Supplementary Material

Supplementary Appendix 1

Of the 54,813 surgery admissions considered as training data in this analysis, 2817 of the admissions (5.14%) included more than one surgery in the admission. To verify that including these surgeries did not alter the distribution of correlations between pairs of surgeries compared to only including the first surgery of each admission, we compared the correlations between randomly selected surgeries from both datasets. For each dataset, we took 100,000 pairs of randomly selected surgeries from two different patients and calculated the Pearson correlation coefficients, using the features in Supplementary Appendix 1 Table 1. The distribution of correlation coefficients is shown in Supplementary Appendix 1 Figure 1, and the distributions are similar. Note that any patients that appear in our testing set are removed from our training set, and therefore no leakage of information occurs.

Supplementary Appendix 1 Figure 1: Correlations between pairs of surgeries in the same admission and randomly selected pairs of surgeries

Violin plot comparing the distribution of Pearson correlation coefficients for 100,000 randomly sampled pairs of surgeries from the set of all surgeries (left, in blue) and from the set of only the first surgery in each admission (right, in green). The distributions are identical.

Supplementary Appendix 1 Table 1: Features used to calculate correlations between pairs of surgeries

Features Used
AGE_LT_90
BICARBONATE
PROTHROMBIN TIME
GLUCOSE

WHITE BLOOD CELL COUNT
INR
PULSE
PLATELET COUNT
WEIGHT_KG
UREA NITROGEN
BNP
BMI
AST
BILIRUBIN TOTAL
DIAS PAP
CHLORIDE
CREATININE
POTASSIUM
ALKALINE PHOSPHATASE
ALT
SYS BLOOD PRESSURE
SYS PAP
ECHO EF
HRS_ADMSN_TO_SURGERY
HEMOGLOBIN
SODIUM
DIAS BLOOD PRESSURE
ALBUMIN
HEIGHT_IN
SPO2
PAT_CLASS
HCUP_CODE
GENDER
CASE_SRV_NAME
PRE_SURG_LOCATION
PAT_ADMSN_NUMBER
ADMSN_SURGERY_NUMBER
ASA_STATUS

Supplementary Figure 1: Consort Diagram

Filtering steps taken to select our cohort.

Supplementary Figure 2: Receiver Operating Characteristic (ROC) curves

ROC curves show the false positive rate on the x-axis and the true positive rate on the y-axis. The optimal point is the upper-left corner. Plots were generated using cross-validated predictions on entire dataset. Models that use preoperative features consistently outperform models that only use Charlson score or ASA status. Logistic Regression (a) and ElasticNet (b) (linear models) outperform Random Forest (c) and XGBoost (d) (non-linear models) when using a single input feature. However, non-linear models (c, d) outperform linear models (a, b) when using multiple features. Corresponding AUROC values and confidence intervals can be found in Table 2.

Supplementary Figure 3: Precision-recall (PR) curves

(a) Logistic Regression (b) ElasticNet Classifier (c) Random Forest (d) XGBoost Classifier

PR curves show the recall on the x-axis and precision on the y-axis. The optimal point is in the upper-right corner. Figs (a) and (b) show that the linear models have very similar PR curves. The gradient boosted trees model (d) has better precision-recall compared to the random forest (c).

Supplementary Figure 4: Distribution of standardized feature values for continuous Real (non-missing) values (left), SoftImpute values (middle), and Mean imputed values (right).

Supplementary Figure 5: Real, SoftImpute, and MeanImpute values for variables in the training data set with the highest percentage of missing data, ordered in descending value from left to right. In (a), values are from all patients in the training data set, (b) shows patients that did not die, and (c) shows patients that did die.

Supplementary Figure 6: (a) Receiver Operating Characteristic (ROC) curves and (b) precision-recall (PR) curves for a random forest model trained on preoperative features and the ASA status, without lab result times, where missing data was imputed with the mean value for each variable.

Supplementary Table 1: Feature List

Feature	Percentage of Data Missing	Data Type
Age	0	Continuous
Albumin	33.1	Continuous
Albumin Timestamp	34	Continuous
Alkaline Phosphatase	33.6	Continuous
Alkaline Phosphatase Timestamp	33.9	Continuous
ALT	31.1	Continuous
ALT Timestamp	31.3	Continuous
ASA Status	0	Continuous
AST	30.6	Continuous
AST Timestamp	31.4	Continuous
Bicarbonate	89.3	Continuous
Bicarbonate Timestamp	89.5	Continuous
Bilirubin Total	35	Continuous
Bilirubin Total Timestamp	34.1	Continuous
Blood Pressure Timestamp	0.6	Continuous
Body Mass Index	1.3	Continuous
BNP	89	Continuous
BNP Timestamp	88.2	Continuous
Case Service Name	0.1	Categorical (32)
Chloride	12.6	Continuous
Chloride Timestamp	13.4	Continuous
Creatinine	23.1	Continuous
Creatinine Timestamp	22.8	Continuous
Diastolic Blood Pressure	0.5	Continuous
Diastolic Pulmonary Artery Pressure	95.6	Continuous
Echo Ejection Fraction	75.6	Continuous
Echo Ejection Fraction Timestamp	76	Continuous
Gender	0	Categorical (2)
Glucose	20.3	Continuous
Glucose Timestamp	20.4	Continuous
HCUP Code	4.6	Categorical (176)
Height (inches)	1.7	Continuous
Hemoglobin	10.9	Continuous

Hemoglobin Timestamp	11.9	Continuous
INR	25.6	Continuous
INR Timestamp	26.7	Continuous
Pulmonary Artery Pressure Timestamp	95.6	Continuous
Patient Class	0	Categorical (4)
Platelet Count	22.2	Continuous
Platelet Count Timestamp	22.9	Continuous
Potassium	12.1	Continuous
Potassium Timestamp	13.1	Continuous
Pre-surgical Location	0.5	Categorical (52)
Prothrombin Time	26.9	Continuous
Prothrombin Time Timestamp	27	Continuous
Pulse	0.8	Continuous
Pulse Timestamp	0.6	Continuous
Sodium	12.3	Continuous
Sodium Timestamp	13.3	Continuous
SpO2	1.2	Continuous
SpO2 Timestamp	1.3	Continuous
Systolic Blood Pressure	0.5	Continuous
Systolic Pulmonary Artery Pressure	95.6	Continuous
Urea Nitrogen	13.7	Continuous
Urea Nitrogen Timestamp	13.5	Continuous
Weight (kilograms)	1.1	Continuous
White Blood Cell Count	22.7	Continuous
White Blood Cell Count Timestamp	23.3	Continuous

Preoperative features used in the model. All features are readily available via the EHR system prior to surgery. Feature values are either continuous or categorical, and the number of possible variables for each categorical variable is shown in parenthesis. HCUP codes are included as features, but not shown in this table. Refer to Supplementary Table 5 for a full list of HCUP codes. For physiologic features the most recent value prior to surgery was obtained. Lab timestamp features represent the difference in time from when the lab resulted to the admission start time.

