**Supplementary table 1 - Baseline data in the development data, from 1st January 2009 to 31st December 2011, and the validation data, from 1st January 2012 to 30th June 2019.**

|  |  |  |
| --- | --- | --- |
| Variable | Development data | Validation data |
|  | n = 3021 | n = 7749 |
| Age\* | 65.8 (11.7) | 65.2 (12.2) |
| Male | 2146 (71%) | 5629 (72.6%) |
| Diabetes | 529 (17.5%) | 1762 (22.7%) |
| History of Pulmonary Disease | 428 (14.2%) | 1122 (14.5%) |
| History of Neurological Dysfunction | 101 (3.3%) | 236 (3%) |
| Angina | 82 (2.7%) | 296 (3.8%) |
| Extracardiac arteriopathy | 358 (11.9%) | 759 (9.8%) |
| Previous surgery | 122 (4%) | 595 (7.7%) |
| Recent MI | 518 (17.1%) | 2011 (26%) |
| Surgery on thoracic aorta | 108 (3.6%) | 318 (4.1%) |
| LV function |  |  |
| Good | 2250 (74.5%) | 5017 (64.8%) |
| Moderate | 562 (18.6%) | 1762 (22.7%) |
| Poor | 199 (6.6%) | 516 (6.7%) |
| Urgency |  |  |
| Elective | 2133 (70.6%) | 4204 (54.3%) |
| Emergency | 123 (4.1%) | 303 (3.9%) |
| Urgent | 765 (25.3%) | 3242 (41.8%) |
| Critical preoperative state | 140 (4.6%) | 792 (10.2%) |
| Died | 92 (3.0%) | 321 (4.1%) |

\*mean (standard deviation)

Supplementary table 2 - Model coefficients for the logistic regression and varying coefficient models

|  |  |  |
| --- | --- | --- |
|  | Logistic regression model | Varying coefficient model |
| Intercept | -7.292 | -7.943 |
| Age | 0.042 | 0.042 |
| Sex (Male) | 0.218 | 0.339 |
| Diabetes | -0.262 | -0.869 |
| History of Pulmonary Disease | 0.221 | 0.339 |
| Neurological Dysfunction | 0.563 | 0.630 |
| Critical preoperative state | 0.663 | 0.128 |
| Angina | -1.381 | -0.982 |
| Extracardiac arteriopathy | 0.729 | 0.874 |
| Previous surgery | 0.904 | 1.343 |
| Extracardiac arteriopathy | 0.690 | 0.494 |
| LV function (Moderate) | 0.180 | 0.261 |
| LV function (Poor) | 0.254 | 0.690 |
| MI < 90 days before surgery | -0.122 | -0.157 |
| Urgency (Emergency) | 2.582 | 2.108 |
| Urgency (Urgent) | 0.905 | 0.857 |
| Surgery on thoracic aorta | 1.051 | 1.155 |

Supplementary table 3 - Model coefficients for each version for the yearly updated logistic regression model. The column 2013 represents the model updated using data from 1st January 2012 to 31st December 2012 and was applied to all patients from 1st January 2013 to 31st December 2014

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Intercept | -7.292 | -6.681 | -7.361 | -8.133 | -7.069 | -7.966 | -7.739 | -7.149 |
| Age | 0.042 | 0.037 | -0.237 | -0.302 | -0.235 | -0.292 | -0.283 | -0.261 |
| Sex (Male) | 0.218 | 0.193 | -0.058 | -0.074 | -0.057 | -0.071 | -0.069 | -0.064 |
| Diabetes | -0.262 | -0.231 | -0.546 | -0.696 | -0.541 | -0.672 | -0.652 | -0.603 |
| History of Pulmonary Disease | 0.221 | 0.195 | -0.055 | -0.070 | -0.054 | -0.067 | -0.065 | -0.061 |
| Neurological Dysfunction | 0.563 | 0.497 | 0.293 | 0.374 | 0.291 | 0.361 | 0.350 | 0.324 |
| Critical preoperative state | 0.663 | 0.585 | 0.394 | 0.503 | 0.391 | 0.485 | 0.471 | 0.435 |
| Angina | -1.381 | -1.220 | -1.685 | -2.149 | -1.671 | -2.075 | -2.013 | -1.861 |
| Extracardiac arteriopathy | 0.729 | 0.644 | 0.462 | 0.590 | 0.458 | 0.569 | 0.552 | 0.510 |
| Previous surgery | 0.904 | 0.798 | 0.640 | 0.816 | 0.635 | 0.788 | 0.764 | 0.707 |
| Extracardiac arteriopathy | 0.690 | 0.609 | 0.422 | 0.538 | 0.418 | 0.520 | 0.504 | 0.466 |
| LV function (Moderate) | 0.180 | 0.159 | -0.096 | -0.123 | -0.096 | -0.119 | -0.115 | -0.106 |
| LV function (Poor) | 0.254 | 0.224 | -0.022 | -0.028 | -0.022 | -0.027 | -0.026 | -0.024 |
| MI < 90 days before surgery | -0.122 | -0.107 | -0.404 | -0.515 | -0.400 | -0.497 | -0.482 | -0.446 |
| Urgency (Emergency) | 2.582 | 2.2800 | 2.347 | 2.993 | 2.327 | 2.890 | 2.803 | 2.592 |
| Urgency (Urgent) | 0.905 | 0.799 | 0.641 | 0.818 | 0.636 | 0.790 | 0.766 | 0.708 |
| Surgery on thoracic aorta | 1.051 | 0.928 | 0.789 | 1.006 | 0.782 | 0.972 | 0.942 | 0.871 |

