Supplemental Table 1 – Coding of Surgery Categories and Associated Examples

Surgery Category	Common Procedure Terminology (CPT) Codes	Examples
Abdominal Wall	11008, 35840, 49250, 49491, 49492, 49495, 49500, 49505, 49507, 49520, 49521, 49525, 49550, 49553, 49557, 49560, 49561, 49565, 49566, 49568, 49570, 49572, 49580, 49582, 49585, 49587, 49590, 49600, 49650, 49651, 49652, 49653, 49654, 49655, 49656, 49657, 49659, 49900, 49904, 49999	Inguinal hernia repair, umbilical hernia repair, incisional/ventral hernia repair
Vascular	33320, 33322, 33845, 33860, 33863, 33864, 33875, 33877, 33880, 33881, 33891, 33916, 34001, 34101, 34151, 34201, 34421, 34701, 34703, 34705, 34800, 34802, 34803, 34804, 34808, 34825, 34830, 34831, 34841, 34844, 34845, 35001, 35002, 35013, 35081, 35091, 35102, 35111, 35121, 35141, 35142, 35151, 35189, 35251, 35256, 35281, 35301, 35302, 35303, 35305, 35331, 35355, 35371, 35372, 35501, 35506, 35518, 35521, 35522, 35523, 35533, 35539, 35540, 35556, 35558, 35565, 35566, 35571, 35583, 35585, 35606, 35621, 35623, 35646, 35647, 35654, 35656, 35661, 35665, 35666, 35879, 35883, 35903, 35907, 37140, 37160, 75952, 75953	Thromboendarterectomy (carotid, vertebral, femoral, subclavian), bypass graft (femoral-popliteal, femoral-femoral)
Major Orthopedic	27076, 27090, 27091, 27122, 27125, 27130, 27132, 27134, 27137, 27138, 27187, 27227, 27228, 27236, 27244, 27245, 27248, 27253, 27254, 27269, 27290, 27329, 27440, 27441, 27442, 27443, 27445, 27446, 27447, 27472, 27486, 27487, 27488, 27495, 27506, 27507, 27511, 27514, 27524, 27535, 27536, 27540, 27580, 27590, 27591, 27592, 27594, 27596, 27598, 27758, 27759, 27784, 27827, 27828, 27829, 27832, 27848, 27880, 27881, 27882, 27884, 27886	Total knee arthroplasty, total hip arthroplasty, amputation through femur, amputation through tibia/fibula, open treatment of femoral neck fracture with internal fixation
Chest*	21630, 32035, 32096, 32097, 32098, 32100, 32110, 32120, 32140, 32150, 32160, 32220, 32225, 32320, 32440, 32480, 32482, 32491, 32500, 32503, 32505, 32650, 32651, 32652, 32654, 32656, 32657, 32658, 32659, 32660, 32661, 32662, 32663, 32666, 32667, 32668, 32669, 32673, 32800, 32820, 35820, 38381, 38746, 39220, 43107, 43112, 43113, 43116, 43314, 43328, 43352	Pulmonary lobectomy, thoracoscopy with lobectomy, pleurodesis, wedge resection
Cardiac*	33025, 33030, 33031, 33120, 33250, 33251, 33255, 33256, 33257, 33258, 33300, 33315, 33400, 33404, 33405, 33406, 33410, 33412, 33420, 33422, 33425, 33426, 33430, 33465, 33496, 33500, 33501, 33504, 33510, 33511, 33512, 33513, 33517, 33518, 33519, 33530, 33533, 33534, 33535, 33572, 33641, 33945, 33975, 33976, 33991	Aortic valve replacement (with cardiopulmonary bypass), coronary artery bypass graft, mitral valve replacement (with cardiopulmonary bypass)
Abdominal†	38100, 38102, 38120, 38573, 38747, 39502, 43117, 43118, 43121, 43122, 43123, 43279, 43280, 43281, 43282, 43330, 43337, 43361, 43425, 43510, 43620, 43621, 43622, 43631, 43632, 43644, 43653, 43659, 43770, 43775, 43820, 43830, 43831, 43845, 43860, 43880, 44005, 44020, 44050, 44110, 44111, 44120, 44121, 44130, 44139, 44140, 44141, 44143, 44144, 44145, 44146, 44147, 44150, 44151, 44155, 44158, 44160, 44180, 44186, 44187, 44188, 44202, 44204, 44205, 44206, 44207, 44208, 44210, 44211, 44213, 44227, 44238, 44310, 44312, 44314, 44320, 44620, 44625, 44626, 44640, 44660, 44661, 44799, 44820, 44950, 44960, 44970, 45110, 45111, 45395, 45563, 47562, 47563, 47564, 47600, 47605, 47612, 47740, 47741, 47780, 48105, 48140, 48145, 48146, 48150, 48153, 48154, 48155, 48520, 48548, 49000, 49002, 49020, 49255, 49320, 49321, 49322, 49324, 49325, 49329, 49402	Cholecystectomy, exploratory laparotomy, colectomy, laparoscopy for diagnosis or washout, appendectomy, pancreatectomy (Whipple)
Central Nervous System	61304, 61305, 61312, 61313, 61314, 61343, 61500, 61510, 61512, 61516, 61518, 61520, 61521, 61546, 61556, 61580, 61590, 61697, 61705, 61781, 62141, 62142, 62143	Craniectomy or craniotomy for evacuation of hematoma, excision of tumor, exploration, excision of meningioma

