

Supplementary Appendix

MultiDiseasePred: An Interpretable Multi-Disease Risk Prediction Framework and Its Application for Early Risk Stratification in the Emergency Department with External Validation

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eMethods 1. Data quality assessment and missing-data handling.

Data quality assessment.

Prior to modeling, physiologically implausible vital-sign values were winsorized to the nearest plausible physiologic limit, with values above or below the accepted range set to the upper or lower bound, respectively. Encounters lacking a recorded arrival time, in which no information other than the encounter identifier was available, were treated as empty records and excluded during cohort derivation. Baseline missingness across the twelve retained variables was low: no continuous vital sign was missing in more than 0.5% of encounters at any site, and chief-complaint categories were missing in 2.5% of UMN encounters and in none elsewhere. Missingness by variable and cohort is reported in eTable 3.

Missing-data handling by variable type.

Given the low missingness, we adopted a deterministic imputation strategy to support reproducible, low-latency computation at deployment. Missing values were handled according to variable type.

1. Numerical variables (triage vital signs). Missing systolic and diastolic blood pressure, mean arterial pressure, heart rate, respiratory rate, and oxygen saturation were imputed using site- and variable-specific population medians, preserving the underlying feature distributions.
2. Rule-based clinical variables. Missing Glasgow Coma Scale scores were set to the normal value of 15, consistent with the informatics convention of assuming a normal baseline neurological status unless acute impairment was explicitly documented at triage. Missing initial pain scores were set to 0, under the assumption that the absence of a documented pain score reflects a non-pain-related presentation.
3. Structurally absent variables (coding definition, not imputation). Historical comorbidities were represented as binary indicators (present = 1, absent = 0) derived from the Charlson and Elixhauser comorbidity groupings. For encounters with no matching diagnostic code within the preceding 365 days, the corresponding indicator was set to 0. This reflects the structural absence of the condition rather than a missing data entry and therefore does not constitute imputation.

Triage acuity was excluded from the candidate set a priori and was therefore not imputed. It is reported in eTable 17 only as a stratifying variable for subgroup analysis.

eMethods 2. Network specification and training hyperparameters.

The twelve retained variables are standardized and passed to a shared pool of 13 feedforward expert subnetworks, each with two hidden layers of width 256 and rectified linear activations. Each of the nine prediction targets carries its own gate over that pool. The gate distribution is formed from two matrices of per-target logits learned during training, each passed through a softmax at temperature 0.2 and then averaged and renormalized. The gate does not depend on the input, so a given target applies the same weighting of experts to every encounter, and it is dense, so every expert receives non-zero weight for every target and no hard selection is made at any point. Expert outputs are combined by each target's gate weights into a target-specific representation, which is passed to that target's linear output layer, so that all nine risks are produced in a single forward pass per encounter. The number of experts was fixed at 13 before training and was not tuned.

The training objective is the binary cross-entropy summed over the nine targets, with no auxiliary penalty on the gate. Three further mechanisms were evaluated and not retained: an L1 penalty on the gate logits, an input-dependent shared router mixed into the per-target gates together with a symmetric Kullback–Leibler term tying the two, and expert dropout. Each of these pulls the gate toward the uniform distribution. In the arms that carried them the nine per-target gates converged on almost the same weighting, with a mean pairwise cosine of 1.00 and 12.9 of the 13 experts in effective use, so the model was multi-task in its loss but not in its routing. Removing them left discrimination unchanged, at a macro-AUROC over the seven acute conditions of 0.868 in both cases, while the mean pairwise cosine fell to 0.74. All fourteen arms are compared in eTable 18.

Training used Adam at a learning rate of $1e-3$, a batch size of 256, gradient-norm clipping at 3.0, and ten epochs, with ReduceLROnPlateau on the mean validation AUROC (factor 0.5, patience 2). A random 20% of the development cohort, drawn with a fixed seed, was held out for variable selection and for choosing the checkpoint; the checkpoint with the best mean validation AUROC was retained. All results are the mean over three training seeds (42, 43, 44). Random seeds were set for weight initialization and batch shuffling, so a run can be reproduced exactly.

Variable selection was run separately from model fitting. At each greedy step a gradient-boosted tree model (150 trees, maximum depth 6, learning rate 0.1, row and column subsampling 0.8) was fitted for each of the seven acute conditions on a random 400,000-encounter subsample of the training data, and the candidate that most improved the macro-average AUROC over those seven endpoints on the held-out selection split was added. The two disposition endpoints did not contribute to the selection criterion. The full curve is given in eTable 9.

eTable 1. The twelve variables, in the order of selection.

Order	Variable	Name	Domain	Type	Definition	Cumulative macro AUROC, acute endpoints	Gain at this step
1	age	Age	Demographics	Continuous, years	Age in years at emergency department arrival	0.687739	
2	chiefcom_shortness_of_breath	Chief complaint: shortness of breath	Chief complaint	Binary		0.77262	0.0384
3	eci_PHTN	Pulmonary hypertension	Comorbidity	Binary		0.811024	0.0252
4	triage_o2sat	Oxygen saturation	Triage vital sign	Continuous, %	Peripheral oxygen saturation recorded at triage	0.836202	0.018
5	eci_FluidsLytes	Fluid and electrolyte disorder	Comorbidity	Binary	Elixhauser comorbidity index component: fluid and electrolyte disorders	0.854186	0.0157
6	cci_MI	Myocardial infarction	Comorbidity	Binary	Coded diagnosis in the preceding 365 days. ICD-9-CM: 410.x, 412.x; ICD-10-CM: I21.x, I22.x, I25.2	0.869854	0.0136
7	cci_Pulmonary	Chronic pulmonary disease	Comorbidity	Binary	Charlson comorbidity index component: chronic pulmonary disease	0.883479	0.0105
8	triage_dbp	Diastolic blood pressure	Triage vital sign	Continuous, mmHg	Diastolic blood pressure recorded at triage	0.894019	0.0056
9	chiefcom_fever_chills	Chief complaint: fever or chills	Chief complaint	Binary		0.899658	0.005
10	triage_resprate	Respiratory rate	Triage vital sign	Continuous, breaths/min	Respiratory rate recorded at triage	0.904653	0.0032
11	triage_hearttrate	Heart rate	Triage vital sign	Continuous, beats/min	Heart rate recorded at triage	0.907845	0.0037
12	cci_Renal	Renal disease	Comorbidity	Binary	Charlson comorbidity index component: renal disease	0.911509	0.0027

Notes: Variables were added one at a time by greedy forward selection on the UMN variable selection set, maximizing the macro-average AUROC over the seven primary endpoints. Twelve is the smallest k reaching 98% of the AUROC obtained with all 62 candidate variables, a threshold fixed in advance. Triage acuity (Emergency Severity Index) was excluded from every candidate set.

eTable 2. Comorbidity phenotypes and diagnosis codes.