Supplementary Table 2: Calibration of Models: Brier Score

Model / Brier Score	Logistic Regression	ElasticNet Classifier	Random Forest	XGBoost Classifier
POSPOM	0.163 (0.160-0.166)	0.163 (0.160-0.166)	**0.098 (0.092-0.104)**	**0.098 (0.092-0.104)**
Charlson Comorbidity	0.100 (0.093-0.109)	0.100 (0.093-0.109)	**0.091 (0.083-0.100)**	**0.091 (0.083-0.100)**
ASA Status	0.087 (0.080-0.095)	0.087 (0.080-0.094)	**0.086 (0.078-0.092)**	**0.086 (0.078-0.092)**
Preop Features	0.068 (0.062-0.075)	0.069 (0.064-0.076)	0.018 (0.016-0.021)	**0.015 (0.012-0.019)**
Preop + ASA Status	0.064 (0.058-0.070)	0.065 (0.059-0.072)	0.017 (0.015-0.020)	**0.015 (0.012-0.018)**
Preop + surrogate-ASA	0.060 (0.054-0.066)	0.062 (0.056-0.068)	0.018 (0.016-0.021)	**0.016 (0.013-0.020)**
Preop (No Time) + ASA Status	0.066 (0.059-0.072)	0.066 (0.060-0.073)	0.018 (0.015-0.021)	**0.016 (0.012-0.019)**
Preop (No Time) + surrogate-ASA	0.063 (0.057-0.070)	0.064 (0.057-0.071)	0.019 (0.016-0.022)	**0.017 (0.013-0.021)**

Calibration of the models was measured using the Brier score (lower is better). Models with the lowest Brier score are shown in bold. The non-linear classifiers (Random Forest, XGBoost) consistently have lower Brier scores compared to the linear classifiers (Logistic Regression, ElasticNet), except when using the ASA status as a single feature.

Supplementary Table 3: Random Forest Feature Importance

Feature	Preop + ASA Status	Preop (No Time) + ASA Status	Preop	Preop (No Time)
ASA_STATUS	**0.08**	**0.12**	NA	NA
PAT_CLASS_INPATIENT	**0.04**	**0.05**	0.04	0.06
PRE_SURG_LOCATION_PRE-ADMISSION	**0.03**	**0.05**	0.03	0.05
BNP HRS_2_SURGERY	**0.03**	NA	0.03	NA
ALBUMIN	**0.03**	**0.04**	0.03	0.04
INR	**0.03**	**0.04**	0.03	0.05
BICARBONATE HRS_2_SURGERY	**0.03**	NA	0.04	NA
PROTHROMBIN TIME	0.02	**0.04**	0.03	0.04
HEMOGLOBIN	0.02	**0.04**	0.03	0.04
BILIRUBIN TOTAL	0.02	**0.04**	0.03	0.04
PAP HRS_2_SURGERY	0.02	NA	**0.03**	NA
PAT_CLASS_SAME DAY ADMIT	0.02	0.03	**0.03**	0.04
AST	0.02	0.03	**0.03**	0.04

The top five features of the random forest model, ranked by Gini importance, for each feature set are shown in bold. If multiple features had the same importance in the model, then all features with that importance were included. Features with a NA value were not included in the dataset. All models included the preoperative features. "No Time'" means the timestamps of the lab results were not included (i.e. features with the "HRS_2_SURGERY" suffix).

Supplementary Table 4a: Change in Pre- to Post-operative Risk Percentile Bins for Entire Population

	Post 0-0.2	Post 0.2-0.4	Post 0.4-0.6	Post 0.6-0.8	Post 0.8-1	Sum
Pre 0-0.2	0.37	0.29	0.21	0.12	0.02	10583
Pre 0.2-0.4	0.26	0.26	0.24	0.18	0.05	10582
Pre 0.4-0.6	0.20	0.22	0.23	0.23	0.11	10582
Pre 0.6-0.8	0.14	0.17	0.20	0.26	0.23	10582
Pre 0.8-1	0.04	0.06	0.11	0.21	0.58	10582
Sum	10583	10582	10582	10582	10582	52911

This tables shows how the fraction of patients in each risk percentile bin change between before and after surgery. Bins are defined by the percentile of a patient's risk score relative to all other patients. Fractions sum to one across rows.

Supplementary Table 4b: Change in Pre- to Post-operative Risk Percentile Bins for In-hospital Mortalities

	Post 0-0.2	Post 0.2-0.4	Post 0.4-0.6	Post 0.6-0.8	Post 0.8-1	Sum
Pre 0-0.2	0.00	0.00	0.00	0.50	0.50	2
Pre 0.2-0.4	0.00	0.00	0.00	0.20	0.80	10
Pre 0.4-0.6	0.00	0.00	0.00	0.14	0.86	7
Pre 0.6-0.8	0.00	0.03	0.00	0.13	0.83	30
Pre 0.8-1	0.00	0.00	0.01	0.02	0.97	410
Sum	2	2	3	16	436	459

This table shows how the fraction of in-hospital mortalities in each risk percentile bin change between before and after surgery. Fractions sum to one across rows. There is an increase in the number of postoperative high-risk patients (0.8-1.0) compared to preoperative high-risk patients (0.8-1.0).