Supplementary table 4 – Bayesian updating model coefficients on 1st January each year in the validation data

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| Intercept | -7.292 | -5.827 | -5.582 | -4.894 | -5.041 | -4.92 | -5.084 | -5.183 |
| Age | 0.042 | 0.024 | 0.021 | 0.014 | 0.016 | 0.012 | 0.017 | 0.019 |
| Sex (Male) | 0.218 | 0.571 | 0.224 | 0.152 | 0.024 | 0.432 | 0.465 | 0.623 |
| Diabetes | -0.262 | -0.14 | -0.057 | -0.322 | -0.132 | -0.164 | -0.265 | -0.08 |
| History of Pulmonary Disease | 0.221 | 0.148 | 0.129 | -0.031 | -0.1 | 0.057 | -0.036 | 0.407 |
| Neurological Dysfunction | 0.563 | 0.194 | 0.347 | 0.403 | 0.236 | 0.165 | 0.102 | -0.06 |
| Critical preoperative state | 0.663 | 1.19 | 1.711 | 1.865 | 2.147 | 2.45 | 2.343 | 2.446 |
| Angina | -1.381 | -1.9 | 0.078 | -0.155 | 0.035 | 0.154 | 0.29 | 0.255 |
| Extracardiac arteriopathy | 0.729 | 0.632 | 0.484 | 0.242 | 0.116 | 0.11 | 0.211 | 0.51 |
| Previous surgery | 0.904 | 0.566 | 0.505 | 0.183 | 0.725 | 0.754 | 0.874 | 0.824 |
| Extracardiac arteriopathy | 0.69 | 1.07 | 0.643 | 0.441 | 0.381 | 0.228 | -0.115 | -0.083 |
| LV function (Moderate) | 0.18 | 0.105 | 0.28 | 0.103 | 0.131 | 0.01 | 0.175 | -0.018 |
| LV function (Poor) | 0.254 | 0.47 | 0.502 | 0.372 | 0.362 | 0.225 | 0.341 | 0.174 |
| MI < 90 days before surgery | -0.122 | -0.132 | 0.018 | -0.3 | -0.317 | -0.431 | -0.244 | -0.226 |
| Urgency (Emergency) | 2.582 | 2.024 | 1.392 | 1.337 | 1.185 | 0.679 | 0.573 | 0.393 |
| Urgency (Urgent) | 0.905 | 0.55 | 0.17 | 0.242 | 0.238 | -0.036 | -0.062 | -0.066 |
| Surgery on thoracic aorta | 1.051 | 0.853 | 0.734 | 0.87 | 0.625 | 0.725 | 0.533 | 0.406 |

Supplementary table 5 – Performance measures and 95% confidence intervals from each model when validating in the complete validation data from 1st January 2012 to 30th June 2019.

|  |  |  |
| --- | --- | --- |
| Performance measure | Model | Performance value (95% CI) |
| Calibration-in-the-large | Logistic model | -0.237 (-0.398, -0.083) |
| Yearly updated logistic model | 0.057 (-0.059, 0.17) |
| Bayesian model | 0.019 (-0.107, 0.14) |
| Varying coefficient model | -0.688 (-0.849, -0.535) |
| Calibration slope | Logistic model | 0.73 (0.602, 0.856) |
| Yearly updated logistic model | 0.919 (0.794, 1.044) |
| Bayesian model | 0.925 (0.837, 1.013) |
| Varying coefficient model | 0.656 (0.525, 0.785) |
| Observed-expected ratio | Logistic model | 0.81 (0.694, 0.935) |
| Yearly updated logistic model | 1.054 (0.942, 1.172) |
| Bayesian model | 1.016 (0.904, 1.134) |
| Varying coefficient model | 0.544 (0.466, 0.628) |
| Discrimination | Logistic model | 0.709 (0.667, 0.751) |
| Yearly updated logistic model | 0.694 (0.66, 0.727) |
| Bayesian model | 0.778 (0.747, 0.809) |
| Varying coefficient model | 0.686 (0.642, 0.73) |