

1 SUPPLEMENTAL DIGITAL CONTENT

2
3 SUPPLEMENTAL FIGURE & TABLE CAPTIONS

4
5 **Table E1: Vasopressor Breakdown per Cohort**

6 The table shows the set of all vasopressors considered when constructing our primary outcome:
7 vasopressor onset. The table also shows the counts and percentages indicating how often each particular
8 drug was the type of vasopressor initially administered within each data source. Note that values do not
9 necessarily sum to 100%, as it is possible for multiple vasopressor types to be initially administered
10 together. Phenylephrine was the main drug used at Beth Israel, while norepinephrine was most common
11 at Methodist.

12
13 **Table E2: Summary Statistics of All Modeled Variables with Missingness**

14 The table shows the full list of variables used by our predictive models, all of which exist in all data
15 sources. Also listed are variable summaries for the specific development datasets to construct the models
16 to predict onset of vasopressors 4 hours in advance. Median values along with 2.5%, 25%, 75%, and
17 97.5% quantiles are shown for continuous values, while counts and percentages are shown for binary
18 variables. Variable summaries are further broken down by the primary outcome, so that differences
19 between cases and controls can be seen. The raw percentage of cases and controls where measurements
20 were made can be seen, e.g. for the important variables that had statistically significant changes in model
21 coefficient signs from Figure 3. The first variable shown (hours after admission) is not used in prediction
22 models, but indicates the number of hours this prediction is being made. For instance, if vasopressors
23 start at hour 20, this model's prediction was made at hour 16.

24
25 **Table E3: Additional Qualitative Results from 4 Hour Onset Models**

26 The table shows additional quantitative results from the 4 hour onset models. Results from the 12
27 different models are shown from evaluation on each of the 3 datasets. The table shows area under the
28 ROC (AUROC) curves with 95% bootstrap confidence intervals, and bootstrap p-values from a one-sided
29 test against the model with highest AUROC on each dataset. The rows with significantly highest
30 AUROC values were always the combined model that was fit to the same dataset being evaluated on, so
31 these rows are bolded throughout. We also show area under the precision-recall curves (AUPRs) with
32 bootstrap confidence values, and positive predictive values (PPVs) at both 50% and 75% sensitivity, with
33 bootstrap 95% confidence intervals. To measure calibration, we show the unscaled Brier score along with
34 confidence intervals, and also P-values from the Hosmer-Lemeshow test for calibration. The null
35 hypothesis is that there is adequate calibration (i.e. that observed event rates and predicted risks have no
36 significant differences); low P-values indicate a lack of evidence that the null hypothesis is true.

37
38 **Figure E1:** The diagram shows the consort diagrams outlining the filtering process for how we arrived at
39 our final cohorts in each of the three datasets. We limited our analysis to adult patients (age ≥ 18 years)
40 with lengths of stay between 6 and 600 hours, and exclude admissions where vasopressors are
41 administered in the first 6 hours of a hospital admission or ICU stay.

42
43 **Figure E2:** Histograms show the distribution of when during the course of hospital or ICU admission
44 vasopressors were first administered, along with the randomly selected terminal times that were used for
45 right aligning positive vasopressor cases with negative controls where no vasopressors were administered.
46 Each pane shows histograms on a different data source. Vasopressors were most frequently administered
47 earlier on.

48
49 **Figure E3:** Calibration plots for the 4 hour models, after post-processing with isotonic regressions. For
50 each evaluation data source, results on 12 different models are shown. Models with a name beginning
51 with “A” were fit from the Methodist floor data, and appear in blue throughout. Models with a name

52 beginning with “B” were fit from the Methodist ICU data, and appear in green throughout. Models with a
53 name beginning with “C” were fit from the Beth Israel ICU data, and appear in red throughout. Models
54 with a name ending in “-1” are the combined models that use both physiologic and measurement indicator
55 variables, both when fitting models and during evaluation; their lines are solid. Models with a name
56 ending in “-2” are the combined models that use both physiologic and measurement indicator variables
57 during model fitting, but only use physiologic variables during evaluation; their lines are dash-dotted.
58 Models with a name ending in “-3” are the models solely using physiologic variables; their lines are
59 dashed. Models with a name ending in “-4” are the models solely using the measurement indicator
60 variables; their lines are dotted. Calibration is generally good.

61

62 **Figure E4:** Additional quantitative results for the 4 hour models. The top row shows ROC curves, and
63 the bottom row shows precision-recall curves. For each evaluation data source, results on 12 different
64 models are shown. Models with a name beginning with “A” were fit from the Methodist floor data, and
65 appear in blue throughout. Models with a name beginning with “B” were fit from the Methodist ICU
66 data, and appear in green throughout. Models with a name beginning with “C” were fit from the Beth
67 Israel ICU data, and appear in red throughout. Models with a name ending in “-1” are the combined
68 models that use both physiologic and measurement indicator variables, both when fitting models and
69 during evaluation; their lines are solid. Models with a name ending in “-2” are the combined models that
70 use both physiologic and measurement indicator variables during model fitting, but only use physiologic
71 variables during evaluation; their lines are dash-dotted. Models with a name ending in “-3” are the
72 models solely using physiologic variables; their lines are dashed. Models with a name ending in “-4” are
73 the models solely using the measurement indicator variables; their lines are dotted. An important finding
74 is that combined models always perform best, and models trained on the same dataset being evaluated
75 also perform better than models learned from other data sources. For Beth Israel-derived models,
76 generally the best model out-of-sample are models that were trained on both physiologic and indicator

77 features, but then only using physiologic features during evaluation. However, the combined models

78 derived from Methodist cohorts generally do best when validated externally.

79

Table E1

Variable	Methodist floor cohort	Methodist ICU cohort	Beth Israel ICU cohort
Total hospital/ICU admissions in cohort where vasopressor therapy was initiated, n	539	265	1499
Dobutamine, n (%)	4 (0.7%)	0 (0.0%)	0 (0.0%)
Dopamine, n (%)	81 (15.0%)	15 (5.7%)	125 (8.3%)
Epinephrine, n (%)	16 (3.0%)	7 (2.6%)	79 (5.3%)
Isoproterenol, n (%)	5 (0.9%)	2 (0.8%)	0 (0.0%)
Norepinephrine, n (%)	420 (77.9%)	233 (87.9%)	389 (26.0%)
Phenylephrine, n(%)	19 (3.5%)	10 (3.8%)	954 (63.6%)

Table E2

Continuous vars: median (5%, 25%, 75%, 95% quantiles) Proportion vars: n (%)	Methodist General Floor Cohort, 539 Positive Cases (0.9%)	Methodist General Floor Cohort, 59211 Negative Controls (99.1%)	Methodist ICU Cohort, 265 Positive Cases (12.4%)	Methodist ICU Cohort, 1872 Negative Controls (87.6%)	Beth Israel ICU Cohort, 1499 Positive Cases (11.5%)	Beth Israel ICU Cohort, 11500 Negative Controls (88.5%)
Hours after admission to hospital/ICU	28.4 (2.8, 8.9, 94.9, 244.6)	22.0 (3.1, 9.5, 46.0, 126.0)	73.5 (4.5, 21.3, 163.0, 316.6)	86.3 (11.0, 41.5, 164.0, 369.8)	14.7 (2.4, 5.0, 42.4, 160.9)	15.7 (3.2, 8.3, 31.4, 91.8)
Age	65.0 (35.9, 55.0, 74.0, 86.0)	59.0 (24.0, 42.0, 71.0, 87.0)	63.0 (34.0, 54.0, 70.0, 85.8)	62.0 (30.6, 52.0, 71.0, 84.0)	67.1 (37.8, 56.6, 77.9, 88.3)	64.1 (27.9, 51.1, 77.8, 90.0)
Arterial diastolic blood pressure	60.0 (55.8, 60.0, 60.0, 61.1)	60.0 (60.0, 60.0, 60.0, 60.0)	60.0 (47.0, 60.0, 60.0, 73.4)	60.0 (52.0, 60.0, 60.0, 79.4)	60.0 (44.0, 60.0, 60.0, 78.1)	60.0 (51.0, 60.0, 60.0, 76.0)
Noninvasive diastolic blood pressure	62.0 (42.0, 55.0, 75.0, 90.1)	71.0 (55.0, 61.0, 81.0, 96.0)	61.0 (41.0, 52.0, 71.0, 89.0)	72.0 (51.0, 63.0, 83.0, 99.0)	60.0 (39.0, 52.0, 65.0, 86.0)	62.0 (43.0, 55.0, 73.0, 90.0)
ALT	34.0 (26.0, 34.0, 34.0, 57.0)	34.0 (34.0, 34.0, 34.0, 34.0)	34.0 (13.0, 29.0, 34.0, 261.4)	34.0 (13.0, 34.0, 34.0, 103.4)	34.0 (11.0, 20.0, 37.0, 138.0)	34.0 (11.0, 22.0, 34.0, 135.0)
Arterial MAP	85.0 (77.9, 85.0, 85.0, 85.0)	85.0 (85.0, 85.0, 85.0, 85.0)	85.0 (64.0, 85.0, 85.0, 96.8)	85.0 (71.0, 85.0, 85.0, 105.0)	85.0 (60.0, 77.0, 85.0, 102.0)	85.0 (70.0, 85.0, 85.0, 99.0)
MAP	85.0 (64.9, 82.5, 85.0, 108.0)	85.0 (80.0, 85.0, 85.0, 112.0)	80.0 (58.0, 70.0, 97.0, 115.8)	94.5 (69.0, 84.0, 107.0, 127.0)	76.0 (52.0, 64.0, 85.0, 99.0)	79.0 (57.0, 69.0, 86.0, 103.0)
Arterial SBP	120.0 (109.9, 120.0, 120.0, 120.5)	120.0 (120.0, 120.0, 120.0, 120.0)	120.0 (92.2, 120.0, 120.0, 145.0)	120.0 (101.0, 120.0, 120.0, 161.0)	120.0 (91.0, 114.0, 120.0, 147.1)	120.0 (105.0, 120.0, 120.0, 147.0)
Arterial SBP measured in last hour	38 (7.1%)	368 (0.6%)	42 (15.8%)	119 (6.4%)	507 (33.8%)	2462 (21.4%)
Arterial SBP ever measured	66 (12.2%)	1301 (2.2%)	69 (26.0%)	428 (22.9%)	689 (46.0%)	3174 (27.6%)
SBP	113.0 (84.9, 97.0, 130.5, 155.0)	127.0 (98.0, 114.0, 144.0, 168.0)	111.0 (81.0, 94.0, 129.0, 155.8)	130.0 (95.0, 114.0, 146.0, 170.4)	120.0 (83.0, 100.0, 122.0, 150.0)	120.0 (91.0, 108.0, 134.0, 159.0)
SBP measured in last hour	307 (57.0%)	18432 (31.1%)	223 (84.2%)	1399 (74.7%)	643 (42.9%)	8539 (74.3%)
AST	40.0 (26.0, 40.0, 40.0, 93.4)	40.0 (40.0, 40.0, 40.0, 40.0)	40.0 (14.2, 40.0, 47.0, 322.8)	40.0 (14.0, 40.0, 40.0, 115.9)	40.0 (16.0, 26.0, 50.0, 240.0)	40.0 (15.0, 27.0, 40.0, 162.0)
AST measured in last hour	10 (1.9%)	38 (0.1%)	5 (1.9%)	11 (0.6%)	42 (2.8%)	194 (1.7%)
AST measured in last 8 hours	35 (6.5%)	334 (0.6%)	38 (14.3%)	108 (5.8%)	525 (35.0%)	2457 (21.4%)