Comorbidity	Index	ICD-9-CM codes	ICD-10-CM codes
Myocardial infarction	Charlson	410.x, 412.x	I21.x, I22.x, I25.2
Congestive heart failure	Charlson	398.91, 402.0x/402.1x/402.9x, 404.0x/404.1x/404.9x, 425.4-425.9, 428.x	I09.9, I11.0, I13.2, I25.5, I42.0-I42.9, I43, I50.x, P29.0
Peripheral vascular disease	Charlson	093.0, 437.3, 440.x, 441.x, 443.1-443.9, 447.1, 557.1, 557.9, V43.4	I70.x, I71.x, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9
Cerebrovascular disease	Charlson	362.34, 430-438.x	H34.0, G45.x, G46.x, I60-I69.x
Dementia	Charlson	290.x, 294.1, 331.2	F00.x-F03.x, F05.1, G30.x, G31.1
Chronic pulmonary disease	Charlson	490-505.x, 416.8-416.9, 506.4, 508.1, 508.8	J40-J47, J60-J67, I27.8-I27.9, J68.4, J70.1, J70.3
Rheumatic disease	Charlson	446.5, 710.0-710.4, 714.0-714.2, 714.8, 725	M05.x, M06.x, M31.5, M32.x-M34.x, M35.1, M35.3, M36.0
Peptic ulcer disease	Charlson	531.x-534.x	K25.x-K28.x
Mild liver disease	Charlson	070.22, 070.23, 070.32, 070.33, 070.44, 070.54, 070.6, 070.9, 573.3, 573.4, 573.8, 573.9, V42.7, 570, 571.x	K70.0-K70.3, K70.9, K71.3-K71.5, K71.7, K76.0, K76.2-K76.4, K76.8-K76.9, Z94.4, B18.x, K73.x, K74.x
Diabetes without complications	Charlson	250.0-250.3, 250.8-250.9	E10.0-E10.1, E10.6, E10.8-E10.9; E11.0-E11.1, E11.6, E11.8-E11.9; E12.0-E12.1, E12.6, E12.8-E12.9; E13.0-E13.1, E13.6, E13.8-E13.9; E14.0-E14.1, E14.6, E14.8-E14.9
Diabetes with complications	Charlson	250.4-250.7	E10.2-E10.5, E10.7; E11.2-E11.5, E11.7; E12.2-E12.5, E12.7; E13.2-E13.5, E13.7; E14.2-E14.5, E14.7
Hemiplegia or paraplegia	Charlson	334.0-334.6, 334.9, 334.1, 342.x, 343.x	G04.1, G11.4, G80.1-G80.2, G81.x, G82.x, G83.0-G83.4, G83.9
Renal disease	Charlson	403.01/403.11/403.91, 404.02/404.03/404.12/404.13/404.92/404.93, 582.x, 583.0-583.7, 585, 586, 588.0, V42.0, V45.1, V56.x	I12.0, I13.1, N03.2-N03.7, N05.2-N05.7, N18.x, N19, N25.0, Z49.0-Z49.2, Z94.0, Z99.2
Solid tumour without metastasis	Charlson	140-195.x, 238.6	C00-C26, C30-C41, C43, C45-C49, C50-C58, C60-C76, C97
Moderate or severe liver disease	Charlson	456.0-456.2, 572.2-572.8	I85.0, I85.9, I86.4, I98.2, K70.4, K71.1, K72.1, K72.9, K76.5-K76.7
Metastatic solid tumour	Charlson	196-199.x	C77-C80
HIV / AIDS	Charlson	042-044	B20-B24
Cardiac arrhythmias	Elixhauser	426.0, 426.10, 426.12-426.13, 426.7, 426.9, 427.0-427.4, 427.6-427.9, 785.0, 996.01, 996.04, V45.0, V53.3	I44.1-I44.3, I45.6, I45.9, I47.x-I49.x, R00.0-R00.1, R00.8, T82.1, Z45.0, Z95.0
Valvular disease	Elixhauser	093.2, 394-397.x, 424.x, 746.3-746.6, V42.2, V43.3	A52.0, I05-I08, I09.1, I09.8, I34-I39, Q23.0-Q23.3, Z95.2-Z95.4

Comorbidity	Index	ICD-9-CM codes	ICD-10-CM codes
Pulmonary circulation disorders	Elixhauser	415.0-415.1, 416.x, 417.0, 417.8-417.9	I26.x, I27.x, I28.0, I28.8-I28.9
Hypertension, uncomplicated	Elixhauser	401.x	I10
Hypertension, complicated	Elixhauser	402.x, 403.x, 404.x, 405.x	I11, I12, I13, I15
Other neurological disorders	Elixhauser	331.9, 332.0-332.1, 333.4-333.5, 333.92, 334.x, 335.x, 336.2, 340.x, 341.x, 345.x, 348.1, 348.3, 780.3, 784.3	G10-G13, G20-G22, G32, G35-G37, G40-G41, R56, G25.4-G25.5, G31.2, G31.8-G31.9, G93.1, G93.4, R47.0
Hypothyroidism	Elixhauser	240.9, 243, 244.x, 246.1, 246.8	E00-E03, E89.0
Lymphoma	Elixhauser	200-202.x, 203.0, 238.6	C81-C85, C88, C90.0, C90.2, C96
Coagulopathy	Elixhauser	286.x, 287.1, 287.3-287.5	D65-D68, D69.1, D69.3-D69.6
Obesity	Elixhauser	278.0	E66.x
Weight loss	Elixhauser	783.2, 799.4, 260-263.x	R63.4, R64, E40-E46
Fluid and electrolyte disorders	Elixhauser	253.6, 276.x	E86-E87
Blood loss anaemia	Elixhauser	280.0	D50.0
Deficiency anaemia	Elixhauser	280.1-280.9, 281.x	D50.8-D50.9, D51-D53
Alcohol abuse	Elixhauser	291.1, 291.3, 291.5-291.9, 303.0, 303.9, 305.0, 357.5, 425.5, 535.3, 571.0-571.3, V11.3, 980.x	F10.x, E52, G62.1, I42.6, K29.2, K70.0, K70.3, K70.9, T51.x, Z50.2, Z71.4, Z72.1
Drug abuse	Elixhauser	292.x, 304.x, 305.2-305.9, V65.42	F11-F16, F18-F19, Z71.5, Z72.2
Psychoses	Elixhauser	293.8, 295.x, 297.x, 298.x, 296.04, 296.14, 296.44, 296.54	F20-F25, F28-F29, F30.2, F31.2, F31.5
Depression	Elixhauser	296.2, 296.3, 296.5, 300.4, 311, 309.x	F32.x, F33.x, F34.1, F41.2, F43.2, F31.3-F31.5

Notes: Comorbidities were identified from coded diagnosis history in the 365 days before the index encounter; the look-back window closes before that encounter begins.

eTable 3. Missingness of the twelve retained variables, by cohort.

Variable	UMN development	UMN internal validation	BIDMC	Stanford
Age	0.00	0.00	0.00	0.00
Diastolic blood pressure at triage	0.00	0.00	0.00	0.44
Oxygen saturation at triage	0.00	0.00	0.00	0.12
Respiratory rate at triage	0.00	0.00	0.00	0.09
Heart rate at triage	0.00	0.00	0.00	0.06
Chief complaint: shortness of breath	2.45	2.11	0.00	0.00
Chief complaint: fever or chills	2.45	2.11	0.00	0.00
Pulmonary hypertension	0.00	0.00	0.00	0.00
Fluid and electrolyte disorders	0.00	0.00	0.00	0.00
Myocardial infarction	0.00	0.00	0.00	0.00
Chronic pulmonary disease	0.00	0.00	0.00	0.00
Renal disease	0.00	0.00	0.00	0.00

Notes: Values are the percentage of encounters in which the variable was not recorded, before imputation. Continuous vital signs were imputed with site- and variable-specific medians; chief-complaint categories were treated as absent when not recorded. Comorbidity flags are 0 when no matching diagnosis code appears in the 365 days before the index encounter, which is a coding definition rather than a missing value, so no missingness is reported for them.

eTable 4. Definitions and diagnosis codes for the nine endpoints.

