**EARLY DETECTION OF IMPENDING PHYSIOLOGIC DETERIORATION AMONG PATIENTS WHO ARE NOT IN INTENSIVE CARE:**

**DEVELOPMENT OF PREDICTIVE MODELS USING DATA FROM AN AUTOMATED ELECTRONIC MEDICAL RECORD**

**WEB APPENDIX FOR INTERESTED READERS**

**APPENDIX 1: Unit of analysis**

Figure 1: Structure of event and comparison shifts

Figure 2: Transformation of patient-level records into 12 hour patient shift records

**APPENDIX 2: Independent variables**

Description of (a) all independent variables used in the study, and (b) imputation strategy used for handling missing data.

**APPENDIX 3: Data processing strategy for vital signs and neurological status checks**

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Figure 3: relationship between sample size and the dropoff in the c statistic (cDeriv – cValid)

**APPENDIX 9: Expanded comparison of MEWS(re) and EMR-based models**

**REFERENCES**

**APPENDIX 1**

**DATA PROCESSING STRATEGY FOR CREATING ANALYSIS RECORDS**

Figure 1. (Comparison and Event Shifts) and Figure 2 (Transforming Patient Hospital Records into Shifts)illustrate the analytic structure we used in this project.

Figure 1 shows hypothetical event and comparison shifts. We captured predictors and outcomes during time periods divided into twelve hour shifts starting at 7 am or 7 pm (T0).

The upper diagram illustrates that the “look back” time frame for scanning vital signs and laboratory test results was 24 hours preceding T0, while the “look forward” time frame to scan for an event (transfer to the ICU, ward/transitional care unit death without a “do not resuscitate” order) was 12 hours.

The lower diagram shows that, in event shifts, the event can occur at any time between T0 and T0 +12 hours.

**Figure 1. Comparison and Event Shifts**

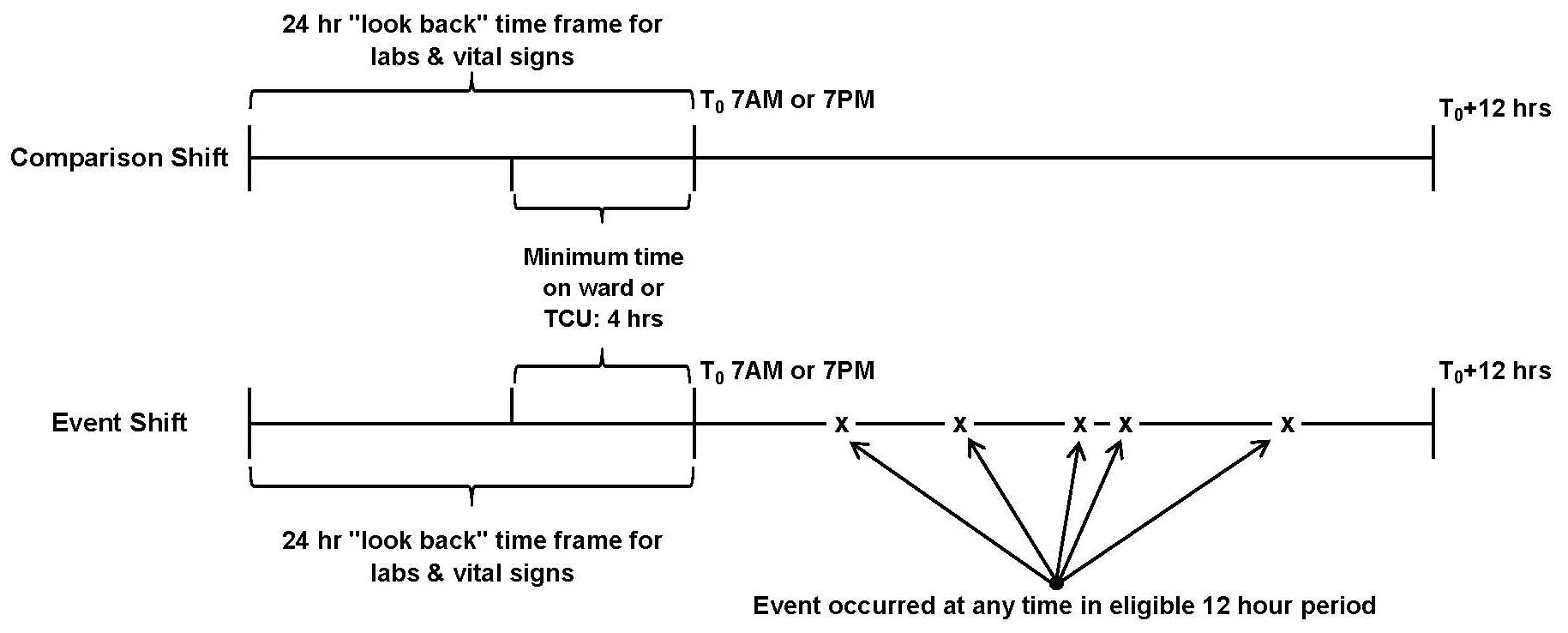


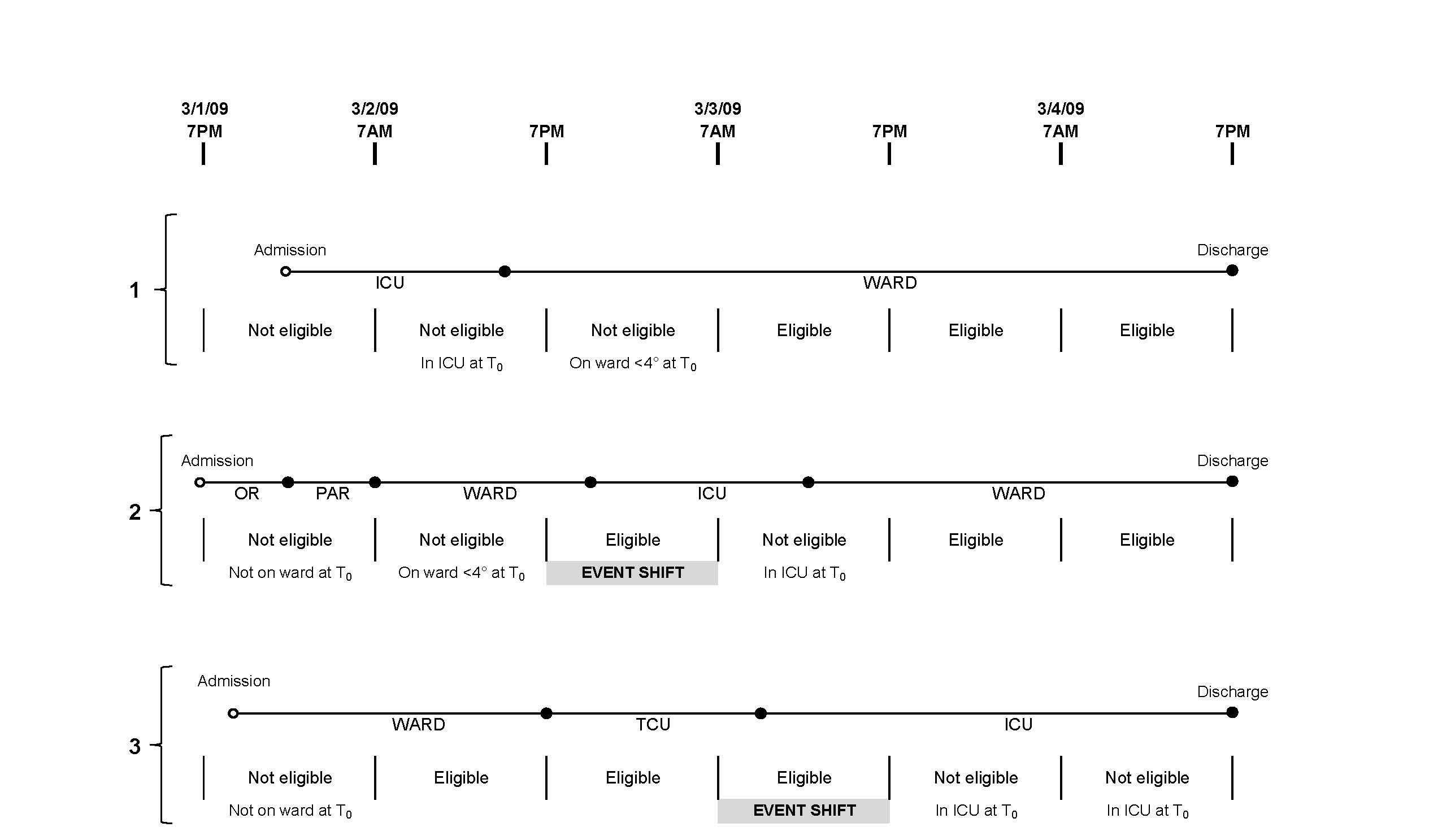
Figure 2 provides three examples of how we transformed patient-level hospitalization records into 12 hour patient shift records.

At top, example 1 shows the patient was admitted to the hospital on 3/1/09 at 0300 hours and discharged alive at 1500 hours on 3/4/09. Her hospitalization thus included six 12 hour shifts. Her initial hospital location was in the intensive care unit (ICU), and she was transferred from the ICU to the ward at 1700 hours on 3/2/09. Of her 6 shifts, 3 were not eligible for inclusion in the analysis: the first two shifts because she was not on the ward at the T0, and the third shift because she had been in the ward for less than 4 hours at the T0. Her remaining 3 shifts were eligible to be included in the analysis; since no transfer to the ICU occurred in any of them, and since she was discharged alive from the hospital, these 3 shifts were all *comparison shifts.* In the event her last shift had been one in which she died on the ward without a “do not resuscitate” order in place, then that last shift would have been classified as an *event shift*.

In the middle, example 2 shows the patient was admitted to the hospital on 3/1/09 at 2300 hours and discharged alive at 1300 hours on 3/4/09. This patient’s hospitalization also included six 12 hour shifts. His initial hospital location was the operating room (OR, 4 hours total) followed by 4 hours in the post-anesthesia recovery (PAR) room prior to transfer to the ward. On 3/2/09 at 2100 hours, this patient was transferred to the ICU from the ward – hence, this patient’s 3rd shift was eligible to be included in our analyses and was considered an *event shift*. Note that this patient’s 4th shift then became ineligible, as the patient was in the ICU at the T0. Thus, like patient 1, this patient only had 3 out of 6 shifts eligible for analysis, although one of those was an event shift.

At bottom, example 3 shows the patient was admitted at 2000 hours on 3/1/09 and had 3 eligible shifts, one of which was an event shift. The first shift was ineligible because the patient was not on the ward at the T0, while the last two were not eligible because the patient was in the ICU.

**Figure 2. Transforming Patient Hospital Records into Shifts**



**APPENDIX 2**

**INDEPENDENT VARIABLES INCLUDED IN FINAL ELECTRONIC MEDICAL RECORD-BASED MODELS**

**2.1 PRIMARY CONDITION**

Patients admitted to a KPMCP hospital receive an admission diagnosis as well as a final principal diagnosis. As described in our previous report ([1](#_ENREF_1)), in order to have a manageable number of diagnostic categories for our regression models, we divided all 16,090 possible International Classification of Diseases codes, including the V and E codes, into 44 mutually exclusive Primary Conditions (every ICD code was assigned to one and only one category). We followed an approach conceptually similar to that of Render et al. ([2](#_ENREF_2)). We did not use Render’s scheme because their groupings did not include all possible ICD codes and because the Veterans Administration population was primarily male. We defined groupings based on biological plausibility (we tried, insofar as possible, to group diseases with similar pathophysiology) as well as similar overall inpatient mortality and length of stay. More details on how we grouped codes are available in the web appendix from our previous study ([1](#_ENREF_1)) and the SAS code we used is available to interested readers on request.

The table below shows our ICU grouping scheme. The numbers of patients with some Primary Conditions who experienced transfer to the ICU from the ward or TCU were small. Consequently, in some cases we had to create larger groups that subsumed several primary conditions. These are described in Appendix 5.

|  |  |
| --- | --- |
| **PRIMARY CONDITION** | **DESCRIPTION & INCLUDED ICD CODES** |
| Congestive Heart Failure  010 CHF | Congestive heart failure & some related illnesses  Major codes are 425, 428, and miscellaneous (398.91, 402s, 422s, and some 429s, incl. ‘429’) |
| Sepsis  20 SEPSIS | Sepsis, meningitis, septic shock, and major catastrophic infections (003.1, 003.21, 027.0, 036-038, 040, 320-326, 422.92, 728.86, 785.4, 785.59, 790.7, 995.92, 9993) |
| Catastrophic conditions  030 CATAST | Catastrophic conditions, incl. dissecting aneurysms, cardiac arrest, respiratory arrest, all forms of shock except septic shock; intracranial & subdural hemorrhages (multiple ICD codes) |
| Pneumonia  40 PNEUM | All forms of pneumonia (480-487); empyema (510); pleurisy (511); and lung abscess (513); also includes pulmonary TB (011, 012.8); pulmonary congestion and hypostasis (514) |

|  |  |
| --- | --- |
| **PRIMARY CONDITION** | **DESCRIPTION & INCLUDED ICD CODES** |
| Ingestions and benign tumors  66 OD&BNCA | Non-gynecologic benign tumors  210-217, 222-239, 610, 611  Drug overdoses, drug abuse, adverse drug reactions, and poisonings  291, 292, 303-305, 790.3, 796, 960-989, 995.2 |
| Fluid and electrolyte disorders  71 FL&ELEC | Typical fluid & electrolyte disorders & dehydration  275.2 – 276.9 |
| Other metabolic  72 METAB3 | All other endocrine, metabolic & miscellaneous immune disorders (but not including SLE or RA)  240-255, 257-272, 274-275.1, 277-279, misc. 790s |
| Urinary tract infections  80 UTI | Urinary tract infections, not including pregnancy-related ones  590, 595, 597, 599, 601, 604, misc. 996s |
| All other infections  90 INFEC4 | All other infections with the exception of hepatitis; unspecified fever  001-139, multiple others, incl. joint infections & muscle infections (711 & 728); 780.6 (fever) |
| Stroke  110 STROKE | Stroke & post-stroke complications  434-438, 997.0x |
| Acute myocardial infarction  121 AMI | Myocardial infarction  410-414 |

|  |  |
| --- | --- |
| **PRIMARY CONDITION** | **DESCRIPTION & INCLUDED ICD CODES** |
| Other cardiac conditions  130 HEART2 | Diseases of pulmonary circulation & cardiac dysrhythmias  415-417, 426, 427, misc. 785s, misc. 996s |
| Gynecology  140 GYNEC1 | Non-malignant, non-infectious gynecologic diseases, incl. benign neoplasms  Must be female patient  218-221, 256 & multiple miscellaneous codes (including V codes). |
| Atherosclerosis and peripheral vascular disease  150 HEART4 | Atherosclerosis (including that affecting precerebral arteries) & other forms of peripheral vascular disease  429.2, 433, 440-459 |
| Other renal  170 RENAL3 | All other renal diseases other than infections  Miscellaneous 405s, 591-608, misc. other codes |
| Gynecologic cancers  180 GYNECA | Gynecologic malignancies other than ovarian cancer; female breast cancer  Must be female patient  174, 179-182, 184 |
| Pregnancy  190 PRGNCY | Pregnancy & related conditions  Must be female patient  630-677, V22 through V28 |
| Cancer A  201 CANCRA | Malignant neoplasms of respiratory tract & intrathoracic organs; leukemias, non-Hodgkin’s lymphomas, & other histiocytic malignancies  160-165, 202-208 |
| **PRIMARY CONDITION** | **DESCRIPTION & INCLUDED ICD CODES** |
| Ovarian and metastatic cancer  210 CANCRM | Ovarian cancer & metastatic cancer  183, 196-199 |
| Non-malignant hematologic  230 HEMTOL | Hematologic problems other than malignancies  273, 280-289, misc 790s, 996.85 |
| Seizures  240 SEIZURE | Seizure disorders  345, misc. 780.1-780.4 |
| Other neurological  251 NEUMENT | All other neurologic problems and mental disorders (other than drug overdoses); senility  290-319, 327-344, 346-389, 781, 797, V71.0 |
| Acute renal failure  270 RENAL1 | Acute renal failure, nephrotic syndrome, & related conditions  580, 581, 584 |
| Chronic renal failure  280 RENAL2 | Chronic renal failure, ESRD, & kidney transplants  582, 583, 585-589, 996.81, V42.0xx |
| Miscellaneous cardiac  290 MISCHRT | Miscellaneous cardiac conditions & congenital heart disease  392-405, 745-747 |
| COPD  300 COPD | COPD & some less common respiratory conditions  490-496, 500-508, 512, 515, 517-519 |

|  |  |
| --- | --- |
| **PRIMARY CONDITION** | **DESCRIPTION & INCLUDED ICD CODES** |
| Hip fracture  350 HIPFX | Hip fracture  Some 733s, 808, 820, 821, some 905s, 959.6 |
| Arthropathies  361 ARTHSPIN | Arthropathies and spine disorders (but no infections or autoimmune conditions)  712, 715-729, most 731-739 (except for 733.1xx, pathologic fracture) |
| Fractures and dislocations  381 FXDISLC | All other fractures & dislocations, incl. pathologic fractures  733.1xx, 805-807, 809-819, 822-839, misc. 905, 907, 952 |
| All other trauma  390 TRAUMA | Traumatic injuries not included elsewhere, including head injuries without intracranial or subdural bleeds  800-804, 840-848, 850-854, 860-904, most of 905-959 |
| Appendicitis & cholecystitis  411 APPCHOL | Appendicitis, hernias, cholecystitis, & cholangitis  540-543, 550-553, 574-576 |
| Pancreatic disorders  440 PNCRDZ | Pancreatic disorders  577 |
| GI IBD & obstruction  451 GIOBSENT | Inflammatory bowel disease and malabsorption; GI obstruction; enteritides  555-558,560, 568, 579 |

|  |  |
| --- | --- |
| **PRIMARY CONDITION** | **DESCRIPTION & INCLUDED ICD CODES** |
| Liver disorders  510 LIVERDZ | Liver disorders, including hepatitis  570-573 |
| Miscellaneous # 1  520 MISCL1 | Miscellaneous conditions not classified previously  990-999 |
| Miscellaneous # 2  531 MSC2&3 | Remaining V codes; remaining 790-796; all E codes. |
| Pericarditis  550 PERVALV | Pericarditis & valvular heart disease  391, 423, 424 |
| Skin & autoimmune disorders  560 SKNAUT | SLE, rheumatoid arthritis, skin disorders, & related autoimmune diseases, sialoadenitis  690-710, 713, 714, 782 |
| Miscellaneous # 3  591 MISCL5 | Miscellaneous non-cardiac congenital anomalies; miscellaneous symptoms other than fever; miscellaneous tooth & tongue disorders  520-529 (tooth & tongue disorders); 740-759, 780 (except for 780.6), 783-785 (if not found elsewhere) |

**2.2 SEX**

This field is routinely captured by several KPMCP databases and is readily available from the EMR.