Heart rate	86.0 (60.0, 73.0, 100.0, 127.1)	80.0 (58.0, 70.0, 90.0, 108.0)	91.0 (60.0, 78.0, 105.0, 132.8)	85.0 (59.0, 74.0, 97.0, 117.0)	86.0 (60.0, 77.0, 100.0, 125.0)	82.0 (57.0, 71.0, 94.0, 114.0)
Heart rate measured in last hour	303 (56.2%)	19127 (32.3%)	224 (84.5%)	1446 (77.2%)	1065 (71.0%)	11096 (96.5%)
BUN	23.0 (16.0, 23.0, 23.0, 52.0)	23.0 (23.0, 23.0, 23.0, 23.0)	23.0 (10.0, 18.0, 38.0, 71.8)	23.0 (7.0, 16.0, 29.0, 64.4)	23.0 (8.0, 15.0, 35.0, 74.1)	18.0 (7.0, 12.0, 27.0, 61.0)
Total bilirubin	0.9 (0.9, 0.9, 0.9, 1.4)	0.9 (0.7, 0.9, 0.9, 0.9)	0.9 (0.9, 0.9, 0.9, 6.3)	0.9 (0.4, 0.9, 0.9, 2.8)	0.9 (0.3, 0.5, 1.0, 7.1)	0.9 (0.2, 0.5, 0.9, 3.1)
Total bilirubin measured in last hour	7 (1.3%)	140 (0.2%)	1 (0.4%)	10 (0.5%)	70 (4.7%)	326 (2.8%)
Total bilirubin measured in last 8 hours	16 (3.0%)	1263 (2.1%)	15 (5.7%)	85 (4.5%)	529 (35.3%)	2510 (21.8%)
Creatinine	1.0 (1.0, 1.0, 1.0, 3.3)	1.0 (0.8, 1.0, 1.0, 1.8)	1.2 (1.0, 1.0, 2.7, 7.2)	1.0 (0.6, 1.0, 1.8, 5.8)	1.0 (0.5, 0.8, 1.5, 4.1)	0.9 (0.5, 0.7, 1.2, 3.2)
Creatinine measured in last hour	15 (2.8%)	612 (1.0%)	10 (3.8%)	37 (2.0%)	97 (6.5%)	858 (7.5%)
Creatinine measured in last 8 hours	52 (9.6%)	4616 (7.8%)	53 (20.0%)	328 (17.5%)	1045 (69.7%)	7226 (62.8%)
Glucose	120.0 (89.8, 120.0, 120.0, 172.2)	120.0 (120.0, 120.0, 120.0, 120.0)	120.0 (82.0, 108.0, 145.0, 228.4)	120.0 (82.0, 106.0, 138.2, 234.0)	127.0 (84.0, 108.0, 158.0, 235.2)	123.0 (84.0, 104.0, 152.0, 230.0)
Glucose measured in last hour	16 (3.0%)	133 (0.2%)	12 (4.5%)	30 (1.6%)	587 (39.2%)	2504 (21.8%)
Glucose measured in last 8 hours	66 (12.2%)	1216 (2.1%)	70 (26.4%)	284 (15.2%)	1402 (93.5%)	9692 (84.3%)
Hematocrit	30.2 (25.4, 30.2, 30.2, 38.6)	30.2 (30.2, 30.2, 30.2, 30.2)	30.2 (22.0, 25.7, 32.0, 41.4)	30.2 (22.8, 28.6, 33.5, 41.6)	30.9 (23.0, 27.3, 35.7, 42.0)	32.4 (24.0, 28.5, 36.7, 42.7)
Hemoglobin	10.2 (8.4, 10.2, 10.2, 12.7)	10.2 (10.2, 10.2, 10.2, 10.2)	10.2 (7.1, 8.4, 10.5, 13.6)	10.2 (7.5, 9.4, 11.0, 13.8)	10.4 (7.5, 9.2, 12.0, 14.2)	11.0 (7.9, 9.6, 12.5, 14.6)
Hemoglobin measured in last hour	19 (3.5%)	114 (0.2%)	12 (4.5%)	32 (1.7%)	384 (25.6%)	1321 (11.5%)
Hemoglobin measured in last 8 hours	66 (12.2%)	1086 (1.8%)	73 (27.5%)	272 (14.5%)	1156 (77.1%)	7178 (62.4%)
FiO2	21.0 (21.0, 21.0, 21.0, 51.0)	21.0 (21.0, 21.0, 21.0, 21.0)	21.0 (21.0, 21.0, 40.0, 100.0)	21.0 (21.0, 21.0, 21.0, 50.0)	40.0 (21.0, 21.0, 50.0, 100.0)	21.0 (21.0, 21.0, 40.0, 70.0)

FiO2 measured in last hour	21 (3.9%)	91 (0.2%)	31 (11.7%)	101 (5.4%)	257 (17.1%)	867 (7.5%)
FiO2 measured in last 8 hours	41 (7.6%)	146 (0.2%)	49 (18.5%)	137 (7.3%)	743 (49.6%)	3149 (27.4%)
Bicarbonate	25.0 (19.0, 25.0, 25.0, 27.0)	25.0 (25.0, 25.0, 25.0)	25.0 (16.0, 21.0, 26.0, 30.0)	25.0 (20.0, 24.0, 27.0, 34.0)	25.0 (16.9, 22.0, 28.0, 32.0)	25.0 (18.0, 23.0, 28.0, 33.0)
Bicarbonate measured in last hour	28 (5.2%)	146 (0.2%)	19 (7.2%)	37 (2.0%)	437 (29.2%)	1071 (9.3%)
Bicarbonate measured in last 8 hours	90 (16.7%)	1290 (2.2%)	90 (34.0%)	306 (16.3%)	1299 (86.7%)	7675 (66.7%)
PCO2	40.0 (39.0, 40.0, 40.0, 43.0)	40.0 (40.0, 40.0, 40.0, 40.0)	40.0 (27.0, 40.0, 40.0, 51.0)	40.0 (31.0, 40.0, 40.0, 51.4)	40.0 (28.0, 36.0, 43.0, 55.0)	40.0 (31.0, 40.0, 40.0, 52.0)
PO2	95.0 (74.0, 95.0, 95.0, 146.1)	95.0 (95.0, 95.0, 95.0, 95.0)	95.0 (58.2, 95.0, 95.0, 215.8)	95.0 (68.0, 95.0, 95.0, 226.9)	116.0 (57.9, 94.5, 229.5, 419.0)	95.0 (60.0, 95.0, 112.0, 247.0)
PO2 measured in last hour	17 (3.2%)	27 (0.0%)	9 (3.4%)	7 (0.4%)	381 (25.4%)	294 (2.6%)
PO2 measured in last 8 hours	57 (10.6%)	253 (0.4%)	38 (14.3%)	53 (2.8%)	981 (65.4%)	2384 (20.7%)
Potassium	4.1 (3.6, 4.1, 4.1, 4.8)	4.1 (4.0, 4.1, 4.1, 4.1)	4.1 (3.2, 3.7, 4.3, 5.3)	4.1 (3.2, 3.7, 4.1, 4.8)	4.1 (3.3, 3.8, 4.5, 5.4)	4.0 (3.3, 3.7, 4.3, 5.0)
Potassium measured in last hour	21 (3.9%)	140 (0.2%)	12 (4.5%)	34 (1.8%)	342 (22.8%)	965 (8.4%)
Potassium measured in last 8 hours	75 (13.9%)	1280 (2.2%)	75 (28.3%)	297 (15.9%)	1231 (82.1%)	7618 (66.2%)
Sodium	140.0 (135.0, 140.0, 140.0, 144.0)	140.0 (140.0, 140.0, 140.0, 140.0)	140.0 (132.0, 138.0, 142.0, 149.0)	140.0 (134.0, 139.0, 142.0, 149.0)	138.0 (130.0, 135.0, 141.0, 146.0)	139.0 (132.0, 136.0, 141.0, 145.0)
Lactate	1.0 (1.0, 1.0, 1.0, 2.1)	1.0 (1.0, 1.0, 1.0, 1.0)	1.0 (1.0, 1.0, 1.2, 5.7)	1.0 (1.0, 1.0, 1.0, 2.2)	1.5 (0.8, 1.0, 2.2, 4.4)	1.0 (0.8, 1.0, 1.7, 3.1)
Lactate measured in last hour	9 (1.7%)	8 (0.0%)	5 (1.9%)	3 (0.2%)	219 (14.6%)	195 (1.7%)
Lactate measured in last 8 hours	24 (4.5%)	111 (0.2%)	32 (12.1%)	26 (1.4%)	901 (60.1%)	2433 (21.2%)
Lactate ever measured	48 (8.9%)	556 (0.9%)	76 (28.7%)	309 (16.5%)	1295 (86.4%)	7298 (63.5%)
Magnesium	2.0 (1.9, 2.0, 2.0, 2.2)	2.0 (2.0, 2.0, 2.0, 2.0)	2.0 (1.7, 2.0, 2.1, 2.6)	2.0 (1.7, 2.0, 2.1, 2.6)	2.0 (1.5, 1.9, 2.1, 2.6)	2.0 (1.6, 1.9, 2.1, 2.5)
Magnesium	9 (1.7%)	59 (0.1%)	6 (2.3%)	19 (1.0%)	94 (6.3%)	824 (7.2%)