Prediction target	Definition	ICD-9-CM codes	ICD-10-CM codes
Hospitalization	Admission from the emergency department to an inpatient ward following the index encounter	Disposition field	Disposition field
Critical outcome	Intensive care unit admission within 12 hours of emergency department arrival, or in-hospital mortality	Disposition and care-location fields	Disposition and care-location fields
Sepsis	Sepsis diagnosed during the emergency department or hospital stay	038, 99591, 99592, 78552, 6702	A40, A41, R6520, R6521, R572, T8144, O85, O0337, O0387, O0487
ARDS	Acute respiratory distress syndrome	51882	J80
COPD/asthma exacerbation	Acute exacerbation of chronic obstructive pulmonary disease or asthma	49121, 49122, 49301, 49302, 49311, 49312, 49392	J441, J440, J4521, J4531, J4541, J4551, J45901
Acute coronary syndrome	Acute coronary syndrome, including myocardial infarction	410, 4111	I200, I21, I22, I23, I24
Viral pneumonia	Pneumonia of viral aetiology	480, 487, 488	J12, J09X1, J100, J110
Pulmonary embolism	Acute pulmonary embolism	41511, 41512, 41513, 41519, 4162	I2601, I2602, I2609, I2690, I2692, I2693, I2694, I2699, I2782, I2724
Acute kidney injury	Acute kidney injury	584, 586	N17

Notes: Codes were cross-mapped between ICD-9-CM and ICD-10-CM so that the definitions apply identically to all three health systems. Pulmonary embolism and COPD/asthma exacerbation are incident events at the index encounter.

eTable 5. Full comparison against six comparators, twelve variables, seven primary endpoints.

Cohort	Endpoint	Metric	MultiDiseasePred (ours)	XGBoost	LightGBM	Random Forest	Logistic Regression	HistGradientBoosting	NEWS (abbreviated)
UMN variable selection	Sepsis	AUROC	0.8595	0.8584	0.858	0.8518	0.8445	0.858	0.6787
UMN variable selection	Sepsis	AUPRC	0.2048	0.2024	0.2024	0.1974	0.175	0.2024	0.076
UMN variable selection	Viral pneumonia	AUROC	0.88	0.8778	0.8759	0.8691	0.852	0.8763	0.7444
UMN variable selection	Viral pneumonia	AUPRC	0.1532	0.1495	0.1431	0.1477	0.0764	0.1381	0.0447
UMN variable selection	ARDS	AUROC	0.9296	0.9273	0.9156	0.9119	0.9126	0.9122	0.8067
UMN variable selection	ARDS	AUPRC	0.0431	0.0461	0.0257	0.044	0.0223	0.0294	0.0139
UMN variable selection	Pulmonary embolism	AUROC	0.97	0.9696	0.9688	0.9663	0.9483	0.9673	0.6533
UMN variable selection	Pulmonary embolism	AUPRC	0.301	0.2974	0.2904	0.2981	0.269	0.2717	0.0167
UMN variable selection	COPD/asthma exacerbation	AUROC	0.9624	0.9622	0.962	0.9604	0.9581	0.9612	0.7289
UMN variable selection	COPD/asthma exacerbation	AUPRC	0.4534	0.4483	0.4459	0.4503	0.4178	0.4452	0.094
UMN variable selection	Acute coronary syndrome	AUROC	0.918	0.9172	0.9161	0.914	0.8986	0.9164	0.586
UMN variable selection	Acute coronary syndrome	AUPRC	0.2552	0.2486	0.2437	0.2485	0.1987	0.2454	0.0336
UMN variable selection	Acute kidney injury	AUROC	0.8658	0.865	0.8652	0.8612	0.853	0.8651	0.6076
UMN variable selection	Acute kidney injury	AUPRC	0.227	0.2261	0.2268	0.2216	0.2086	0.2281	0.0747
BIDMC	Sepsis	AUROC	0.8381	0.838	0.8368	0.8334	0.8362	0.8389	0.7381
BIDMC	Sepsis	AUPRC	0.1828	0.1832	0.1817	0.1764	0.1799	0.1839	0.1189
BIDMC	Viral pneumonia	AUROC	0.7467	0.7383	0.727	0.7397	0.718	0.7296	0.7055
BIDMC	Viral pneumonia	AUPRC	0.0121	0.0121	0.0116	0.0121	0.0128	0.0121	0.0103
BIDMC	ARDS	AUROC	0.7737	0.7383	0.7219	0.7307	0.7676	0.7439	0.6634
BIDMC	ARDS	AUPRC	0.008	0.0064	0.005	0.0089	0.0092	0.0066	0.0054
BIDMC	Pulmonary embolism	AUROC	0.7438	0.7454	0.7343	0.7262	0.695	0.7444	0.603
BIDMC	Pulmonary embolism	AUPRC	0.0502	0.0481	0.0458	0.0497	0.0486	0.0466	0.0156
BIDMC	COPD/asthma exacerbation	AUROC	0.8478	0.8472	0.8429	0.8551	0.8677	0.8414	0.6847
BIDMC	COPD/asthma exacerbation	AUPRC	0.2316	0.2285	0.2274	0.2324	0.2173	0.2301	0.056

Cohort	Endpoint	Metric	MultiDiseasePred (ours)	XGBoost	LightGBM	Random Forest	Logistic Regression	HistGradientBoosting	NEWS (abbreviated)
BIDMC	Acute coronary syndrome	AUROC	0.7907	0.7899	0.7899	0.7796	0.7929	0.7932	0.5297
BIDMC	Acute coronary syndrome	AUPRC	0.0782	0.0768	0.0764	0.0752	0.0827	0.0776	0.027
BIDMC	Acute kidney injury	AUROC	0.8079	0.8062	0.8056	0.8053	0.8003	0.8083	0.6121
BIDMC	Acute kidney injury	AUPRC	0.2464	0.2443	0.244	0.2438	0.2422	0.2465	0.1278
Stanford	Sepsis	AUROC	0.8825	0.8826	0.8803	0.8853	0.8745	0.8835	0.8701
Stanford	Sepsis	AUPRC	0.0789	0.0846	0.0843	0.0749	0.0761	0.0821	0.0569
Stanford	Viral pneumonia	AUROC	0.8033	0.7893	0.7738	0.8027	0.7925	0.7853	0.7598
Stanford	Viral pneumonia	AUPRC	0.0205	0.02	0.0187	0.0197	0.0173	0.0179	0.009
Stanford	ARDS	AUROC	0.855	0.841	0.7471	0.8759	0.8793	0.862	0.8539
Stanford	ARDS	AUPRC	0.0036	0.0025	0.002	0.0032	0.0031	0.0031	0.0028
Stanford	Pulmonary embolism	AUROC	0.9324	0.9286	0.9266	0.9299	0.9394	0.9251	0.6424
Stanford	Pulmonary embolism	AUPRC	0.1424	0.1442	0.138	0.1526	0.1371	0.1314	0.0073
Stanford	COPD/asthma exacerbation	AUROC	0.9147	0.9148	0.9125	0.9207	0.9278	0.9166	0.663
Stanford	COPD/asthma exacerbation	AUPRC	0.1726	0.1676	0.1645	0.1719	0.1468	0.1704	0.0126
Stanford	Acute coronary syndrome	AUROC	0.8896	0.8875	0.887	0.8824	0.886	0.8893	0.4856
Stanford	Acute coronary syndrome	AUPRC	0.1311	0.1294	0.1264	0.128	0.1141	0.1252	0.008
Stanford	Acute kidney injury	AUROC	0.787	0.7864	0.7854	0.7813	0.7793	0.787	0.5563
Stanford	Acute kidney injury	AUPRC	0.0215	0.0208	0.0206	0.0224	0.0214	0.021	0.0073

Notes: Each cohort contributes 84 comparisons (7 endpoints x 2 metrics x 6 comparators). MultiDiseasePred is higher than every comparator on 82 of 84 comparisons in the UMN variable selection set. The UMN internal validation cohort is not repeated here because it is given with confidence intervals in Table 2.

eTable 6. Prevalence of chief complaints and comorbidities by cohort.