**2.3 CARE ORDER STATUS**

Patients admitted to a KPMCP hospital must be assigned a level of care. In most cases, this is a “hard stop,” but some patients who are transferred across units may have brief periods during which no level of care order is in place. Based on audits conducted by our units, these periods seldom last more than 2-4 hours and tend to cluster early in the hospitalization.

The actual range of care directives is quite broad (e.g., some patients may be willing to receive pressor support but not intubation, some may not want antibiotic therapy, etc.). However, for analytic purposes, we have grouped data elements extracted from the EMR into 5 mutually exclusive categories.

No order No signed physician level of care order in effect.

Full code Patient desires full resuscitation efforts in the event of a cardiac or respiratory arrest.

Partial code Patient desires some resuscitation efforts in the event of a cardiac or respiratory arrest, and these are specified in the order.

DNR Do not resuscitate. Patient does not desire resuscitation efforts or transfer to the ICU in the event of a cardiac or respiratory arrest.

Comfort care Patient does not desire resuscitation or any support other than that required to increase comfort.

**2.4 COMPOSITE SCORES**

**LAPS**

**L**aboratory **A**cute **P**hysiology **S**core. This is an admission severity of illness score based on 14 laboratory test results obtained in the 72 hours preceding hospitalization:

Anion gap Bicarbonate Hematocrit

Albumin Bilirubin Sodium

Arterial pH Blood urea nitrogen Troponin I

Arterial PaCO2 Creatinine White blood cell count

Arterial PaO2 Glucose

This score is now routinely generated for internal risk adjustment purposes by the KPMCP. Its development, subsequent external validation, and use for research have been described previously ([1](#_ENREF_1)). With respect to a patient’s physiologic derangement, the unadjusted relationship of LAPS and inpatient mortality is as follows: a LAPS < 7 is associated with a mortality risk of < 1%, < 7 to 30 with a mortality risk of 0 - 5%, 30 to 60 with a mortality risk of 5 to 9%, and > 60 with a mortality risk of 10% or more. More details on how we grouped codes are available in the web appendix from our previous study, and the SAS code used to assign the LAPS is available to interested readers on request.

For these analyses we first standardized the LAPS and included both LAPS and LAPS squared.

**COPS**

**CO**morbidity **P**oint **S**core. This is a comorbidity burden score assigned on a monthly basis to all California Kaiser Foundation Health Plan, Inc. members ≥ 15 years of age. The score is based on electronic scanning of all diagnoses assigned to the patient in the preceding 12 months. Its development, subsequent external validation, and use for research have been described previously ([1](#_ENREF_1)). Analogous to POA (present on admission) coding, scores can range from 0 to a theoretical maximum of 701 but scores > 200 are rare. With respect to a patient’s pre-existing comorbidity burden, the unadjusted relationship of COPS and inpatient mortality is as follows: a COPS < 50 is associated with a mortality risk of < 1%, < 100 with a mortality risk of 0 - 5%, 100 to 145 with a mortality risk of 5 to 10%, and > 145 with a mortality risk of 10% or more.

For these analyses we first standardized the COPS and included both COPS and COPS squared.

We also included a COPS status variable to indicate when longitudinal data are not available for a given patient. Patients, for example, who are not members of the Kaiser Foundation Health Plan, Inc. will not have a COPS available in the KPMCP servers.

**2.5 HOSPITAL STATUS VARIABLES**

**LOS at T0**

This is the total time (in hours) that a patient was in the hospital at the T0. The variable was standardized.

**T0 time of day**

This could be 7 AM or 7 PM.

**Mortality**

Death in the hospital is captured by the KPMCP hospitalization database, along with the date and time of death.

**2.6 VITAL SIGNS**

In the course of defining our models, we tested multiple variables and interaction terms involving vital signs. The final variables we included, which varied by vital sign, were ‘most recent’, ‘worst’ and ‘variability’ which are described below. Shifts without values for any one of the vital signs (temperature, heart rate, blood pressure, respiratory rate, oxygen saturation) in the 24 hours before T0 were dropped from the analysis. If neurological status was missing, we imputed the value to normal.

**Most recent** If a patient had more than one vital sign measured in the 24 hours preceding the T0, this refers to the value closest to the T0.

**Worst** If a patient had more than one vital sign measured in the 24 hours preceding the T0, this refers to the value that is the most deranged.

**Variability** We calculated variability by subtracting the lowest value from the highest value. For example, a patient had the 3 respiratory rates below during the 24 hours preceding T0:

5/8/07 2240 14

5/9/07 0400 9

5/9/07 0640 27

The respiratory rate variability for this patient was equal to 13. If a patient had a single measurement in the time frame, then the variability would be 0. Similarly, if a patient had no measurement of a vital sign in the time frame, then the variability also would equal 0.

**Temperature**

We included worst (furthest from 98) temperature in the 24 hours preceding T0 and variability in temperature in the 24 hours preceding T0.

**Heart rate**

We included most recent heart rate in the 24 hours preceding T0 and variability in heart rate in the 24 hours preceding T0.

**Respiratory rate**

We included most recent respiratory rate in the 24 hours preceding T0, worst (furthest from 11) respiratory rate in the 24 hours preceding T0 and variability in respiratory rate in the 24 hours preceding T0.

**Diastolic pressure**

We transformed most recent diastolic blood pressure in the 24 hours preceding T0 by subtracting 70 and then squaring the result. We considered any value above 2,000 an outlier and so set any value above 2000 to 2000, thus yielding a continuous variable ranging from 0 to 2000.

**Systolic pressure**

We included variability in systolic blood pressure in the 24 hours preceding T0.

**Pulse oximetry**

We included worst (furthest from 100%) oxygen saturation in the 24 hours preceding T0 and variability in oxygen saturation in the 24 hours preceding T0.

**Neurological status**

We included most recent neurological status check in the 24 hours preceding T0. See Appendix 3 for a description of how these were generated from the EMR.

**2.5 INDIVIDUAL LABORATORY TEST RESULTS**

Ideally, we would use multiple laboratory test results in a predictive model. In practice, not all laboratory tests are uniformly available, and thus our final models included the following test results: blood urea nitrogen, hematocrit, white blood cell count, and a proxy for measured lactate (PML), which is equal to (anion gap ÷ serum bicarbonate) X 100. Although lactate measures are becoming routine in the KPMCP for emergency department patients, lactate is not generally obtained on large numbers of ward patients. Many ward patients, however, have anion gap and bicarbonate results and the research literature suggests these lab results are a suitable substitute for lactate measures (3-5).

Appendix 5 provides a detailed description of the imputation strategy we used when laboratory results were missing.

**APPENDIX 3**

**3.1 DATA PROCESSING STRATEGY FOR VITAL SIGNS (TEMPERATURE, HEART RATE, RESPIRATORY RATE, BLOOD PRESSURE, AND PULSE OXIMETRY)**

The KPMCP EMR does not have automatic limits for vital signs measurements. This means that it is possible for erroneous values (e.g., temperature = 67.4°F) to be entered into the EMR. During clinical care and with manual data abstraction, erroneous values may not be a problem, because the erroneous value can be evaluated (and probably dismissed) within the context of the patient’s general condition.

In our study, however, we downloaded a large amount of vital signs data that could not always be evaluated in the context of the patient’s general condition. With some vital signs, we assumed out of range values were errors (e.g., temperature = 67.4°F, or a heart rate of 312). This approach, however, was not appropriate for some abnormal values. For example, a heart rate of zero could be an error, but it could also represent a cardiac arrest.

Our team performed multiple audits to develop the data processing strategy used in this study. First, quality assurance nurses used the KP HealthConnect electronic medical record to perform contextual audits. For example, an audit of a respiratory rate of zero included a review of physician progress notes, nursing notes, respiratory care technician notes, and relevant flow sheets (including those tracking assisted ventilation). We also tested imputation strategies (e.g., attempting to define the “correct” value for an obviously erroneous vital sign based on contextual clues, such as the values of adjacent vital signs). In the course of these audits we found that, in many cases, nurses were assigning a respiratory rate of zero to patients receiving assisted ventilation.

Our final data processing strategy is summarized in the diagrams on the following pages. This strategy places vital signs into the following categories.

**Keep** The value found in the EMR is accepted as is, along with its corresponding time stamp.

**M** The EMR records a time for a vital sign, but the entry is blank.

**U** Based on the data cleaning algorithm, the value found in the EMR cannot be accepted, so it is assigned to an “uncertain” category indicating only that a measurement was obtained. The time stamp is retained.

**V** This category applies only to the respiratory rate of patients receiving nasal continuous positive airway pressure, intermittent mandatory ventilation, or respiratory support through a tracheostomy. For these situations, a value of V means that the respiratory rate found in the EMR cannot be accepted, so it is assigned to a “ventilator” category indicating only that a measurement was obtained. The time stamp is retained.

Allinstances of a heart rate of zero were manually verified using a standard protocol. If the heart rate of zero was confirmed by contextual clues (e.g., a progress note indicating that a “code blue” was called), then the value of zero was retained. If the heart rate of zero could not be confirmed, then its value was set to U.

We also found instances in which the EMR had two vital signs readings with an identical time stamp. In these cases, we first determined whether the two values differed by < 10%. If the difference between the two values was < 10%, we randomly selected one of the two values. If the difference was not < 10%, then we kept the time stamp but set the value of the vital sign to U.

The table below shows the results of running our vital sign cleaning algorithm on our initial study sample, which consisted of 145,197 hospitalizations between November 2006 and December 2009. This dataset included data from 102,422 patients for whom we retrieved a total of 36,730,352 vital signs measurements.

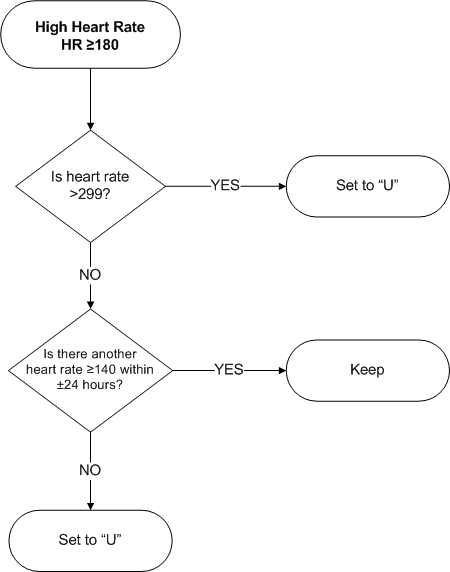
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  | **After algorithm value set to…** | |
| **Vital sign** | **Number** | **Missing** | **Uknown** | **Ventilator** |
| **Temperature** | 4,607,740 | 24,686 (0.54%) | 2,854 (0.06%) |  |
| **Heart rate** | 7,026,045 | 18,130 (0.26%) | 8,653 (0.12%) |  |
| **Respiratory rate** | 6,803,107 | 15,633 (0.23%) | 8,216 (0.12%) | 105 (0.002%) |
| **Oxygen saturation** | 6,132,634 | 0 | 19,712 (0.32%) |  |
| **Systolic pressure** | 6,080,413 | 25,001 (0.41%) | 1,258 (0.02%) |  |
| **Diastolic pressure** | 6,080,413 | 25,002 (0.41%) | 920 (0.02%) |  |

The diagrams on the following pages describe our vital sign cleaning algorithm.

**Vital Sign Cleaning Algorithm**











**3.2 DATA PROCESSING STRATEGY FOR NEUROLOGICAL STATUS CHECKS**

**Data source**

Neurological status checks are captured in multiple flowsheets in KP HealthConnect and assess the following neurological status parameters: consciousness level, mental status, speech, orientation (person, place, time, and event), the mentation component of the Schmid Fall Risk Assessment Tool, and pupils’ reactivity to light. The Glasgow Coma Scale is also captured in KP HealthConnect. Some of these flowsheets (e.g., those that capture the elements for the Glasgow Coma Scale for ICU patients) have drop down-menus that restrict what can be recorded, while others permit combining text from different drop down-menus. A patient may also have multiple concurrent measurements.

**Neurological status scale**

Given limited resources and the difficulties in reconciling different terms, we elected to categorize neurological status checks into the following groups.

0 Missing

1 Normal (i.e., entry clearly indicates that the patient’s neurological status and state of consciousness were unequivocally normal)

2 Ambiguous (i.e., entry suggests that patient’s neurological status was not normal, but does not permit a strong inference as to the degree of abnormality. This category also includes instances in which a provider states that he / she is “unable to assess” a patient’s neurological status)

3 Abnormal (i.e., entry permits a strong inference that patient’s neurological status was abnormal)

4 Extremely abnormal (i.e., entry permits a strong inference that patient’s neurological status was severely deranged and possibly life threatening)

**Scale development**

We used the following approach to categorize flowsheet entries. First, the principal investigator and an experienced project manager independently reviewed all the flowsheet text entries and categorized them using the 1 – 4 scheme noted above. Since complete agreement did not occur for some entries, we reviewed the ones where we disagreed and came to consensus on these.

In addition, we decided to keep only the most deranged status at each moment, when multiple concurrent neurological measurements existed. For example, a patient with a “Level of Consciousness” measure of “Awake” would be assigned a neurological status of “Normal”. However, if at that same moment, the patient’s “Orientation” was marked as “Confused”, then the patient would also be assigned a neurological status of “Abnormal”. The “Abnormal” status, however, would supersede the “Normal” status for that moment in time.

Sample flowsheet entries, by neurological status, are shown in the table below.

|  |  |  |
| --- | --- | --- |
| **Neurological status** | **Type of Measure** | **Value** |
| 1 (Normal) | Schmid Mentation Score | 0-ALERT, ORIENTED X 3 |
|  | Orientation | PERSON;PLACE;TIME;EVENT |
|  | Mental Status | RELAXED/CALM |
| 2 (Ambiguous) | Orientation | UNABLE TO ASSESS |
|  | Pupils | UNABLE TO ASSESS |
|  | Speech | UNABLE TO ASSESS |
| 3 (Abnormal) | Schmid Mentation Score | 1-PERIODIC CONFUSION |
|  | Speech | SLURRED |
|  | Orientation | CONFUSED |
| 4 (Very Abnormal) | Schmid Mentation Score | 1-CONFUSED AT ALL TIMES |
|  | Schmid Mentation Score | 0-COMATOSE/UNRESPONSIVE |
|  | Level of Consciousness | COMATOSE |

**Audit of Neurological Status**

We audited 115 separate neurological status measurements, increasing our sample size for the more deranged neurological status measurements. The purpose of the audit was two-fold: first, we compared extracted neurological status to the EMR to assess whether our extraction process worked properly; and second, we compared measured neurological status to the patient’s general condition and other neurological measurements in close proximity, to assess whether the patient’s measured neurological status correlated with other clinical measurements.

Our audit showed 100% agreement with the measurement shown in the EMR.

The following table shows the number and percent of neurological status measurements that did not correlate with other clinical and neurological measurements, by neurological status:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Neurological status | Normal | Ambiguous | Abnormal | Very Abnormal |
| N incorrect / total audited | 0 / 5 | 1 / 20 | 3 / 30 | 3 / 60 |
| % incorrect | 0% | 5% | 10% | 5% |

The table below shows a sample of our audited records.

|  |  |  |  |
| --- | --- | --- | --- |
| **Source of neurological assessment** | **Electronically assigned value** | **Is electronically assigned value correct according to manual chart review?** | **Categorization** |
| LASGOW COMA SCORE TOTAL | 7 | Y | Very Abnormal |
| SCHMID MENTATION | 0-COMATOSE/  UNRESPONSIVE | N | Very Abnormal |
| SCHMID MENTATION | 1-CONFUSED AT ALL TIMES | Y | Very Abnormal |
| ORIENTATION | PERSON | Y | Ambiguous |
| SPEECH | SPONTANEOUS, WELL PACED, LOGICAL;CLEAR | Y | Normal |
| SCHMID MENTATION | 1-CONFUSED AT ALL TIMES | Y | Very Abnormal |
| LEVEL OF CONSCIOUSNESS | STUPOROUS | N | Very Abnormal |
| SPEECH | EXPRESSIVE APHASIA | Y | Abnormal |
| SCHMID MENTATION | 1-PERIODIC CONFUSION | Y | Abnormal |
| SCHMID MENTATION | 0-COMATOSE/  UNRESPONSIVE | Y | Very Abnormal |
| SCHMID MENTATION | 1-PERIODIC CONFUSION | Y | Abnormal |
| SPEECH | DYSARTHIA | Y | Abnormal |

**Neurological Status and Inpatient Mortality**

In a sample of 57,586 KPMCP patients who came in through the emergency department in 2009, our final categorization scheme showed the following relationship of pre-admission neurological status to in-hospital mortality:

|  |  |  |  |
| --- | --- | --- | --- |
| Category | N of patients | N of deaths | Mortality rate (95% CI) |
| 0 Missing | 39 | 7 | 17.9% (5.7 - 30.1) |
| 1 Normal | 45,246 | 978 | 2.2% (2.0 - 2.3) |
| 2 Ambiguous | 368 | 21 | 5.7% (3.3 - 8.1) |
| 3 Abnormal | 7,686 | 527 | 6.9% (6.3 - 7.4) |
| 4 Very Abnormal | 4,247 | 582 | 13.7% (12.7 - 14.7) |

Patients with normal pre-admission neurological status had the lowest inpatient mortality, while those with abnormal or very abnormal status had higher inpatient mortality. Patients with ambiguous neurological status and those with no pre-admission measurements also fared worse than patients with normal pre-admission neurological status.

**APPENDIX 4**

**DATA PROCESSING STRATEGY FOR ASSIGNING THE MEWS(re)**

To generate the retrospective electronically-assigned MEWS, we used vital signs and neurological status checks that were cleaned as described in Appendix 3, above. The time frame for capture of data was 24 hours preceding the T0. Points were then assigned as follows and a MEWS score was compiled as the sum of the maximum points for each vital.

.

**Systolic blood pressure Heart Rate**

|  |  |
| --- | --- |
| VALUE | POINTS |
| Missing, U | 0 |
| 51 – 100 | 0 |
| 101 – 110 | 1 |
| 111 – 129 | 2 |
| ≥ 130 | 3 |
| 41 – 50 | 1 |
| < 40 | 2 |

|  |  |
| --- | --- |
| VALUE | POINTS |
| Missing, U | 0 |
| 101-199 | 0 |
| 81 – 100 | 1 |
| 71 – 80 | 2 |
| < 70 | 3 |
| ≥ 200 | 2 |

**Respiratory rate Temperature**

|  |  |
| --- | --- |
| VALUE | POINTS |
| Missing, U | 0 |
| 9 – 14 | 0 |
| < 9 | 2 |
| 15 – 20 | 1 |
| 21 – 29 | 2 |
| ≥ 30 | 3 |

|  |  |
| --- | --- |
| VALUE | POINTS |
| Missing, U | 0 |
| < 95˚F | 2 |
| 95 – 101.1˚F | 0 |
| ≥ 101.2˚F | 2 |

**Neurological status**

|  |  |
| --- | --- |
| VALUE | POINTS |
| 0, 1, missing | 0 |
| 2 | 1 |
| 3 | 2 |
| 4 | 3 |

**APPENDIX 5**

**ANALYTIC STRATEGY**

**5.1 JUSTIFICATION FOR CONDITION-SPECIFIC MODELS**

Our initial analyses were limited to data from a single KPMCP hospital (the first KPMCP hospital to adopt the inpatient EMR) between 11/1/06 and 1/31/08. This dataset consisted of 12,121 linked hospitalizations comprising 13,125 individual hospital stays for 8,815 patients. Our first extraction of selected vital signs (temperature, heart rate, respiratory rate, systolic blood pressure, diastolic blood pressure, oxygen saturation measured by pulse oximetry, and urine output) for these patients yielded a dataset with 4,994,952 individual vital signs measurements.