Supplementary Table 5: Comparison of HCUP codes in training and testing cohorts

HCUP Description	Training Data Occurrence (%)	Testing Data Occurrence (%)
INCISION AND EXCISION OF CNS	2114.0 (3.6)	291.0 (3.9)
OTHER THERAPEUTIC PROCEDURES, HEMIC AND LYMPHATIC SYSTEM	1752.0 (3.0)	265.0 (3.6)
ARTHROPLASTY KNEE	1542.0 (2.6)	113.0 (1.5)

OTHER THERAPEUTIC ENDOCRINE PROCEDURES	1527.0 (2.6)	224.0 (3.0)
HIP REPLACEMENT, TOTAL AND PARTIAL	1517.0 (2.6)	211.0 (2.9)
SPINAL FUSION	1431.0 (2.4)	177.0 (2.4)
KIDNEY TRANSPLANT	1419.0 (2.4)	199.0 (2.7)
CHOLECYSTECTOMY AND COMMON DUCT EXPLORATION	1401.0 (2.4)	130.0 (1.8)
HEART VALVE PROCEDURES	1256.0 (2.1)	116.0 (1.6)
OTHER OR THERAPEUTIC NERVOUS SYSTEM PROCEDURES	1256.0 (2.1)	177.0 (2.4)
OTHER OR PROCEDURES ON VESSELS OTHER THAN HEAD AND NECK	1246.0 (2.1)	142.0 (1.9)
COLORECTAL RESECTION	1231.0 (2.1)	128.0 (1.7)
TREATMENT, FRACTURE OR DISLOCATION OF HIP AND FEMUR	1190.0 (2.0)	139.0 (1.9)
LAMINECTOMY, EXCISION INTERVERTEBRAL DISC	1174.0 (2.0)	136.0 (1.8)
APPENDECTOMY	1169.0 (2.0)	136.0 (1.8)
HYSTERECTOMY, ABDOMINAL AND VAGINAL	1155.0 (2.0)	124.0 (1.7)
OTHER OR GASTROINTESTINAL THERAPEUTIC PROCEDURES	1126.0 (1.9)	129.0 (1.7)
OTHER OR THERAPEUTIC PROCEDURES ON RESPIRATORY SYSTEM	1111.0 (1.9)	129.0 (1.7)
OTHER HERNIA REPAIR	1091.0 (1.9)	124.0 (1.7)
OPEN PROSTATECTOMY	1090.0 (1.9)	134.0 (1.8)
OTHER ORGAN TRANSPLANTATION	1073.0 (1.8)	108.0 (1.5)
THYROIDECTOMY, PARTIAL OR COMPLETE	1072.0 (1.8)	116.0 (1.6)
NEPHRECTOMY, PARTIAL OR COMPLETE	1058.0 (1.8)	108.0 (1.5)
OTHER OR THERAPEUTIC PROCEDURES ON BONE	1002.0 (1.7)	143.0 (1.9)
OTHER OR THERAPEUTIC PROCEDURES ON NOSE, MOUTH AND PHARYNX	929.0 (1.6)	139.0 (1.9)
OTHER OR LOWER GI THERAPEUTIC PROCEDURES	796.0 (1.4)	89.0 (1.2)
GASTRIC BYPASS AND VOLUME REDUCTION	755.0 (1.3)	150.0 (2.0)
CORONARY ARTERY BYPASS GRAFT (CABG)	697.0 (1.2)	76.0 (1.0)
OTHER OR THERAPEUTIC PROCEDURES ON SKIN AND BREAST	687.0 (1.2)	81.0 (1.1)
OTHER OR HEART PROCEDURES	687.0 (1.2)	77.0 (1.0)
SKIN GRAFT	675.0 (1.1)	66.0 (0.9)
OTHER EXCISION OF CERVIX AND UTERUS	660.0 (1.1)	58.0 (0.8)
INSERTION, REPLACEMENT, OR REMOVAL OF EXTRACRANIAL VENTRICULAR SHUNT	644.0 (1.1)	88.0 (1.2)
OTHER THERAPEUTIC PROCEDURES ON MUSCLES AND TENDONS	625.0 (1.1)	76.0 (1.0)
LOBECTOMY OR PNEUMONECTOMY	622.0 (1.1)	71.0 (1.0)
DEBRIDEMENT OF WOUND, INFECTION OR BURN	594.0 (1.0)	50.0 (0.7)

ILEOSTOMY AND OTHER ENTEROSTOMY	567.0 (1.0)	59.0 (0.8)
GENITOURINARY INCONTINENCE PROCEDURES	566.0 (1.0)	58.0 (0.8)
PARTIAL EXCISION BONE	563.0 (1.0)	76.0 (1.0)
UPPER GASTROINTESTINAL ENDOSCOPY, BIOPSY	556.0 (0.9)	125.0 (1.7)
TRACHEOSCOPY AND LARYNGOSCOPY WITH BIOPSY	548.0 (0.9)	79.0 (1.1)
LAPAROSCOPY	521.0 (0.9)	54.0 (0.7)
TRANSURETHRAL RESECTION OF PROSTATE (TURP)	500.0 (0.8)	57.0 (0.8)
OTHER OR THERAPEUTIC PROCEDURES, FEMALE ORGANS	498.0 (0.8)	60.0 (0.8)
SUTURE OF SKIN AND SUBCUTANEOUS TISSUE	484.0 (0.8)	53.0 (0.7)
TREATMENT, FRACTURE OR DISLOCATION OF LOWER EXTREMITY (OTHER THAN HIP OR FEMUR)	462.0 (0.8)	47.0 (0.6)
SMALL BOWEL RESECTION	459.0 (0.8)	47.0 (0.6)
OTHER OR THERAPEUTIC PROCEDURES OF URINARY TRACT	427.0 (0.7)	29.0 (0.4)
OTHER FRACTURE AND DISLOCATION PROCEDURE	379.0 (0.6)	37.0 (0.5)
OTHER OR THERAPEUTIC PROCEDURES ON JOINTS	358.0 (0.6)	44.0 (0.6)
OTHER OR UPPER GI THERAPEUTIC PROCEDURES	345.0 (0.6)	30.0 (0.4)
AMPUTATION OF LOWER EXTREMITY	337.0 (0.6)	48.0 (0.7)
TRANSURETHRAL EXCISION, DRAINAGE, OR REMOVAL URINARY OBSTRUCTION	334.0 (0.6)	45.0 (0.6)
DIAGNOSTIC BRONCHOSCOPY AND BIOPSY OF BRONCHUS	332.0 (0.6)	49.0 (0.7)
AORTIC RESECTION, REPLACEMENT OR ANASTOMOSIS	316.0 (0.5)	29.0 (0.4)
OTHER OR PROCEDURES ON VESSELS OF HEAD AND NECK	306.0 (0.5)	34.0 (0.5)
TRACHEOSTOMY, TEMPORARY AND PERMANENT	301.0 (0.5)	32.0 (0.4)
ENDOSCOPIC RETROGRADE CANNULATION OF PANCREAS (ERCP)	297.0 (0.5)	35.0 (0.5)
ARTHROPLASTY OTHER THAN HIP OR KNEE	264.0 (0.4)	47.0 (0.6)
INGUINAL AND FEMORAL HERNIA REPAIR	262.0 (0.4)	39.0 (0.5)
URETERAL CATHETERIZATION	249.0 (0.4)	43.0 (0.6)
EXPLORATORY LAPAROTOMY	235.0 (0.4)	40.0 (0.5)
INCISION AND DRAINAGE, SKIN AND SUBCUTANEOUS TISSUE	229.0 (0.4)	35.0 (0.5)
OTHER DIAGNOSTIC PROCEDURES (INTERVIEW, EVALUATION, CONSULTATION)	227.0 (0.4)	30.0 (0.4)
OOPHORECTOMY, UNILATERAL AND BILATERAL	217.0 (0.4)	35.0 (0.5)
CREATION, REVISION AND REMOVAL OF ARTERIOVENOUS FISTULA OR VESSEL-TO-VESSEL CANNULA FOR DIALYSIS	211.0 (0.4)	12.0 (0.2)
DIAGNOSTIC ULTRASOUND OF HEART (ECHOCARDIOGRAM)	195.0 (0.3)	11.0 (0.1)