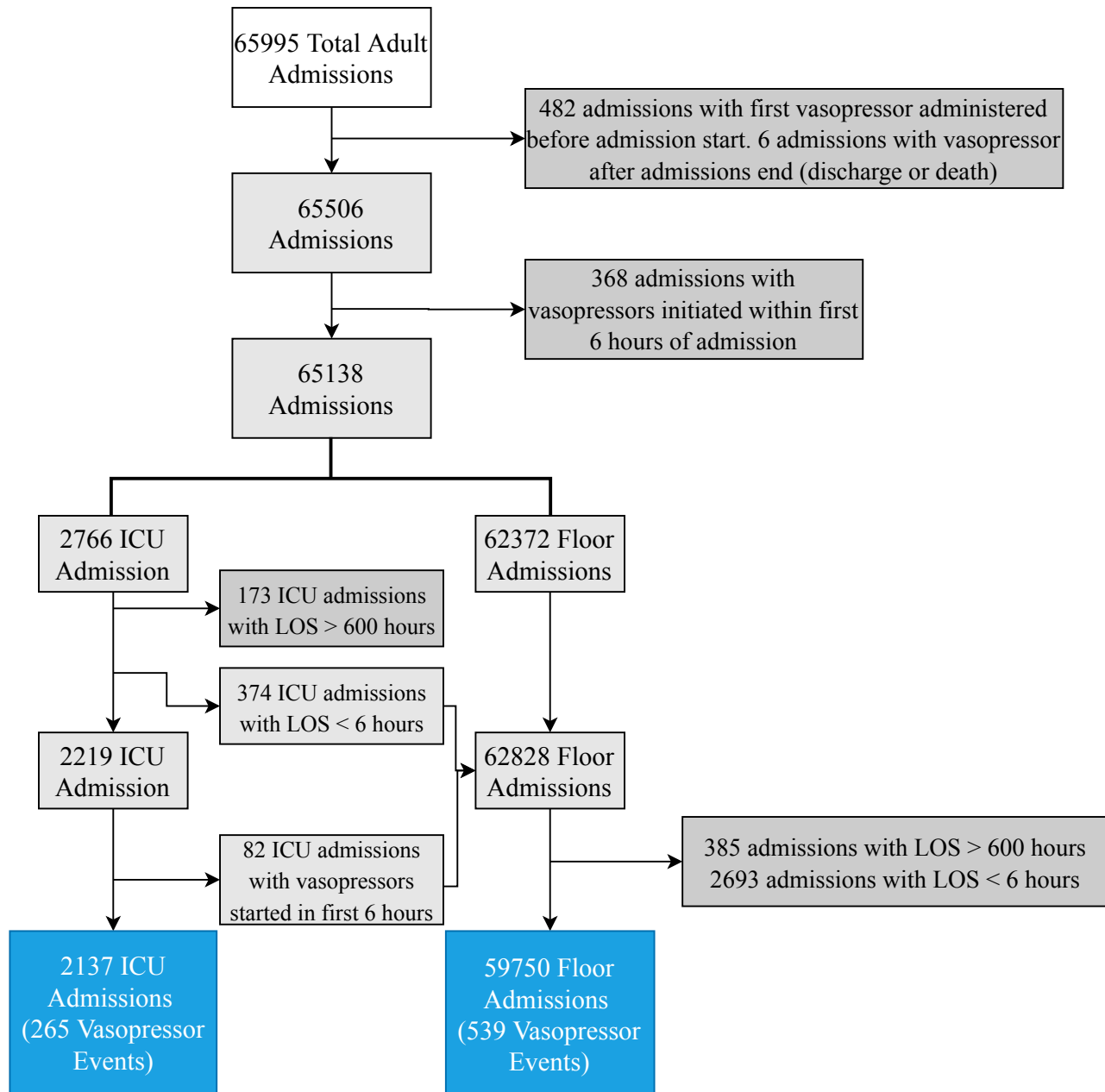
measured in last hour						
Magnesium measured in last 8 hours	36 (6.7%)	600 (1.0%)	40 (15.1%)	154 (8.2%)	734 (49.0%)	5729 (49.8%)
Platelets	208.0 (110.0, 208.0, 208.0, 229.5)	208.0 (165.0, 208.0, 208.0, 277.0)	208.0 (50.4, 144.0, 218.0, 366.2)	208.0 (77.0, 155.0, 249.0, 415.8)	202.0 (63.0, 138.0, 272.0, 462.8)	214.0 (77.0, 162.0, 282.0, 438.0)
Respiration Rate	18.0 (12.0, 16.0, 20.0, 30.0)	18.0 (16.0, 18.0, 18.0, 20.0)	19.0 (12.0, 16.0, 25.0, 33.8)	18.0 (13.0, 16.0, 20.0, 26.0)	19.0 (12.0, 17.0, 24.0, 32.0)	18.0 (11.0, 15.0, 22.0, 28.0)
Respiration Rate measured in last hour	266 (49.4%)	16909 (28.6%)	167 (63.0%)	1073 (57.3%)	1057 (70.5%)	11029 (95.9%)
SpO2	95.0 (92.0, 95.0, 96.0, 100.0)	95.0 (95.0, 95.0, 95.0, 98.0)	97.0 (88.2, 95.0, 100.0, 100.0)	97.0 (89.6, 95.0, 99.0, 100.0)	97.0 (92.0, 95.0, 99.0, 100.0)	97.0 (92.0, 95.0, 99.0, 100.0)
SpO2 measured in last hour	169 (31.4%)	3713 (6.3%)	184 (69.4%)	1137 (60.7%)	1043 (69.6%)	10853 (94.4%)
WBC	9.0 (7.2, 9.0, 9.0, 17.0)	9.0 (9.0, 9.0, 9.0, 9.0)	9.0 (4.2, 8.5, 13.2, 23.7)	9.0 (4.8, 8.5, 11.3, 19.3)	10.4 (4.2, 7.8, 14.8, 23.1)	9.6 (4.1, 7.3, 12.8, 20.5)
WBC measured in last hour	14 (2.6%)	102 (0.2%)	14 (5.3%)	31 (1.7%)	115 (7.7%)	768 (6.7%)
WBC measured in last 8 hours	60 (11.1%)	1021 (1.7%)	73 (27.5%)	269 (14.4%)	1009 (67.3%)	6752 (58.7%)
Weight	82.0 (58.4, 82.0, 82.0, 113.4)	82.0 (68.0, 82.0, 82.0, 97.2)	82.0 (56.0, 69.9, 90.4, 125.9)	82.0 (51.1, 69.2, 93.0, 127.1)	82.0 (53.0, 71.0, 87.2, 118.0)	80.6 (51.0, 66.6, 90.2, 119.0)
Weight measured in last hour	11 (2.0%)	251 (0.4%)	8 (3.0%)	28 (1.5%)	60 (4.0%)	401 (3.5%)
Weight measured in last 8 hours	73 (13.5%)	2670 (4.5%)	67 (25.3%)	191 (10.2%)	511 (34.1%)	3807 (33.1%)
GCS	15.0 (6.0, 14.0, 15.0, 15.0)	15.0 (14.0, 15.0, 15.0, 15.0)	15.0 (4.0, 10.0, 15.0, 15.0)	15.0 (6.0, 13.0, 15.0, 15.0)	14.0 (3.0, 9.0, 15.0, 15.0)	15.0 (7.0, 14.0, 15.0, 15.0)
GCS measured in last hour	85 (15.8%)	5253 (8.9%)	47 (17.7%)	364 (19.4%)	369 (24.6%)	3733 (32.5%)
Temperature	36.8 (35.6, 36.5, 37.0, 37.9)	36.7 (36.2, 36.5, 37.0, 37.4)	36.9 (35.5, 36.6, 37.3, 38.3)	36.9 (36.3, 36.6, 37.1, 37.8)	37.0 (35.6, 36.4, 37.3, 38.4)	36.8 (35.7, 36.3, 37.2, 37.9)
Temperature measured in last hour	148 (27.5%)	12675 (21.4%)	76 (28.7%)	563 (30.1%)	364 (24.3%)	3128 (27.2%)