* Chest and cardiac surgeries were combined into one group for modeling
† Abdominal surgeries were further characterized as laparoscopic or open for modeling

Supplemental Table 2 – Knot Specifications for Restricted Cubic Spline Basis Functions

Variable	Knot Selections
Albumin (g/dL)	2.7, 3.7, 4.4
Sodium (mEq/L)	132, 137, 141, 145
Platelet Count (1,000/µL)	75, 152, 271

* Note that creatinine and international normalized ratio (INR) were modeled as linear relationships to the outcome

Supplemental Table 3: Model Selection Statistics and Discrimination for 30-day Post-Operative Mortality Among a Final Series of Candidate Models in the Derivation Set

Model	Number of Input Variables	Discrimination	Aikake Information Criterion (AIC)	Bayesian Information Criterion (BIC)
*ASA (ordinal) + platelet count + emergency status + surgery category + albumin + total bilirubin + obesity + NAFLD	8	0.8723	744.6377	837.3844
ASA (ordinal) + platelet count + emergency status + surgery category + albumin + total bilirubin + obesity	7	0.8673	751.6791	838.2428
ASA (binary) + platelet count + emergency status + surgery category + albumin + total bilirubin + obesity	7	0.8554	762.5705	849.1342
ASA (ordinal) + ascites + emergency status + surgery category + albumin + total bilirubin + obesity	7	0.8635	756.616	837.0798
ASA (ordinal) + platelet count + ascites + emergency status + surgery category + albumin + total bilirubin + obesity	8	0.8690	749.3014	842.0482
*ASA (ordinal) + platelet count + emergency status + surgery category + albumin + total bilirubin + obesity + atrial fibrillation	8	0.8690	750.5888	843.3355
*ASA (ordinal) + platelet count + emergency status + surgery category + albumin + total bilirubin + obesity + coronary artery disease	8	0.8674	753.6614	846.4082
*ASA (ordinal) + platelet count + emergency status + surgery category + albumin + total bilirubin + obesity + hypertension	8	0.8669	753.3128	846.0596
*ASA (ordinal) + platelet count + emergency status + surgery category + albumin + total bilirubin + obesity + diabetes mellitus	8	0.8674	753.5988	846.3456