Given limited resources and the relatively small number of EMR records available to us at the time, we made extensive use of simulation methods to compensate for limited sample size. Our most important preliminary finding was that the ability of a “generic” approach (e.g., a score that could be used for all patients) to detect impending physiologic deterioration within a narrow time frame is limited. The reason for this is that different medical conditions can be said to “emit” different “signals,” and in many cases these signals may cancel each other out (a phenomenon analogous to “destructive interference”). This is illustrated in the three figures below, which display some of our modeling work for predicting transfer to the ICU between 8 and 72 hours.

Figure 5.1



Figure 5.2



Figure 5.3



Figures 5.1 through 5.3, above, show the mean systolic blood pressures for ward patients during the first 8 hours of their hospital stay. The horizontal axis displays elapsed hospital LOS in hours, while the vertical axis displays systolic in mm Hg. In these figures, data from patients who had a favorable outcome (survived the hospital stay and never experienced transfer to the ICU) are shown as a solid line, while data from patients who experienced an unplanned transfer to the ICU are shown as a dashed line. Figure 5.1 shows the mean systolic blood pressure for 175 ward patients with pneumonia, of whom 13 required transfer to the ICU. Figure 5.2 shows the same data for 518 ward patients admitted with gastrointestinal diagnoses, of whom 8 required transfer to the ICU. Figure 5.3 shows the patterns when data from all 693 pneumonia and gastrointestinal diagnosis patients (of whom 21 required ICU transfer) are combined. As can be seen, combining the data from the two patient groups leads to loss of a distinctive signal for blood pressure.

We also found that, when using regression models, specific vital signs-based variables showed different relationships in different diagnosis groups. For example, Table 5.1 below compares the value of the most recent (latest, or closest to the T0) systolic blood pressure (mm Hg) among patients with pneumonia, GI diagnoses, and also all patients in our study cohort.

**Table 5.1: Systolic blood pressure comparison**

Diagnostic group Event shifts Comparison shifts p

GI diagnoses 120.5 ± 21.8 126.2 ± 19.5 < 0.001

Pneumonia 125.8 ± 21.8 125.2 ± 19.3 0.69

All diagnoses 122.3 ± 23.1 125.8 ± 19.7 < 0.001

These and other analyses we conducted led us to conclude that employing a generic score (e.g., the MEWS) would not be an optimum strategy to extract the maximum signal.

The major problem we encountered in this effort was that not all of the 44 primary condition groups (described in Appendix 2, above, and in our previous report ([1](#_ENREF_1)) had a sufficient number of events. Therefore, we conducted additional analyses and also employed clinical judgment to collapse these 44 diagnostic categories into a final set of 24. Of these 24, 15 were based on our original grouping of ICD codes –

NEUMENT HEART2

AMI CATAST

GIOBSENT COPD

METAB1 ROAMI

CHF MISCL5

RENAL1 PNEUM

SEIZURE RESPR4

GIBLEED

– while 9 were pooled, as shown below:

K1 GYNECA K5 LIVERDZ

RENAL2 TRAUMA

GYNEC1

PRGNCY K6 RENAL3

MSC2&3 OD&BNCA

METAB3 SKNAUT

HEMTOL

K2 CANCRM FL&ELEC

CANCRB MSCL1

CANCRA

K9 STROKE

K3 UTI HIPFX

SEPSIS MISCHRT

INFEC4

K8 FXDISLC

K4 PERVALV ARTHSPIN

HEART4

K9 APPCHOL

PNCRDZ

**5.2 VARIABLE SELECTION PROCESS - GENERAL**

We evaluated multiple candidate variables prior to choosing our final set. Our evaluation strategy included the following considerations:

1. Physiologic plausibility or literature-based justification
2. Availability
3. Mathematical relationship to outcome, which included consideration of univariate, bivariate, and multivariate relationships
4. Parsimony (trying to keep the number of variables as low as possible, so as to minimize data processing steps when models are embedded in an EMR)

**5.3 INITIAL ANALYSES**

Initial steps included examination of basic descriptive statistics. For example, Table 5.2, below, contrasts event and comparison shifts, while Table 5.3 shows the rate of unplanned transfers in relationship to the care directive in place at the T0.

**Table 5.2: Descriptive statistics in derivation dataset**

Predictor Event shifts Comparison shifts p

Age (years) 67.2 ± 15.2 65.4 ± 17.4 < 0.001

Sex (% male) 49.7 44.5 < 0.001

Shift (% day) 33.8 44.5 < 0.001

Time in hospital (h) 147 ± 259 127 ± 215 0.008

**Table 5.3: Unplanned transfers by care directive in derivation dataset**

Care directive in effect at T0 Frequency Unplanned transfer rate

None 121 2.4%

Full code 17,403 9.8%

Partial code 469 16.4%

Do not resuscitate 3,495 5.5%

We tested regression models that were restricted to demographics, time in hospital, LAPS, and COPS. These models revealed that variables such as time in hospital, LAPS, and COPS did not have simple relationships to the study outcome. We also found that they had varying degrees of correlation. Consequently, we tested models in which these variables were standardized to having a mean value of 0 and a standard deviation of 1. This led to testing variables such as

standardized log (time in hospital)

standardized [standardized log(time in hospital)]2

standardized [standardized log(time in hospital)]3

standardized [standardized log(time in hospital)]4

as well as similar terms for LAPS and COPS.

**5.4 VITAL SIGNS**

We initially tested models using only data collected in the 12 hours preceding the T0. We found that these models suffered because some patients had sparse data. As a result, we eventually settled on a 24 hour time frame. For the vital signs, we tested the following variables, which came to a total of 73 variables (8 vital signs – temperature, heart rate, respiratory rate, systolic blood pressure, diastolic blood pressure, neurological status, pulse oximetry, and shock index – times 9 categories shown below + one overall uncertainty variable):

Worst vital sign in time frame (value representing greatest physiologic derangement)

Latest vital sign in time frame (closest to T0)

Crude trend (latest minus earliest)

Crude trend adjusted for duration of time interval between included vital signs

Extrapolated trend (trend assuming that latest was “brought forward” to the T0)

Extrapolated trend adjusted for time

Crude instability (absolute value of difference between highest and lowest in time frame)

Crude instability adjusted for time

Uncertainty

Uncertainty across all vital signs

The uncertainty term for a given vital sign was the time between the latest vital sign and the T0 divided by 24 hours. For example, if a patient’s last heart rate for a day shift occurred at 5 AM, then the uncertainty for heart rate was 2 hours (time difference between 5 AM and 7 AM) divided by the total interval (24 hours), or 8.3%. If a patient had no heart rates recorded in the time frame, the uncertainty was set to 100%. Out of our analysis cohort, fewer than 0.9% of possible patient shifts had less than a full set of vital signs and subsequent variables created from them, therefore those particular shifts were excluded from the final cohort.

We then employed a combination of recursive partitioning and regression analyses to determine which of the abovementioned 73 variables had the strongest signal. This was done by obtaining the 6 strongest vital sign predictors when added to a model that includes basic demographic variables. The metric to optimize all possible models when using six predictors was the Lagrange multiplier test. This test checks for all terms other than intercept to be in fact zero in the population. Asymptotically, this test statistic is the same as the likelihood ratio test which performs the same check.([3](#_ENREF_3)) The higher the test statistic, the more meaningful the terms are within the model. This process was done for all primary conditions, which was then compressed to listing which variables were picked as one of the 6 within the groups. The variables that appeared most often were then considered as “candidate predictors” for model building. These analyses led to our decision to include the variables listed in Table 3 of the manuscript.

**5.5 LABORATORY DATA**

Because laboratory data are known to be strong predictors of outcome, we wanted to include as many test results as possible. However, while patients in the emergency department often got most of the 14 laboratory tests in our Laboratory Acute Physiology Score, this was not the case with respect to patients in the ward or transitional care unit. The most consistently obtained tests (< 30% of patients with missing data for a given shift) were blood urea nitrogen (BUN), sodium, bicarbonate, anion gap, creatinine, and hematocrit. Based on our previous work ([1](#_ENREF_1)) as well as the literature on the use of the anion gap and bicarbonate (3-5) we combined the anion gap and bicarbonate into the PML (proxy for measured lactate) variable.

Given the high rate of missing laboratory data, and given our experience with the LAPS, we knew that we could not adopt simple imputation strategies for laboratory tests (e.g., simply imputing missing data to normal, as is commonly done in some severity scores). Our initial attempts at imputation were based on the methodology of Saria et al ([4](#_ENREF_4)), which addresses the variable relationship between missing data and outcome when a patient population is not of uniform risk. However, we found Saria et al.’s methodology computationally intensive and we also found that we could get comparable statistical performance with a simpler approach. Consequently, we settled on a simpler approach in which we subdivided the patient population into groups with a different underlying *a priori* risk for deterioration. Imputation then varied depending on a patient’s underlying risk.

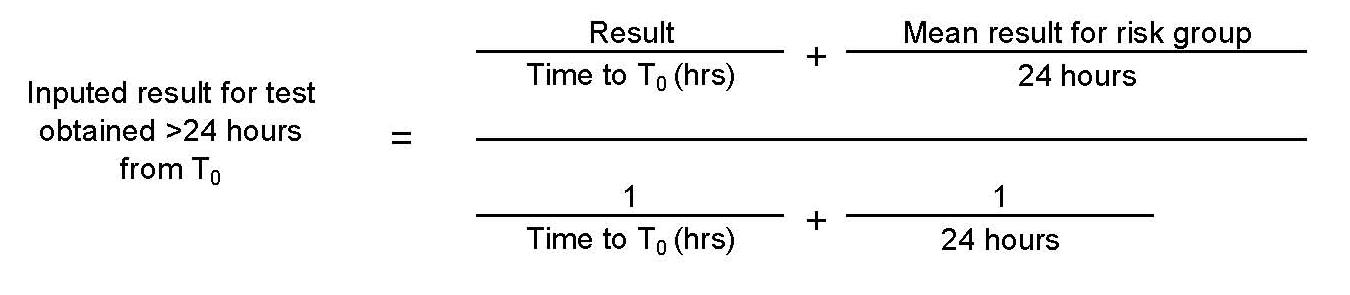
To create these risk groups, we employed recursive partitioning using datasets containing a patient’s age, sex, LAPS, COPS, and care directive. The figure below shows the results of the analysis that we employed to define four risk groups. The number of shifts differs slightly from the numbers reported in the main manuscript because this process was performed prior to final cleaning of the cohort.



Within the four risk groups, we calculated the mean values of laboratory test results for all patients who had that test within 24 hours of the T0. For patients without a given test result during their entire hospitalization, we imputed missing data to equal that of their risk group, as is shown in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **If Risk Group is…** | **Imputed BUN\_VALUE** | **Imputed pml\_value** | **Imputed**  **Hematocrit** | **Imputed WBC\_VALUE** |
| **1**  Laps < 27  Cops < 118 | 15.2 | 27.4 | 34 | 9.4 |
| **2**  Laps < 27  Cops >=118 | 22.4 | 28.2 | 33.1 | 8.9 |
| **3**  Laps >=27  Care Order = No order or DNR | 31.8 | 32.0 | 32.6 | 11.1 |
| **4**  Laps >=27  Care Order = Partial or Full code | 33.3 | 32.3 | 32.2 | 10.8 |

If a patient had a laboratory test result that was > 24 hours from the T0, we employed a weighted average technique that combined the patient’s actual test result with what one would have expected the test result to have been given the patient’s underlying risk group. The formula we employed is shown below, and the figure shows an example of how an individual patient’s BUN was assigned.



**5.6 VARIABLE TRANSFORMATION**

In this section we provide two examples of the approach we employed to transform variables.

We used bivariate comparisons between event shifts and comparison shifts in determining the overall strength of the predictor-outcome relationships. We also employed LOWESS (locally weighted scatterplot smoothing curves) ([5](#_ENREF_5)) to determine if any predictor-outcome relationship was non-linear. For example, both high and low hematocrits were associated with unplanned transfer to intensive care. Therefore, we subtracted individual hematocrit results from the mean hematocrit value among all the observations and then squared the results. This transformation captured the underlying quadratic relationship (Figure 5.6.1) found and transformed it into a linear one (Figure 5.6.2). Consequently, we introduced the transformed hematocrit into all models as a linear term (i.e, hematocrit transformed as in figure 5.6.2). We employed a similar strategy for diastolic blood pressure, although we found that applying a ceiling was necessary to adjust for outliers. This extra step prevented outliers from having an excessive effect on predicted risk.

**Figure 5.6.1**

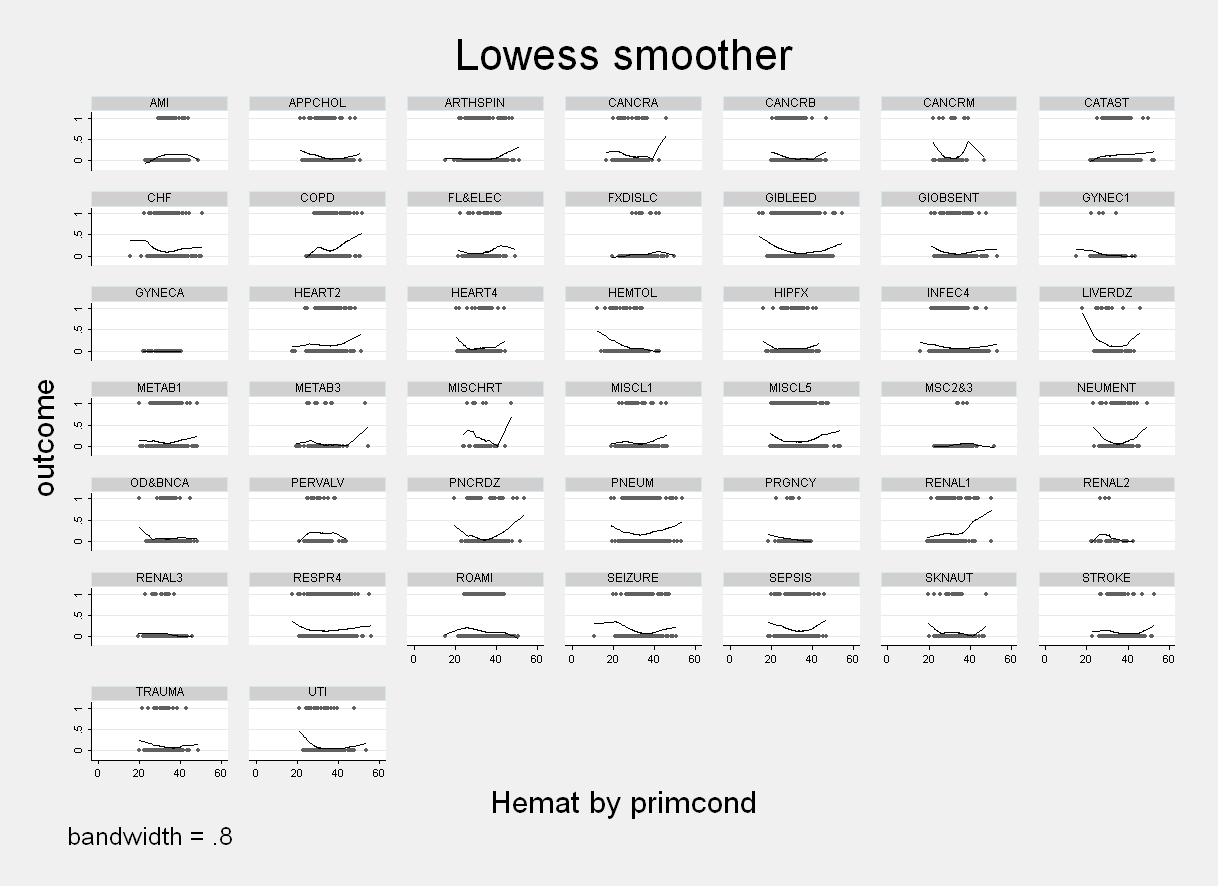


**Figure 5.6.2**



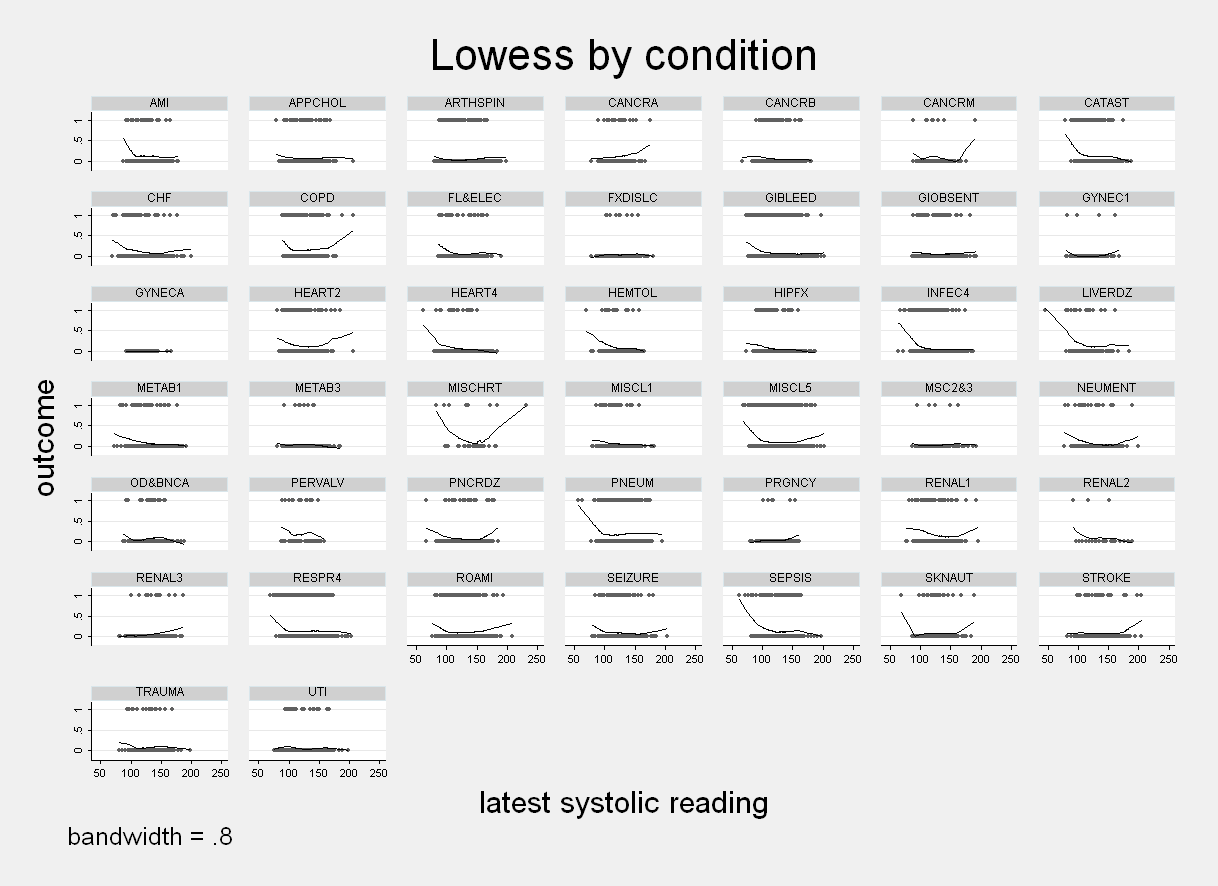
Figure 5.6.3, below, shows that the relationship of transformed hematocrit to outcome varied across primary conditions.