Table E3

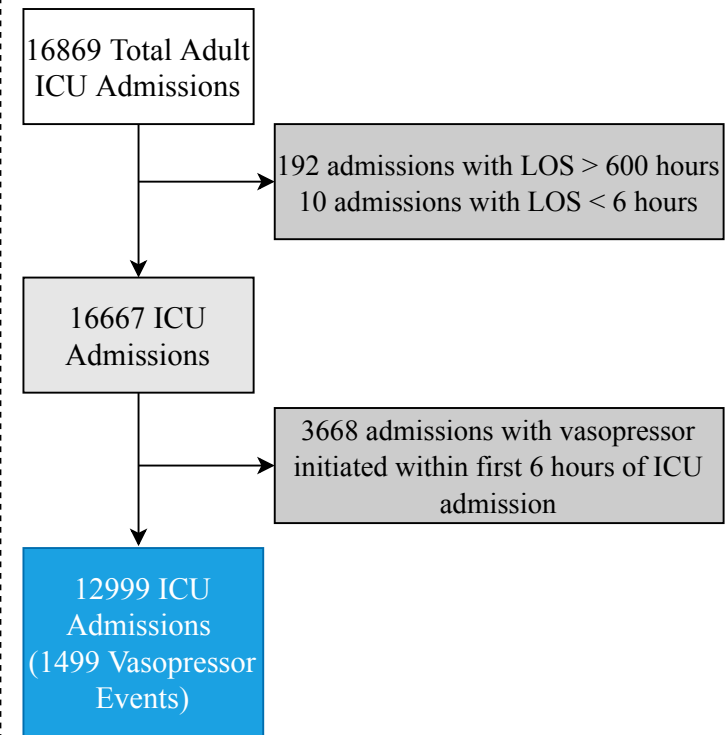
Evaluation Dataset	Model Training Dataset	Features Used in Training	Features Used in Evaluation	AUROC (95%CI)	Bootstrap AUROC P-value	AUPR (95%CI)	PPV at 50% Sens (95% CI)	PPV at 75% Sens (95% CI)	Brier Score (95% CI)	Hosmer-Lemeshow P-value
Methodist Floor	Methodist Floor	Values & Indicators	Values & Indicators	0.862 (0.844, 0.879)	-	0.115 (0.095, 0.139)	0.098 (0.081, 0.120)	0.038 (0.030, 0.049)	0.008 (0.008, 0.009)	0.134
	Methodist Floor	Values & Indicators	Only Values	0.829 (0.809, 0.847)	<0.001	0.089 (0.076, 0.109)	0.075 (0.057, 0.102)	0.026 (0.021, 0.034)	0.009 (0.008, 0.009)	0.892
	Methodist Floor	Only Values	Only Values	0.842 (0.823, 0.860)	0.013	0.094 (0.080, 0.114)	0.091 (0.071, 0.108)	0.029 (0.024, 0.038)	0.008 (0.008, 0.009)	0.108
	Methodist Floor	Only Indicators	Only Indicators	0.759 (0.736, 0.780)	<0.001	0.068 (0.051, 0.089)	0.039 (0.030, 0.044)	0.011 (0.010, 0.012)	0.009 (0.008, 0.009)	0.953
	Methodist ICU	Values & Indicators	Values & Indicators	0.766 (0.744, 0.790)	<0.001	0.091 (0.073, 0.114)	0.051 (0.040, 0.065)	0.015 (0.013, 0.019)	0.009 (0.008, 0.009)	0.487
	Methodist ICU	Values & Indicators	Only Values	0.742 (0.718, 0.768)	<0.001	0.083 (0.067, 0.102)	0.044 (0.031, 0.059)	0.014 (0.012, 0.018)	0.009 (0.008, 0.009)	0.042
	Methodist ICU	Only Values	Only Values	0.755 (0.731, 0.780)	<0.001	0.092 (0.075, 0.115)	0.047 (0.037, 0.068)	0.015 (0.013, 0.019)	0.009 (0.008, 0.009)	0.016
	Methodist ICU	Only Indicators	Only Indicators	0.636 (0.609, 0.663)	<0.001	0.047 (0.034, 0.064)	0.018 (0.008, 0.032)	0.009 (0.008, 0.010)	0.009 (0.008, 0.010)	0.617
	Beth Israel ICU	Values & Indicators	Values & Indicators	0.698 (0.670, 0.723)	<0.001	0.054 (0.043, 0.070)	0.025 (0.020, 0.036)	0.012 (0.010, 0.013)	0.009 (0.008, 0.009)	0.114
	Beth Israel ICU	Values & Indicators	Only Values	0.779 (0.755, 0.804)	<0.001	0.081 (0.067, 0.101)	0.064 (0.050, 0.081)	0.019 (0.016, 0.024)	0.009 (0.008, 0.009)	0.244
	Beth Israel ICU	Only Values	Only Values	0.773 (0.750, 0.797)	<0.001	0.060 (0.050, 0.072)	0.060 (0.048, 0.071)	0.019 (0.015, 0.023)	0.009 (0.008, 0.009)	0.383
	Beth Israel ICU	Only Indicators	Only Indicators	0.425 (0.399, 0.451)	<0.001	0.025 (0.015, 0.041)	0.007 (0.006, 0.007)	0.008 (0.007, 0.009)	0.009 (0.008, 0.010)	0.818
Methodist ICU	Methodist Floor	Values & Indicators	Values & Indicators	0.748 (0.715, 0.782)	<0.001	0.342 (0.287, 0.402)	0.330 (0.263, 0.408)	0.204 (0.171, 0.253)	0.097 (0.087, 0.106)	0.270
	Methodist Floor	Values & Indicators	Only Values	0.735 (0.699, 0.768)	<0.001	0.341 (0.285, 0.402)	0.330 (0.263, 0.418)	0.197 (0.164, 0.241)	0.097 (0.088, 0.107)	0.651
	Methodist Floor	Only Values	Only Values	0.735 (0.698, 0.769)	<0.001	0.347 (0.294, 0.407)	0.345 (0.249, 0.426)	0.199 (0.159, 0.254)	0.096 (0.087, 0.105)	0.112
	Methodist Floor	Only Indicators	Only Indicators	0.653 (0.615, 0.691)	<0.001	0.243 (0.203, 0.296)	0.211 (0.164, 0.270)	0.159 (0.129, 0.178)	0.105 (0.095, 0.114)	0.063
	Methodist ICU	Values & Indicators	Values & Indicators	0.822 (0.793, 0.852)	-	0.465 (0.407, 0.535)	0.463 (0.375, 0.569)	0.306 (0.251, 0.364)	0.086 (0.078, 0.095)	0.016
	Methodist ICU	Values & Indicators	Only Values	0.778 (0.746, 0.810)	0.003	0.410 (0.352, 0.475)	0.370 (0.319, 0.458)	0.244 (0.203, 0.299)	0.093 (0.084, 0.102)	0.063
	Methodist ICU	Only Values	Only Values	0.782 (0.749, 0.813)	0.005	0.403 (0.345, 0.468)	0.361 (0.299, 0.460)	0.253 (0.209, 0.324)	0.092 (0.083, 0.101)	0.066
	Methodist ICU	Only Indicators	Only Indicators	0.717 (0.686, 0.748)	<0.001	0.311 (0.259, 0.372)	0.262 (0.212, 0.334)	0.183 (0.146, 0.213)	0.099 (0.089, 0.108)	0.552

	Beth Israel ICU	Values & Indicators	Values & Indicators	0.690 (0.654, 0.724)	<0.001	0.242 (0.202, 0.290)	0.224 (0.176, 0.265)	0.184 (0.156, 0.213)	0.105 (0.095, 0.114)	0.384
	Beth Israel ICU	Values & Indicators	Only Values	0.736 (0.702, 0.769)	<0.001	0.319 (0.269, 0.376)	0.284 (0.233, 0.379)	0.216 (0.174, 0.250)	0.097 (0.087, 0.106)	0.023
	Beth Israel ICU	Only Values	Only Values	0.717 (0.684, 0.748)	<0.001	0.253 (0.217, 0.304)	0.259 (0.215, 0.314)	0.198 (0.165, 0.241)	0.102 (0.093, 0.112)	0.310
	Beth Israel ICU	Only Indicators	Only Indicators	0.538 (0.499, 0.578)	<0.001	0.159 (0.131, 0.196)	0.146 (0.120, 0.173)	0.128 (0.113, 0.148)	0.108 (0.097, 0.118)	0.074
Beth Israel ICU	Methodist Floor	Values & Indicators	Values & Indicators	0.736 (0.722, 0.749)	<0.001	0.301 (0.281, 0.325)	0.261 (0.237, 0.291)	0.194 (0.182, 0.206)	0.092 (0.088, 0.096)	0.121
	Methodist Floor	Values & Indicators	Only Values	0.668 (0.654, 0.683)	<0.001	0.241 (0.224, 0.263)	0.196 (0.177, 0.215)	0.149 (0.141, 0.159)	0.096 (0.092, 0.100)	0.363
	Methodist Floor	Only Values	Only Values	0.687 (0.672, 0.702)	<0.001	0.259 (0.240, 0.282)	0.216 (0.193, 0.248)	0.155 (0.146, 0.164)	0.095 (0.091, 0.099)	0.577
	Methodist Floor	Only Indicators	Only Indicators	0.727 (0.713, 0.740)	<0.001	0.294 (0.274, 0.319)	0.279 (0.258, 0.315)	0.197 (0.179, 0.208)	0.092 (0.088, 0.095)	0.022
	Methodist ICU	Values & Indicators	Values & Indicators	0.772 (0.760, 0.785)	<0.001	0.333 (0.310, 0.359)	0.305 (0.287, 0.324)	0.243 (0.224, 0.264)	0.089 (0.086, 0.093)	0.342
	Methodist ICU	Values & Indicators	Only Values	0.656 (0.640, 0.672)	<0.001	0.250 (0.232, 0.274)	0.201 (0.183, 0.218)	0.142 (0.135, 0.153)	0.096 (0.092, 0.100)	0.002
	Methodist ICU	Only Values	Only Values	0.677 (0.661, 0.693)	<0.001	0.267 (0.247, 0.292)	0.216 (0.195, 0.240)	0.151 (0.141, 0.160)	0.095 (0.091, 0.099)	0.127
	Methodist ICU	Only Indicators	Only Indicators	0.714 (0.701, 0.729)	<0.001	0.269 (0.250, 0.292)	0.277 (0.261, 0.300)	0.169 (0.159, 0.198)	0.093 (0.089, 0.096)	0.238
	Beth Israel ICU	Values & Indicators	Values & Indicators	0.889 (0.880, 0.898)	-	0.589 (0.564, 0.618)	0.609 (0.571, 0.657)	0.415 (0.384, 0.438)	0.068 (0.065, 0.071)	0.156
	Beth Israel ICU	Values & Indicators	Only Values	0.757 (0.744, 0.770)	<0.001	0.340 (0.316, 0.367)	0.313 (0.284, 0.347)	0.194 (0.179, 0.207)	0.090 (0.086, 0.093)	0.103
	Beth Israel ICU	Only Values	Only Values	0.828 (0.817, 0.839)	<0.001	0.386 (0.362, 0.415)	0.405 (0.377, 0.437)	0.292 (0.270, 0.317)	0.084 (0.081, 0.087)	0.525
	Beth Israel ICU	Only Indicators	Only Indicators	0.827 (0.815, 0.838)	<0.001	0.511 (0.486, 0.538)	0.466 (0.423, 0.505)	0.282 (0.263, 0.308)	0.076 (0.073, 0.080)	0.950