OTHER VASCULAR CATHETERIZATION, NOT HEART	192.0 (0.3)	31.0 (0.4)
PLASTIC PROCEDURES ON NOSE	170.0 (0.3)	25.0 (0.3)
INSERTION, REVISION, REPLACEMENT, REMOVAL OF CARDIAC PACEMAKER OR CARDIOVERTER/DEFIBRILLATOR	169.0 (0.3)	14.0 (0.2)
TREATMENT, FACIAL FRACTURE OR DISLOCATION	166.0 (0.3)	25.0 (0.3)
OTHER OR THERAPEUTIC PROCEDURES ON MUSCULOSKELETAL SYSTEM	162.0 (0.3)	16.0 (0.2)
ENDARTERECTOMY, VESSEL OF HEAD AND NECK	155.0 (0.3)	17.0 (0.2)
PROCEDURES ON THE URETHRA	141.0 (0.2)	15.0 (0.2)
REPAIR OF CYSTOCELE AND RECTOCELE, OBLITERATION OF VAGINAL VAULT	139.0 (0.2)	14.0 (0.2)
TREATMENT, FRACTURE OR DISLOCATION OF RADIUS AND ULNA	135.0 (0.2)	20.0 (0.3)
REPAIR OF RETINAL TEAR, DETACHMENT	135.0 (0.2)	14.0 (0.2)
NEPHROTOMY AND NEPHROSTOMY	135.0 (0.2)	36.0 (0.5)
ANESTHESIA	130.0 (0.2)	8.0 (0.1)
OTHER THERAPEUTIC PROCEDURES ON EYELIDS, CONJUNCTIVA, CORNEA	129.0 (0.2)	16.0 (0.2)
OTHER OR THERAPEUTIC PROCEDURES, MALE GENITAL	126.0 (0.2)	39.0 (0.5)
EXCISION OF SKIN LESION	125.0 (0.2)	17.0 (0.2)
EMBOLECTOMY AND ENDARTERECTOMY OF LOWER LIMBS	119.0 (0.2)	10.0 (0.1)
DECOMPRESSION PERIPHERAL NERVE	111.0 (0.2)	12.0 (0.2)
PROCTOSCOPY AND ANORECTAL BIOPSY	104.0 (0.2)	17.0 (0.2)
EXTRACORPOREAL LITHOTRIPSY, URINARY	101.0 (0.2)	23.0 (0.3)
EXCISION, LYSIS PERITONEAL ADHESIONS	96.0 (0.2)	11.0 (0.1)
GASTROSTOMY, TEMPORARY AND PERMANENT	90.0 (0.2)	7.0 (0.1)
OTHER DIAGNOSTIC PROCEDURES ON MUSCULOSKELETAL SYSTEM	89.0 (0.2)	11.0 (0.1)
COLOSTOMY, TEMPORARY AND PERMANENT	88.0 (0.1)	17.0 (0.2)
MASTOIDECTOMY	87.0 (0.1)	12.0 (0.2)
PERIPHERAL VASCULAR BYPASS	83.0 (0.1)	11.0 (0.1)
OTHER DIAGNOSTIC NERVOUS SYSTEM PROCEDURES	80.0 (0.1)	10.0 (0.1)
ENDOSCOPY AND ENDOSCOPIC BIOPSY OF THE URINARY TRACT	79.0 (0.1)	11.0 (0.1)
TRACTION, SPLINTS, AND OTHER WOUND CARE	78.0 (0.1)	21.0 (0.3)
COLONOSCOPY AND BIOPSY	78.0 (0.1)	17.0 (0.2)
OTHER NON-OR GASTROINTESTINAL THERAPEUTIC PROCEDURES	75.0 (0.1)	0.0 (0.0)
REMOVAL OF ECTOPIC PREGNANCY	73.0 (0.1)	8.0 (0.1)
PROCEDURES ON SPLEEN	72.0 (0.1)	5.0 (0.1)