**Figure 5.6.3**



Incorporation of systolic blood pressure was more challenging. For some primary conditions, a quadratic relationship was present, as was the case with hematocrit. However, for some conditions only hypotension was predictive (Figure 5.6.4, below).

**Figure 5.6.4**



Given these relationships, we experimented with various approaches and eventually settled on the following one for how we handled systolic blood pressure. First, we created 5 systolic blood pressure groupings based on known physiology (< 90, 90-99, 100-139, 140-159, and ≥ 160 mm Hg). The table below shows the relationship between these groupings and the rate of event shifts in the derivation dataset.

|  |  |  |
| --- | --- | --- |
| **Systolic blood pressure range**  **(mm Hg)** | **N of shifts in derivation dataset** | **Rate (%) of event shifts** |
| **< 90** | 428 | 27.1 |
| **90 - 100** | 1,479 | 14.4 |
| **100 – 139** | 14,253 | 8.2 |
| **140 – 159** | 4,141 | 8.3 |
| **≥ 160** | 1,187 | 11.0 |

We created five categorical risk groups for systolic blood pressure and found that multiplying the risk group by the actual value of systolic blood pressure mimicked a splined variable (group cut points would be considered the knots within a spline). Although in the table above it appears that little difference exists between two of the groups (100 – 139 and 140 – 159), we did find that these two groupings did differ when looking at individual primary conditions.

**5.7. Final variable selection**

We defined a final set of variables and models using manual variable selection We assessed models using the approach recommended by Cook ([6](#_ENREF_6)), which includes examining the c statistic (area under the receiver operator characteristic curve), Hosmer-Lemeshow p value ([7](#_ENREF_7)), the Bayes Information Criterion, and the Nagelkerke pseudo R2. As a result of this process, we settled on the final variable list shown in Table 3 of the manuscript.

The table below describes the values we used for each type of variable in the model.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **VITAL SIGNS** | | | **LABORATORY VALUES** | **PATIENT STATUS** |
| **Most recent** | **Instability** | **Worst** | **Imputed** | **Status** |
| Heart rate | Temp | Temperature | Blood urea nitrogen | Sex |
| Respiratory rate | Heart rate | Oxygen Saturation | Proxy for measured lactate | Laboratory Acute Physiology Score |
| Systolic blood pressure | Respiratory rate |  | Hematocrit | Comorbidity Point Score |
| Diastolic blood pressure | Systolic blood pressure |  |  | Length of stay |
| Neurological score | Oxygen Saturation |  |  | Care directives |

**APPENDIX 6: Patient level comparison of patients who experienced unplanned transfer to the ICU with those who did not**1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Predictor** | | **Event patients** |  | **Comparison patients** |  | **P** |
| Number | | 3,525 |  | 26,151 |  |  |
| Age (mean ± SD2) | | 66.92 ± 15.55 |  | 65.05 ± 17.62 |  | <0.001 |
| Male (n, %) |  | 1,724 (48.91%) |  | 11,404 (43.61%) |  | <0.001 |
| Day shift | | 1,207 (34.24%) |  | 11,427 (43.70%) |  | <0.001 |
| LAPS3 | | 27.29 ± 21.78 |  | 18.68 ± 19.31 |  | <0.001 |
| COPS4 | | 110.67 ± 69.49 |  | 87.84 ± 61.47 |  | <0.001 |
| Full Code5 (n, %) | | 3,063 (87%) |  | 20,694 (83%) |  | <0.001 |
| ICU shift during hospitalization6 | | 3,455 (98.01%) |  | 3,928 (15.02%) |  | <0.001 |
| Unplanned transfer to ICU during hospitalization7 | | NA |  | 583 (2.2%) |  | <0.001 |
| Temperature (mean ± SD) | | 98.15 (1.13) |  | 98.10 (0.85) |  | 0.009 |
| Heart rate (mean ± SD) | | 90.34 (20.48) |  | 79.86 (5.27) |  | < 0.001 |
| Respiratory rate (mean ± SD) | | 20.36 (3.70) |  | 18.87 (1.79) |  | < 0.001 |
| Systolic Blood Pressure (mean ± SD) | | 123.65 (23.26) |  | 126.21 (19.88) |  | < 0.001 |
| Diastolic Blood Pressure (mean ± SD) | | 68.38 (14.49) |  | 69.46 (11.95) |  | < 0.001 |
| Oxygen saturation (mean ± SD) | | 95.72 (3.00) |  | 96.47 (2.26) |  | < 0.001 |
| MEWS(re)8 (mean ± SD) | | 3.64 (2.02) |  | 2.37 (1.63) |  | < 0.001 |
|  | % < 5 | 70.00% |  | 90.61% |  |  |
|  | % > 5 | 30.00% |  | 9.39% |  | < 0.001 |
| Proxy for measured lactate9 (mean ± SD) | | 37.22 (28.34) |  | 28.91 (16.24) |  | <0.001 |
|  | % missing in 24 hours before start of shift | 16.99% |  | 25.93% |  | <0.001 |
| Blood urea nitrogen (mean ± SD) | | 31.1 (24.96) |  | 21.48 (17.41) |  | <0.001 |
|  | % missing in 24 hours before start of shift | 19.67% |  | 28.90% |  | <0.001 |
| White blood cell count (mean ± SD) | | 12.32 (11.39) |  | 9.76 (5.43) |  | <0.001 |
|  | % missing in 24 hours before start of shift | 20.23% |  | 27.76% |  | <0.001 |
| Hematocrit (mean ± SD) | | 33.32 (6.36) |  | 33.52 (5.31) |  | 0.103 |
|  | % missing in 24 hours before start of shift | 19.64% |  | 26.28% |  | <0.001 |
|  |  |  |  |  |  |  |
|  | | | | | | |
|  | | | | |  |  |

|  |  |
| --- | --- |
| **FOOTNOTES, Appendix 6**   1. Code status, vital sign and laboratory values measures closest to the start of the shift with the event (7 am or 7 pm) are used for event patients. 2. Standard deviation 3. Laboratory Acute Physiology Score - see Table 1, text, and Appendix citation 1 for more details 4. COmorbidity Point Score - - see Table 1, text, and Appendix citation 1 for more details 5. Refers to patients who had an active “full code” order at the start of the sampling time frame. 6. See text for explanation of sampling time frame and how both cases and controls could have been in the intensive care unit (ICU). 7. See text for explanation of how both case and comparison patients could have experienced an unplanned transfer to the ICU 8. Modified Early Warning Score (retrospective electronic): see text and appendix citation 10 for a description of this score. 9. (Anion gap / bicarbonate) X 100 | |
|  |  |

**APPENDIX 7: Complete details on all 24 models**

**SPECIFIC VARIABLES USED TO GENERATE PREDICTED RISK FOR UNPLANNED TRANSFER TO ICU**

**Calculation is done at 7 am or 7 pm based on previous 24 hours of data.**

| **Variable Name** | **Variable Description** | **Units of change for the odds ratio** | **Explanation of Variables** | **Comment** |
| --- | --- | --- | --- | --- |
| SLAPS | Standardized LAPS assigned at admission or at first shift. | Odds ratio per unit of standardized transoformation of LAPS | (*LAPS -* 21.19) / 20.54 |  |
| SLAPS2 | Standardized LAPS assigned at admission or at first shift—squared. | Odds ratio per unit of standardized squared transformation of LAPS | (*LAPS*2 – 870.8) / 1418 |  |
| SCOPS | Standardized COPS assigned at admission or at first shift. | Odds ratio per unit of standardized transformation of COPS | (*COPS* – 102) / 69.1 |  |
| SCOPS2 | Standardized COPS assigned at admission or at first shift—squared. | Odds ratio per unit of standardized squared transformation of COPS | (*COPS*2 – 15179) / 18186 |  |
| SLELOS | Standardized log of elapsed length of stay. | Odds ratio per unit of standardized log transformation of length of stay | (log(*ELOS*) – 4.19) / 1.11 | Length of stay measured from admit order to start of shift during which algorithm is run. |
| SLELOS2 | Standardized log of elapsed length of stay squared. |  | (log(*ELOS*2) – 18.75) / 9.8 |  |
| SEX |  | Odds ratio of being a Female compared to Male | F=1  M=-1 |  |
| SHIFT | Whether score is being generated at start of day or night shift. | Odds ratio of being night shift compared to day shift | -1=7 am to 7 pm  1=7 pm to 7 am | Beta coefficient is applied as multiplier when value of SHIFT=1. |
| JHRTRT\_1 | Most recent heart rate | Odds ratio per unit increase from mean latest heart rate reading |  |  |
| RSPRT\_1 | Most recent respiratory rate | Odds ratio per unit increase from mean lastest respiratory rate reading |  |  |
| JWRS\_T | Worst temp in past 24 hours | Odds ratio per unit increase from mean worst temperature reading |  |  |
| JWRS\_SAT | Worst oxygen saturation in past 24 hours | Odds ratio per unit increase from mean worst 02sat reading |  |  |
| sbpdia | (latest diastolic BP-**70**)**2** | Odds ratio per unit increase of transformed diastolic blood pressure | if sbpdia > **2000** then sbpdia=**2000** |  |
| JLAT\_NEU | Most recent neurological score available | Odds ratio per unit increase of Level of Neurological Status |  |  |
| JCINS\_T | Range of temp in past 24 hours. | Odds ratio per unit increase of mean range of temperature values within 24 hours | Calculate range by subtracting the lowest value from the highest value. |  |
| JCINS\_HR | Range of heart rate in past 24 hours. | Odds ratio per unit increase of mean range of heart rate values within 24 hours | Calculate range by subtracting the lowest value from the highest value. |  |
| JCINS\_RR | Range of respiratory rate in past 24 hours. | Odds ratio per unit increase of mean range of respiratory rate values within 24 hours | Calculate range by subtracting the lowest value from the highest value. |  |
| JCINS\_SBP | Range of systolic BP in past 24 hours | Odds ratio per unit increase of mean range of systolic blood pressure values within 24 hours | Calculate range by subtracting the lowest value from the highest value. |  |
| JCINS\_SAT | Range of oxygen saturation in past 24 hours. | Odds ratio per unit increase of mean range of O2Sat values within 24 hours | Calculate range by subtracting the lowest value from the highest value. |  |
| BUN\_VALUE | Blood urea nitrogen | Odds ratio per unit increase of Blood Urea Nitrogen |  |  |
| PML\_VALUE | (Anion gap divided by bicarbonate) x 100. | Odds ratio per unit increase of Proxy for Measured Lactate | IF PML\_VALUE > **300** THEN PML\_VALUE=**300** |  |
| SHEMAT | (hematocrit score-**33**)2 | Per unit increase of transformed hematocrit |  |  |
| JWRS\_RR | Worst respiratory rate in past 24 hours | Odds ratio per unit increase of mean worst respiratory rate |  |  |
| CO\_CAT | Care order category | Odds ratio of being Full Code compared to Not Full Code | 0 = partial code, DNR, no order  1=Full Code | Patients with a care order of ‘comfort care’ in the 24 hours prior to T0 do not receive an EDIP score. |
| BPSYS\_1\*SBPSYS\_1 | Latest systolic blood pressure category 1. | Odds ratio per increase of mean systolic blood pressure when value falls in sbpsys1 group | if **90** ≤ latest sys BP < **100** | There are special conditions for this variable when the patient has PRIMCOND3=COPD: See below. |
| BPSYS\_1\*SBPSYS\_2 | Latest systolic blood pressure category 2. | Odds ratio per increase of mean systolic blood pressure when value falls in sbpsys2 group | if latest sys BP ≤ **90** |
| BPSYS\_1\*SBPSYS\_3 | Latest systolic blood pressure category 3. | Odds ratio per increase of mean systolic blood pressure when value falls in sbpsys3 group | if **140** ≤ latest sys BP < **160** |
| BPSYS\_1\*SBPSYS\_4 | Latest systolic blood pressure category 4. | Odds ratio per increase of mean systolic blood pressure when value falls in sbpsys4 group | If latest sys BP ≥ **160** |

Latest systolic blood pressure categories (BPSYS\_1\*sbpsys\_1-4) FOR PRIMCOND3=COPD only

| **Variable Name** | **Variable Description** | **Explanation of Variables** | **Comment** |
| --- | --- | --- | --- |
| BPSYS\_1\*SBPSYS\_1 | Latest systolic blood pressure falls into category 1. | If latest sys BP < 100 | These are the special conditions for this variable when the patient has PRIMCOND3=COPD. There is no category 2 for latest systolic blood pressure. |
| BPSYS\_1\*SBPSYS\_3 | Latest systolic blood pressure falls into category 3. | if latest sys BP ≤ **100** |
| BPSYS\_1\*SBPSYS\_4 | Latest systolic blood pressure falls into category 4. | if **140** ≤ latest sys BP < **160** |

**KEY FOR MODELS**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| AP\_PN |  | 'PNCRDZ','APPCHOL' | | |  |  |  |  |  |  |
| CANCER |  | CANCRA','CANCRB','CANCRM' | | |  |  |  |  |  |  |
| MIX |  | 'STROKE','HIPFX' | | 'MISCHRT' | |  |  |  |  |  |
| K6 |  | 'RENAL3','OD&BNCA','SKNAUT','HEMTOL','FL&ELEC','MISCL1' | | | | | |  |  |  |
| K5 |  | 'LIVERDZ','TRAUMA' | |  |  |  |  |  |  |  |
| K4 |  | 'PERVALV','HEART4' | |  |  |  |  |  |  |  |
| PRGNCY |  | 'GYNECA','RENAL2','GYNEC1','PRGNCY','MSC2&3','METAB3' | | | | | |  |  |  |
| ARTHSPIN |  | 'ARTHSPIN','FXDISLC' | | |  |  |  |  |  |  |
| SEPSIS |  | 'UTI','SEPSIS','INFEC4' | | |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| SLAPS |  | Odds ratio per unit of standardized transoformation of laps | | | | | |  |  |  |
| SLAPS2 |  | Odds ratio per unit of standardized squared transformation of laps | | | | | |  |  |  |
| SCOPS |  | Odds ratio per unit of standardized transoformation of Cops | | | | | |  |  |  |
| SCOPS2 |  | Odds ratio per unit of standardized squared transformation of Cops | | | | | | |  |  |
| SLELOS |  | Odds ratio per unit of standardized log transformation of length of stay | | | | | | |  |  |
| SEX |  | Odds ratio of being a Female compared to Male | | | | |  |  |  |  |
| SHIFT |  | Odds ratio of being night shift compared to day shift | | | | |  |  |  |  |
| JHRTRT\_1 |  | Odds ratio per unit increase from mean latest heart rate reading | | | | | |  |  |  |
| RSPRT\_1 |  | Odds ratio per unit increase from mean lastest respiratory rate reading | | | | | | |  |  |
| JWRS\_T |  | Odds ratio per unit increase from mean worst temperature reading | | | | | |  |  |  |
| JWRS\_SAT |  | Odds ratio per unit increase from mean worst 02sat reading | | | | | |  |  |  |
| SBPDIA |  | Odds ratio per unit increase of transformed diastolic blood pressure | | | | | | |  |  |
| JLAT\_NEU |  | Odds ratio per unit increase of Level of Neurological Status | | | | | |  |  |  |
| JCINS\_T |  | Odds ratio per unit increase of mean range of temperature values within 24 hours | | | | | | | |  |
| JCINS\_HR |  | Odds ratio per unit increase of mean range of heart rate values within 24 hours | | | | | | | |  |
| JCINS\_RR |  | Odds ratio per unit increase of mean range of respiratory rate values within 24 hours | | | | | | | |  |
| JCINS\_SBP |  | Odds ratio per unit increase of mean range of systolic blood pressure values within 24 hours | | | | | | | | |
| JCINS\_SAT |  | Odds ratio per unit increase of mean range of O2Sat values within 24 hours | | | | | | |  |  |
| BUN\_VALUE |  | Odds ratio per unit increase of Blood Urea Nitrogen | | | | |  |  |  |  |
| PML\_VALUE |  | Odds ratio per unit increase of Proxy for Measured Lactate | | | | | |  |  |  |
| SHEMAT |  | Per unit increase of transformed hematocrit | | | |  |  |  |  |  |
| JWRS\_RR |  | Odds ratio per unit increase of mean worst respiratory rate | | | | | |  |  |  |
| CO\_CAT |  | Odds ratio of being Full Code compared to Not Full Code | | | | | |  |  |  |
| BPSYS\_1\*SBPSYS1 |  | Odds ratio per increase of mean systolic blood pressure when value falls in sbpsys1 group | | | | | | | | |
| BPSYS\_1\*SBPSYS2 |  | Odds ratio per increase of mean systolic blood pressure when value falls in sbpsys2 group | | | | | | | | |
| BPSYS\_1\*SBPSYS3 |  | Odds ratio per increase of mean systolic blood pressure when value falls in sbpsys3 group | | | | | | | | |
| BPSYS\_1\*SBPSYS4 |  | Odds ratio per increase of mean systolic blood pressure when value falls in sbpsys4 group | | | | | | | | |
| Cops\_0 |  | Odds ratio of having a cops score higher than 0 versus not. | | | | | |  |  |  |
| WBC\_VALUE |  | Odds ratio per unit increase of mean white blood cell count | | | | | |  |  |  |