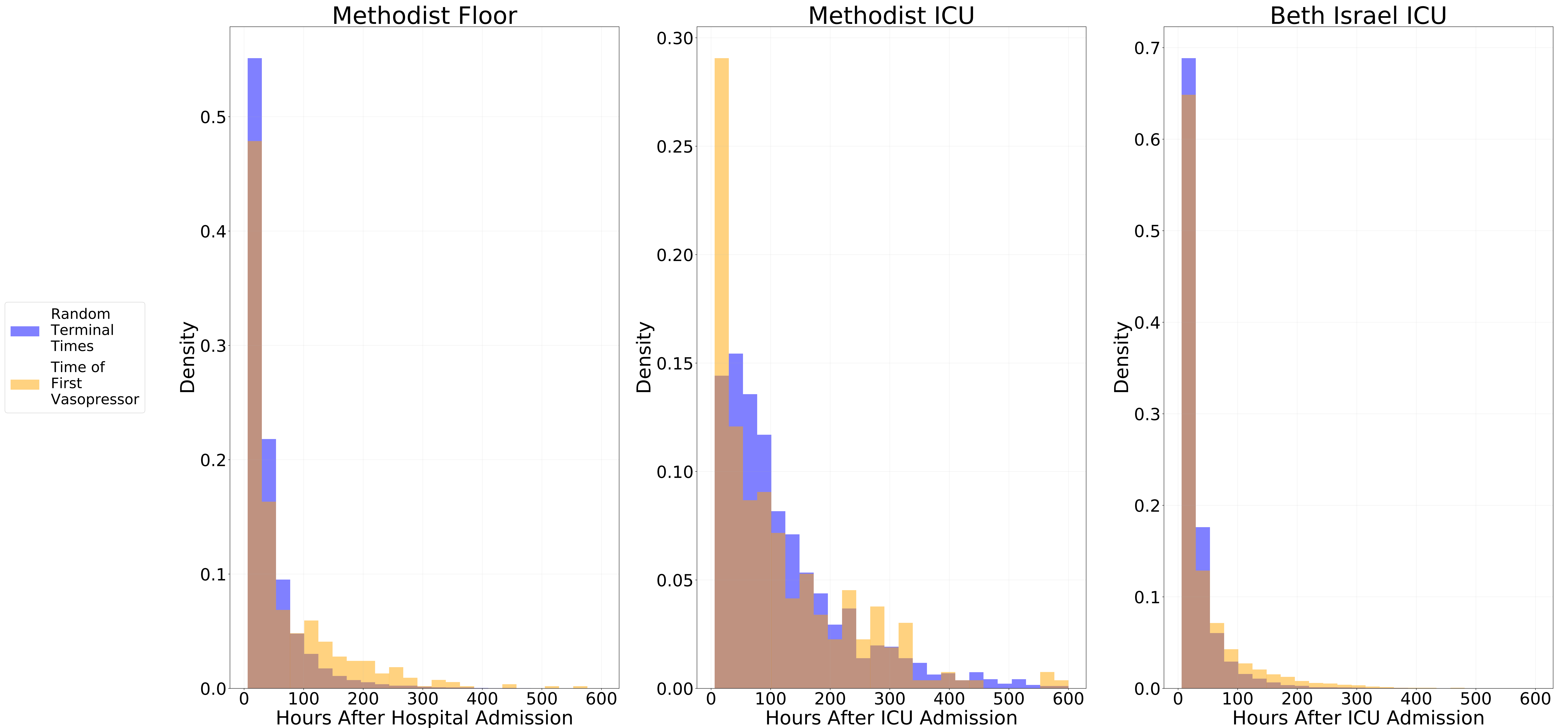
Methodist Floor and ICU Cohorts



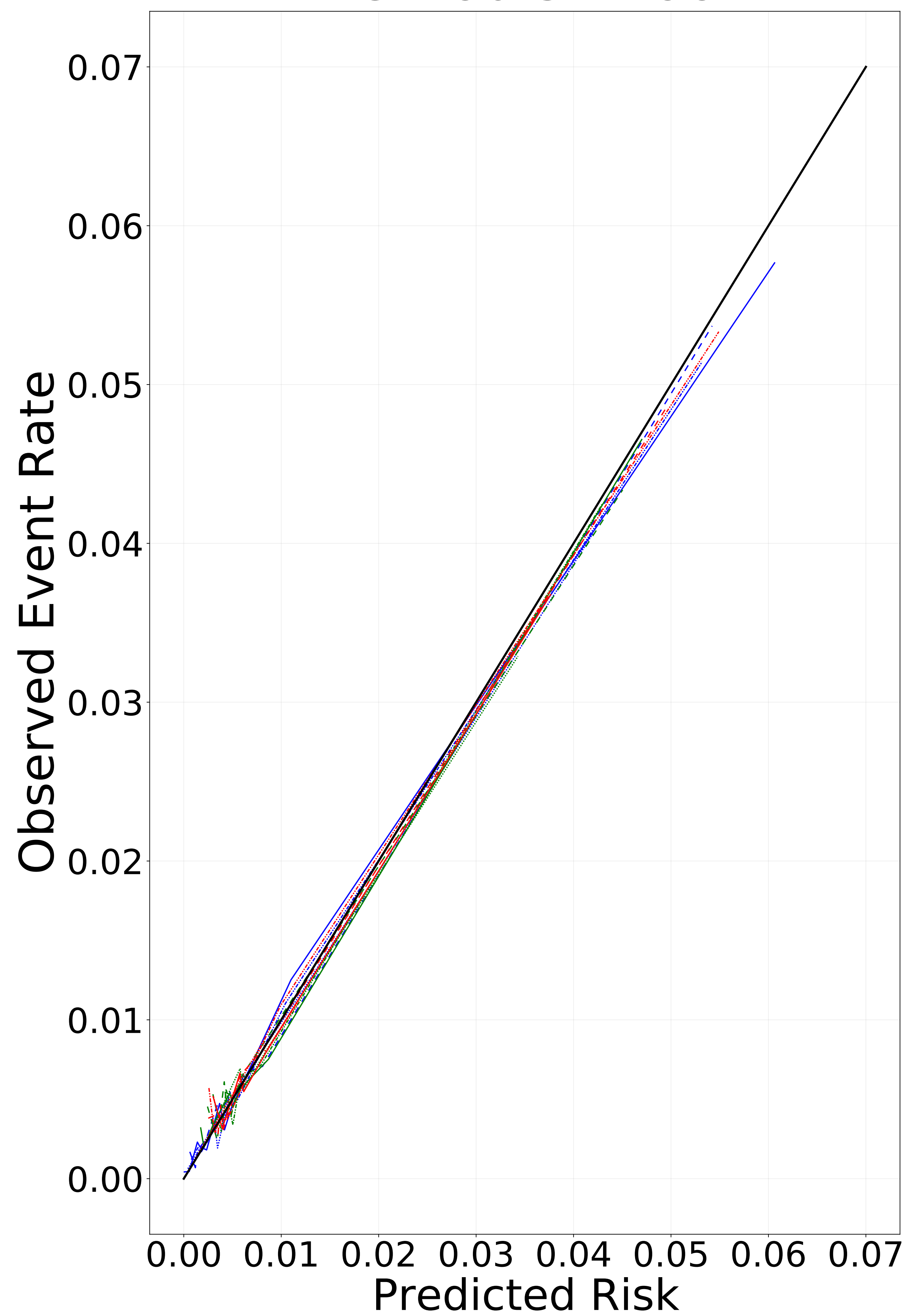
Beth Israel ICU Cohort



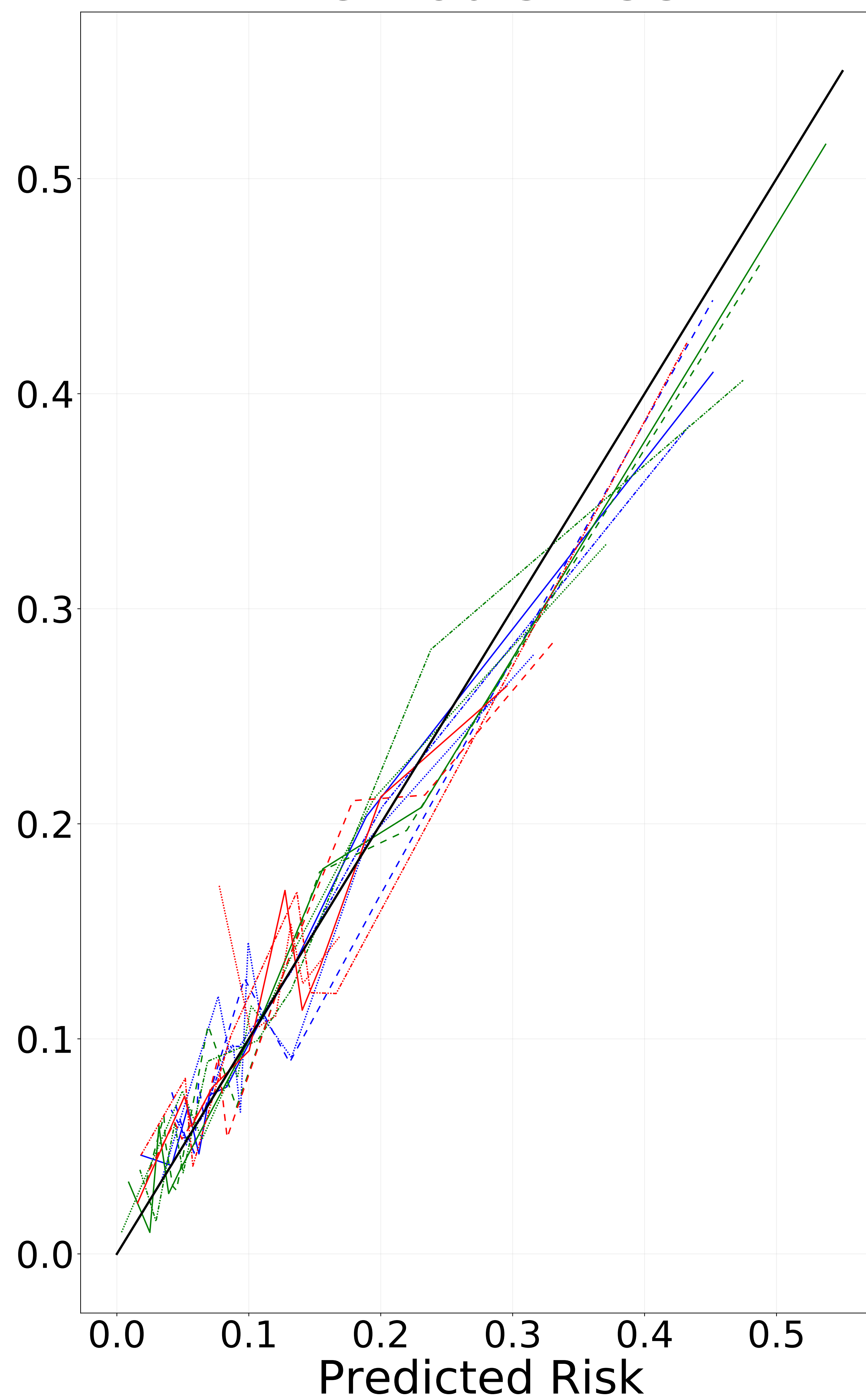
Distribution of Vasopressor & Control Terminal Times Across Datasets



