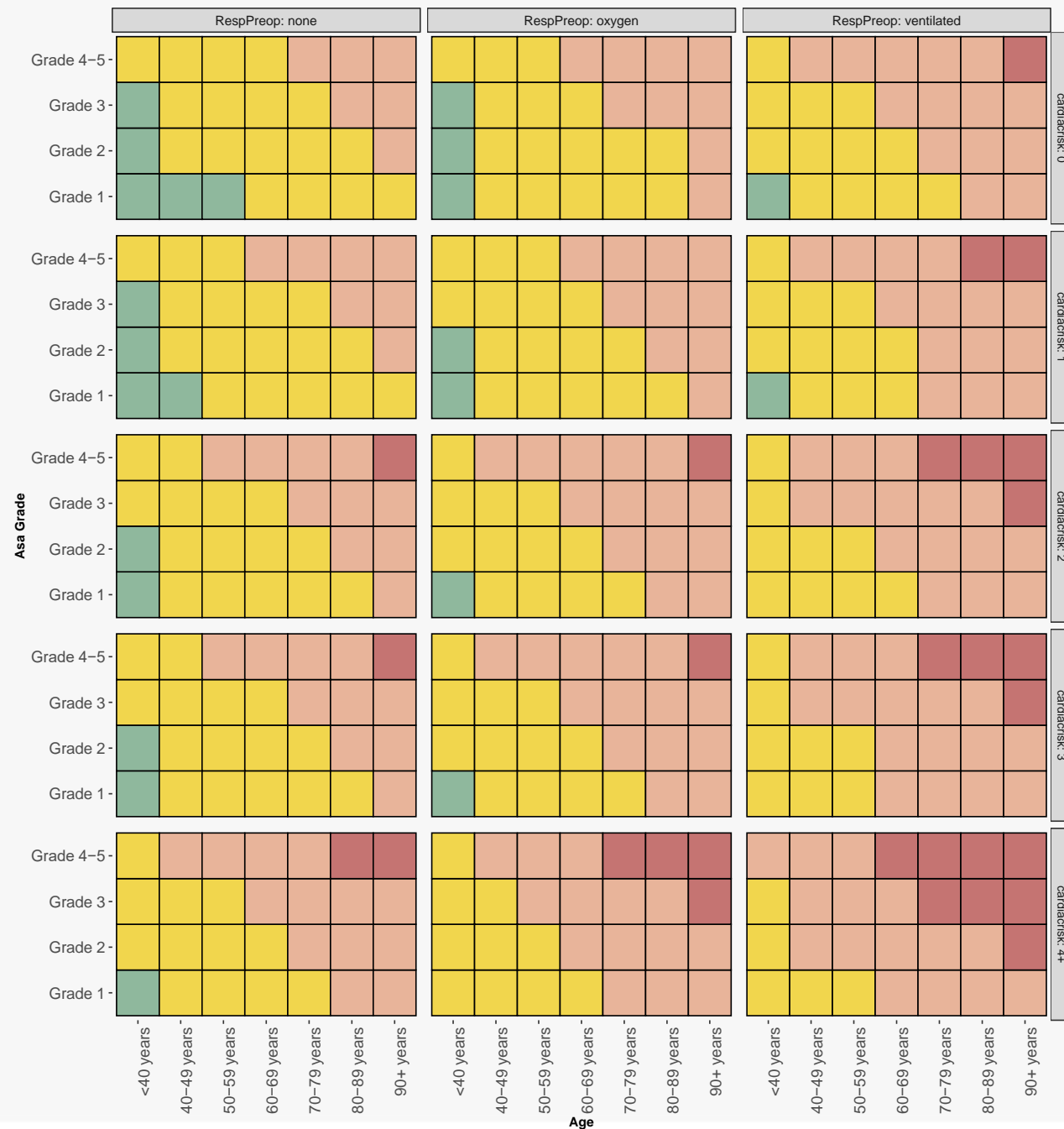
B



C

Set	Brier	Intercept	Slope
Validation	0.08	0.099	1.1
Derivation	0.14	0.003	1.0

## Model Selection



<https://covid-surgrisk.app>



Please maximise the screen for optimal visualization.