EXTRACORPOREAL CIRCULATION AUXILIARY TO OPEN HEART PROCEDURES	71.0 (0.1)	16.0 (0.2)
OTHER DIAGNOSTIC PROCEDURES ON LUNG AND BRONCHUS	71.0 (0.1)	11.0 (0.1)
DIAGNOSTIC PROCEDURES ON NOSE, MOUTH AND PHARYNX	65.0 (0.1)	10.0 (0.1)
OTHER VASCULAR BYPASS AND SHUNT, NOT HEART	64.0 (0.1)	3.0 (0.0)
DILATATION AND CURETTAGE (D&C), ASPIRATION AFTER DELIVERY OR ABORTION	59.0 (0.1)	7.0 (0.1)
OTHER THERAPEUTIC EAR PROCEDURES	52.0 (0.1)	1.0 (0.0)
ESOPHAGEAL DILATATION	52.0 (0.1)	6.0 (0.1)
OTHER DIAGNOSTIC PROCEDURES OF RESPIRATORY TRACT AND MEDIASTINUM	50.0 (0.1)	8.0 (0.1)
CESAREAN SECTION	50.0 (0.1)	3.0 (0.0)
OTHER DIAGNOSTIC PROCEDURES, FEMALE ORGANS	49.0 (0.1)	8.0 (0.1)
TONSILLECTOMY AND/OR ADENOIDECTOMY	48.0 (0.1)	2.0 (0.0)
GASTRECTOMY, PARTIAL AND TOTAL	47.0 (0.1)	6.0 (0.1)
MASTECTOMY	45.0 (0.1)	5.0 (0.1)
ABORTION (TERMINATION OF PREGNANCY)	44.0 (0.1)	3.0 (0.0)
OTHER NON-OR THERAPEUTIC PROCEDURES ON SKIN AND BREAST	43.0 (0.1)	12.0 (0.2)
OTHER NON-OR THERAPEUTIC CARDIOVASCULAR PROCEDURES	42.0 (0.1)	2.0 (0.0)
OTHER INTRAOCULAR THERAPEUTIC PROCEDURES	42.0 (0.1)	3.0 (0.0)
THERAPEUTIC RADIOLOGY	39.0 (0.1)	7.0 (0.1)
CONTROL OF EPISTAXIS	37.0 (0.1)	4.0 (0.1)
OTHER DIAGNOSTIC ULTRASOUND	34.0 (0.1)	7.0 (0.1)
INSERTION OF CATHETER OR SPINAL STIMULATOR AND INJECTION INTO SPINAL CANAL	33.0 (0.1)	4.0 (0.1)
OTHER OPERATIONS ON OVARY	32.0 (0.1)	8.0 (0.1)
ARTHROSCOPY	29.0 (0.0)	1.0 (0.0)
INCISION OF PLEURA, THORACENTESIS, CHEST DRAINAGE	28.0 (0.0)	2.0 (0.0)
LUMPECTOMY, QUADRANTECTOMY OF BREAST	27.0 (0.0)	1.0 (0.0)
OTHER EXTRAOCULAR MUSCLE AND ORBIT THERAPEUTIC PROCEDURES	25.0 (0.0)	3.0 (0.0)
OTHER DIAGNOSTIC PROCEDURES OF URINARY TRACT	25.0 (0.0)	1.0 (0.0)
CORNEAL TRANSPLANT	23.0 (0.0)	3.0 (0.0)
BIOPSY OF LIVER	20.0 (0.0)	6.0 (0.1)
OTHER THERAPEUTIC PROCEDURES	19.0 (0.0)	0.0 (0.0)
PATHOLOGY	19.0 (0.0)	7.0 (0.1)
HEMORRHOID PROCEDURES	17.0 (0.0)	5.0 (0.1)
GLAUCOMA PROCEDURES	17.0 (0.0)	2.0 (0.0)

OTHER DIAGNOSTIC PROCEDURES ON SKIN AND SUBCUTANEOUS TISSUE	16.0 (0.0)	1.0 (0.0)
OTHER NON-OR THERAPEUTIC PROCEDURES OF URINARY TRACT	15.0 (0.0)	3.0 (0.0)
DIAGNOSTIC PROCEDURES ON EYE	14.0 (0.0)	2.0 (0.0)
NONOPERATIVE REMOVAL OF FOREIGN BODY	14.0 (0.0)	1.0 (0.0)
OTHER NON-OR THERAPEUTIC PROCEDURES, MALE GENITAL	13.0 (0.0)	0.0 (0.0)
EXCISION OF SEMILUNAR CARTILAGE OF KNEE	13.0 (0.0)	1.0 (0.0)
DIAGNOSTIC DILATATION AND CURETTAGE (D&C)	13.0 (0.0)	2.0 (0.0)
OTHER GASTROINTESTINAL DIAGNOSTIC PROCEDURES	12.0 (0.0)	2.0 (0.0)
OTHER NON-OR THERAPEUTIC PROCEDURES ON RESPIRATORY SYSTEM	10.0 (0.0)	1.0 (0.0)
ORAL AND DENTAL SERVICES	10.0 (0.0)	4.0 (0.1)
LOCAL EXCISION OF LARGE INTESTINE LESION (NOT ENDOSCOPIC)	10.0 (0.0)	0.0 (0.0)
DIVISION OF JOINT CAPSULE, LIGAMENT OR CARTILAGE	9.0 (0.0)	4.0 (0.1)
INJECTION OR LIGATION OF ESOPHAGEAL VARICES	9.0 (0.0)	1.0 (0.0)
DIAGNOSTIC PROCEDURES, MALE GENITAL	9.0 (0.0)	1.0 (0.0)
OTHER DIAGNOSTIC CARDIOVASCULAR PROCEDURES	7.0 (0.0)	0.0 (0.0)
TYMPANOPLASTY	7.0 (0.0)	1.0 (0.0)
BONE MARROW BIOPSY	7.0 (0.0)	0.0 (0.0)
LENS AND CATARACT PROCEDURES	6.0 (0.0)	0.0 (0.0)
DIAGNOSTIC SPINAL TAP	6.0 (0.0)	2.0 (0.0)
OTHER BOWEL DIAGNOSTIC PROCEDURES	6.0 (0.0)	2.0 (0.0)
ABDOMINAL PARACENTESIS	6.0 (0.0)	0.0 (0.0)
BUNIONECTOMY OR REPAIR OF TOE DEFORMITIES	5.0 (0.0)	1.0 (0.0)
OTHER DIAGNOSTIC RADIOLOGY AND RELATED TECHNIQUES	4.0 (0.0)	0.0 (0.0)
MAGNETIC RESONANCE IMAGING	3.0 (0.0)	1.0 (0.0)
OTHER NON-OR UPPER GI THERAPEUTIC PROCEDURES	3.0 (0.0)	0.0 (0.0)
OTHER OPERATIONS ON FALLOPIAN TUBES	3.0 (0.0)	1.0 (0.0)
ELECTROCARDIOGRAM	3.0 (0.0)	0.0 (0.0)
SWAN-GANZ CATHETERIZATION FOR MONITORING	2.0 (0.0)	0.0 (0.0)
CIRCUMCISION	2.0 (0.0)	0.0 (0.0)
OTHER NON-OR THERAPEUTIC PROCEDURES ON NOSE, MOUTH AND PHARYNX	2.0 (0.0)	0.0 (0.0)
DIAGNOSTIC CARDIAC CATHETERIZATION, CORONARY ARTERIOGRAPHY	2.0 (0.0)	0.0 (0.0)
LIGATION OF FALLOPIAN TUBES	2.0 (0.0)	1.0 (0.0)