**GIBLEED**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 2,515 |  |  |  |
| Number of Outcomes | 218 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 3.6948 |
| SLAPS | 1.282 | (0.995 - 1.650) | 0.0542 | 0.24811 |
| SLAPS2 | 0.881 | (0.704 - 1.104) | 0.2711 | -0.1264 |
| SCOPS | 1.116 | (0.909 - 1.371) | 0.2937 | 0.11012 |
| SCOPS2 | 0.787 | (0.648 - 0.955) | 0.0152 | -0.2399 |
| SLELOS | 1.036 | (0.875 - 1.227) | 0.6785 | 0.03576 |
| SEX | 0.842 | (0.611 - 1.162) | 0.2950 | -0.0858 |
| SHIFT | 1.598 | (1.155 - 2.212) | 0.0047 | 0.23448 |
| JHRTRT\_1 | 1.031 | (1.021 - 1.041) | <.0001 | 0.03038 |
| RSPRT\_1 | 1.140 | (1.042 - 1.246) | 0.0041 | 0.13092 |
| JWRS\_T | 0.966 | (0.872 - 1.071) | 0.5132 | -0.0343 |
| JWRS\_SAT | 0.893 | (0.810 - 0.984) | 0.0222 | -0.1137 |
| sbpdia | 1.000 | (0.999 - 1.001) | 0.8018 | -0.0000 |
| JLAT\_NEU | 1.119 | (0.931 - 1.344) | 0.2310 | 0.11224 |
| JCINS\_T | 0.999 | (0.851 - 1.173) | 0.9879 | -0.0012 |
| JCINS\_HR | 1.008 | (0.997 - 1.020) | 0.1670 | 0.00803 |
| JCINS\_RR | 0.994 | (0.921 - 1.072) | 0.8710 | -0.0063 |
| JCINS\_SBP | 1.008 | (0.998 - 1.017) | 0.1206 | 0.00761 |
| JCINS\_SAT | 0.959 | (0.865 - 1.062) | 0.4179 | -0.0422 |
| BUN\_VALUE | 1.021 | (1.012 - 1.030) | <.0001 | 0.02085 |
| pml\_value | 1.007 | (0.998 - 1.015) | 0.1240 | 0.00662 |
| shemat | 1.006 | (1.003 - 1.010) | 0.0001 | 0.00635 |
| JWRS\_RR | 1.082 | (0.981 - 1.193) | 0.1149 | 0.07879 |
| CO\_CAT | 2.980 | (1.734 - 5.123) | <.0001 | 0.54600 |
| BPSYS\_1\*sbpsys\_1 | 1.000 | (. - .) | 0.9031 | -0.0003 |
| BPSYS\_1\*sbpsys\_2 | 1.014 | (. - .) | 0.0001 | 0.01418 |
| BPSYS\_1\*sbpsys\_3 | 0.995 | (. - .) | 0.0003 | -0.0053 |
| BPSYS\_1\*sbpsys\_4 | 0.996 | (. - .) | 0.0305 | -0.0042 |
|  |  |  |  |  |
| **c statistic** |  | **0.812** |  |  |
| **Hosmer-Lemeshow p value** | | **0.1276** |  |  |

**COPD1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 358 |  |  |  |
| Number of Outcomes | 71 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 18.3357 |
| SLAPS | 1.375 | (0.873 - 2.167) | 0.1699 | 0.31853 |
| SLAPS2 | 0.722 | (0.476 - 1.096) | 0.1257 | -0.3257 |
| SCOPS | 1.016 | (0.661 - 1.562) | 0.9432 | 0.01563 |
| SCOPS2 | 0.928 | (0.639 - 1.347) | 0.6929 | -0.0752 |
| SLELOS | 1.202 | (0.856 - 1.689) | 0.2874 | 0.18431 |
| SEX | 0.803 | (0.431 - 1.498) | 0.4910 | -0.1093 |
| SHIFT | 2.604 | (1.363 - 4.975) | 0.0038 | 0.47848 |
| JHRTRT\_1 | 1.035 | (1.015 - 1.056) | 0.0006 | 0.03482 |
| RSPRT\_1 | 1.058 | (0.943 - 1.188) | 0.3355 | 0.05670 |
| JWRS\_T | 0.796 | (0.614 - 1.032) | 0.0852 | -0.2277 |
| JWRS\_SAT | 0.959 | (0.795 - 1.156) | 0.6581 | -0.0423 |
| sbpdia | 1.001 | (1.000 - 1.003) | 0.0852 | 0.00127 |
| JLAT\_NEU | 1.372 | (0.890 - 2.114) | 0.1519 | 0.31616 |
| JCINS\_T | 1.165 | (0.786 - 1.725) | 0.4476 | 0.15231 |
| JCINS\_HR | 1.032 | (1.010 - 1.055) | 0.0038 | 0.03172 |
| JCINS\_RR | 1.077 | (0.995 - 1.167) | 0.0676 | 0.07438 |
| JCINS\_SBP | 0.996 | (0.977 - 1.016) | 0.7208 | -0.0035 |
| JCINS\_SAT | 0.968 | (0.797 - 1.175) | 0.7390 | -0.0330 |
| BUN\_VALUE | 1.000 | (0.974 - 1.027) | 0.9903 | 0.00016 |
| pml\_value | 1.000 | (0.977 - 1.024) | 0.9874 | 0.00019 |
| shemat | 1.004 | (0.998 - 1.009) | 0.2111 | 0.00361 |
| CO\_CAT | 2.448 | (1.037 - 5.782) | 0.0412 | 0.44765 |
| BPSYS\_1\*sbpsys\_1 | 1.013 | (. - .) | 0.0050 | 0.01248 |
| BPSYS\_1\*sbpsys\_3 | 0.996 | (. - .) | 0.1081 | -0.0039 |
| BPSYS\_1\*sbpsys\_4 | 0.997 | (. - .) | 0.3692 | -0.0029 |
|  |  |  |  |  |
| **c statistic** |  | **0.815** |  |  |
| **Hosmer-Lemeshow p value** | | **0.7925** |  |  |

**GIOBSENT**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 556 |  |  |  |
| Number of Outcomes | 38 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 19.7267 |
| SLAPS | 0.892 | (0.464 - 1.713) | 0.7305 | -0.1147 |
| SLAPS2 | 1.726 | (0.754 - 3.950) | 0.1966 | 0.54559 |
| SCOPS | 1.130 | (0.630 - 2.024) | 0.6824 | 0.12179 |
| SCOPS2 | 1.213 | (0.673 - 2.186) | 0.5200 | 0.19328 |
| SLELOS | 1.358 | (0.863 - 2.137) | 0.1865 | 0.30569 |
| SEX | 0.609 | (0.252 - 1.469) | 0.2694 | -0.2481 |
| SHIFT | 0.854 | (0.366 - 1.990) | 0.7141 | -0.0790 |
| JHRTRT\_1 | 1.050 | (1.021 - 1.080) | 0.0006 | 0.04905 |
| RSPRT\_1 | 0.975 | (0.803 - 1.184) | 0.7969 | -0.0254 |
| JWRS\_T | 0.965 | (0.699 - 1.333) | 0.8311 | -0.0351 |
| JWRS\_SAT | 0.764 | (0.594 - 0.981) | 0.0350 | -0.2696 |
| sbpdia | 0.999 | (0.997 - 1.001) | 0.4033 | -0.0008 |
| JLAT\_NEU | 1.361 | (0.869 - 2.132) | 0.1779 | 0.30835 |
| JCINS\_T | 1.109 | (0.673 - 1.828) | 0.6851 | 0.10336 |
| JCINS\_HR | 1.035 | (1.009 - 1.061) | 0.0076 | 0.03440 |
| JCINS\_RR | 1.165 | (1.023 - 1.328) | 0.0214 | 0.15314 |
| JCINS\_SBP | 1.012 | (0.985 - 1.039) | 0.3883 | 0.01178 |
| JCINS\_SAT | 0.947 | (0.726 - 1.235) | 0.6878 | -0.0543 |
| BUN\_VALUE | 1.050 | (1.017 - 1.084) | 0.0025 | 0.04917 |
| pml\_value | 0.983 | (0.955 - 1.011) | 0.2280 | -0.0173 |
| shemat | 1.005 | (0.998 - 1.013) | 0.1841 | 0.00520 |
| CO\_CAT | 3.826 | (0.537 - 27.272) | 0.1806 | 0.67085 |
| BPSYS\_1\*sbpsys\_1 | 0.989 | (. - .) | 0.2289 | -0.0108 |
| BPSYS\_1\*sbpsys\_2 | 1.027 | (. - .) | 0.0633 | 0.02669 |
| BPSYS\_1\*sbpsys\_3 | 0.990 | (. - .) | 0.0252 | -0.0103 |
| BPSYS\_1\*sbpsys\_4 | 1.003 | (. - .) | 0.4498 | 0.00335 |
|  |  |  |  |  |
| **c statistic** |  | **0.910** |  |  |
| **Hosmer-Lemeshow p value** | | **0.8152** |  |  |

**ROAMI**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 704 |  |  |  |
| Number of Outcomes | 86 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 11.684 |
| SLAPS | 1.494 | (0.966 - 2.312) | 0.0714 | 0.40153 |
| SLAPS2 | 0.765 | (0.500 - 1.170) | 0.2170 | -0.2676 |
| SCOPS | 0.879 | (0.644 - 1.199) | 0.4154 | -0.1291 |
| SCOPS2 | 1.262 | (0.946 - 1.682) | 0.1134 | 0.23232 |
| SLELOS | 0.915 | (0.705 - 1.189) | 0.5084 | -0.0883 |
| SEX | 0.913 | (0.545 - 1.531) | 0.7309 | -0.0453 |
| SHIFT | 1.620 | (0.933 - 2.810) | 0.0863 | 0.24111 |
| JHRTRT\_1 | 1.029 | (1.012 - 1.045) | 0.0006 | 0.02812 |
| RSPRT\_1 | 1.059 | (0.923 - 1.216) | 0.4119 | 0.05759 |
| JWRS\_T | 0.901 | (0.757 - 1.072) | 0.2405 | -0.1041 |
| JWRS\_SAT | 0.916 | (0.760 - 1.102) | 0.3511 | -0.0882 |
| sbpdia | 1.001 | (1.000 - 1.002) | 0.0357 | 0.00115 |
| JLAT\_NEU | 0.865 | (0.556 - 1.345) | 0.5195 | -0.1450 |
| JCINS\_T | 1.689 | (1.239 - 2.303) | 0.0009 | 0.52422 |
| JCINS\_HR | 1.012 | (0.996 - 1.028) | 0.1366 | 0.01199 |
| JCINS\_RR | 1.026 | (0.956 - 1.102) | 0.4730 | 0.02612 |
| JCINS\_SBP | 0.994 | (0.979 - 1.008) | 0.3995 | -0.0063 |
| JCINS\_SAT | 0.970 | (0.795 - 1.184) | 0.7674 | -0.0300 |
| BUN\_VALUE | 1.008 | (0.990 - 1.027) | 0.3632 | 0.00831 |
| pml\_value | 1.007 | (0.988 - 1.027) | 0.4718 | 0.00710 |
| shemat | 0.996 | (0.990 - 1.003) | 0.2811 | -0.0037 |
| CO\_CAT | 1.916 | (0.856 - 4.289) | 0.1138 | 0.32513 |
| SLELOS2 | 1.692 | (1.326 - 2.158) | <.0001 | 0.52570 |
| BPSYS\_1\*sbpsys\_1 | 1.001 | (. - .) | 0.8577 | 0.00075 |
| BPSYS\_1\*sbpsys\_2 | 1.003 | (. - .) | 0.7146 | 0.00275 |
| BPSYS\_1\*sbpsys\_3 | 0.997 | (. - .) | 0.1711 | -0.0034 |
| BPSYS\_1\*sbpsys\_4 | 1.003 | (. - .) | 0.3172 | 0.00305 |
|  |  |  |  |  |
| **c statistic** |  | **0.790** |  |  |
| **Hosmer-Lemeshow p value** | | **0.8666** |  |  |

**HEART2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 317 |  |  |  |
| Number of Outcomes | 52 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 6.986 |
| SLAPS | 0.857 | (0.487 - 1.506) | 0.5905 | -0.1548 |
| SLAPS2 | 0.818 | (0.387 - 1.729) | 0.5981 | -0.2013 |
| SCOPS | 1.015 | (0.667 - 1.547) | 0.9430 | 0.01535 |
| SCOPS2 | 0.993 | (0.625 - 1.576) | 0.9757 | -0.0071 |
| SLELOS | 0.675 | (0.459 - 0.992) | 0.0454 | -0.3930 |
| SEX | 0.979 | (0.494 - 1.941) | 0.9525 | -0.0104 |
| SHIFT | 2.237 | (1.075 - 4.656) | 0.0314 | 0.40252 |
| JHRTRT\_1 | 1.024 | (1.008 - 1.040) | 0.0031 | 0.02346 |
| RSPRT\_1 | 1.121 | (0.947 - 1.327) | 0.1853 | 0.11408 |
| JWRS\_T | 1.044 | (0.817 - 1.335) | 0.7288 | 0.04347 |
| JWRS\_SAT | 0.828 | (0.669 - 1.024) | 0.0811 | -0.1891 |
| sbpdia | 1.001 | (0.999 - 1.002) | 0.3146 | 0.00073 |
| JLAT\_NEU | 1.076 | (0.705 - 1.641) | 0.7343 | 0.07306 |
| JCINS\_T | 1.049 | (0.705 - 1.559) | 0.8146 | 0.04742 |
| JCINS\_HR | 1.003 | (0.988 - 1.018) | 0.7246 | 0.00272 |
| JCINS\_RR | 0.948 | (0.855 - 1.052) | 0.3157 | -0.0531 |
| JCINS\_SBP | 1.001 | (0.979 - 1.023) | 0.9370 | 0.00087 |
| JCINS\_SAT | 0.864 | (0.689 - 1.084) | 0.2077 | -0.1457 |
| BUN\_VALUE | 1.021 | (0.997 - 1.046) | 0.0822 | 0.02113 |
| pml\_value | 1.008 | (0.983 - 1.033) | 0.5519 | 0.00747 |
| shemat | 1.002 | (0.995 - 1.010) | 0.5129 | 0.00238 |
| BPSYS\_1\*sbpsys\_1 | 1.005 | (. - .) | 0.3609 | 0.00480 |
| BPSYS\_1\*sbpsys\_2 | 0.998 | (. - .) | 0.8844 | -0.0016 |
| BPSYS\_1\*sbpsys\_3 | 0.996 | (. - .) | 0.2821 | -0.0040 |
| BPSYS\_1\*sbpsys\_4 | 1.001 | (. - .) | 0.7759 | 0.00123 |
|  |  |  |  |  |
| **c statistic** |  | **0.763** |  |  |
| **Hosmer-Lemeshow p value** | | **0.0609** |  |  |

**CATAST**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 369 |  |  |  |
| Number of Outcomes | 59 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | -3.6766 |
| SLAPS | 0.623 | (0.377 - 1.031) | 0.0654 | -0.4726 |
| SLAPS2 | 1.159 | (0.827 - 1.626) | 0.3919 | 0.14778 |
| SCOPS | 0.974 | (0.633 - 1.498) | 0.9039 | -0.0265 |
| SCOPS2 | 0.880 | (0.621 - 1.245) | 0.4697 | -0.1282 |
| SLELOS | 1.073 | (0.746 - 1.544) | 0.7034 | 0.07071 |
| SEX | 0.521 | (0.239 - 1.137) | 0.1014 | -0.3259 |
| SHIFT | 0.793 | (0.392 - 1.606) | 0.5193 | -0.1159 |
| JHRTRT\_1 | 1.025 | (0.999 - 1.051) | 0.0587 | 0.02421 |
| RSPRT\_1 | 1.167 | (1.046 - 1.302) | 0.0056 | 0.15440 |
| JWRS\_T | 1.053 | (0.869 - 1.277) | 0.5995 | 0.05159 |
| JWRS\_SAT | 0.901 | (0.749 - 1.083) | 0.2661 | -0.1044 |
| sbpdia | 1.000 | (0.998 - 1.001) | 0.6312 | -0.0004 |
| JLAT\_NEU | 0.860 | (0.631 - 1.172) | 0.3403 | -0.1506 |
| JCINS\_T | 1.131 | (0.869 - 1.471) | 0.3604 | 0.12285 |
| JCINS\_HR | 0.995 | (0.968 - 1.023) | 0.7154 | -0.0050 |
| JCINS\_RR | 1.107 | (1.039 - 1.179) | 0.0017 | 0.10136 |
| JCINS\_SBP | 1.005 | (0.986 - 1.025) | 0.5929 | 0.00520 |
| JCINS\_SAT | 0.983 | (0.815 - 1.186) | 0.8588 | -0.0170 |
| BUN\_VALUE | 1.026 | (1.003 - 1.050) | 0.0248 | 0.02607 |
| pml\_value | 1.000 | (0.974 - 1.027) | 0.9790 | 0.00035 |
| shemat | 0.993 | (0.984 - 1.003) | 0.1547 | -0.0067 |
| num\_ut2 | 0.942 | (0.422 - 2.104) | 0.8847 | -0.0594 |
| CO\_CAT | 6.261 | (2.181 - 17.973) | 0.0007 | 0.91716 |
| BPSYS\_1\*sbpsys\_1 | 1.009 | (. - .) | 0.1430 | 0.00901 |
| BPSYS\_1\*sbpsys\_2 | 1.013 | (. - .) | 0.2737 | 0.01295 |
| BPSYS\_1\*sbpsys\_3 | 0.999 | (. - .) | 0.7026 | -0.0013 |
| BPSYS\_1\*sbpsys\_4 | 0.985 | (. - .) | 0.0144 | -0.0147 |
|  |  |  |  |  |
| **c statistic** |  | **0.848** |  |  |
| **Hosmer-Lemeshow p value** | | **0.8904** |  |  |