	UMN development (n = 1,313,435)	UMN internal validation (n = 350,842)	BIDMC (n = 422,114)	Stanford (n = 117,046)
Chief complaints				
Chest pain	95,036 (7.24%)	26,324 (7.50%)	29,135 (6.90%)	9,707 (8.29%)
Abdominal pain	137,838 (10.49%)	38,826 (11.07%)	47,918 (11.35%)	15,122 (12.92%)
Headache	39,888 (3.04%)	11,164 (3.18%)	13,698 (3.25%)	4,767 (4.07%)
Shortness of breath	90,481 (6.89%)	24,227 (6.91%)	24,845 (5.89%)	10,201 (8.72%)
Back pain	46,010 (3.50%)	12,633 (3.60%)	16,683 (3.95%)	4,011 (3.43%)
Cough	39,985 (3.04%)	11,363 (3.24%)	8,742 (2.07%)	2,524 (2.16%)
Nausea or vomiting	61,601 (4.69%)	19,257 (5.49%)	9,983 (2.37%)	5,658 (4.83%)
Fever or chills	31,121 (2.37%)	7,629 (2.17%)	14,394 (3.41%)	4,602 (3.93%)
Syncope	10,430 (0.79%)	4,223 (1.20%)	7,996 (1.89%)	1,949 (1.67%)
Dizziness	36,433 (2.77%)	11,146 (3.18%)	12,220 (2.90%)	3,799 (3.25%)
Charlson comorbidity index components				
Myocardial infarction	93,496 (7.12%)	27,246 (7.77%)	23,931 (5.67%)	4,659 (3.98%)
Congestive heart failure	150,137 (11.43%)	44,574 (12.70%)	39,319 (9.31%)	8,733 (7.46%)
Peripheral vascular disease	106,744 (8.13%)	31,676 (9.03%)	21,242 (5.03%)	6,015 (5.14%)
Cerebrovascular disease	134,451 (10.24%)	39,602 (11.29%)	20,450 (4.84%)	8,338 (7.12%)
Dementia	44,786 (3.41%)	12,959 (3.69%)	7,095 (1.68%)	1,701 (1.45%)
Chronic pulmonary disease	291,858 (22.22%)	78,871 (22.48%)	60,008 (14.22%)	11,162 (9.54%)
Rheumatic disease	43,477 (3.31%)	11,390 (3.25%)	8,721 (2.07%)	2,760 (2.36%)
Peptic ulcer disease	36,644 (2.79%)	9,692 (2.76%)	7,841 (1.86%)	1,147 (0.98%)
Mild liver disease	112,287 (8.55%)	35,220 (10.04%)	28,212 (6.68%)	7,421 (6.34%)
Diabetes without complications	193,338 (14.72%)	56,528 (16.11%)	56,033 (13.27%)	12,528 (10.70%)
Diabetes with complications	168,684 (12.84%)	51,604 (14.71%)	26,998 (6.40%)	4,150 (3.55%)
Hemiplegia or paraplegia	24,615 (1.87%)	7,274 (2.07%)	4,970 (1.18%)	878 (0.75%)
Renal disease	173,918 (13.24%)	55,122 (15.71%)	41,229 (9.77%)	8,980 (7.67%)
Any malignancy	118,076 (8.99%)	33,590 (9.57%)	27,196 (6.44%)	16,246 (13.88%)
Moderate or severe liver disease	17,270 (1.31%)	4,983 (1.42%)	8,573 (2.03%)	2,049 (1.75%)
Metastatic solid tumour	35,597 (2.71%)	10,043 (2.86%)	10,521 (2.49%)	3,803 (3.25%)
HIV or AIDS	3,812 (0.29%)	1,295 (0.37%)	3,942 (0.93%)	412 (0.35%)
Elixhauser comorbidity index components				
Cardiac arrhythmia	356,626 (27.15%)	101,464 (28.92%)	59,097 (14.00%)	16,629 (14.21%)
Valvular disease	150,904 (11.49%)	42,329 (12.06%)	21,454 (5.08%)	5,021 (4.29%)
Pulmonary hypertension	90,465 (6.89%)	24,793 (7.07%)	19,518 (4.62%)	5,172 (4.42%)

	UMN development (n = 1,313,435)	UMN internal validation (n = 350,842)	BIDMC (n = 422,114)	Stanford (n = 117,046)
Hypertension, uncomplicated	485,884 (36.99%)	138,610 (39.51%)	42,846 (10.15%)	25,288 (21.61%)
Hypertension, complicated	184,967 (14.08%)	62,003 (17.67%)	103,412 (24.50%)	1,169 (1.00%)
Other neurological disorder	108,421 (8.25%)	31,614 (9.01%)	32,055 (7.59%)	7,137 (6.10%)
Hypothyroidism	138,714 (10.56%)	39,015 (11.12%)	28,203 (6.68%)	7,548 (6.45%)
Lymphoma	11,563 (0.88%)	3,289 (0.94%)	4,536 (1.07%)	1,912 (1.63%)
Coagulopathy	140,913 (10.73%)	62,326 (17.76%)	29,943 (7.09%)	4,459 (3.81%)
Obesity	284,221 (21.64%)	111,319 (31.73%)	37,105 (8.79%)	8,313 (7.10%)
Weight loss	129,031 (9.82%)	39,486 (11.25%)	22,421 (5.31%)	4,023 (3.44%)
Fluid and electrolyte disorders	376,790 (28.69%)	109,405 (31.18%)	79,321 (18.79%)	13,995 (11.96%)
Blood-loss anaemia	41,242 (3.14%)	12,363 (3.52%)	5,834 (1.38%)	1,777 (1.52%)
Deficiency anaemia	128,365 (9.77%)	38,533 (10.98%)	25,454 (6.03%)	5,026 (4.29%)
Alcohol abuse	151,346 (11.52%)	39,582 (11.28%)	32,767 (7.76%)	5,246 (4.48%)
Drug abuse	180,216 (13.72%)	51,045 (14.55%)	28,163 (6.67%)	4,668 (3.99%)
Psychoses	64,742 (4.93%)	17,212 (4.91%)	11,779 (2.79%)	2,346 (2.00%)
Depression	385,304 (29.34%)	102,485 (29.21%)	69,106 (16.37%)	11,838 (10.11%)

Notes: Values are n (%) of all encounters in that cohort. Counts are reconstructed from the reported percentage and the cohort size, so the last digit may differ by one from a direct count. Within the UMN development column, a random 20% (n = 262,687) was held out for variable selection. Chief complaints are recorded as free-text categories at triage. Only four of these flags enter the twelve-variable model: pulmonary hypertension, fluid and electrolyte disorders, myocardial infarction, chronic pulmonary disease and renal disease, together with the chief complaints shortness of breath and fever or chills.

eTable 7. Secondary endpoints: all seven models, four cohorts, twelve variables.