Abbreviations: ASA = American Society of Anesthesiologists

* Final selected 30-day post-operative mortality model. This model maximized discrimination and minimized AIC and BIC. Addition of NAFLD improved models beyond inclusion of obesity alone. Models with ASA modeled as a binary variable were uniformly inferior (in terms of discrimination, AIC, and BIC) to ASA modeled as an ordinal variable. Addition of ascites did not improve models if platelet count was already in the model. Substitution of ascites for platelet count resulted in equivocal changes to model performance parameters.
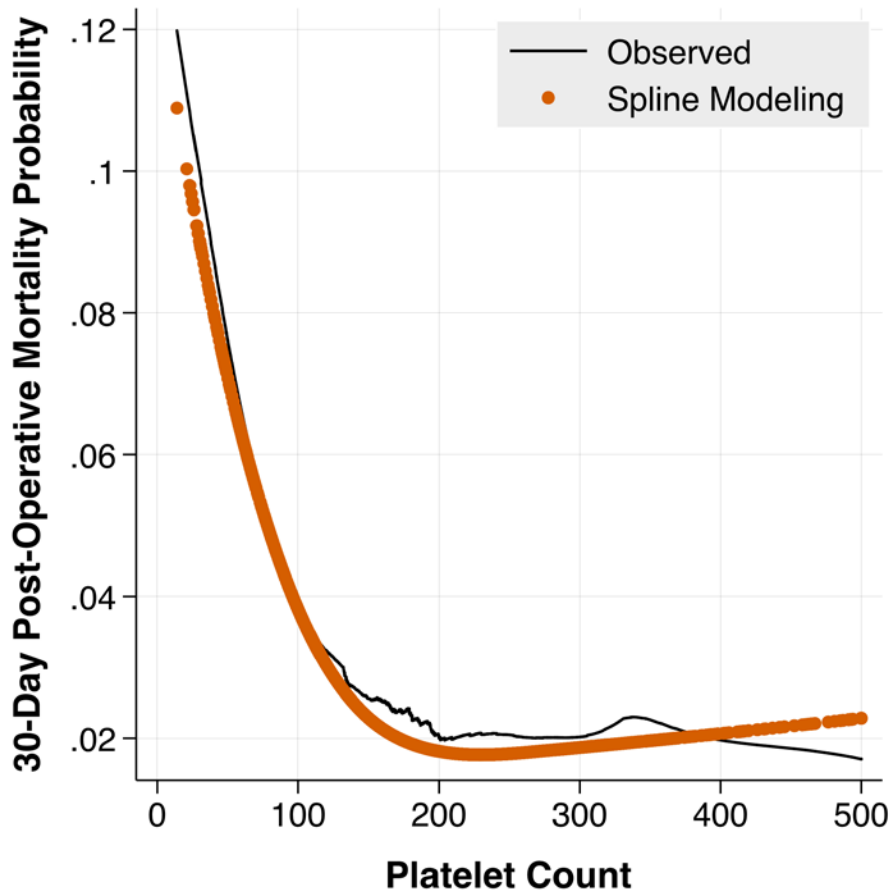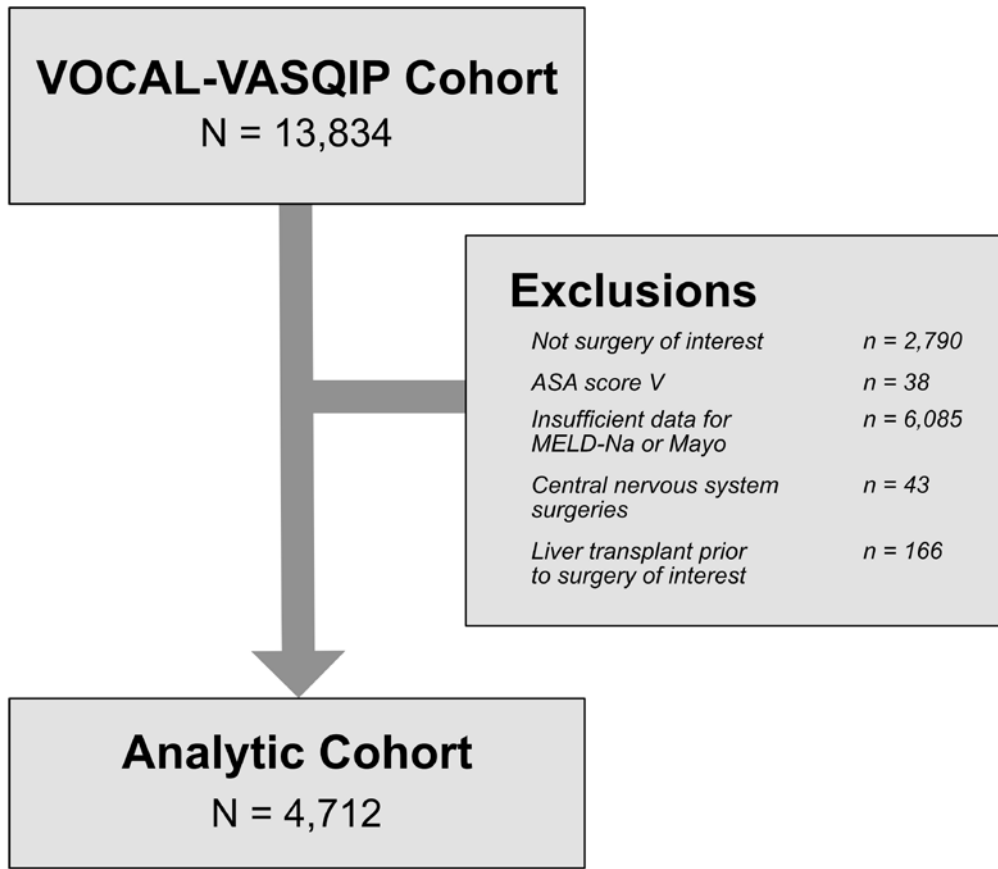
Supplemental Table 4: Discrimination (C-statistics) of Post-Operative Mortality for the VOCAL-Penn Models at 30, 90, and 180 Days when Restricted to Female Sex