**SEIZURE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 494 |  |  |  |
| Number of Outcomes | 49 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 2.5097 |
| SLAPS | 1.777 | (1.010 - 3.127) | 0.0461 | 0.57499 |
| SLAPS2 | 0.776 | (0.451 - 1.337) | 0.3612 | -0.2532 |
| SCOPS | 1.712 | (0.981 - 2.989) | 0.0586 | 0.53771 |
| SCOPS2 | 0.741 | (0.463 - 1.187) | 0.2126 | -0.2995 |
| SLELOS | 1.130 | (0.760 - 1.678) | 0.5464 | 0.12185 |
| SEX | 0.403 | (0.189 - 0.861) | 0.0189 | -0.4546 |
| SHIFT | 1.804 | (0.876 - 3.714) | 0.1094 | 0.29492 |
| JHRTRT\_1 | 1.008 | (0.987 - 1.029) | 0.4734 | 0.00764 |
| RSPRT\_1 | 1.184 | (0.993 - 1.411) | 0.0601 | 0.16856 |
| JWRS\_T | 0.984 | (0.782 - 1.238) | 0.8881 | -0.0164 |
| JWRS\_SAT | 0.916 | (0.708 - 1.185) | 0.5056 | -0.0875 |
| sbpdia | 1.000 | (0.998 - 1.002) | 0.8424 | 0.00017 |
| JLAT\_NEU | 1.392 | (1.025 - 1.890) | 0.0341 | 0.33062 |
| JCINS\_T | 1.172 | (0.819 - 1.678) | 0.3858 | 0.15882 |
| JCINS\_HR | 1.005 | (0.981 - 1.030) | 0.6831 | 0.00515 |
| JCINS\_RR | 1.053 | (0.964 - 1.149) | 0.2544 | 0.05121 |
| JCINS\_SBP | 1.004 | (0.987 - 1.021) | 0.6632 | 0.00372 |
| JCINS\_SAT | 0.959 | (0.725 - 1.267) | 0.7663 | -0.0423 |
| BUN\_VALUE | 0.995 | (0.974 - 1.017) | 0.6731 | -0.0047 |
| pml\_value | 1.020 | (0.999 - 1.041) | 0.0601 | 0.01989 |
| shemat | 1.005 | (0.998 - 1.011) | 0.1373 | 0.00472 |
| CO\_CAT | 7.693 | (2.346 - 25.220) | 0.0008 | 1.02012 |
| COPS\_0 | 12.486 | (1.738 - 89.721) | 0.0121 | 1.26231 |
| BPSYS\_1\*sbpsys\_1 | 1.000 | (. - .) | 0.9491 | -0.0003 |
| BPSYS\_1\*sbpsys\_2 | 1.013 | (. - .) | 0.3100 | 0.01340 |
| BPSYS\_1\*sbpsys\_3 | 0.993 | (. - .) | 0.0729 | -0.0069 |
| BPSYS\_1\*sbpsys\_4 | 0.998 | (. - .) | 0.5917 | -0.0021 |
|  |  |  |  |  |
| **c statistic** |  | **0.818** |  |  |
| **Hosmer-Lemeshow p value** | | **0.6415** |  |  |

**AMI**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 199 |  |  |  |
| Number of Outcomes | 33 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | -9.3052 |
| SLAPS | 0.857 | (0.415 - 1.768) | 0.6759 | -0.1545 |
| SLAPS2 | 0.410 | (0.139 - 1.209) | 0.1061 | -0.8905 |
| SCOPS | 1.646 | (0.870 - 3.113) | 0.1255 | 0.49821 |
| SCOPS2 | 1.167 | (0.596 - 2.285) | 0.6526 | 0.15432 |
| SLELOS | 0.755 | (0.441 - 1.292) | 0.3059 | -0.2805 |
| SEX | 1.711 | (0.649 - 4.511) | 0.2774 | 0.26860 |
| SHIFT | 2.925 | (1.006 - 8.502) | 0.0487 | 0.53661 |
| JHRTRT\_1 | 1.011 | (0.975 - 1.048) | 0.5527 | 0.01082 |
| RSPRT\_1 | 1.209 | (0.918 - 1.591) | 0.1766 | 0.18956 |
| JWRS\_T | 0.864 | (0.579 - 1.289) | 0.4735 | -0.1462 |
| JWRS\_SAT | 1.147 | (0.822 - 1.599) | 0.4200 | 0.13684 |
| sbpdia | 1.000 | (0.997 - 1.003) | 0.8240 | -0.0003 |
| JLAT\_NEU | 0.636 | (0.263 - 1.534) | 0.3137 | -0.4528 |
| JCINS\_T | 0.964 | (0.458 - 2.029) | 0.9231 | -0.0366 |
| JCINS\_HR | 1.005 | (0.970 - 1.041) | 0.7778 | 0.00511 |
| JCINS\_RR | 1.035 | (0.896 - 1.196) | 0.6412 | 0.03435 |
| JCINS\_SBP | 1.006 | (0.982 - 1.030) | 0.6285 | 0.00582 |
| JCINS\_SAT | 1.165 | (0.808 - 1.680) | 0.4125 | 0.15300 |
| BUN\_VALUE | 1.015 | (0.986 - 1.045) | 0.3024 | 0.01523 |
| pml\_value | 1.035 | (1.005 - 1.066) | 0.0217 | 0.03447 |
| shemat | 0.997 | (0.982 - 1.011) | 0.6654 | -0.0032 |
| CO\_CAT | 1.947 | (0.477 - 7.943) | 0.3532 | 0.33304 |
| BPSYS\_1\*sbpsys\_1 | 1.039 | (. - .) | 0.2344 | 0.03805 |
| BPSYS\_1\*sbpsys\_2 | 0.936 | (. - .) | 0.4911 | -0.0656 |
| BPSYS\_1\*sbpsys\_3 | 1.009 | (. - .) | 0.6669 | 0.00911 |
| BPSYS\_1\*sbpsys\_4 | 1.003 | (. - .) | 0.8656 | 0.00326 |
|  |  |  |  |  |
| **c statistic** |  | **0.827** |  |  |
| **Hosmer-Lemeshow p value** | | **0.9696** |  |  |

**RENAL1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 230 |  |  |  |
| Number of Outcomes | 47 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 59.6463 |
| SLAPS | 1.455 | (0.726 - 2.917) | 0.2902 | 0.37521 |
| SLAPS2 | 0.838 | (0.522 - 1.346) | 0.4651 | -0.1763 |
| SCOPS | 1.175 | (0.726 - 1.900) | 0.5119 | 0.16094 |
| SCOPS2 | 1.026 | (0.683 - 1.541) | 0.9030 | 0.02531 |
| SLELOS | 2.430 | (1.477 - 4.000) | 0.0005 | 0.88806 |
| SEX | 0.839 | (0.335 - 2.101) | 0.7074 | -0.0879 |
| SHIFT | 4.095 | (1.467 - 11.434) | 0.0071 | 0.70494 |
| JHRTRT\_1 | 1.035 | (1.008 - 1.063) | 0.0103 | 0.03475 |
| RSPRT\_1 | 1.158 | (0.951 - 1.410) | 0.1431 | 0.14695 |
| JWRS\_T | 0.667 | (0.504 - 0.882) | 0.0045 | -0.4050 |
| JWRS\_SAT | 0.715 | (0.534 - 0.959) | 0.0249 | -0.3351 |
| sbpdia | 1.001 | (0.999 - 1.003) | 0.2017 | 0.00099 |
| JLAT\_NEU | 0.906 | (0.572 - 1.435) | 0.6733 | -0.0989 |
| JCINS\_T | 1.559 | (0.903 - 2.693) | 0.1111 | 0.44423 |
| JCINS\_HR | 1.030 | (0.995 - 1.066) | 0.0900 | 0.02973 |
| JCINS\_RR | 1.149 | (0.999 - 1.321) | 0.0513 | 0.13870 |
| JCINS\_SBP | 1.006 | (0.982 - 1.031) | 0.6286 | 0.00607 |
| JCINS\_SAT | 0.796 | (0.593 - 1.068) | 0.1287 | -0.2280 |
| BUN\_VALUE | 1.005 | (0.992 - 1.019) | 0.4509 | 0.00526 |
| pml\_value | 1.025 | (1.012 - 1.038) | 0.0001 | 0.02470 |
| shemat | 1.011 | (1.000 - 1.022) | 0.0484 | 0.01084 |
| CO\_CAT | 7.664 | (1.902 - 30.878) | 0.0042 | 1.01828 |
| BPSYS\_1\*sbpsys\_1 | 1.000 | (. - .) | 0.9557 | -0.0003 |
| BPSYS\_1\*sbpsys\_2 | 1.010 | (. - .) | 0.3980 | 0.01041 |
| BPSYS\_1\*sbpsys\_3 | 0.991 | (. - .) | 0.0421 | -0.0088 |
| BPSYS\_1\*sbpsys\_4 | 1.003 | (. - .) | 0.5718 | 0.00261 |
|  |  |  |  |  |
| **c statistic** |  | **0.898** |  |  |
| **Hosmer-Lemeshow p value** | | **0.4302** |  |  |

**CHF**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 382 |  |  |  |
| Number of Outcomes | 51 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | -12.147 |
| SLAPS | 0.857 | (0.490 - 1.500) | 0.5888 | -0.1542 |
| SLAPS2 | 1.224 | (0.838 - 1.786) | 0.2953 | 0.20181 |
| SCOPS | 1.026 | (0.651 - 1.617) | 0.9116 | 0.02576 |
| SCOPS2 | 1.122 | (0.801 - 1.570) | 0.5034 | 0.11483 |
| SLELOS | 0.907 | (0.592 - 1.390) | 0.6550 | -0.0973 |
| SEX | 1.117 | (0.529 - 2.358) | 0.7721 | 0.05523 |
| SHIFT | 1.088 | (0.537 - 2.204) | 0.8140 | 0.04234 |
| JHRTRT\_1 | 1.017 | (0.996 - 1.039) | 0.1200 | 0.01683 |
| RSPRT\_1 | 1.092 | (0.936 - 1.273) | 0.2619 | 0.08796 |
| JWRS\_T | 1.120 | (0.853 - 1.470) | 0.4153 | 0.11313 |
| JWRS\_SAT | 0.926 | (0.732 - 1.172) | 0.5232 | -0.0767 |
| sbpdia | 1.001 | (1.000 - 1.002) | 0.0349 | 0.00111 |
| JLAT\_NEU | 1.035 | (0.667 - 1.605) | 0.8791 | 0.03406 |
| JCINS\_T | 1.061 | (0.676 - 1.665) | 0.7968 | 0.05922 |
| JCINS\_HR | 1.004 | (0.980 - 1.029) | 0.7268 | 0.00433 |
| JCINS\_RR | 1.014 | (0.917 - 1.121) | 0.7887 | 0.01375 |
| JCINS\_SBP | 1.009 | (0.988 - 1.032) | 0.3995 | 0.00942 |
| JCINS\_SAT | 1.013 | (0.794 - 1.292) | 0.9203 | 0.01243 |
| BUN\_VALUE | 1.015 | (0.999 - 1.032) | 0.0612 | 0.01518 |
| pml\_value | 1.015 | (0.996 - 1.034) | 0.1240 | 0.01457 |
| shemat | 1.004 | (0.997 - 1.011) | 0.2584 | 0.00400 |
| WBC\_VALUE | 1.108 | (1.013 - 1.212) | 0.0256 | 0.10230 |
| CO\_CAT | 2.270 | (0.890 - 5.788) | 0.0860 | 0.40990 |
| BPSYS\_1\*sbpsys\_1 | 1.005 | (. - .) | 0.2745 | 0.00494 |
| BPSYS\_1\*sbpsys\_2 | 1.014 | (. - .) | 0.0204 | 0.01415 |
| BPSYS\_1\*sbpsys\_3 | 0.992 | (. - .) | 0.0269 | -0.0080 |
| BPSYS\_1\*sbpsys\_4 | 0.994 | (. - .) | 0.1506 | -0.0064 |
|  |  |  |  |  |
| **c statistic** |  | **0.823** |  |  |
| **Hosmer-Lemeshow p value** | | **0.7873** |  |  |

**MIX**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 862 |  |  |  |
| Number of Outcomes | 71 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 17.3983 |
| SLAPS | 0.907 | (0.592 - 1.390) | 0.6550 | -0.0973 |
| SLAPS2 | 1.321 | (0.868 - 2.010) | 0.1943 | 0.27806 |
| SCOPS | 1.066 | (0.722 - 1.575) | 0.7483 | 0.06390 |
| SCOPS2 | 1.294 | (0.901 - 1.859) | 0.1623 | 0.25809 |
| SLELOS | 1.431 | (0.793 - 2.581) | 0.2340 | 0.35820 |
| SEX | 0.937 | (0.528 - 1.665) | 0.8251 | -0.0323 |
| SHIFT | 1.859 | (1.036 - 3.337) | 0.0376 | 0.31014 |
| JHRTRT\_1 | 1.013 | (0.995 - 1.031) | 0.1635 | 0.01255 |
| RSPRT\_1 | 1.220 | (1.071 - 1.390) | 0.0027 | 0.19920 |
| JWRS\_T | 0.871 | (0.717 - 1.057) | 0.1626 | -0.1382 |
| JWRS\_SAT | 0.872 | (0.728 - 1.045) | 0.1378 | -0.1369 |
| sbpdia | 1.001 | (1.000 - 1.002) | 0.0867 | 0.00080 |
| JLAT\_NEU | 1.043 | (0.815 - 1.335) | 0.7377 | 0.04219 |
| JCINS\_T | 0.825 | (0.602 - 1.131) | 0.2317 | -0.1921 |
| JCINS\_HR | 1.022 | (1.003 - 1.041) | 0.0251 | 0.02165 |
| JCINS\_RR | 1.104 | (1.022 - 1.192) | 0.0120 | 0.09853 |
| JCINS\_SBP | 1.014 | (0.998 - 1.031) | 0.0787 | 0.01425 |
| JCINS\_SAT | 0.969 | (0.806 - 1.165) | 0.7368 | -0.0316 |
| BUN\_VALUE | 1.013 | (0.991 - 1.036) | 0.2541 | 0.01316 |
| pml\_value | 0.999 | (0.984 - 1.015) | 0.9269 | -0.0007 |
| shemat | 1.002 | (0.997 - 1.008) | 0.3560 | 0.00242 |
| SLELOS2 | 0.621 | (0.253 - 1.525) | 0.2990 | -0.4758 |
| SLELOS3 | 0.469 | (0.221 - 0.994) | 0.0482 | -0.7571 |
| SLELOS4 | 1.474 | (0.397 - 5.470) | 0.5616 | 0.38830 |
| CO\_CAT | 3.049 | (1.383 - 6.724) | 0.0057 | 0.55743 |
| COPS\_0 | 2.193 | (0.609 - 7.902) | 0.2299 | 0.39260 |
| BPSYS\_1\*sbpsys\_1 | 1.006 | (. - .) | 0.2257 | 0.00632 |
| BPSYS\_1\*sbpsys\_2 | 1.000 | (. - .) | 0.9941 | -0.0000 |
| BPSYS\_1\*sbpsys\_3 | 0.997 | (. - .) | 0.2738 | -0.0032 |
| BPSYS\_1\*sbpsys\_4 | 0.998 | (. - .) | 0.5516 | -0.0017 |
|  |  |  |  |  |
| **c statistic** |  | **0.795** |  |  |
| **Hosmer-Lemeshow p value** | | **0.6160** |  |  |

**METAB1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 540 |  |  |  |
| Number of Outcomes | 54 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | -2.3684 |
| SLAPS | 0.983 | (0.570 - 1.697) | 0.9512 | -0.0170 |
| SLAPS2 | 1.139 | (0.840 - 1.545) | 0.4021 | 0.13030 |
| SCOPS | 1.831 | (1.096 - 3.059) | 0.0208 | 0.60500 |
| SCOPS2 | 0.702 | (0.485 - 1.016) | 0.0604 | -0.3537 |
| SLELOS | 1.079 | (0.752 - 1.547) | 0.6802 | 0.07585 |
| SEX | 0.857 | (0.422 - 1.742) | 0.6703 | -0.0769 |
| SHIFT | 1.240 | (0.592 - 2.599) | 0.5688 | 0.10754 |
| JHRTRT\_1 | 1.036 | (1.010 - 1.063) | 0.0060 | 0.03542 |
| RSPRT\_1 | 1.138 | (0.997 - 1.299) | 0.0546 | 0.12958 |
| JWRS\_T | 0.997 | (0.822 - 1.208) | 0.9739 | -0.0032 |
| JWRS\_SAT | 0.917 | (0.739 - 1.139) | 0.4342 | -0.0862 |
| sbpdia | 1.000 | (0.999 - 1.002) | 0.5430 | 0.00041 |
| JLAT\_NEU | 1.279 | (0.936 - 1.749) | 0.1226 | 0.24639 |
| JCINS\_T | 1.055 | (0.767 - 1.452) | 0.7421 | 0.05363 |
| JCINS\_HR | 0.994 | (0.967 - 1.021) | 0.6419 | -0.0064 |
| JCINS\_RR | 1.118 | (1.038 - 1.205) | 0.0034 | 0.11178 |
| JCINS\_SBP | 0.997 | (0.976 - 1.018) | 0.7824 | -0.0029 |
| JCINS\_SAT | 1.048 | (0.842 - 1.304) | 0.6767 | 0.04661 |
| BUN\_VALUE | 1.006 | (0.991 - 1.022) | 0.4393 | 0.00606 |
| pml\_value | 1.028 | (1.011 - 1.045) | 0.0010 | 0.02786 |
| shemat | 1.002 | (0.992 - 1.012) | 0.6626 | 0.00216 |
| CO\_CAT | 3.924 | (1.579 - 9.752) | 0.0032 | 0.68357 |
| BPSYS\_1\*sbpsys\_1 | 0.982 | (. - .) | 0.0441 | -0.0177 |
| BPSYS\_1\*sbpsys\_2 | 1.039 | (. - .) | <.0001 | 0.03841 |
| BPSYS\_1\*sbpsys\_3 | 0.990 | (. - .) | 0.0115 | -0.0101 |
| BPSYS\_1\*sbpsys\_4 | 0.990 | (. - .) | 0.0343 | -0.0100 |
|  |  |  |  |  |
| **c statistic** |  | **0.869** |  |  |
| **Hosmer-Lemeshow p value** | | **0.1235** |  |  |

**NEUMENT**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 255 |  |  |  |
| Number of Outcomes | 22 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | -19.7365 |
| SLAPS | 0.810 | (0.262 - 2.510) | 0.7153 | -0.2103 |
| SLAPS2 | 0.474 | (0.096 - 2.342) | 0.3596 | -0.7469 |
| SCOPS | 4.868 | (1.484 - 15.973) | 0.0090 | 1.58276 |
| SCOPS2 | 0.274 | (0.074 - 1.014) | 0.0525 | -1.2932 |
| SLELOS | 0.900 | (0.448 - 1.809) | 0.7681 | -0.1049 |
| SEX | 1.059 | (0.246 - 4.551) | 0.9385 | 0.02867 |
| SHIFT | 1.290 | (0.285 - 5.843) | 0.7414 | 0.12718 |
| JHRTRT\_1 | 0.974 | (0.921 - 1.029) | 0.3419 | -0.0267 |
| RSPRT\_1 | 1.280 | (0.775 - 2.114) | 0.3346 | 0.24696 |
| JWRS\_T | 1.295 | (0.812 - 2.066) | 0.2768 | 0.25889 |
| JWRS\_SAT | 0.850 | (0.465 - 1.554) | 0.5973 | -0.1626 |
| sbpdia | 1.000 | (0.996 - 1.003) | 0.8078 | -0.0004 |
| JLAT\_NEU | 0.542 | (0.234 - 1.257) | 0.1538 | -0.6118 |
| JCINS\_T | 1.592 | (0.733 - 3.456) | 0.2399 | 0.46490 |
| JCINS\_HR | 1.068 | (0.997 - 1.143) | 0.0608 | 0.06537 |
| JCINS\_RR | 0.797 | (0.564 - 1.125) | 0.1964 | -0.2274 |
| JCINS\_SBP | 0.996 | (0.953 - 1.041) | 0.8624 | -0.0039 |
| JCINS\_SAT | 1.659 | (0.900 - 3.057) | 0.1045 | 0.50628 |
| BUN\_VALUE | 1.054 | (1.004 - 1.107) | 0.0339 | 0.05290 |
| pml\_value | 0.977 | (0.923 - 1.033) | 0.4140 | -0.0234 |
| shemat | 1.042 | (1.015 - 1.069) | 0.0022 | 0.04098 |
| CO\_CAT | 17.016 | (1.435 - 201.838) | 0.0247 | 1.41708 |
| BPSYS\_1\*sbpsys\_1 | 0.986 | (. - .) | 0.3253 | -0.0142 |
| BPSYS\_1\*sbpsys\_2 | 1.045 | (. - .) | 0.0263 | 0.04393 |
| BPSYS\_1\*sbpsys\_3 | 0.982 | (. - .) | 0.0136 | -0.0177 |
| BPSYS\_1\*sbpsys\_4 | 0.995 | (. - .) | 0.6024 | -0.0052 |
|  |  |  |  |  |
| **c statistic** |  | **0.945** |  |  |
| **Hosmer-Lemeshow p value** | | **0.6478** |  |  |