Cohort	Endpoint	Model	AUROC (95% CI)	AUPRC (95% CI)
UMN variable selection	Hospitalization	MultiDiseasePred (ours)	0.7926 (0.7904–0.7947)	0.5256 (0.5209–0.5303)
		XGBoost	0.7943 (0.7921–0.7964)	0.5276 (0.5230–0.5322)
		LightGBM	0.7943 (0.7921–0.7964)	0.5275 (0.5229–0.5321)
		Random Forest	0.7900 (0.7879–0.7922)	0.5202 (0.5155–0.5249)
		Logistic Regression	0.7735 (0.7713–0.7758)	0.4934 (0.4887–0.4980)
		HistGradientBoosting	0.7939 (0.7918–0.7960)	0.5269 (0.5222–0.5316)
		NEWS (abbreviated)	0.5853 (0.5827–0.5880)	0.2745 (0.2712–0.2778)
UMN variable selection	Critical outcome	MultiDiseasePred (ours)	0.8648 (0.8574–0.8723)	0.1203 (0.1075–0.1331)
		XGBoost	0.8636 (0.8560–0.8711)	0.1300 (0.1162–0.1439)

Cohort	Endpoint	Model	AUROC (95% CI)	AUPRC (95% CI)
UMN internal validation	Hospitalization	LightGBM	0.8613 (0.8537–0.8689)	0.1236 (0.1098–0.1374)
		Random Forest	0.8543 (0.8464–0.8623)	0.1210 (0.1077–0.1342)
		Logistic Regression	0.8321 (0.8233–0.8409)	0.0894 (0.0791–0.0997)
		HistGradientBoosting	0.8635 (0.8560–0.8710)	0.1194 (0.1072–0.1317)
		NEWS (abbreviated)	0.7373 (0.7258–0.7487)	0.0569 (0.0503–0.0635)
		MultiDiseasePred (ours)	0.7896 (0.7877–0.7915)	0.5053 (0.5011–0.5094)
		XGBoost	0.7890 (0.7871–0.7909)	0.5054 (0.5011–0.5097)
		LightGBM	0.7891 (0.7872–0.7910)	0.5052 (0.5009–0.5095)
UMN internal validation	Critical outcome	Random Forest	0.7870 (0.7851–0.7889)	0.4993 (0.4951–0.5036)
		Logistic Regression	0.7740 (0.7720–0.7759)	0.4777 (0.4736–0.4818)
		HistGradientBoosting	0.7892 (0.7873–0.7911)	0.5052 (0.5010–0.5094)
		NEWS (abbreviated)	0.5629 (0.5606–0.5652)	0.2528 (0.2503–0.2552)
		MultiDiseasePred (ours)	0.9145 (0.9078–0.9213)	0.1092 (0.0922–0.1261)
		XGBoost	0.9180 (0.9114–0.9246)	0.1225 (0.1051–0.1400)
		LightGBM	0.9167 (0.9101–0.9234)	0.1137 (0.0966–0.1308)
		Random Forest	0.9072 (0.8995–0.9148)	0.1104 (0.0939–0.1269)
BIDMC	Hospitalization	Logistic Regression	0.8951 (0.8867–0.9036)	0.0649 (0.0556–0.0741)
		HistGradientBoosting	0.9177 (0.9110–0.9243)	0.1150 (0.0980–0.1321)
		NEWS (abbreviated)	0.8005 (0.7871–0.8139)	0.0412 (0.0334–0.0489)
		MultiDiseasePred (ours)	0.6905 (0.6889–0.6921)	0.6727 (0.6703–0.6751)
		XGBoost	0.6867 (0.6851–0.6883)	0.6708 (0.6684–0.6732)
		LightGBM	0.6861 (0.6845–0.6877)	0.6702 (0.6679–0.6726)
		Random Forest	0.6921 (0.6905–0.6937)	0.6726 (0.6702–0.6750)

Cohort	Endpoint	Model	AUROC (95% CI)	AUPRC (95% CI)
BIDMC	Critical outcome	Logistic Regression	0.6892 (0.6876–0.6908)	0.6751 (0.6728–0.6774)
		HistGradientBoosting	0.6885 (0.6869–0.6901)	0.6725 (0.6701–0.6749)
		NEWS (abbreviated)	0.5764 (0.5748–0.5780)	0.5586 (0.5564–0.5608)
		MultiDiseasePred (ours)	0.7080 (0.7049–0.7111)	0.1798 (0.1754–0.1841)
		XGBoost	0.6917 (0.6885–0.6949)	0.1717 (0.1673–0.1761)
		LightGBM	0.6833 (0.6801–0.6866)	0.1675 (0.1632–0.1718)
		Random Forest	0.6790 (0.6755–0.6824)	0.1718 (0.1676–0.1761)
		Logistic Regression	0.7099 (0.7069–0.7130)	0.1735 (0.1693–0.1777)
Stanford	Hospitalization	HistGradientBoosting	0.6957 (0.6926–0.6988)	0.1700 (0.1656–0.1744)
		NEWS (abbreviated)	0.5950 (0.5912–0.5988)	0.1472 (0.1431–0.1512)
		MultiDiseasePred (ours)	0.6766 (0.6730–0.6803)	0.4145 (0.4089–0.4201)
		XGBoost	0.6754 (0.6717–0.6790)	0.4155 (0.4098–0.4212)
		LightGBM	0.6747 (0.6711–0.6784)	0.4150 (0.4093–0.4208)
		Random Forest	0.6854 (0.6818–0.6889)	0.4172 (0.4116–0.4228)
		Logistic Regression	0.6683 (0.6646–0.6720)	0.4106 (0.4050–0.4163)
		HistGradientBoosting	0.6754 (0.6718–0.6791)	0.4158 (0.4101–0.4215)
Stanford	Critical outcome	NEWS (abbreviated)	0.6404 (0.6368–0.6440)	0.3646 (0.3600–0.3691)
		MultiDiseasePred (ours)	0.7442 (0.7348–0.7535)	0.1050 (0.0940–0.1160)
		XGBoost	0.7451 (0.7357–0.7546)	0.1035 (0.0932–0.1137)
		LightGBM	0.7384 (0.7287–0.7481)	0.1027 (0.0926–0.1128)
		Random Forest	0.7488 (0.7392–0.7585)	0.1085 (0.0979–0.1192)
		Logistic Regression	0.6588 (0.6469–0.6707)	0.0835 (0.0739–0.0930)
		HistGradientBoosting	0.7485 (0.7392–0.7578)	0.1003 (0.0906–0.1099)

Cohort	Endpoint	Model	AUROC (95% CI)	AUPRC (95% CI)
		NEWS (abbreviated)	0.7572 (0.7468–0.7677)	0.1275 (0.1159–0.1391)

Notes: Hospitalization and critical outcome are disposition endpoints rather than acute conditions and are reported as secondary.

eTable 8. Cohort sizes and event counts for the nine endpoints.