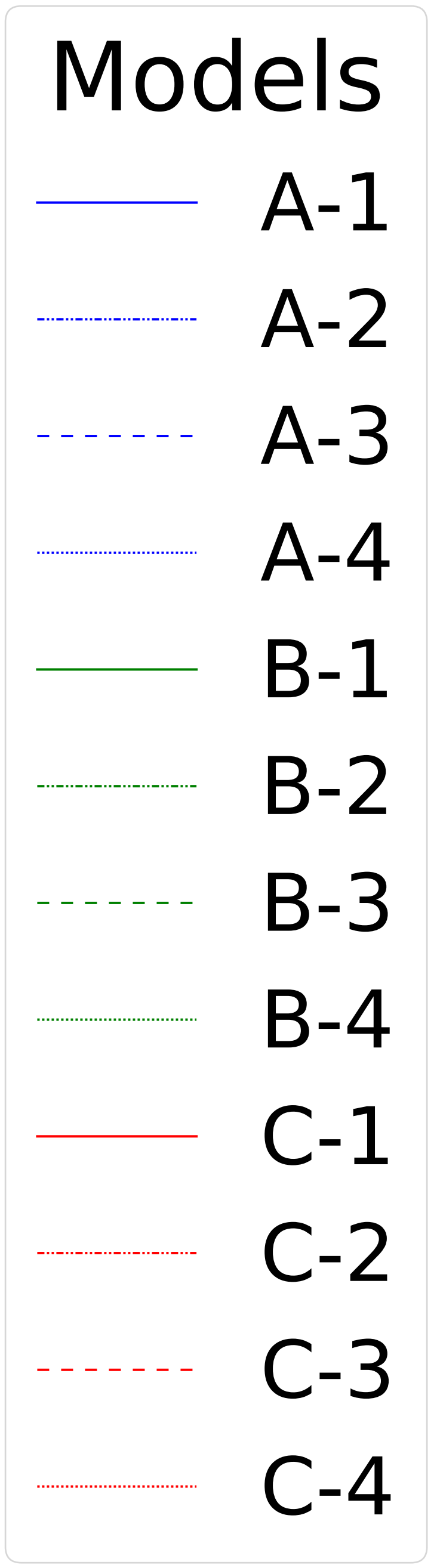
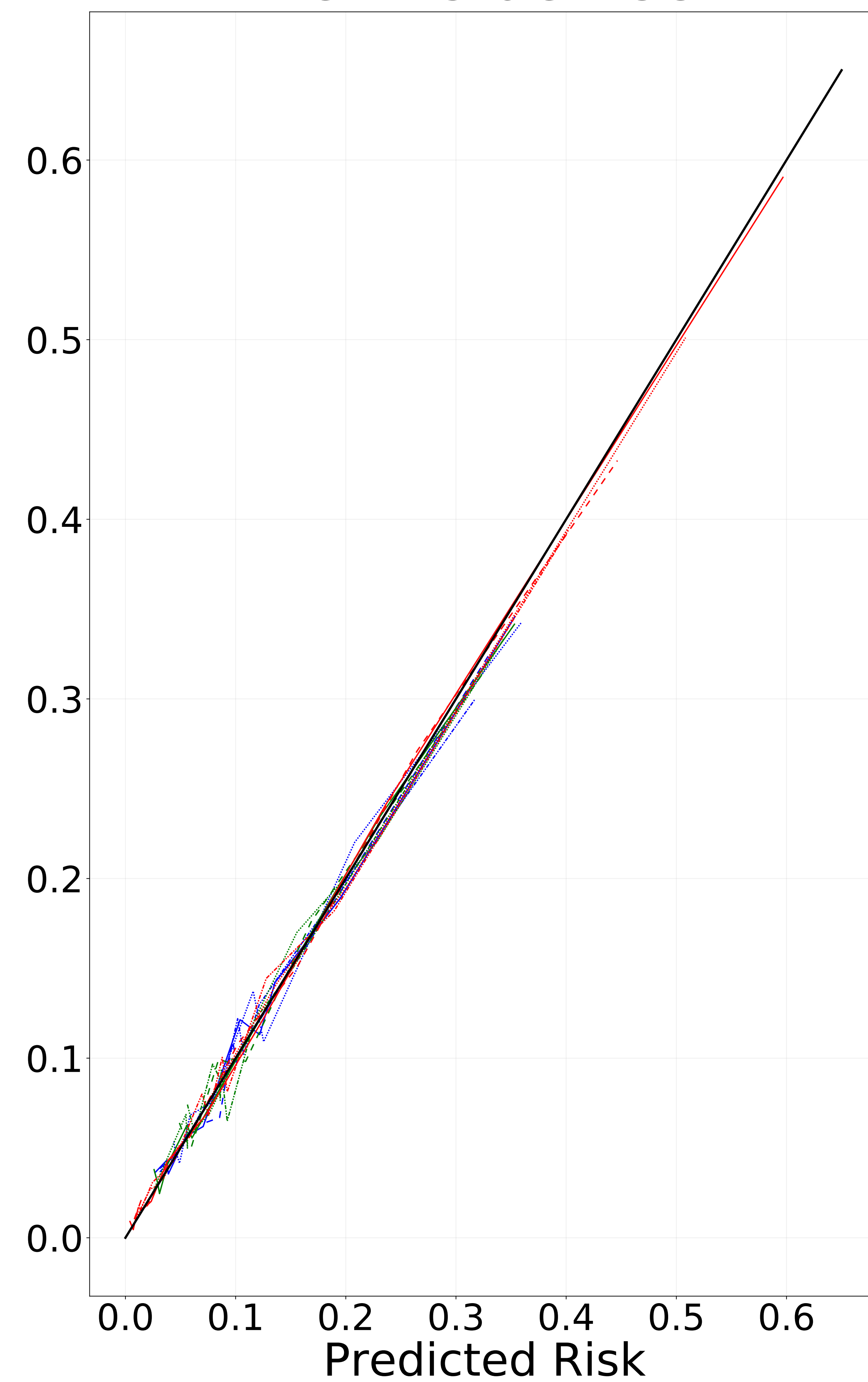
Methodist Floor