**ARTHSPIN**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 1,794 |  |  |  |
| Number of Outcomes | 74 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 4.4633 |
| SLAPS | 1.143 | (0.770 - 1.696) | 0.5078 | 0.13348 |
| SLAPS2 | 0.970 | (0.581 - 1.618) | 0.9057 | -0.0309 |
| SCOPS | 1.630 | (1.132 - 2.347) | 0.0086 | 0.48877 |
| SCOPS2 | 1.050 | (0.756 - 1.459) | 0.7694 | 0.04911 |
| SLELOS | 0.742 | (0.514 - 1.071) | 0.1115 | -0.2979 |
| SEX | 0.685 | (0.403 - 1.167) | 0.1642 | -0.1888 |
| SHIFT | 1.062 | (0.622 - 1.811) | 0.8257 | 0.02999 |
| JHRTRT\_1 | 1.016 | (0.999 - 1.034) | 0.0716 | 0.01581 |
| RSPRT\_1 | 1.146 | (0.985 - 1.333) | 0.0783 | 0.13614 |
| JWRS\_T | 0.975 | (0.825 - 1.153) | 0.7695 | -0.0249 |
| JWRS\_SAT | 0.847 | (0.720 - 0.997) | 0.0462 | -0.1657 |
| sbpdia | 1.002 | (1.001 - 1.003) | 0.0007 | 0.00187 |
| JLAT\_NEU | 1.662 | (1.258 - 2.197) | 0.0004 | 0.50830 |
| JCINS\_T | 0.948 | (0.743 - 1.211) | 0.6705 | -0.0529 |
| JCINS\_HR | 1.031 | (1.010 - 1.053) | 0.0043 | 0.03051 |
| JCINS\_RR | 0.945 | (0.836 - 1.069) | 0.3695 | -0.0561 |
| JCINS\_SBP | 1.000 | (0.983 - 1.018) | 0.9833 | 0.00018 |
| JCINS\_SAT | 0.997 | (0.838 - 1.186) | 0.9703 | -0.0033 |
| BUN\_VALUE | 1.021 | (1.000 - 1.043) | 0.0484 | 0.02099 |
| pml\_value | 1.004 | (0.982 - 1.026) | 0.7416 | 0.00371 |
| shemat | 1.001 | (0.995 - 1.008) | 0.7073 | 0.00126 |
| JWRS\_RR | 1.196 | (1.009 - 1.418) | 0.0386 | 0.17933 |
| CO\_CAT | 8.352 | (2.305 - 30.267) | 0.0012 | 1.06126 |
| BPSYS\_1\*sbpsys\_1 | 0.993 | (. - .) | 0.1170 | -0.0074 |
| BPSYS\_1\*sbpsys\_2 | 1.011 | (. - .) | 0.1505 | 0.01081 |
| BPSYS\_1\*sbpsys\_3 | 0.999 | (. - .) | 0.7769 | -0.0007 |
| BPSYS\_1\*sbpsys\_4 | 0.999 | (. - .) | 0.7654 | -0.0009 |
|  |  |  |  |  |
| **c statistic** |  | **0.849** |  |  |
| **Hosmer-Lemeshow p value** | | **0.7394** |  |  |

**SEPSIS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 2,117 |  |  |  |
| Number of Outcomes | 196 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 17.8249 |
| SLAPS | 1.209 | (0.931 - 1.571) | 0.1546 | 0.18999 |
| SLAPS2 | 0.948 | (0.775 - 1.160) | 0.6048 | -0.0533 |
| SCOPS | 1.164 | (0.929 - 1.458) | 0.1880 | 0.15156 |
| SCOPS2 | 0.966 | (0.805 - 1.159) | 0.7117 | -0.0343 |
| SLELOS | 1.087 | (0.908 - 1.301) | 0.3612 | 0.08371 |
| SEX | 0.766 | (0.538 - 1.091) | 0.1390 | -0.1335 |
| SHIFT | 2.009 | (1.396 - 2.890) | 0.0002 | 0.34877 |
| JHRTRT\_1 | 1.032 | (1.022 - 1.043) | <.0001 | 0.03192 |
| RSPRT\_1 | 1.179 | (1.091 - 1.273) | <.0001 | 0.16427 |
| JWRS\_T | 0.920 | (0.825 - 1.026) | 0.1328 | -0.0834 |
| JWRS\_SAT | 0.809 | (0.732 - 0.894) | <.0001 | -0.2123 |
| sbpdia | 1.000 | (0.999 - 1.001) | 0.6065 | 0.00020 |
| JLAT\_NEU | 1.090 | (0.931 - 1.278) | 0.2840 | 0.08659 |
| JCINS\_T | 1.175 | (1.002 - 1.377) | 0.0468 | 0.16100 |
| JCINS\_HR | 1.006 | (0.994 - 1.019) | 0.2991 | 0.00642 |
| JCINS\_RR | 1.031 | (0.982 - 1.081) | 0.2170 | 0.03007 |
| JCINS\_SBP | 1.016 | (1.005 - 1.027) | 0.0039 | 0.01560 |
| JCINS\_SAT | 0.943 | (0.846 - 1.050) | 0.2855 | -0.0588 |
| BUN\_VALUE | 1.008 | (0.997 - 1.018) | 0.1384 | 0.00780 |
| pml\_value | 1.027 | (1.017 - 1.037) | <.0001 | 0.02650 |
| shemat | 1.003 | (0.999 - 1.008) | 0.1411 | 0.00334 |
| BPSYS\_1\*sbpsys\_1 | 1.002 | (. - .) | 0.5282 | 0.00159 |
| BPSYS\_1\*sbpsys\_2 | 1.015 | (. - .) | <.0001 | 0.01517 |
| BPSYS\_1\*sbpsys\_3 | 0.997 | (. - .) | 0.0404 | -0.0032 |
| BPSYS\_1\*sbpsys\_4 | 0.991 | (. - .) | 0.0015 | -0.0088 |
|  |  |  |  |  |
| **c statistic** |  | **0.846** |  |  |
| **Hosmer-Lemeshow p value** | | **0.8683** |  |  |

**PNEUM**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 785 |  |  |  |
| Number of Outcomes | 170 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 8.6119 |
| SLAPS | 0.935 | (0.693 - 1.263) | 0.6627 | -0.0667 |
| SLAPS2 | 0.987 | (0.781 - 1.246) | 0.9098 | -0.0135 |
| SCOPS | 1.160 | (0.888 - 1.514) | 0.2757 | 0.14829 |
| SCOPS2 | 0.895 | (0.710 - 1.130) | 0.3522 | -0.1104 |
| SLELOS | 0.911 | (0.739 - 1.124) | 0.3854 | -0.0928 |
| SEX | 1.000 | (0.675 - 1.483) | 0.9981 | 0.00023 |
| SHIFT | 2.053 | (1.376 - 3.063) | 0.0004 | 0.35966 |
| JHRTRT\_1 | 1.034 | (1.021 - 1.047) | <.0001 | 0.03335 |
| RSPRT\_1 | 1.075 | (1.000 - 1.156) | 0.0495 | 0.07273 |
| JWRS\_T | 0.955 | (0.837 - 1.090) | 0.4939 | -0.0461 |
| JWRS\_SAT | 0.886 | (0.793 - 0.991) | 0.0339 | -0.1206 |
| sbpdia | 1.001 | (1.000 - 1.002) | 0.1009 | 0.00075 |
| JLAT\_NEU | 0.944 | (0.769 - 1.159) | 0.5825 | -0.0576 |
| JCINS\_T | 1.048 | (0.868 - 1.266) | 0.6259 | 0.04703 |
| JCINS\_HR | 1.007 | (0.994 - 1.020) | 0.2874 | 0.00705 |
| JCINS\_RR | 1.035 | (0.989 - 1.083) | 0.1393 | 0.03439 |
| JCINS\_SBP | 1.011 | (0.997 - 1.024) | 0.1144 | 0.01053 |
| JCINS\_SAT | 1.035 | (0.921 - 1.164) | 0.5626 | 0.03469 |
| BUN\_VALUE | 1.007 | (0.995 - 1.019) | 0.2608 | 0.00702 |
| pml\_value | 1.010 | (0.997 - 1.023) | 0.1193 | 0.01022 |
| shemat | 1.004 | (1.000 - 1.008) | 0.0584 | 0.00393 |
| CO\_CAT | 2.895 | (1.700 - 4.929) | <.0001 | 0.53146 |
| COPS\_0 | 2.898 | (1.047 - 8.022) | 0.0405 | 0.53207 |
| BPSYS\_1\*sbpsys\_1 | 0.998 | (. - .) | 0.6377 | -0.0015 |
| BPSYS\_1\*sbpsys\_2 | 1.010 | (. - .) | 0.0974 | 0.00997 |
| BPSYS\_1\*sbpsys\_3 | 0.998 | (. - .) | 0.2246 | -0.0022 |
| BPSYS\_1\*sbpsys\_4 | 0.998 | (. - .) | 0.5079 | -0.0017 |
|  |  |  |  |  |
| **c statistic** |  | **0.807** |  |  |
| **Hosmer-Lemeshow p value** | | **0.0770** |  |  |

**RESPR4**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 1,219 |  |  |  |
| Number of Outcomes | 190 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 6.0809 |
| SLAPS2 | 0.950 | (0.733 - 1.231) | 0.6962 | -0.0516 |
| SCOPS | 0.990 | (0.796 - 1.230) | 0.9254 | -0.0103 |
| SCOPS2 | 0.965 | (0.808 - 1.152) | 0.6903 | -0.0360 |
| SLELOS | 1.092 | (0.903 - 1.322) | 0.3636 | 0.08846 |
| SEX | 0.812 | (0.576 - 1.147) | 0.2374 | -0.1038 |
| SHIFT | 2.857 | (1.957 - 4.172) | <.0001 | 0.52491 |
| JHRTRT\_1 | 1.022 | (1.011 - 1.033) | <.0001 | 0.02147 |
| RSPRT\_1 | 1.153 | (1.084 - 1.226) | <.0001 | 0.14223 |
| JWRS\_T | 0.970 | (0.868 - 1.084) | 0.5888 | -0.0306 |
| JWRS\_SAT | 0.886 | (0.804 - 0.975) | 0.0133 | -0.1215 |
| sbpdia | 1.000 | (1.000 - 1.001) | 0.4387 | 0.00025 |
| JLAT\_NEU | 1.097 | (0.902 - 1.334) | 0.3544 | 0.09246 |
| JCINS\_T | 1.217 | (1.018 - 1.455) | 0.0315 | 0.19602 |
| JCINS\_HR | 1.009 | (0.997 - 1.021) | 0.1395 | 0.00902 |
| JCINS\_RR | 1.001 | (0.960 - 1.043) | 0.9767 | 0.00061 |
| JCINS\_SBP | 1.019 | (1.009 - 1.030) | 0.0004 | 0.01892 |
| JCINS\_SAT | 0.962 | (0.870 - 1.065) | 0.4587 | -0.0383 |
| BUN\_VALUE | 1.009 | (0.999 - 1.019) | 0.0784 | 0.00877 |
| pml\_value | 1.000 | (0.988 - 1.012) | 0.9873 | -0.0000 |
| shemat | 1.001 | (0.997 - 1.004) | 0.6854 | 0.00068 |
| CO\_CAT | 3.136 | (1.967 - 4.998) | <.0001 | 0.57144 |
| BPSYS\_1\*sbpsys\_1 | 0.998 | (. - .) | 0.5852 | -0.0016 |
| BPSYS\_1\*sbpsys\_2 | 1.012 | (. - .) | 0.0157 | 0.01215 |
| BPSYS\_1\*sbpsys\_3 | 0.997 | (. - .) | 0.0694 | -0.0029 |
| BPSYS\_1\*sbpsys\_4 | 0.995 | (. - .) | 0.0204 | -0.0047 |
|  |  |  |  |  |
| **c statistic** |  | **0.780** |  |  |
| **Hosmer-Lemeshow p value** | | **0.4711** |  |  |

**PRGNCY**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 921 |  |  |  |
| Number of Outcomes | 28 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 6.3389 |
| SLAPS | 1.273 | (0.633 - 2.559) | 0.4991 | 0.24098 |
| SLAPS2 | 0.819 | (0.395 - 1.695) | 0.5899 | -0.2002 |
| SCOPS | 1.531 | (0.754 - 3.112) | 0.2387 | 0.42621 |
| SCOPS2 | 0.645 | (0.359 - 1.158) | 0.1418 | -0.4387 |
| SLELOS | 1.180 | (0.675 - 2.062) | 0.5615 | 0.16535 |
| SEX | 0.561 | (0.194 - 1.621) | 0.2860 | -0.2886 |
| SHIFT | 1.010 | (0.381 - 2.674) | 0.9848 | 0.00473 |
| JHRTRT\_1 | 1.084 | (1.042 - 1.127) | <.0001 | 0.08033 |
| RSPRT\_1 | 1.459 | (1.128 - 1.887) | 0.0040 | 0.37777 |
| JWRS\_T | 0.986 | (0.712 - 1.366) | 0.9321 | -0.0141 |
| JWRS\_SAT | 0.800 | (0.581 - 1.102) | 0.1719 | -0.2226 |
| sbpdia | 1.001 | (0.999 - 1.004) | 0.1736 | 0.00144 |
| JLAT\_NEU | 0.771 | (0.442 - 1.345) | 0.3590 | -0.2605 |
| JCINS\_T | 1.187 | (0.715 - 1.971) | 0.5062 | 0.17180 |
| JCINS\_HR | 0.991 | (0.955 - 1.029) | 0.6476 | -0.0086 |
| JCINS\_RR | 0.975 | (0.869 - 1.093) | 0.6608 | -0.0257 |
| JCINS\_SBP | 1.006 | (0.977 - 1.035) | 0.6923 | 0.00578 |
| JCINS\_SAT | 0.927 | (0.672 - 1.280) | 0.6458 | -0.0755 |
| BUN\_VALUE | 1.032 | (1.007 - 1.058) | 0.0129 | 0.03137 |
| pml\_value | 0.971 | (0.938 - 1.005) | 0.0889 | -0.0296 |
| shemat | 0.996 | (0.987 - 1.005) | 0.3887 | -0.0038 |
| WBC\_VALUE | 1.064 | (0.980 - 1.157) | 0.1403 | 0.06243 |
| COPS\_0 | 11.074 | (1.729 - 70.936) | 0.0112 | 1.20232 |
| BPSYS\_1\*sbpsys\_1 | 0.999 | (. - .) | 0.8469 | -0.0013 |
| BPSYS\_1\*sbpsys\_2 | 1.019 | (. - .) | 0.1390 | 0.01889 |
| BPSYS\_1\*sbpsys\_3 | 0.996 | (. - .) | 0.4006 | -0.0036 |
| BPSYS\_1\*sbpsys\_4 | 0.996 | (. - .) | 0.4684 | -0.0037 |
|  |  |  |  |  |
| **c statistic** |  | **0.918** |  |  |
| **Hosmer-Lemeshow p value** | | **0.0038** |  |  |

**CANCER**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 882 |  |  |  |
| Number of Outcomes | 72 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 22.8469 |
| SLAPS | 1.174 | (0.764 - 1.806) | 0.4637 | 0.16080 |
| SLAPS2 | 0.571 | (0.280 - 1.163) | 0.1227 | -0.5600 |
| SCOPS | 1.228 | (0.827 - 1.825) | 0.3082 | 0.20569 |
| SCOPS2 | 1.048 | (0.739 - 1.487) | 0.7921 | 0.04698 |
| SLELOS | 0.890 | (0.623 - 1.271) | 0.5226 | -0.1162 |
| SEX | 0.756 | (0.417 - 1.370) | 0.3568 | -0.1396 |
| SHIFT | 1.573 | (0.870 - 2.844) | 0.1341 | 0.22637 |
| JHRTRT\_1 | 1.039 | (1.020 - 1.058) | <.0001 | 0.03828 |
| RSPRT\_1 | 1.065 | (0.938 - 1.210) | 0.3325 | 0.06302 |
| JWRS\_T | 0.981 | (0.816 - 1.179) | 0.8365 | -0.0193 |
| JWRS\_SAT | 0.730 | (0.619 - 0.861) | 0.0002 | -0.3148 |
| sbpdia | 1.000 | (0.999 - 1.002) | 0.5965 | 0.00038 |
| JLAT\_NEU | 1.614 | (1.165 - 2.236) | 0.0040 | 0.47893 |
| JCINS\_T | 1.119 | (0.838 - 1.495) | 0.4463 | 0.11251 |
| JCINS\_HR | 0.996 | (0.970 - 1.022) | 0.7520 | -0.0042 |
| JCINS\_RR | 1.113 | (1.031 - 1.203) | 0.0064 | 0.10746 |
| JCINS\_SBP | 1.015 | (0.995 - 1.035) | 0.1355 | 0.01485 |
| JCINS\_SAT | 0.799 | (0.670 - 0.954) | 0.0131 | -0.2241 |
| BUN\_VALUE | 1.003 | (0.976 - 1.031) | 0.8226 | 0.00314 |
| pml\_value | 1.000 | (0.981 - 1.019) | 0.9707 | -0.0003 |
| shemat | 1.010 | (1.003 - 1.016) | 0.0047 | 0.00963 |
| WBC\_VALUE | 1.015 | (0.997 - 1.033) | 0.0945 | 0.01482 |
| SLELOS2 | 0.963 | (0.712 - 1.303) | 0.8075 | -0.0376 |
| CO\_CAT | 2.740 | (0.849 - 8.841) | 0.0918 | 0.50388 |
| BPSYS\_1\*sbpsys\_1 | 0.996 | (. - .) | 0.4978 | -0.0035 |
| BPSYS\_1\*sbpsys\_2 | 1.010 | (. - .) | 0.2222 | 0.00994 |
| BPSYS\_1\*sbpsys\_3 | 0.998 | (. - .) | 0.5011 | -0.0019 |
| BPSYS\_1\*sbpsys\_4 | 0.996 | (. - .) | 0.2845 | -0.0044 |
|  |  |  |  |  |
| **c statistic** |  | **0.844** |  |  |
| **Hosmer-Lemeshow p value** | | **0.6506** |  |  |