Cohort	Encounters	Hospitalization	Critical outcome	Sepsis	Viral pneumonia	ARDS	Pulmonary embolism	COPD/asthma exacerbation	Acute coronary syndrome	Acute kidney injury
umn_train	1313435	267978	12171	33419	11791	1352	9352	30036	25083	55612
umn_test	350842	69331	1392	9386	1344	199	2596	8647	7922	18429
bidmc	422114	202304	28013	11388	1488	436	4017	8182	8687	31249
stanford	117046	29224	2749	843	290	37	473	631	929	739

Notes: The UMN development cohort is 2019-2023 and contains the 262,687-encounter variable-selection split; umn_test is the 2024-2025 internal validation set.

eTable 9. Greedy forward selection: full curve and threshold sensitivity.

k	Variable added	Macro AUROC, acute endpoints, UMN variable selection	Proportion of the 62-variable AUROC	Gain at this step
1	age	0.687739	0.7411	
2	chiefcom_shortness_of_breath	0.77262	0.8325	0.0849
3	eci_PHTN	0.811024	0.8739	0.0384
4	triage_o2sat	0.836202	0.9011	0.0252
5	eci_FluidsLytes	0.854186	0.9204	0.018
6	cci_MI	0.869854	0.9373	0.0157
7	cci_Pulmonary	0.883479	0.952	0.0136
8	triage_dbp	0.894019	0.9634	0.0105
9	chiefcom_fever_chills	0.899658	0.9694	0.0056
10	triage_resprate	0.904653	0.9748	0.005
11	triage_heartrate	0.907845	0.9783	0.0032
12	cci_Renal	0.911509	0.9822	0.0037
13	chiefcom_chest_pain	0.91419	0.9851	0.0027
14	n_ed_365d	0.912732	0.9835	-0.0015
15	n_hosp_365d	0.9149	0.9859	0.0022
62	all candidates	0.928022	1	
Threshold	k obtained			
95%	7			
96%	8			
97%	10			
98% (adopted)	12			
99%	not reached by k = 15			

Notes: The 98% threshold was fixed before the curve was examined. Marginal gain decays smoothly from +0.0105 at k = 7 to +0.0020 at k = 13 with no plateau, so k = 12 is a disclosed choice rather than an inflection point. In paired tests k = 13 and k = 14 are significantly better than k = 12 (+0.0011 and +0.0034).

eTable 10. Macro AUROC over the acute endpoints against the variable budget k.

Cohort	k	Model	Macro AUROC, acute endpoints	Difference from MultiDiseasePred
UMN internal validation	12	MultiDiseasePred (ours)	0.9	
UMN internal validation	12	XGBoost	0.8989	0.0011
UMN internal validation	12	Random Forest	0.8919	0.0081
UMN internal validation	12	Logistic Regression	0.8816	0.0184
UMN internal validation	12	HistGradientBoosting	0.8962	0.0038
UMN internal validation	13	MultiDiseasePred (ours)	0.9011	
UMN internal validation	13	XGBoost	0.9005	0.0006
UMN internal validation	13	Random Forest	0.8942	0.0069

Cohort	k	Model	Macro AUROC, acute endpoints	Difference from MultiDiseasePred
UMN internal validation	13	Logistic Regression	0.8835	0.0176
UMN internal validation	13	HistGradientBoosting	0.8974	0.0037
UMN internal validation	14	MultiDiseasePred (ours)	0.9034	
UMN internal validation	14	XGBoost	0.9022	0.0012
UMN internal validation	14	Random Forest	0.8971	0.0063
UMN internal validation	14	Logistic Regression	0.8847	0.0187
UMN internal validation	14	HistGradientBoosting	0.8982	0.0052
UMN internal validation	62	MultiDiseasePred (ours)	0.9176	
UMN internal validation	62	XGBoost	0.9184	-0.0008
UMN internal validation	62	Random Forest	0.9137	0.0039
UMN internal validation	62	Logistic Regression	0.8954	0.0222
UMN internal validation	62	HistGradientBoosting	0.9104	0.0072
BIDMC	12	MultiDiseasePred (ours)	0.7927	
BIDMC	12	XGBoost	0.7862	0.0065
BIDMC	12	Random Forest	0.7814	0.0113
BIDMC	12	Logistic Regression	0.7825	0.0102
BIDMC	12	HistGradientBoosting	0.7857	0.007
BIDMC	13	MultiDiseasePred (ours)	0.7996	
BIDMC	13	XGBoost	0.7944	0.0052
BIDMC	13	Random Forest	0.7923	0.0073
BIDMC	13	Logistic Regression	0.7932	0.0064
BIDMC	13	HistGradientBoosting	0.7931	0.0065
BIDMC	14	MultiDiseasePred (ours)	0.8049	
BIDMC	14	XGBoost	0.7972	0.0077
BIDMC	14	Random Forest	0.7931	0.0118
BIDMC	14	Logistic Regression	0.7941	0.0108
BIDMC	14	HistGradientBoosting	0.7974	0.0075
BIDMC	62	MultiDiseasePred (ours)	0.8094	
BIDMC	62	XGBoost	0.8153	-0.0059
BIDMC	62	Random Forest	0.8005	0.0089
BIDMC	62	Logistic Regression	0.8123	-0.0029
BIDMC	62	HistGradientBoosting	0.8077	0.0017
Stanford	12	MultiDiseasePred (ours)	0.8664	
Stanford	12	XGBoost	0.8614	0.005

Cohort	k	Model	Macro AUROC, acute endpoints	Difference from MultiDiseasePred
Stanford	12	Random Forest	0.8683	-0.0019
Stanford	12	Logistic Regression	0.8684	-0.002
Stanford	12	HistGradientBoosting	0.8641	0.0023
Stanford	13	MultiDiseasePred (ours)	0.8728	
Stanford	13	XGBoost	0.8678	0.005
Stanford	13	Random Forest	0.8763	-0.0035
Stanford	13	Logistic Regression	0.8755	-0.0027
Stanford	13	HistGradientBoosting	0.8722	0.0006
Stanford	14	MultiDiseasePred (ours)	0.8724	
Stanford	14	XGBoost	0.8683	0.0041
Stanford	14	Random Forest	0.8756	-0.0032
Stanford	14	Logistic Regression	0.875	-0.0026
Stanford	14	HistGradientBoosting	0.8703	0.0021
Stanford	62	MultiDiseasePred (ours)	0.8844	
Stanford	62	XGBoost	0.8815	0.0029
Stanford	62	Random Forest	0.8954	-0.011
Stanford	62	Logistic Regression	0.8818	0.0026
Stanford	62	HistGradientBoosting	0.8826	0.0018

Notes: MultiDiseasePred is ahead at k = 12, 13 and 14 in the UMN internal validation set and at BIDMC, behind with all 62 variables, and not ahead at Stanford at any k. The margin does not decay with k (BIDMC +0.0065, +0.0052, +0.0075).

eTable 11. MultiDiseasePred with all 62 candidate variables and with the twelve retained variables, seven acute endpoints.