To predict

Preop. Respiratory Support:

none

Age:

<40 years

\*ASA grade:

Grade 1

\*\*Revised Cardiac Risk Index:

0

- \*ASA Grade:
- Healthy person
  - Mild systemic disease
  - Severe systemic disease
  - Severe systemic disease that is a constant threat to life
  - A moribund person who is not expected to survive without the operation.
- \*\*Revised Cardiac Risk Index - Total sum of the following risk factors:
- History of ischemic heart disease (+1)
  - History of congestive heart failure (+1)
  - History of cerebrovascular disease (stroke or transient ischemic attack) (+1)
  - History of diabetes requiring preoperative insulin use (+1)
  - Chronic kidney disease [creatinine > 2 mg/dL (176.8 μmol/L)] (+1)
  - Undergoing suprainguinal vascular, intraperitoneal, or intrathoracic surgery (+1)

About us

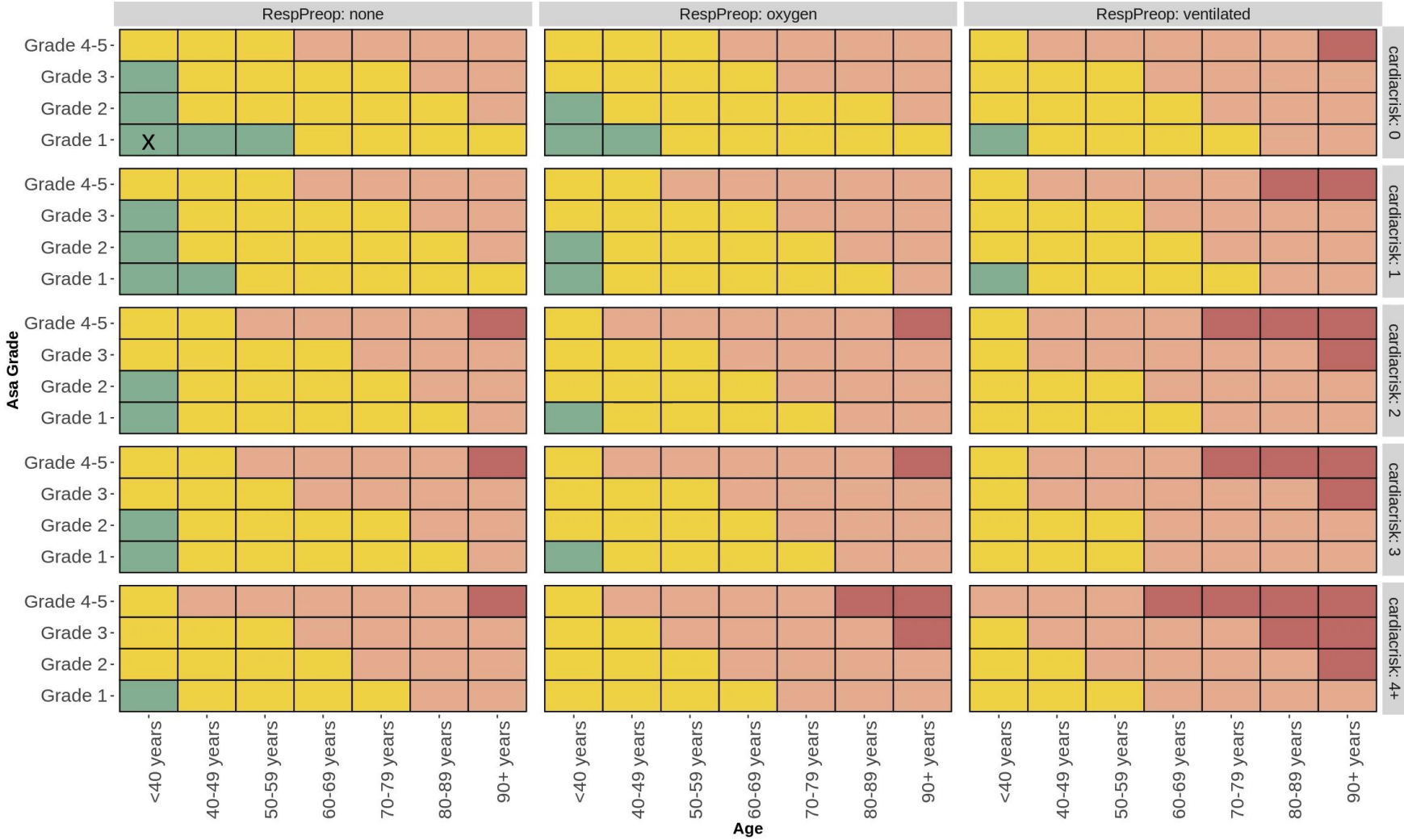
COVIDSurg Collaborative is led by the NIHR Global Surgery Research Unit. This machine learning risk stratification tool has been developed with the Health Data Research UK (HDRUK) team at the Institute of Translational Medicine, hosted within the University of Birmingham. The risk calculator is based upon data from patients infected with SARS-CoV-2 within the 7-days before to 30-days after surgery (perioperative infection). Patients underwent surgery of all types and for any indication during the COVID-19 pandemic (February 2020 to July 2020). The link to the study protocol is available at: [CovidSurg](#). A machine learning technique was used to generate the CovidSurg Risk calculator and has the potential to inform surgeons, patients, and healthcare decision makers to reach a better understanding of risk when treating surgical patients during the COVID-19 pandemic

Model probability output: 0.02

Case-fatality/Mortality percentage: 2%



Calculator



Probability Threshold and Mortality



Thank you!!!