ARTHROCENTESIS	2.0 (0.0)	0.0 (0.0)
FORCEPS, VACUUM, AND BREECH DELIVERY	2.0 (0.0)	0.0 (0.0)
MYRINGOTOMY	2.0 (0.0)	0.0 (0.0)
OPHTHALMOLOGIC AND OTOLOGIC DIAGNOSIS AND TREATMENT	2.0 (0.0)	0.0 (0.0)
CANCER CHEMOTHERAPY	2.0 (0.0)	1.0 (0.0)
DIAGNOSTIC PROCEDURES ON EAR	1.0 (0.0)	0.0 (0.0)
OTHER NON-OR OR CLOSED THERAPEUTIC NERVOUS SYSTEM PROCEDURES	1.0 (0.0)	0.0 (0.0)
PERCUTANEOUS TRANSLUMINAL CORONARY ANGIOPLASTY (PTCA)	1.0 (0.0)	0.0 (0.0)
OTHER THERAPEUTIC OBSTETRICAL PROCEDURES	1.0 (0.0)	0.0 (0.0)
NASOGASTRIC TUBE	1.0 (0.0)	0.0 (0.0)
OTHER PROCEDURES TO ASSIST DELIVERY	1.0 (0.0)	0.0 (0.0)
OTHER NON-OR LOWER GI THERAPEUTIC PROCEDURES	1.0 (0.0)	0.0 (0.0)

The number of occurrences for each HCUP code in the training and testing set are given, with percentages shown in parentheses.

Supplementary Table 6. Model Feature Importance: Without ASA and Without Lab Time Features

Feature	Logistic Regression	Elastic Net	Random Forest	XGBoost
PRE_SURG_LOCATION_RR ED	**0.72**	**0.56**	0.01	0.01
CASE_SRV_NAME_Neurological Surgery	**0.70**	**0.72**	0.01	**0.02**
PRE_SURG_LOCATION_PRE-ADMISSION	**0.47**	-0.18	**0.05**	**0.15**
PRE_SURG_LOCATION_RR 6ICU	**0.46**	**0.35**	0.01	0.01
PRE_SURG_LOCATION_RR 8ICU	**0.44**	**0.33**	0.01	**0.02**
HCUP_CODE_124.0	0.29	**0.37**	0.00	0.01
PAT_CLASS_INPATIENT	-0.23	-0.09	**0.06**	0.33
INR	0.13	0.13	**0.05**	0.01
ALBUMIN	-0.38	-0.38	**0.04**	0.00
PROTHROMBIN TIME	0.12	0.11	**0.04**	0.00
PAT_CLASS_SAME DAY ADMIT	-0.93	-0.51	**0.04**	0.00
HEMOGLOBIN	-0.41	-0.37	**0.04**	0.00
AST	0.20	0.16	**0.04**	0.00
BILIRUBIN TOTAL	0.08	0.11	**0.04**	0.00
CASE_SRV_NAME_Orthopaedics	-0.63	-0.66	0.01	**0.05**
GENDER_M	0.34	0.29	0.02	**0.03**
PRE_SURG_LOCATION_RR 8E	-0.07	-0.14	0.00	**0.02**

PRE_SURG_LOCATION_RR 8W	-0.02	-0.09	0.00	**0.02**
HCUP_CODE_67.0	0.20	0.27	0.00	**0.02**
HCUP_CODE_84.0	-0.55	-0.38	0.00	**0.02**

The bold values indicate that the value was one of the top five strongest predictors for the given model. If multiple features had the same importance in the model, then all features with that importance were included. In the Logistic Regression and ElasticNet columns the model weights are shown, where negative values indicate the feature lowers the probability of mortality. The non-linear model features are ranked according to the mean decrease in Gini impurity.

Supplementary Table 7: Predicting Mortality using POSPOM

Model	Logistic Regression	ElasticNet Classifier	Random Forest	XGBoost Classifier
Accuracy	0.766 (0.755-0.776)	0.766 (0.755-0.776)	0.861 (0.851-0.869)	0.861 (0.851-0.869)
F1 Score	0.053 (0.034-0.075)	0.053 (0.034-0.075)	0.047 (0.021-0.078)	0.047 (0.021-0.078)
Precision	0.028 (0.018-0.041)	0.028 (0.018-0.041)	0.026 (0.012-0.045)	0.026 (0.012-0.045)
Recall	0.388 (0.264-0.518)	0.388 (0.264-0.518)	0.201 (0.097-0.318)	0.201 (0.097-0.318)
Specificity	0.772 (0.762-0.782)	0.772 (0.762-0.782)	0.872 (0.864-0.881)	0.872 (0.864-0.881)

Model performance metrics for predicting mortality using only the POSPOM score as an input feature on the held-out test set.
True positives: TP, False positives: FP, True negatives: TN, False negatives: FN.
Accuracy = (TP+TN)/(TP+TN+FP+FN). Precision = TP/(TP+FP). Recall = TP/(TP+FN).
Specificity = TN/(TN+FP). F1 Score = 2/((1/Recall) + (1/Precision)).

Supplementary Table 8: Predicting Mortality using Charlson Comorbidity

Model	Logistic Regression	ElasticNet Classifier	Random Forest	XGBoost Classifier
Accuracy	0.895 (0.885-0.904)	0.895 (0.885-0.904)	0.895 (0.885-0.904)	0.895 (0.885-0.904)
F1 Score	0.112 (0.064-0.165)	0.112 (0.064-0.165)	0.112 (0.064-0.165)	0.112 (0.064-0.165)
Precision	0.065 (0.037-0.098)	0.065 (0.037-0.098)	0.065 (0.037-0.098)	0.065 (0.037-0.098)
Recall	0.390 (0.240-0.538)	0.390 (0.240-0.538)	0.390 (0.240-0.538)	0.390 (0.240-0.538)
Specificity	0.904 (0.895-0.913)	0.904 (0.895-0.913)	0.904 (0.895-0.913)	0.904 (0.895-0.913)

Model performance metrics for predicting mortality using only the Charlson comorbidity as an input feature on the held-out test set. For an explanation of the metrics see the description of Supplementary Table 7.