Cohort	Endpoint	AUROC, 62 variables	AUROC, 12 variables	Difference	AUPRC, 62 variables	AUPRC, 12 variables	Difference
UMN variable selection	Sepsis	0.8881	0.8595	-0.0286	0.2590	0.2048	-0.0542
UMN variable selection	Viral pneumonia	0.9045	0.8800	-0.0245	0.2142	0.1532	-0.0610
UMN variable selection	ARDS	0.9433	0.9296	-0.0137	0.0616	0.0431	-0.0185
UMN variable selection	Pulmonary embolism	0.9749	0.9700	-0.0049	0.4311	0.3010	-0.1301
UMN variable selection	COPD/asthma exacerbation	0.9705	0.9624	-0.0081	0.5319	0.4534	-0.0785
UMN variable selection	Acute coronary syndrome	0.9421	0.9180	-0.0241	0.4113	0.2552	-0.1561
UMN variable selection	Acute kidney injury	0.8900	0.8658	-0.0242	0.2782	0.2270	-0.0512
UMN variable selection	Macro average, seven acute endpoints	0.9305	0.9122	-0.0183	0.3125	0.2340	-0.0785
UMN internal validation	Sepsis	0.8733	0.8437	-0.0296	0.2346	0.1901	-0.0445
UMN internal validation	Viral pneumonia	0.8923	0.8724	-0.0199	0.0502	0.0387	-0.0115
UMN internal validation	ARDS	0.9144	0.8966	-0.0178	0.0358	0.0216	-0.0142
UMN internal validation	Pulmonary embolism	0.9686	0.9645	-0.0041	0.4111	0.2817	-0.1294
UMN internal validation	COPD/asthma exacerbation	0.9701	0.9634	-0.0067	0.5384	0.4856	-0.0528
UMN internal validation	Acute coronary syndrome	0.9300	0.9105	-0.0195	0.3600	0.2322	-0.1278
UMN internal validation	Acute kidney injury	0.8749	0.8490	-0.0259	0.2911	0.2412	-0.0499
UMN internal validation	Macro average, seven acute endpoints	0.9177	0.9000	-0.0176	0.2745	0.2130	-0.0614
BIDMC	Sepsis	0.8409	0.8381	-0.0028	0.1947	0.1828	-0.0119
BIDMC	Viral pneumonia	0.8009	0.7467	-0.0542	0.0170	0.0121	-0.0049
BIDMC	ARDS	0.7780	0.7737	-0.0043	0.0062	0.0080	+0.0018
BIDMC	Pulmonary embolism	0.7540	0.7438	-0.0102	0.0590	0.0502	-0.0088
BIDMC	COPD/asthma exacerbation	0.8552	0.8478	-0.0074	0.2575	0.2316	-0.0259
BIDMC	Acute coronary syndrome	0.8240	0.7907	-0.0333	0.1103	0.0782	-0.0321
BIDMC	Acute kidney injury	0.8131	0.8079	-0.0052	0.2565	0.2464	-0.0101

Cohort	Endpoint	AUROC, 62 variables	AUROC, 12 variables	Difference	AUPRC, 62 variables	AUPRC, 12 variables	Difference
BIDMC	Macro average, seven acute endpoints	0.8094	0.7927	-0.0168	0.1287	0.1156	-0.0131
Stanford	Sepsis	0.8889	0.8825	-0.0064	0.0970	0.0789	-0.0181
Stanford	Viral pneumonia	0.8397	0.8033	-0.0364	0.0301	0.0205	-0.0096
Stanford	ARDS	0.8619	0.8550	-0.0069	0.0020	0.0036	+0.0016
Stanford	Pulmonary embolism	0.9413	0.9324	-0.0089	0.2668	0.1424	-0.1244
Stanford	COPD/asthma exacerbation	0.9286	0.9147	-0.0139	0.2529	0.1726	-0.0803
Stanford	Acute coronary syndrome	0.9218	0.8896	-0.0322	0.2831	0.1311	-0.1520
Stanford	Acute kidney injury	0.8086	0.7870	-0.0216	0.0245	0.0215	-0.0030
Stanford	Macro average, seven acute endpoints	0.8844	0.8664	-0.0180	0.1366	0.0815	-0.0551

Notes: Values are point estimates for MultiDiseasePred alone; the 62-variable model is a reference point for the cost of parsimony and is not the model proposed. Comparisons against the six comparator models are reported for the twelve-variable model in eTable 5. Difference is the twelve-variable value minus the 62-variable value, so a negative number is the amount lost to the reduction. Macro averages are unweighted means over the seven acute endpoints.

eTable 12. Univariate discrimination of each comorbidity flag.

Flag	Selection order among the twelve	Prevalence	Maximum risk ratio	Endpoint	Maximum univariate AUROC	Endpoint	Model AUROC, same endpoint	Proportion of the model's lift
eci_PHTN	3	0.0688	159.1957	pe	0.9294	pe	0.9645	0.924
cci_Pulmonary	7	0.2222	114.2305	copd_asthma	0.8827	copd_asthma	0.9634	0.826
cci_MI	6	0.0711	23.9084	acs_mi	0.7934	acs_mi	0.9105	0.715
cci_Renal	12	0.1324	7.7673	aki	0.714	aki	0.849	0.613
eci_FluidsLytes	5	0.2868	5.4596	aki	0.7089	aki	0.849	0.599
eci-HTN1	not selected	0.3699	5.2465	aki	0.701	aki	0.849	0.576
eci-HTN2	not selected	0.1408	6.3622	aki	0.693	aki	0.849	0.553
cci_CHF	not selected	0.1143	6.4898	acs_mi	0.674	acs_mi	0.9105	0.424
eci_Arrhythmia	not selected	0.2715	3.7236	critical	0.6562	critical	0.9145	0.377
eci_Valvular	not selected	0.1148	4.2849	acs_mi	0.6236	acs_mi	0.9105	0.301
cci_DM2	not selected	0.1284	3.8765	aki	0.6227	aki	0.849	0.352
cci_DM1	not selected	0.1471	3.2958	aki	0.6124	aki	0.849	0.322
eci_Coagulopathy	not selected	0.1072	3.6471	aki	0.603	aki	0.849	0.295

Flag	Selection order among the twelve	Prevalence	Maximum risk ratio	Endpoint	Maximum univariate AUROC	Endpoint	Model AUROC, same endpoint	Proportion of the model's lift
eci_WeightLoss	not selected	0.0982	3.5669	sepsis	0.5931	sepsis	0.8437	0.271
cci_Stroke	not selected	0.1023	3.4549	critical	0.5909	critical	0.9145	0.219
cci_Cancer1	not selected	0.0898	3.5896	pe	0.5865	pe	0.9645	0.186
cci_PVD	not selected	0.0812	3.5567	acs_mi	0.5805	acs_mi	0.9105	0.196
eci_Anemia	not selected	0.0977	3.0984	aki	0.5801	aki	0.849	0.23
eci_Obesity	not selected	0.2163	2.0327	aki	0.5747	aki	0.849	0.214
cci_Cancer2	not selected	0.0271	5.6563	pe	0.5549	pe	0.9645	0.118
eci_Depression	not selected	0.2933	1.5289	copd_asthma	0.5485	copd_asthma	0.9634	0.105
cci_Liver1	not selected	0.0854	2.3323	sepsis	0.5479	sepsis	0.8437	0.139
eci_Hypothyroid	not selected	0.1056	2.073	aki	0.5475	aki	0.849	0.136
eci_NeuroOther	not selected	0.0825	2.2909	critical	0.5445	critical	0.9145	0.107
cci_Dementia	not selected	0.034	3.0995	sepsis	0.5331	sepsis	0.8437	0.096
eci_BloodLoss	not selected	0.0314	2.9333	aki	0.5289	aki	0.849	0.083
eci_Alcohol	not selected	0.1152	1.4534	hospitalization	0.5275	hospitalization	0.7896	0.095
cci_Paralysis	not selected	0.0187	4.0602	sepsis	0.5273	sepsis	0.8437	0.079
cci_PUD	not selected	0.0278	2.7543	aki	0.5236	aki	0.849	0.068
cci_Rheumatic	not selected	0.0331	2.3251	sepsis	0.5208	sepsis	0.8437	0.061
cci_Liver2	not selected	0.0131	4.0376	aki	0.5197	aki	0.849	0.056
eci_Drugs	not selected	0.1372	1.1762	copd_asthma	0.5113	hospitalization	0.7896	0.039
cci_Lymphoma	not selected	0.0088	3.5208	ards	0.5107	ards	0.8966	0.027
eci_Psychoses	not selected	0.0492	1.133	hospitalization	0.5038	hospitalization	0.7896	0.013
cci_HIV	not selected	0.0029	1.6843	sepsis	0.501	sepsis	0.8437	0.003

Notes: Univariate AUROC is that of the single flag used alone; the model AUROC column is MultiDiseasePred on the UMN internal validation set, the same cohort in which the univariate values were computed and the cohort reported in Table 2. Proportion of the model's lift is (univariate AUROC - 0.5) / (model AUROC - 0.5). Pulmonary hypertension alone reaches AUROC 0.9294 for pulmonary embolism, 92.4% of the lift achieved by the full model; chronic pulmonary disease alone reaches 0.8827 for COPD/asthma exacerbation, 82.6% of the lift. Both endpoints are incident events at the index encounter and the comorbidity look-back window closes before it.

eTable 13. Expected-gradient contributions of the twelve variables, overall and by endpoint.