**K6**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 1,507 |  |  |  |
| Number of Outcomes | 123 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 12.6833 |
| SLAPS | 1.103 | (0.831 - 1.464) | 0.4989 | 0.09773 |
| SLAPS2 | 1.004 | (0.772 - 1.307) | 0.9738 | 0.00441 |
| SCOPS | 1.161 | (0.893 - 1.510) | 0.2639 | 0.14960 |
| SCOPS2 | 1.111 | (0.871 - 1.417) | 0.3982 | 0.10499 |
| SLELOS | 0.793 | (0.626 - 1.006) | 0.0563 | -0.2313 |
| SEX | 1.216 | (0.793 - 1.867) | 0.3698 | 0.09796 |
| SHIFT | 0.998 | (0.654 - 1.523) | 0.9917 | -0.0011 |
| JHRTRT\_1 | 1.030 | (1.017 - 1.045) | <.0001 | 0.03004 |
| RSPRT\_1 | 1.157 | (1.054 - 1.270) | 0.0022 | 0.14578 |
| JWRS\_T | 0.906 | (0.809 - 1.014) | 0.0867 | -0.0991 |
| JWRS\_SAT | 0.870 | (0.757 - 1.001) | 0.0518 | -0.1389 |
| sbpdia | 1.001 | (1.000 - 1.002) | 0.0237 | 0.00100 |
| JLAT\_NEU | 1.244 | (1.014 - 1.527) | 0.0367 | 0.21844 |
| JCINS\_T | 1.284 | (1.094 - 1.507) | 0.0022 | 0.25003 |
| JCINS\_HR | 1.025 | (1.009 - 1.042) | 0.0021 | 0.02486 |
| JCINS\_RR | 1.033 | (0.974 - 1.095) | 0.2777 | 0.03229 |
| JCINS\_SBP | 1.000 | (0.987 - 1.014) | 0.9725 | 0.00023 |
| JCINS\_SAT | 0.931 | (0.804 - 1.077) | 0.3346 | -0.0719 |
| BUN\_VALUE | 1.006 | (0.994 - 1.019) | 0.3290 | 0.00626 |
| pml\_value | 1.007 | (0.996 - 1.017) | 0.1968 | 0.00681 |
| shemat | 1.005 | (1.001 - 1.009) | 0.0234 | 0.00468 |
| num\_ut2 | 2.596 | (1.666 - 4.043) | <.0001 | 0.95387 |
| CO\_CAT | 3.550 | (1.725 - 7.304) | 0.0006 | 0.63340 |
| BPSYS\_1\*sbpsys\_1 | 1.003 | (. - .) | 0.4117 | 0.00281 |
| BPSYS\_1\*sbpsys\_2 | 1.002 | (. - .) | 0.7863 | 0.00166 |
| BPSYS\_1\*sbpsys\_3 | 1.000 | (. - .) | 0.9325 | 0.00016 |
| BPSYS\_1\*sbpsys\_4 | 0.997 | (. - .) | 0.2820 | -0.0027 |
|  |  |  |  |  |
| **c statistic** |  | **0.809** |  |  |
| **Hosmer-Lemeshow p value** | | **0.0052** |  |  |

**K5**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 276 |  |  |  |
| Number of Outcomes | 34 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 9.5196 |
| SLAPS | 2.600 | (1.337 - 5.057) | 0.0049 | 0.95552 |
| SLAPS2 | 0.674 | (0.426 - 1.066) | 0.0914 | -0.3951 |
| SCOPS | 0.865 | (0.511 - 1.466) | 0.5898 | -0.1450 |
| SCOPS2 | 1.224 | (0.737 - 2.032) | 0.4354 | 0.20184 |
| SLELOS | 0.560 | (0.334 - 0.938) | 0.0276 | -0.5800 |
| SEX | 0.899 | (0.322 - 2.512) | 0.8392 | -0.0531 |
| SHIFT | 1.695 | (0.673 - 4.268) | 0.2632 | 0.26370 |
| JHRTRT\_1 | 1.017 | (0.991 - 1.045) | 0.2052 | 0.01721 |
| RSPRT\_1 | 1.455 | (1.098 - 1.928) | 0.0091 | 0.37503 |
| JWRS\_T | 0.768 | (0.572 - 1.031) | 0.0794 | -0.2636 |
| JWRS\_SAT | 1.053 | (0.775 - 1.433) | 0.7405 | 0.05196 |
| sbpdia | 1.000 | (0.998 - 1.002) | 0.8746 | 0.00014 |
| JLAT\_NEU | 1.087 | (0.711 - 1.661) | 0.7005 | 0.08319 |
| JCINS\_T | 1.306 | (0.768 - 2.222) | 0.3247 | 0.26704 |
| JCINS\_HR | 1.021 | (0.986 - 1.058) | 0.2386 | 0.02120 |
| JCINS\_RR | 0.952 | (0.804 - 1.126) | 0.5646 | -0.0495 |
| JCINS\_SBP | 1.003 | (0.976 - 1.032) | 0.8131 | 0.00335 |
| JCINS\_SAT | 0.986 | (0.706 - 1.376) | 0.9319 | -0.0145 |
| BUN\_VALUE | 0.995 | (0.965 - 1.025) | 0.7198 | -0.0054 |
| pml\_value | 0.995 | (0.974 - 1.016) | 0.6270 | -0.0051 |
| shemat | 1.006 | (0.993 - 1.019) | 0.3643 | 0.00592 |
| num\_ut2 | 3.620 | (0.987 - 13.281) | 0.0524 | 1.28640 |
| BPSYS\_1\*sbpsys\_1 | 1.003 | (. - .) | 0.5648 | 0.00337 |
| BPSYS\_1\*sbpsys\_2 | 1.009 | (. - .) | 0.3909 | 0.00849 |
| BPSYS\_1\*sbpsys\_3 | 1.000 | (. - .) | 0.9061 | 0.00047 |
| BPSYS\_1\*sbpsys\_4 | 0.996 | (. - .) | 0.4392 | -0.0043 |
|  |  |  |  |  |
| **c statistic** |  | **0.833** |  |  |
| **Hosmer-Lemeshow p value** | | **0.0002** |  |  |

**K4**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 292 |  |  |  |
| Number of Outcomes | 32 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 8.1859 |
| SLAPS | 1.012 | (0.526 - 1.950) | 0.9707 | 0.01227 |
| SLAPS2 | 0.987 | (0.547 - 1.779) | 0.9645 | -0.0133 |
| SCOPS | 1.635 | (0.762 - 3.507) | 0.2066 | 0.49166 |
| SCOPS2 | 0.733 | (0.388 - 1.384) | 0.3376 | -0.3111 |
| SLELOS | 0.809 | (0.470 - 1.395) | 0.4467 | -0.2114 |
| SEX | 1.592 | (0.586 - 4.322) | 0.3615 | 0.23251 |
| SHIFT | 1.078 | (0.390 - 2.979) | 0.8855 | 0.03737 |
| JHRTRT\_1 | 1.061 | (1.029 - 1.094) | 0.0002 | 0.05912 |
| RSPRT\_1 | 0.884 | (0.703 - 1.112) | 0.2927 | -0.1230 |
| JWRS\_T | 0.936 | (0.706 - 1.242) | 0.6483 | -0.0657 |
| JWRS\_SAT | 0.895 | (0.642 - 1.248) | 0.5126 | -0.1110 |
| sbpdia | 1.002 | (0.999 - 1.004) | 0.1557 | 0.00150 |
| JLAT\_NEU | 1.246 | (0.780 - 1.991) | 0.3565 | 0.22029 |
| JCINS\_T | 1.620 | (1.013 - 2.590) | 0.0439 | 0.48233 |
| JCINS\_HR | 1.009 | (0.974 - 1.044) | 0.6285 | 0.00847 |
| JCINS\_RR | 0.917 | (0.802 - 1.050) | 0.2088 | -0.0864 |
| JCINS\_SBP | 1.007 | (0.983 - 1.030) | 0.5843 | 0.00655 |
| JCINS\_SAT | 0.925 | (0.658 - 1.299) | 0.6526 | -0.0780 |
| BUN\_VALUE | 1.011 | (0.990 - 1.032) | 0.3063 | 0.01066 |
| pml\_value | 1.043 | (1.013 - 1.074) | 0.0043 | 0.04220 |
| shemat | 0.998 | (0.981 - 1.015) | 0.8137 | -0.0020 |
| num\_ut2 | 3.670 | (0.871 - 15.462) | 0.0764 | 1.30024 |
| CO\_CAT | 2.142 | (0.521 - 8.798) | 0.2908 | 0.38077 |
| BPSYS\_1\*sbpsys\_1 | 1.005 | (. - .) | 0.5761 | 0.00512 |
| BPSYS\_1\*sbpsys\_2 | 1.011 | (. - .) | 0.3130 | 0.01105 |
| BPSYS\_1\*sbpsys\_3 | 1.003 | (. - .) | 0.5829 | 0.00320 |
| BPSYS\_1\*sbpsys\_4 | 0.977 | (. - .) | 0.2401 | -0.0232 |
|  |  |  |  |  |
| **c statistic** |  | **0.854** |  |  |
| **Hosmer-Lemeshow p value** | | **0.5680** |  |  |

**MISCL5**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 931 |  |  |  |
| Number of Outcomes | 114 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | -18.2683 |
| SLAPS | 1.207 | (0.857 - 1.700) | 0.2823 | 0.18801 |
| SLAPS2 | 1.028 | (0.773 - 1.368) | 0.8478 | 0.02795 |
| SCOPS | 1.110 | (0.820 - 1.503) | 0.4980 | 0.10463 |
| SCOPS2 | 0.941 | (0.690 - 1.284) | 0.7034 | -0.0602 |
| SLELOS | 0.913 | (0.719 - 1.161) | 0.4596 | -0.0905 |
| SEX | 2.351 | (1.407 - 3.929) | 0.0011 | 0.42739 |
| SHIFT | 1.759 | (1.078 - 2.868) | 0.0237 | 0.28228 |
| JHRTRT\_1 | 1.034 | (1.019 - 1.049) | <.0001 | 0.03343 |
| RSPRT\_1 | 1.149 | (1.035 - 1.276) | 0.0095 | 0.13886 |
| JWRS\_T | 1.095 | (0.953 - 1.258) | 0.1984 | 0.09106 |
| JWRS\_SAT | 0.986 | (0.850 - 1.144) | 0.8530 | -0.0140 |
| sbpdia | 1.001 | (1.000 - 1.002) | 0.0045 | 0.00119 |
| JLAT\_NEU | 1.322 | (1.067 - 1.639) | 0.0108 | 0.27922 |
| JCINS\_T | 1.076 | (0.864 - 1.340) | 0.5123 | 0.07329 |
| JCINS\_HR | 1.009 | (0.993 - 1.026) | 0.2749 | 0.00917 |
| JCINS\_RR | 1.049 | (0.984 - 1.117) | 0.1428 | 0.04742 |
| JCINS\_SBP | 1.010 | (0.998 - 1.023) | 0.1104 | 0.01023 |
| JCINS\_SAT | 1.063 | (0.907 - 1.247) | 0.4492 | 0.06140 |
| BUN\_VALUE | 1.018 | (1.005 - 1.031) | 0.0069 | 0.01772 |
| pml\_value | 0.995 | (0.986 - 1.005) | 0.3664 | -0.0046 |
| shemat | 1.003 | (0.998 - 1.008) | 0.2953 | 0.00261 |
| CO\_CAT | 8.285 | (3.986 - 17.221) | <.0001 | 1.05723 |
| SLELOS2 | 0.880 | (0.687 - 1.128) | 0.3130 | -0.1275 |
| BPSYS\_1\*sbpsys\_1 | 0.998 | (. - .) | 0.6492 | -0.0017 |
| BPSYS\_1\*sbpsys\_2 | 1.007 | (. - .) | 0.3128 | 0.00687 |
| BPSYS\_1\*sbpsys\_3 | 0.998 | (. - .) | 0.3334 | -0.0021 |
| BPSYS\_1\*sbpsys\_4 | 1.000 | (. - .) | 0.8969 | 0.00030 |
|  |  |  |  |  |
| **c statistic** |  | **0.836** |  |  |
| **Hosmer-Lemeshow p value** | | **0.4557** |  |  |

**AP\_PN**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | outcome |  |  |  |
| Number of Controls | 874 |  |  |  |
| Number of Outcomes | 72 |  |  |  |
|  |  |  |  |  |
|  | **Odds Ratio** | **95% CI** | **p value** | **Betas** |
| Intercept |  |  |  | 25.2578 |
| SLAPS | 1.045 | (0.701 - 1.558) | 0.8299 | 0.04378 |
| SLAPS2 | 1.023 | (0.663 - 1.577) | 0.9187 | 0.02254 |
| SCOPS | 1.628 | (1.135 - 2.335) | 0.0081 | 0.48731 |
| SCOPS2 | 0.902 | (0.579 - 1.403) | 0.6465 | -0.1035 |
| SLELOS | 1.016 | (0.726 - 1.423) | 0.9242 | 0.01634 |
| SEX | 1.038 | (0.551 - 1.955) | 0.9091 | 0.01845 |
| SHIFT | 2.136 | (1.110 - 4.109) | 0.0230 | 0.37938 |
| JHRTRT\_1 | 1.030 | (1.011 - 1.049) | 0.0015 | 0.02962 |
| RSPRT\_1 | 1.149 | (0.991 - 1.333) | 0.0664 | 0.13896 |
| JWRS\_T | 0.958 | (0.777 - 1.180) | 0.6848 | -0.0432 |
| JWRS\_SAT | 0.728 | (0.613 - 0.865) | 0.0003 | -0.3172 |
| sbpdia | 1.000 | (0.999 - 1.001) | 0.9384 | 0.00004 |
| JLAT\_NEU | 1.202 | (0.842 - 1.715) | 0.3108 | 0.18385 |
| JCINS\_T | 1.032 | (0.730 - 1.457) | 0.8595 | 0.03118 |
| JCINS\_HR | 1.009 | (0.985 - 1.032) | 0.4749 | 0.00854 |
| JCINS\_RR | 1.048 | (0.968 - 1.135) | 0.2458 | 0.04712 |
| JCINS\_SBP | 1.010 | (0.992 - 1.028) | 0.2775 | 0.00998 |
| JCINS\_SAT | 0.859 | (0.711 - 1.039) | 0.1169 | -0.1514 |
| BUN\_VALUE | 1.034 | (1.014 - 1.054) | 0.0007 | 0.03361 |
| pml\_value | 0.982 | (0.962 - 1.002) | 0.0802 | -0.0180 |
| shemat | 1.009 | (1.002 - 1.015) | 0.0058 | 0.00847 |
| num\_ut2 | 1.638 | (1.086 - 2.470) | 0.0186 | 0.49326 |
| CO\_CAT | 3.016 | (0.694 - 13.108) | 0.1409 | 0.55194 |
| BPSYS\_1\*sbpsys\_1 | 1.008 | (. - .) | 0.1440 | 0.00789 |
| BPSYS\_1\*sbpsys\_2 | 1.004 | (. - .) | 0.6657 | 0.00432 |
| BPSYS\_1\*sbpsys\_3 | 0.994 | (. - .) | 0.0509 | -0.0062 |
| BPSYS\_1\*sbpsys\_4 | 0.996 | (. - .) | 0.2533 | -0.0040 |
|  |  |  |  |  |
| **c statistic** |  | **0.859** |  |  |
| **Hosmer-Lemeshow p value** | | **0.6333** |  |  |

**APPENDIX 8**: **Relationship between sample size and c statistic**

Figure: Relationship between sample size and the dropoff in the c statistic (cDeriv – cValid)



**APPENDIX 9: Expanded comparison of MEWS(re) and EMR-based models**

If one employed a MEWS(re) threshold of ≥ 6 to trigger an alarm, this would result in identification of 15% of all transfers to the ICU. Table 9.1, below, shows that using this threshold would result in a work-up to detection (W:D) ratio of approximately 32:1. In contrast, if one employed the EMR based models described in the text, the W:D ratio would range from approximately 11 to 15:1, depending on the hospital. Table 9.1 shows the results of the model applied in a small hospital in our system (Antioch), in a large hospital (Roseville), and across all 21 Northern California KPMCP hospitals.

**Table 9.1: Work-up to detection ratio (W:D) for MEWS(re) ≥ 6 (15% of events identified)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Hospital** | **MEWS(re)** | **W:D** | **EMR** | **W:D** |
| Antioch | 2.3 | 32.9:1 | 0.9 | 14.6:1 |
| Roseville | 5.3 | 31.6:1 | 2.2 | 10.7:1 |
| Region | 52.3 | 34.4:1 | 21.8 | 14.5:1 |

Table 9.2 shows that, at this threshold, both the MEWS(re) and EMR models preferentially detect events where the patient involved subsequently died, althought the EMR models are more discriminating.

**Table 9.2: Outcomes detected at 15% threshold**

|  |  |  |
| --- | --- | --- |
|  | **Events detected (N) Died (%)** | **Events missed (N) Died (%)** |
| MEWS(re) | 611 | 3,425 |
| 31% | 25% |
| EMR | 611 | 3,425 |
| 38% | 24% |

Tables 9.3 through 9.6 show the results one would see if one employed a MEWS(re) threshold of ≥ 5 (which would result in identification of 27% of events) and ≥ 4 (which would result in identification of 44% of events).

**Table 9.3: Work-up to detection ratio (W:D) for MEWS(re) ≥ 5 (27% of events identified)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Hospital** | **MEWS(re)** | **W:D** | **EMR** | **W:D** |
| Antioch | 5.7 | 48.2:1 | 2.4 | 21.4:1 |
| Roseville | 13.6 | 36.9:1 | 5.9 | 17.2:1 |
| Region | 125.4 | 50.3:1 | 55.3 | 21.3:1 |

**Table 9.4: Outcomes detected at 27% threshold**

|  |  |  |
| --- | --- | --- |
|  | **Events detected (N) Died (%)** | **Events missed (N) Died (%)** |
| MEWS(re) | 1,093 | 2,943 |
| 32% | 24% |
| EMR | 1,093 | 2,943 |
| 36% | 23% |

**Table 9.5: Work-up to detection ratio (W:D) for MEWS(re) ≥ 4 (44% of events identified)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Hospital** | **MEWS(re)** | **W:D** | **EMR** | **W:D** |
| Antioch | 13.4 | 77.3:1 | 6.2 | 32.7:1 |
| Roseville | 31.6 | 50:1 | 14.9 | 25.8:1 |
| Region | 275.8 | 69.4:1 | 136.4 | 33.7:1 |

**Table 9.6: Outcomes detected at 44% threshold**

|  |  |  |
| --- | --- | --- |
|  | **Events detected (N) Died (%)** | **Events missed (N) Died (%)** |
| MEWS(re) | 1,774 | 2,262 |
| 31% | 23% |
| EMR | 1,774 | 2,262 |
| 33% | 21% |

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