Risk Score	30-Day	90-Day	180-Day
Derivation Cohort: *VOCAL-Penn*	**0.960 (0.920 – 1.000)**	**0.957 (0.919 – 0.995)**	**0.893 (0.780 – 1.000)**
Validation Cohort: *VOCAL-Penn*	**(no events)**	**(no events)**	**0.940 (0.845 – 1.000)**

Supplemental Table 5: Discrimination (C-statistics) of Post-Operative Mortality for the VOCAL-Penn Models at 30, 90, and 180 Days when Restricted to First Surgeries among Unique Patients

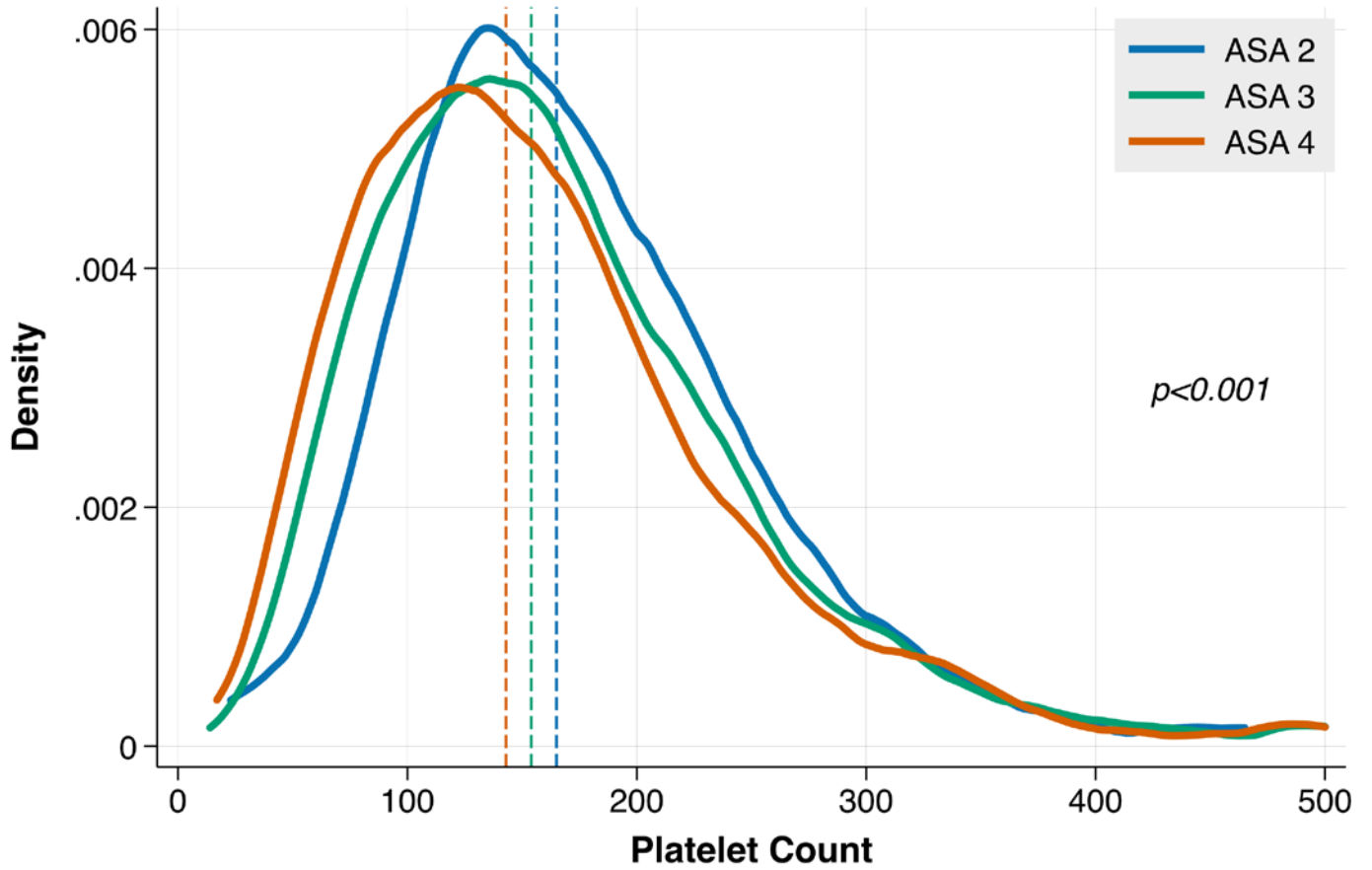| Risk Score	30-Day	90-Day	180-Day
Derivation Cohort: *VOCAL-Penn*	**0.888 (0.853 – 0.923)**	**0.844 (0.814 – 0.875)**	**0.818 (0.789 – 0.847)**
Validation Cohort: *VOCAL-Penn*	**0.855 (0.798 – 0.911)**	**0.820 (0.750 – 0.890)**	**0.814 (0.755 – 0.873)**

Supplemental Figure 1: Restricted Cubic Spline Modeling of 30-Day Post-Operative Mortality as a Function of Pre-Operative Platelet Count