Supplementary Table 9: Predicting Mortality using Preoperative Features

Model	Logistic Regression	ElasticNet Classifier	Random Forest	XGBoost Classifier
Accuracy	0.907 (0.898-0.916)	0.906 (0.897-0.914)	0.985 (0.981-0.988)	0.983 (0.979-0.987)
F1 Score	0.202 (0.147-0.266)	0.205 (0.147-0.270)	0.275 (0.115-0.446)	0.295 (0.155-0.448)
Precision	0.118 (0.082-0.161)	0.119 (0.082-0.163)	0.610 (0.333-0.814)	0.459 (0.243-0.667)

Recall	0.707 (0.603-0.797)	0.731 (0.628-0.821)	0.179 (0.069-0.315)	0.220 (0.110-0.354)
Specificity	0.911 (0.902-0.919)	0.909 (0.900-0.917)	0.998 (0.997-0.999)	0.996 (0.993-0.998)

Model performance metrics for predicting mortality using preoperative features on the held-out test set. For an explanation of the metrics see the description of Supplementary Table 7.

Supplementary Table 10: Predicting Mortality using Preoperative Features + ASA Status

Model	Logistic Regression	ElasticNet Classifier	Random Forest	XGBoost Classifier
Accuracy	0.915 (0.907-0.923)	0.916 (0.907-0.923)	0.984 (0.980-0.988)	0.983 (0.979-0.987)
F1 Score	0.228 (0.167-0.292)	0.234 (0.175-0.298)	0.284 (0.119-0.464)	0.352 (0.214-0.490)
Precision	0.135 (0.095-0.179)	0.138 (0.100-0.182)	0.590 (0.333-0.810)	0.487 (0.300-0.673)
Recall	0.748 (0.646-0.839)	0.773 (0.679-0.856)	0.189 (0.074-0.329)	0.278 (0.161-0.403)
Specificity	0.918 (0.910-0.926)	0.918 (0.909-0.926)	0.998 (0.997-0.999)	0.995 (0.993-0.997)

Model performance metrics for predicting mortality using both preoperative features and ASA status as input features on the held-out test set. For an explanation of the metrics see the description of Supplementary Table 7.

Supplementary Table 11: Predicting Mortality using ASA Status

Model	Logistic Regression	ElasticNet Classifier	Random Forest	XGBoost Classifier
Accuracy	0.895 (0.886-0.904)	0.895 (0.886-0.904)	0.897 (0.889-0.906)	0.897 (0.889-0.906)
F1 Score	0.187 (0.133-0.249)	0.187 (0.133-0.249)	0.160 (0.110-0.222)	0.160 (0.110-0.222)
Precision	0.108 (0.074-0.149)	0.108 (0.074-0.149)	0.093 (0.061-0.133)	0.093 (0.061-0.133)
Recall	0.724 (0.621-0.816)	0.724 (0.621-0.816)	0.587 (0.472-0.709)	0.587 (0.472-0.709)
Specificity	0.898 (0.889-0.907)	0.898 (0.889-0.907)	0.903 (0.895-0.911)	0.903 (0.895-0.911)

Model performance metrics for predicting mortality using only the ASA status as an input feature on the held-out test set. For an explanation of the metrics see the description of Supplementary Table 7.

Supplementary Table 12: Predicting Mortality using Preoperative Features + surrogate-ASA Score

Model	Logistic Regression	ElasticNet Classifier	Random Forest	XGBoost Classifier
Accuracy	0.919 (0.911-0.927)	0.916 (0.909-0.925)	0.984 (0.980-0.988)	0.980 (0.976-0.984)
F1 Score	0.226 (0.166-0.293)	0.234 (0.174-0.298)	0.280 (0.125-0.452)	0.301 (0.153-0.448)
Precision	0.135 (0.094-0.183)	0.138 (0.098-0.184)	0.541 (0.294-0.750)	0.372 (0.184-0.561)
Recall	0.701 (0.605-0.792)	0.759 (0.669-0.841)	0.191 (0.078-0.331)	0.255 (0.127-0.379)
Specificity	0.923 (0.915-0.931)	0.919 (0.911-0.927)	0.997 (0.996-0.998)	0.993 (0.990-0.995)

Model performance metrics for predicting mortality using both preoperative features and the surrogate-ASA score as input features on the held-out test set. For an explanation of the metrics see the description of Supplementary Table 7.

Supplementary Table 13: Predicting Mortality using Preoperative Features + ASA status, Without Lab Times

Model	Logistic Regression	ElasticNet Classifier	Random Forest	XGBoost Classifier
Accuracy	0.915 (0.906-0.923)	0.914 (0.904-0.922)	0.982 (0.977-0.986)	0.982 (0.978-0.985)
F1 Score	0.231 (0.169-0.295)	0.230 (0.169-0.294)	0.302 (0.172-0.449)	0.375 (0.221-0.511)
Precision	0.136 (0.096-0.182)	0.136 (0.096-0.181)	0.420 (0.245-0.615)	0.437 (0.258-0.618)
Recall	0.764 (0.674-	0.773 (0.689-	0.239 (0.127-	0.331 (0.191-

	0.852)	0.854)	0.379)	0.463)
Specificity	0.917 (0.908-0.926)	0.916 (0.907-0.924)	0.994 (0.992-0.997)	0.993 (0.990-0.995)

Model performance metrics for predicting mortality using both preoperative features and the ASA score but without lab times as input features on the held-out test set. For an explanation of the metrics see the description of Supplementary Table 7.

Supplementary Table 14: Predicting Mortality using Preoperative Features + surrogate-ASA status, Without Lab Times

Model	Logistic Regression	ElasticNet Classifier	Random Forest	XGBoost Classifier
Accuracy	0.915 (0.906-0.923)	0.915 (0.906-0.924)	0.980 (0.976-0.985)	0.980 (0.976-0.985)
F1 Score	0.224 (0.168-0.292)	0.229 (0.169-0.298)	0.258 (0.127-0.412)	0.368 (0.231-0.505)
Precision	0.133 (0.095-0.180)	0.136 (0.096-0.184)	0.358 (0.180-0.551)	0.402 (0.245-0.562)
Recall	0.730 (0.631-0.824)	0.748 (0.653-0.837)	0.204 (0.094-0.342)	0.342 (0.208-0.481)
Specificity	0.918 (0.910-0.927)	0.918 (0.909-0.927)	0.994 (0.992-0.996)	0.991 (0.988-0.994)

Model performance metrics for predicting mortality using both preoperative features and the surrogate-ASA score but without lab times as input features on the held-out test set. For an explanation of the metrics see the description of Supplementary Table 7.