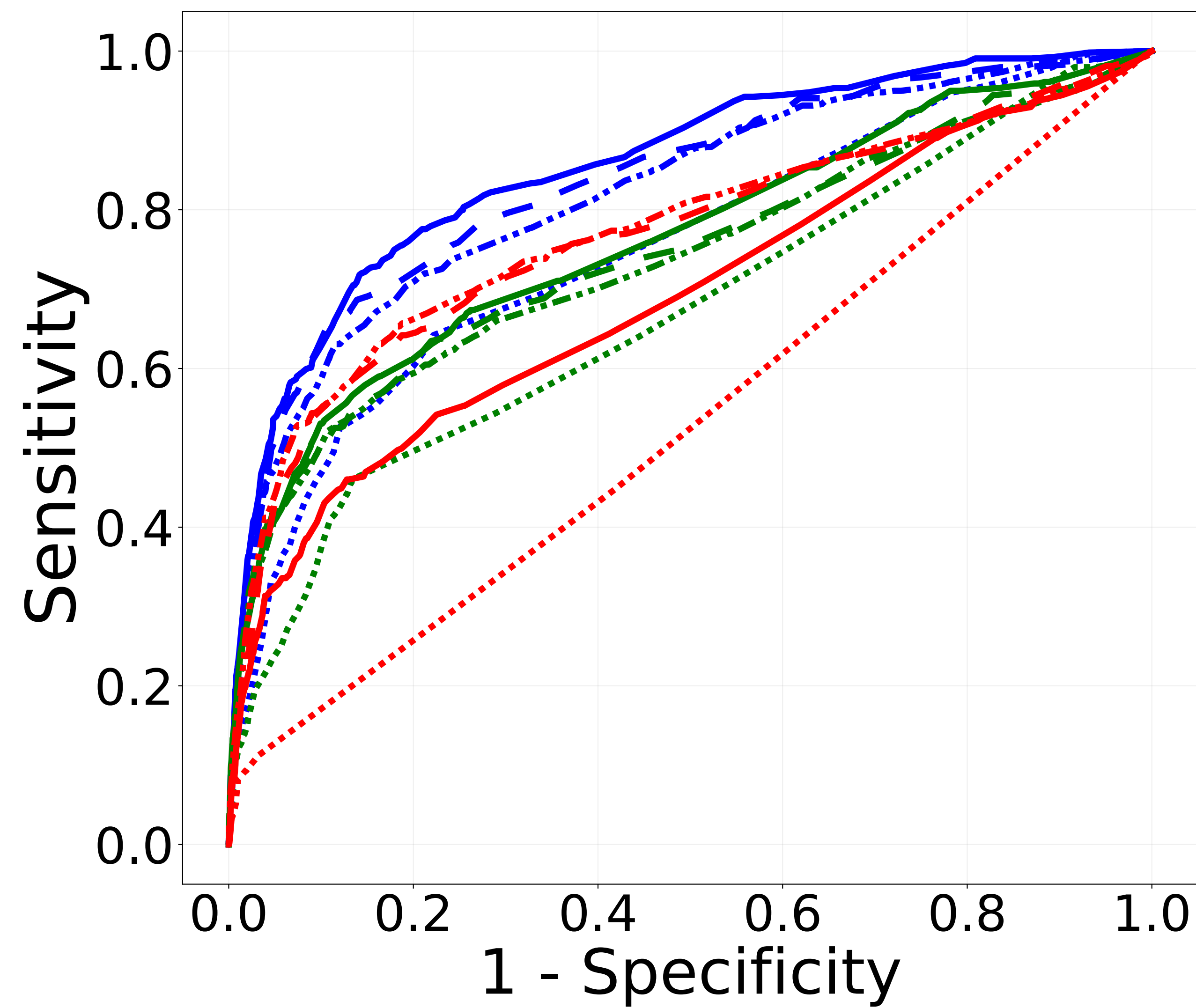
Methodist ICU



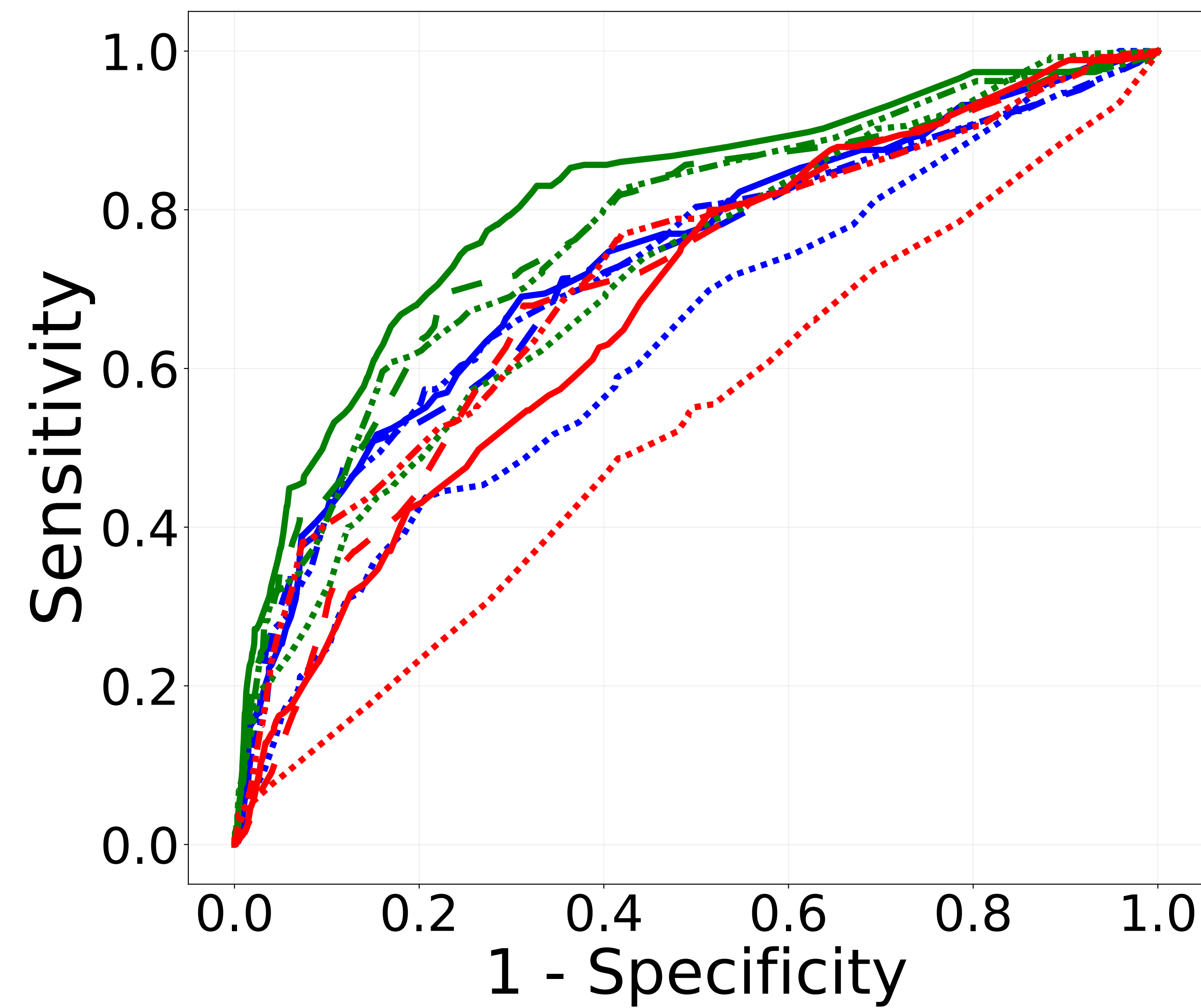
Beth Israel ICU



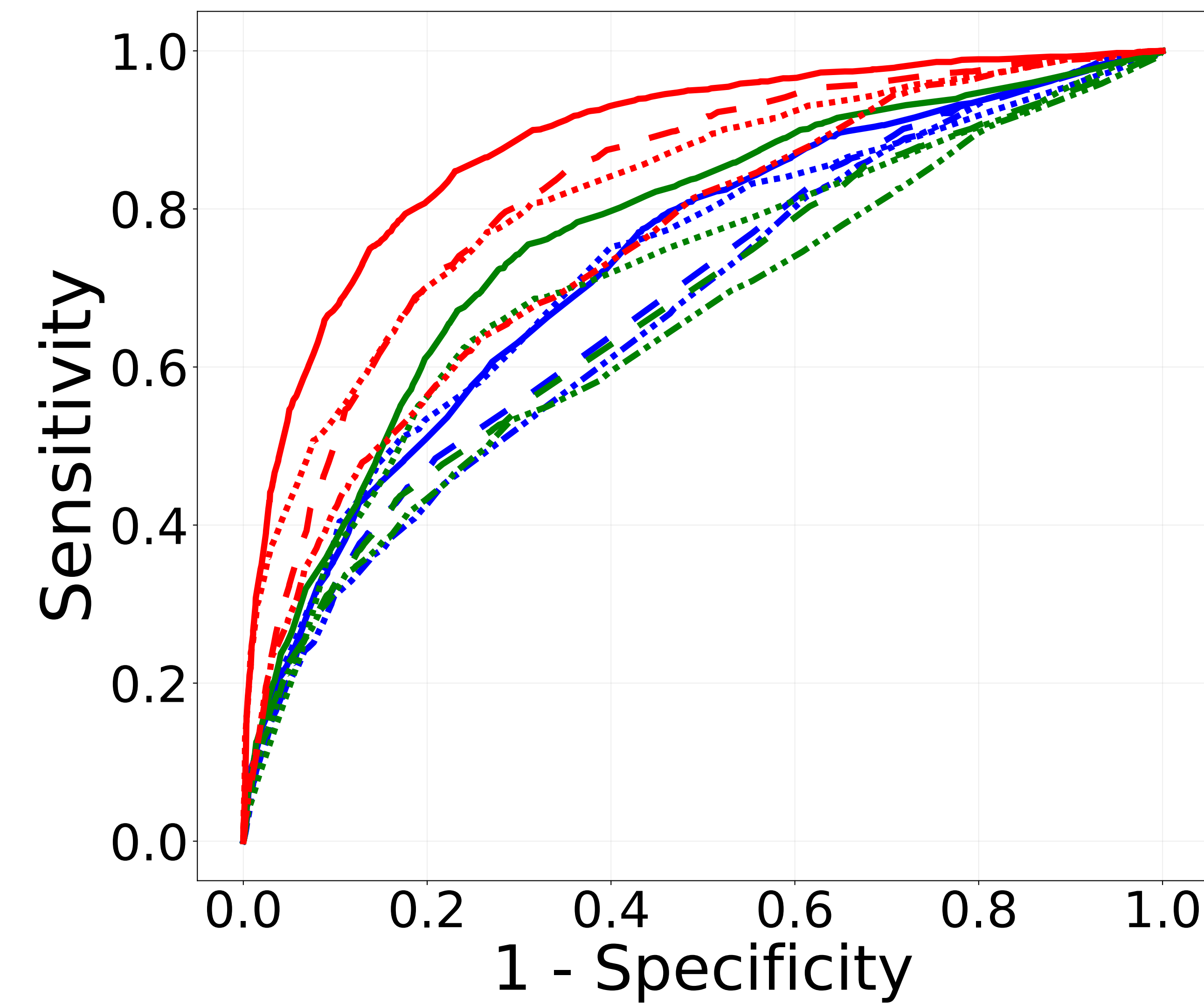
Methodist Floor



Methodist ICU

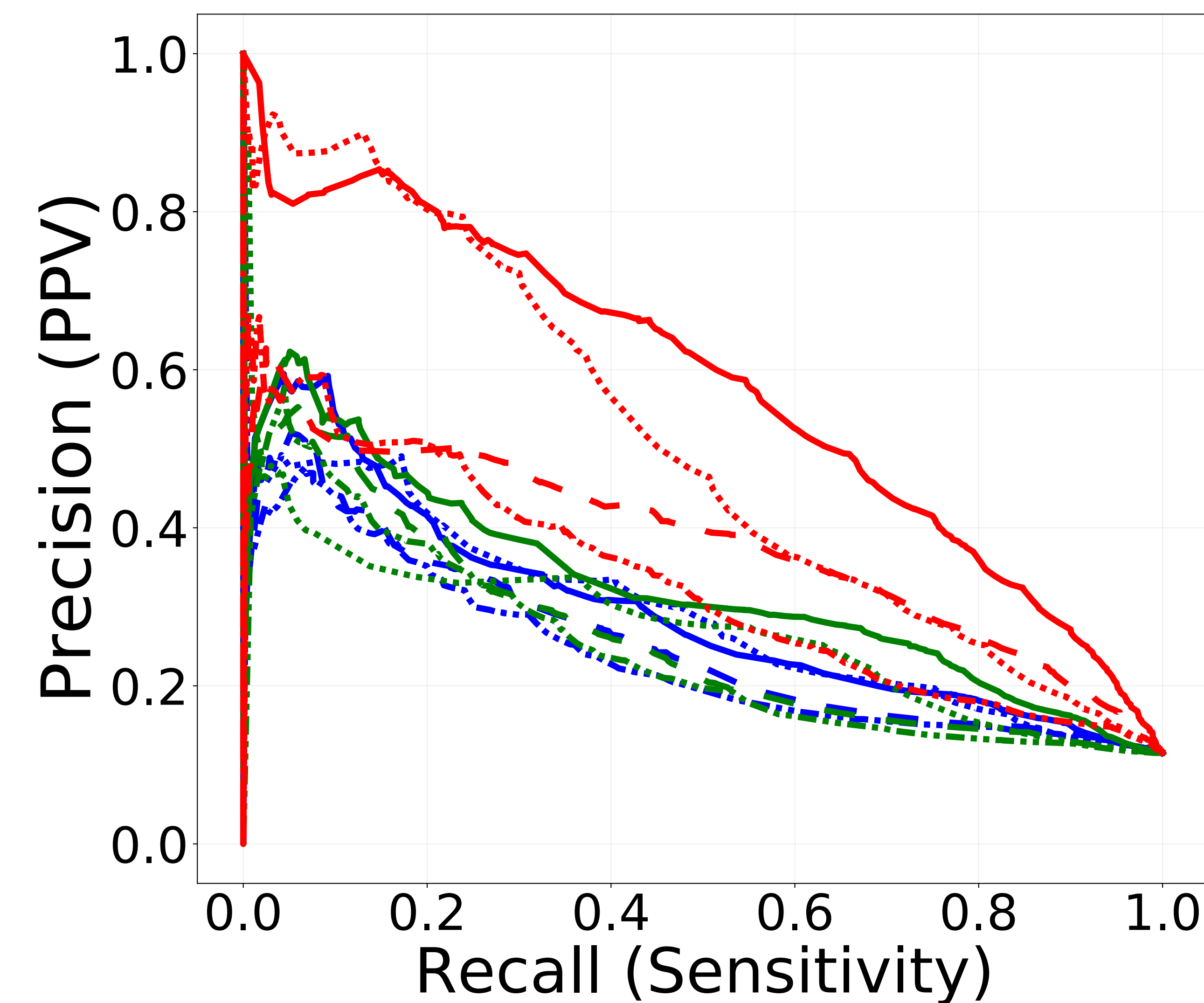
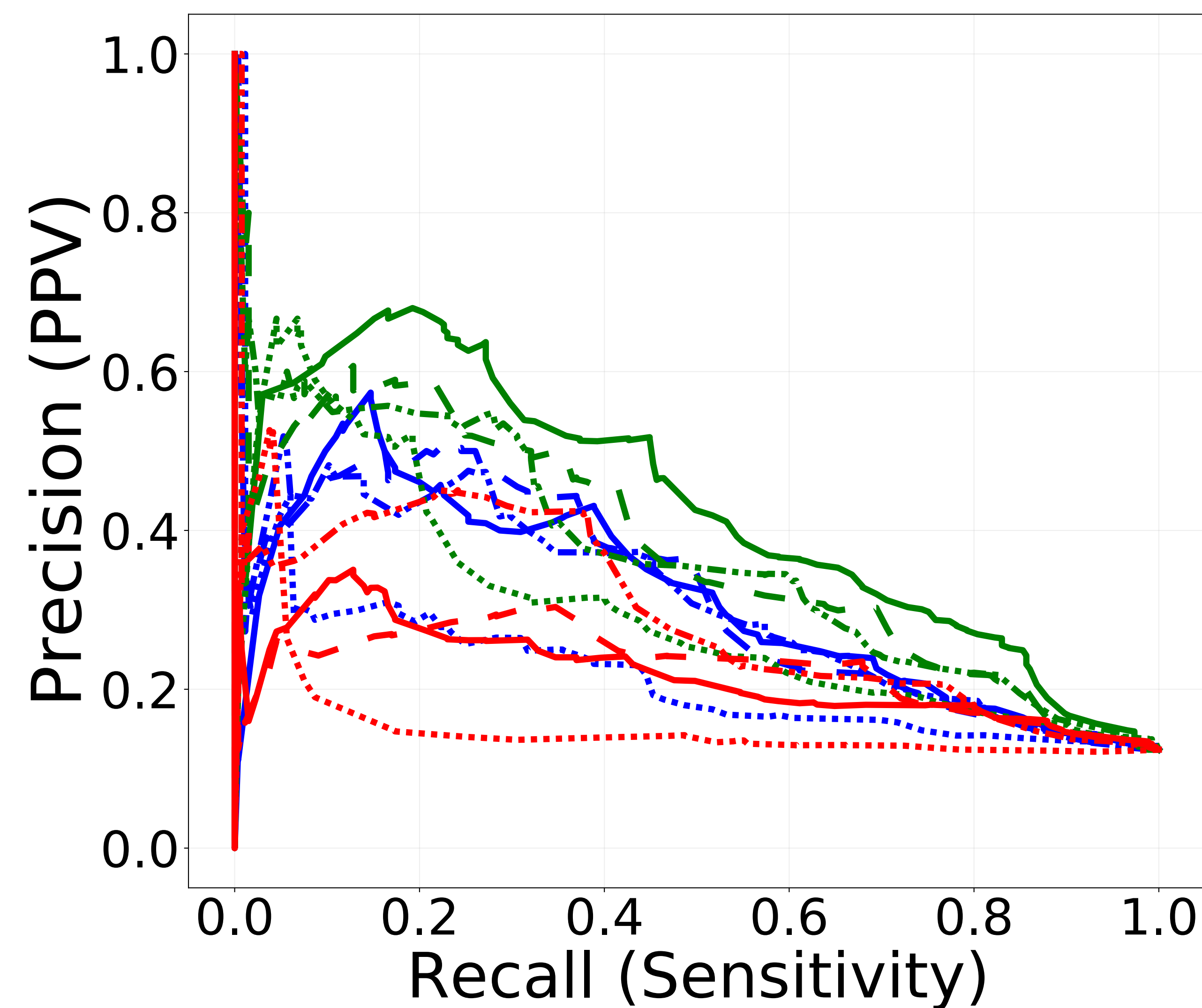
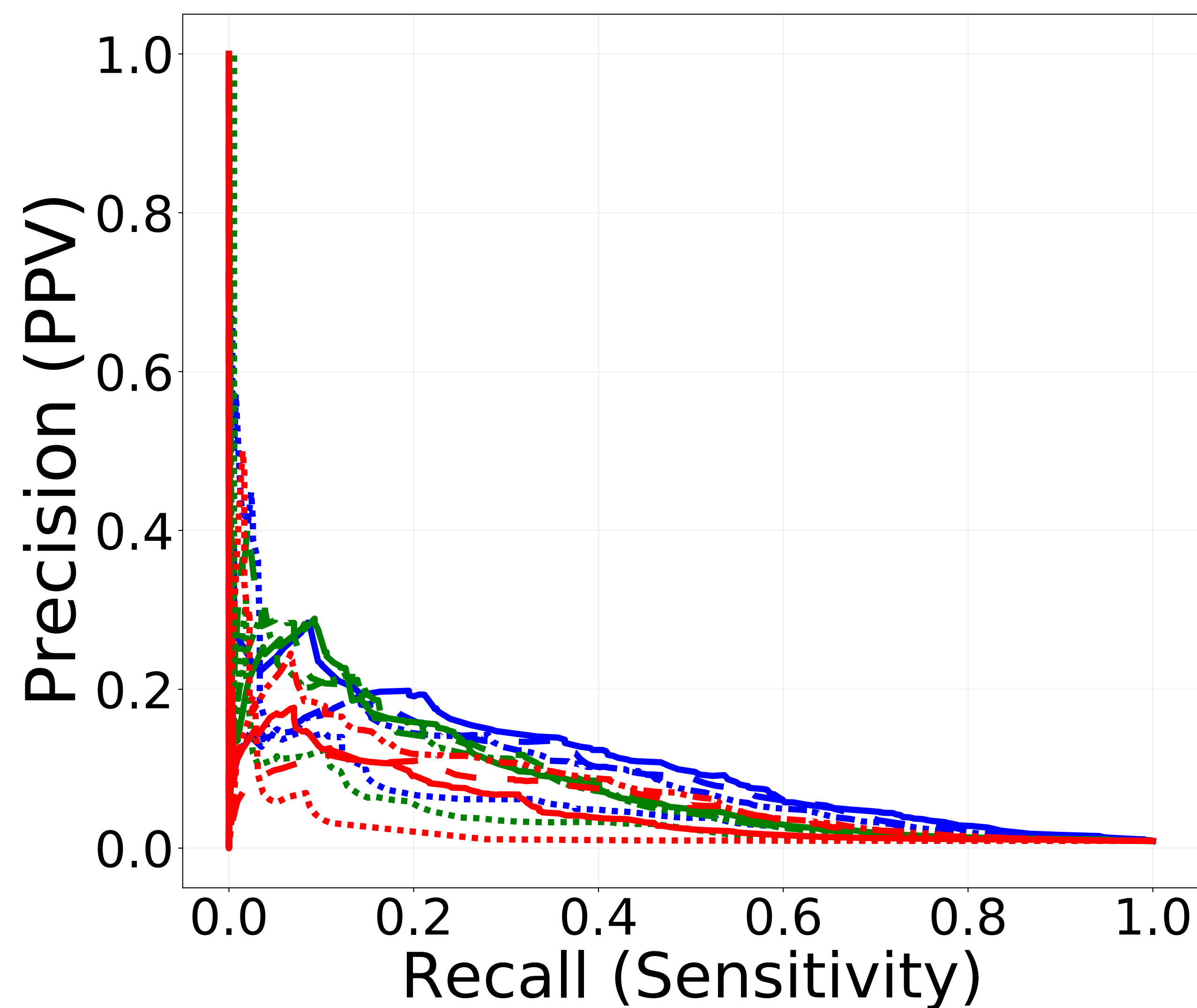


Beth Israel ICU



Models

- A-1
- ⋯ A-2
- - A-3
- · A-4
- B-1
- ⋯ B-2
- - B-3
- · B-4
- C-1
- ⋯ C-2
- - C-3
- · C-4



Section/Topic	Item	Checklist Item	Page
Title and abstract			
Title	1	Identify the study as developing and/or validating a multivariable prediction model, the target population, and the outcome to be predicted.	1
Abstract	2	Provide a summary of objectives, study design, setting, participants, sample size, predictors, outcome, statistical analysis, results, and conclusions.	3-4
Introduction			
Background and objectives	3a	Explain the medical context (including whether diagnostic or prognostic) and rationale for developing or validating the multivariable prediction model, including references to existing models.	5-6
	3b	Specify the objectives, including whether the study describes the development or validation of the model or both.	5-6
Methods			
Source of data	4a	Describe the study design or source of data (e.g., randomized trial, cohort, or registry data), separately for the development and validation data sets, if applicable.	6-7
	4b	Specify the key study dates, including start of accrual; end of accrual; and, if applicable, end of follow-up.	6-7
Participants	5a	Specify key elements of the study setting (e.g., primary care, secondary care, general population) including number and location of centres.	6-7
	5b	Describe eligibility criteria for participants.	6-7
	5c	Give details of treatments received, if relevant.	N/A
Outcome	6a	Clearly define the outcome that is predicted by the prediction model, including how and when assessed.	6-7; Table E1
	6b	Report any actions to blind assessment of the outcome to be predicted.	N/A
Predictors	7a	Clearly define all predictors used in developing or validating the multivariable prediction model, including how and when they were measured.	6-7, Table E2
	7b	Report any actions to blind assessment of predictors for the outcome and other predictors.	N/A
Sample size	8	Explain how the study size was arrived at.	6-8