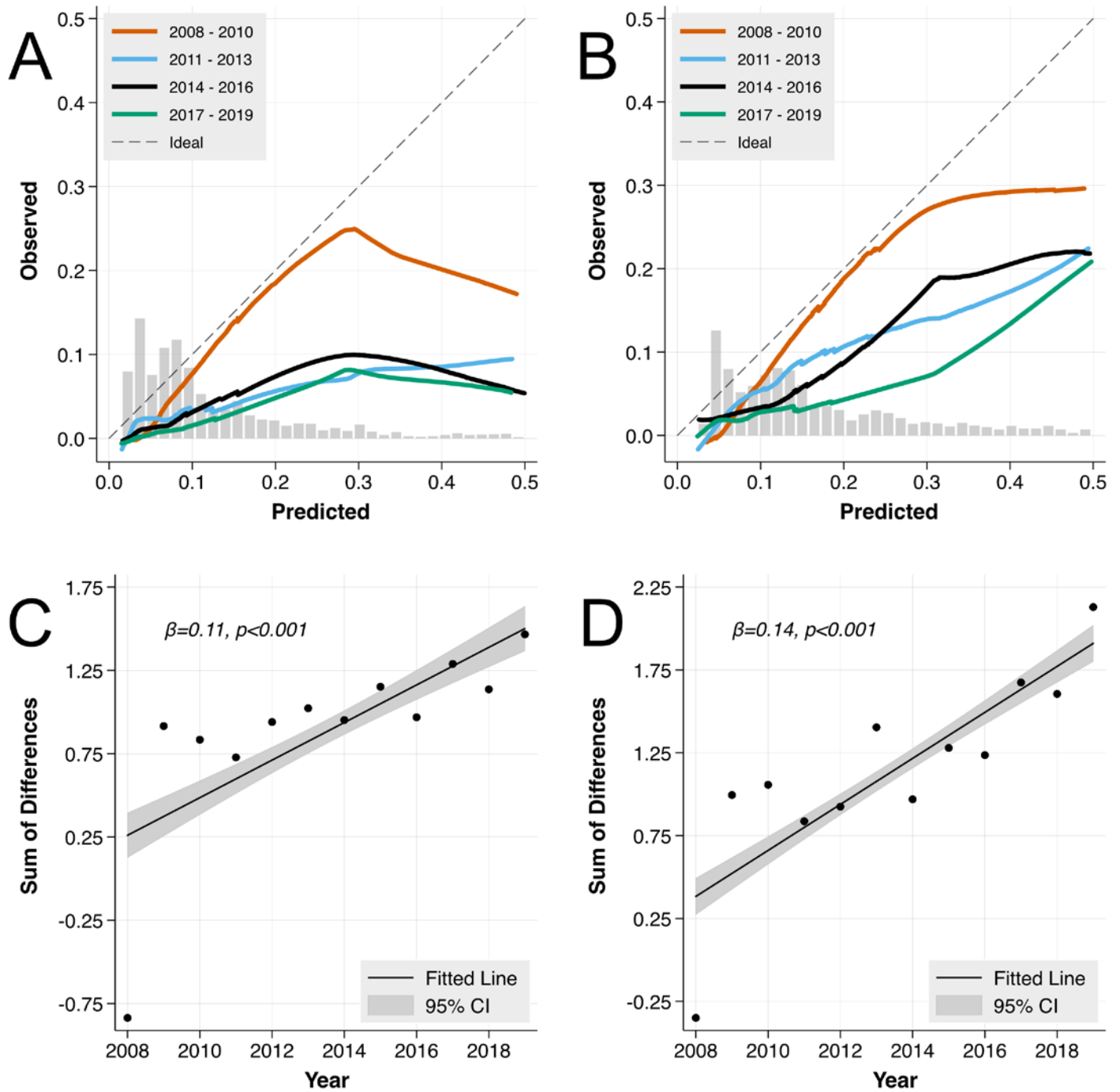**Supplemental Figure 2: Patient Flow Diagram for Analytic Cohort Creation**

Supplemental Figure 3: Pre-operative Platelet Count Distributions by ASA Classification

Abbreviations: ASA = American Society of Anesthesiologists
* Vertical dashed lines denote distribution medians. Distributions were compared using the Kruskal-Wallis test

Supplemental Figure 4: Post-operative Mortality Calibration of the Mayo Score over Time Restricted to Major Cardiovascular, Major Orthopedic, and Major Digestive Surgeries at 30 Days (A) and 90 Days (B), and Sum of Differences between Predicted and Observed Mortality over Time at 30 Days (C) and 90 Days (D)

* Overlaid histograms indicate the distribution of contributing data points

Appendix – Derivation of Formulas Defining Surgical Risk Models

These formulas may be used for subsequent validation studies. The authors are also available to run the formulas on a large dataset if the necessary fields are provided, or to provide coding functions to calculate predicted probabilities on external data. If this is desired, please contact the corresponding author.