Supplementary Table 15: Model Feature Importance: With ASA and Without Lab Time Features

Feature	Logistic Regression	Elastic Net	Random Forest	XGBoost
ASA_STATUS	**1.35**	**1.36**	**0.12**	**0.22**
PRE_SURG_LOCATION_PRE-ADMISSION	**0.61**	-0.20	**0.05**	**0.10**
WEIGHT_KG	**0.61**	0.21	0.01	0.00
PRE_SURG_LOCATION_RR ED	**0.56**	**0.37**	0.00	0.00
CASE_SRV_NAME_Neurological Surgery	**0.52**	**0.63**	0.01	0.00
PRE_SURG_LOCATION_RR 8ICU	**0.44**	0.30	0.01	0.00
HCUP_CODE_124.0	0.29	**0.32**	0.00	0.00
HCUP_CODE_67.0	0.26	**0.32**	0.00	0.02
PAT_CLASS_INPATIENT	-0.19	0.00	**0.05**	**0.05**
INR	0.09	0.08	**0.04**	0.01
ALBUMIN	-0.35	-0.34	**0.04**	0.01
PROTHROMBIN TIME	0.08	0.08	**0.04**	0.00
HEMOGLOBIN	-0.36	-0.33	**0.04**	0.00
BILIRUBIN TOTAL	0.07	0.10	**0.04**	0.00
PRE_SURG_LOCATION_RR 7W	0.09	0.00	0.00	**0.04**
HCUP_CODE_76.0	0.02	0.04	0.00	**0.04**

The bold values indicate that the value was one of the top five strongest predictors for the given model. If multiple features had the same importance in the model, then all features with that importance were included. In the Logistic Regression and ElasticNet columns the model weights

are shown, where negative values indicate the feature lowers the probability of mortality. The non-linear model features are ranked according to the mean decrease in Gini impurity.

Supplementary Table 16: Model Feature Importance: Without ASA and With Lab Time Features

Feature	Logistic Regression	Elastic Net	Random Forest	XGBoost
CASE_SRV_NAME_Neurological Surgery	**0.84**	**0.69**	0.01	**0.02**
PRE_SURG_LOCATION_RR ED	**0.75**	**0.67**	0.01	0.01
CASE_SRV_NAME_Surgery, General	**0.50**	0.18	0.00	0.00
WEIGHT_KG	**0.46**	0.00	0.01	0.00
PRE_SURG_LOCATION_RR 6ICU	**0.43**	**0.39**	0.01	0.01
PRE_SURG_LOCATION_RR 8ICU	**0.43**	**0.38**	0.00	0.01
PRE_SURG_LOCATION_RR 7ICU	0.34	**0.34**	0.00	0.00
PAT_CLASS_INPATIENT	-0.25	-0.05	**0.04**	**0.31**
BICARBONATE HRS_2_SURGERY	0.39	0.00	**0.04**	0.01
BNP HRS_2_SURGERY	-0.46	-0.17	**0.03**	0.00
INR	0.15	0.14	**0.03**	0.01
PRE_SURG_LOCATION_PRE-ADMISSION	0.37	-0.36	**0.03**	**0.11**
ALBUMIN	-0.29	-0.29	**0.03**	0.00
PAP HRS_2_SURGERY	-0.35	0.00	**0.03**	0.00
PAT_CLASS_SAME DAY ADMIT	-0.78	0.00	**0.03**	0.00
PROTHROMBIN TIME	0.11	0.11	**0.03**	0.00
AST	0.18	0.14	**0.03**	0.00
HEMOGLOBIN	-0.37	-0.34	**0.03**	0.00
BILIRUBIN TOTAL	0.06	0.10	**0.03**	0.00
CASE_SRV_NAME_Orthopaedics	-0.48	-0.68	0.01	**0.04**
GENDER_M	0.31	0.27	0.01	**0.02**
PRE_SURG_LOCATION_RR 8N	0.07	0.03	0.00	**0.02**
PRE_SURG_LOCATION_RR 8E	-0.09	-0.10	0.00	**0.02**
HCUP_CODE_36.0	-0.06	0.03	0.00	**0.02**
HCUP_CODE_67.0	0.19	0.28	0.00	**0.02**
PRE_SURG_LOCATION_RR 8W	-0.01	0.00	0.00	**0.02**
HCUP_CODE_84.0	-0.45	-0.30	0.00	**0.02**
PRE_SURG_LOCATION_RR 7W	0.02	0.00	0.00	**0.02**
CASE_SRV_NAME_Urology	0.42	0.00	0.00	**0.02**

The bold values indicate features which were one of the top five strongest predictors for the given model. If multiple features had the same importance in the model, then all features with that importance were included. In the Logistic Regression and ElasticNet columns the model weights are shown, where negative values indicate the feature lowers the probability of mortality. The non-linear model features are ranked according to the mean decrease in Gini impurity.

Supplementary Table 17: Model Feature Importance: With ASA and Lab Time Features

Feature	Logistic Regression	Elastic Net	Random Forest	XGBoost
ASA_STATUS	**1.36**	**1.43**	**0.08**	**0.16**
WEIGHT_KG	**0.66**	0.20	0.01	0.00
CASE_SRV_NAME_Neurological Surgery	**0.66**	**0.69**	0.00	0.01
PRE_SURG_LOCATION_RR ED	**0.57**	**0.46**	0.00	0.00
PRE_SURG_LOCATION_PRE-ADMISSION	**0.55**	-0.05	**0.03**	**0.16**
BICARBONATE HRS_2_SURGERY	0.45	0.04	**0.03**	0.00
HCUP_CODE_124.0	0.34	**0.41**	0.00	0.00
GENDER_M	0.38	**0.34**	0.01	0.02
PAT_CLASS_INPATIENT	-0.25	0.00	**0.04**	**0.05**
BNP HRS_2_SURGERY	-0.38	-0.09	**0.03**	0.00
ALBUMIN	-0.35	-0.36	**0.03**	0.01
INR	0.12	0.12	**0.03**	0.00
PAT_CLASS_SAME DAY ADMIT	-0.53	0.00	0.02	**0.09**
HCUP_CODE_2.0	0.03	0.05	0.00	**0.05**
PRE_SURG_LOCATION_RR 7W	0.05	0.00	0.00	**0.05**

The bold values indicate features which were one of the top five strongest predictors for the given model. If multiple features had the same importance in the model, then all features with that importance were included. In the Logistic Regression and ElasticNet columns the model weights are shown, where negative values indicate the feature lowers the probability of mortality. The non-linear model features are ranked according to the mean decrease in Gini impurity.