Missing data	9	Describe how missing data were handled (e.g., complete-case analysis, single imputation, multiple imputation) with details of any imputation method.	7
Statistical analysis methods	10a	Describe how predictors were handled in the analyses.	6-8
	10b	Specify type of model, all model-building procedures (including any predictor selection), and method for internal validation.	6-8
	10d	Specify all measures used to assess model performance and, if relevant, to compare multiple models.	8
Risk groups	11	Provide details on how risk groups were created, if done.	N/A
Results			
Participants	13a	Describe the flow of participants through the study, including the number of participants with and without the outcome and, if applicable, a summary of the follow-up time. A diagram may be helpful.	8, Figure E1
	13b	Describe the characteristics of the participants (basic demographics, clinical features, available predictors), including the number of participants with missing data for predictors and outcome.	8, Table 1
Model development	14a	Specify the number of participants and outcome events in each analysis.	8, Table 1
	14b	If done, report the unadjusted association between each candidate predictor and outcome.	N/A
Model specification	15a	Present the full prediction model to allow predictions for individuals (i.e., all regression coefficients, and model intercept or baseline survival at a given time point).	Figure 3
	15b	Explain how to use the prediction model.	8-12
Model performance	16	Report performance measures (with CIs) for the prediction model.	8-12, Figures 1, 2, E3, E4
Discussion			
Limitations	18	Discuss any limitations of the study (such as nonrepresentative sample, few events per predictor, missing data).	13
Interpretation	19b	Give an overall interpretation of the results, considering objectives, limitations, and results from similar studies, and other relevant evidence.	8-12
Implications	20	Discuss the potential clinical use of the model and implications for future research.	8-12
Other information			
Supplementary information	21	Provide information about the availability of supplementary resources, such as study protocol, Web calculator, and data sets.	N/A
Funding	22	Give the source of funding and the role of the funders for the present study.	1-2