Step 1: Obtain Spline Basis Functions (refer to Supplemental Table 2 for knot locations)

For a three-knot cubic spline:
Let k1, k2, and k3 correspond to the knot locations
Let x correspond to the target variable
$$Spline1 = x$$
$$Spline2 = ((x - k1)^3 * (x > k1) - (k3 - k2)^{-1}$$
$$* \left((x - k2)^3 * (x > k2) * (k3 - k1) - (x - k3)^3 * (x > k3) * (k2 - k1)\right))/(k3 - k1)^2$$

Step 2: Compute the Log Odds for Models

Post-operative Mortality at 30 Days:
$$log\ odds = -5.472096 + 1.061725 * \text{ASA} + 0.927904 * \text{emergency} + 1.56071 * surgery_{open\ abdominal}$$
$$+ 0.7418021 * surgery_{\text{abdominal wall}} + 0.9165415 * \text{surgery}_{\text{vascular}} + 1.464183$$
$$* \text{surgery}_{\text{major orthopedic}} + 1.893621 * \text{surgery}_{\text{chest/cardiac}} - 0.0075185 * \text{platelets}_{\text{sp1}}$$
$$+ 0.0036657 * \text{platelets}_{\text{sp2}} - 0.5181509 * \text{albumin}_{\text{sp1}} - 1.000672 * \text{albumin}_{\text{sp2}}$$
$$+ 0.1448936 * bilirubin - 0.7541669 * \text{obesity} + 0.8268748 * \text{NAFLD}$$

Post-operative Mortality at 90 Days:
$$log\ odds = -7.381628 + 0.6891587 * \text{ASA} + 0.6246303 * \text{emergency} + 0.0365738 * \text{age} + 1.349889$$
$$* surgery_{open\ abdominal} + 0.2480613 * surgery_{\text{abdominal wall}} + 1.054497 * \text{surgery}_{\text{vascular}}$$
$$+ 1.067452 * \text{surgery}_{\text{major orthopedic}} + 1.26527 * \text{surgery}_{\text{chest/cardiac}} - 0.4851036$$
$$* \text{albumin}_{\text{sp1}} - 0.9821122 * \text{albumin}_{\text{sp2}} + 0.82691 * \text{NAFLD}$$

Post-operative Mortality at 180 Days:
$$log\ odds = -6.169259 + 0.850114 * \text{ASA} + 0.0293034 * \text{age} + 0.8838124 * surgery_{open\ abdominal}$$
$$+ 0.197697 * surgery_{\text{abdominal wall}} + 0.4630691 * \text{surgery}_{\text{vascular}} + 0.1229086$$
$$* \text{surgery}_{\text{major orthopedic}} + 0.4320639 * \text{surgery}_{\frac{\text{chest}}{\text{cardiac}}} - 0.003719 * \text{platelets}_{\text{sp1}}$$
$$- 0.0004196 * \text{platelets}_{\text{sp2}} - 0.4560354 * \text{albumin}_{\text{sp1}} - 0.4166421 * \text{albumin}_{\text{sp2}}$$
$$- 0.5176601 * \text{obesity}$$

Step 3: Convert Log Odds to Predicted Probabilities (Unadjusted)

$$probability = \frac{exp(log\ odds)}{1 + exp(log\ odds)}$$

Step 4: Obtain Final Adjusted Probabilities for Post-Operative Mortality

Let p_30unadj = unadjusted probability at 30 days
Let p_90unadj = unadjusted probability at 90 days
Let p_180unadj = unadjusted probability at 180 days
Let p_30adj = adjusted probability at 30 days

Let p_90adj = adjusted probability at 90 days
Let p_180adj = adjusted probability at 180 days

$$p_{30adj} = p_{30unadj}$$
$$p_{90adj} = 1 - (1 - p_{30adj}) * (1 - p_{90unadj})$$
$$p_{180adj} = 1 - (1 - p_{30adj}) * (1 - p_{90unadj}) * (1 - p_{180unadj})$$