Variable	Rank	Mean EG	Mean signed EG	Spread	Ranks across seeds	Hospitalization	Critical outcome	Sepsis	Viral pneumonia	ARDS	Pulmonary embolism	COPD/asthma exacerbation	Acute coronary syndrome	Acute kidney injury
age	1	0.6029	-0.0442	0.0590	1/1/1	0.3236	0.3565	0.4081	0.4426	0.4671	0.4415	0.7270	1.0783	0.6559
triage_dbp	2	0.3869	0.0070	0.1098	2/3/3	0.4372	0.2997	0.4476	0.3350	0.7265	0.4671	0.2891	0.1687	0.2746

Variable	Rank	Mean EG	Mean signed EG	Spread	Ranks across seeds	Hospitaliza tion	Critical outcome	Sepsis	Viral pneumonia	ARDS	Pulmonary embolism	COPD/ asthma exacerbatio n	Acute coronary syndrome	Acute kidney injury
cci_Pulmonary	3	0.3753	-0.0198	0.0383	3/2/2	0.0589	0.1588	0.1198	0.0933	0.1844	0.1968	1.7641	0.1162	0.1522
eci_FluidsL ytes	4	0.3345	-0.0210	0.0241	4/5/4	0.3649	0.5034	0.5238	0.1002	0.6148	0.2222	0.0928	0.2474	0.5403
triage_o2sat	5	0.2841	0.0131	0.0749	5/4/5	0.1583	0.2728	0.2426	0.4733	0.4883	0.2218	0.2788	0.1452	0.1387
triage_heartrate	6	0.2342	0.0024	0.0482	7/7/6	0.2234	0.1758	0.2294	0.2098	0.3804	0.2452	0.2216	0.1912	0.1615
triage_resprate	7	0.2197	-0.0605	0.0373	6/6/7	0.1031	0.2319	0.2693	0.2802	0.3347	0.0966	0.2354	0.1536	0.1679
cci_Renal	8	0.1930	0.0065	0.0290	8/8/8	0.1163	0.1594	0.2010	0.1016	0.1855	0.1690	0.0972	0.1978	0.3985
chiefcom_sh ortness_of_ breath	9	0.1689	-0.0158	0.0113	9/9/9	0.0433	0.0750	0.0512	0.2653	0.2390	0.1227	0.3039	0.1542	0.0460
eci_PHTN	10	0.1544	-0.0131	0.0095	10/10/10	0.0554	0.0631	0.0493	0.0502	0.1062	0.6919	0.0492	0.0847	0.0489
cci_MI	11	0.1299	-0.0001	0.0105	11/11/11	0.0713	0.1226	0.0486	0.0471	0.1131	0.0816	0.0677	0.4701	0.0814
chiefcom_fe ver_chills	12	0.0622	-0.0034	0.0075	12/12/12	0.0287	0.0331	0.1182	0.0740	0.0668	0.0573	0.0496	0.0336	0.0359

Notes: EG, expected gradient. Mean |EG| is the mean of the seven acute-endpoint columns; the two disposition columns are reported but not included in it. Values are on the logit scale and are comparable across endpoints. Ranks across seeds gives the variable's rank in each of the three training seeds; spread is the standard deviation of mean |EG| across them. The sign of the mean indicates which side of the cohort baseline the typical value lies on, not the direction of risk.

eTable 14. Calibration of MultiDiseasePred, twelve variables.

Cohort	Endpoint	Calibration slope (95% CI)	Calibration intercept (95% CI)	Brier score	Expected calibration error	Alert rate
UMN variable selection	Sepsis	0.9456 (0.9279– 0.9634)	-0.0978 (-0.1536–0.0419)	0.022396	0.001629	0.2357
UMN variable selection	Viral pneumonia	0.9997 (0.9732– 1.0262)	0.0265 (-0.0765– 0.1294)	0.008017	0.000299	0.1681
UMN variable selection	ARDS	0.9639 (0.9019– 1.0260)	-0.1032 (-0.4351– 0.2288)	0.000987	0.00009	0.1546
UMN variable selection	Pulmonary embolism	0.9844 (0.9561– 1.0126)	-0.0201 (-0.1055– 0.0653)	0.005696	0.000158	0.0741
UMN variable selection	COPD/asthma exacerbation	1.0098 (0.9909– 1.0288)	0.0239 (-0.0208– 0.0686)	0.01568	0.000459	0.1712
UMN variable selection	Acute coronary syndrome	0.9953 (0.9758– 1.0149)	0.0050 (-0.0525– 0.0625)	0.015729	0.000382	0.1818
UMN variable selection	Acute kidney injury	0.9884 (0.9721– 1.0048)	0.0326 (-0.0100– 0.0752)	0.035492	0.002125	0.2695
UMN variable selection	Hospitalization	0.9803 (0.9705– 0.9900)	0.0237 (0.0083– 0.0392)	0.128664	0.005846	0.3551
UMN variable selection	Critical outcome	0.9711 (0.9441– 0.9981)	-0.0695 (-0.1772– 0.0383)	0.008334	0.000369	0.1956
UMN internal validation	Sepsis	0.9272 (0.9117– 0.9427)	-0.1876 (-0.2362–0.1391)	0.023623	0.001759	0.2651
UMN internal validation	Viral pneumonia	0.9504 (0.9157– 0.9849)	-1.0431 (-1.1794–0.9069)	0.003964	0.00486	0.1826
UMN internal validation	ARDS	1.0512 (0.9789– 1.1235)	-0.1311 (-0.5081– 0.2458)	0.000568	0.000391	0.1696
UMN internal validation	Pulmonary embolism	0.9400 (0.9177– 0.9622)	-0.1061 (-0.1775–0.0348)	0.006081	0.000376	0.0748
UMN internal validation	COPD/asthma exacerbation	1.0494 (1.0329– 1.0659)	0.1361 (0.0980– 0.1743)	0.01629	0.001034	0.1811
UMN internal validation	Acute coronary syndrome	0.9550 (0.9395– 0.9705)	0.0210 (-0.0258– 0.0678)	0.019209	0.002459	0.2036
UMN internal validation	Acute kidney injury	0.9345 (0.9218– 0.9472)	0.0453 (0.0120– 0.0786)	0.043999	0.007812	0.3018
UMN internal validation	Hospitalization	0.9826 (0.9739– 0.9912)	-0.1319 (-0.1447–0.1192)	0.127715	0.014873	0.3913
UMN internal validation	Critical outcome	1.1974 (1.1605– 1.2343)	-0.2280 (-0.3563–0.0996)	0.003825	0.005185	0.22
BIDMC	Sepsis	0.8289 (0.8166– 0.8411)	-0.3131 (-0.3550–0.2712)	0.024028	0.005404	0.2052
BIDMC	Viral pneumonia	0.5742 (0.5436– 0.6047)	-2.4126 (-2.5707–2.2546)	0.00372	0.003205	0.1322
BIDMC	ARDS	0.5124 (0.4702– 0.5547)	-2.6227 (-2.9346–2.3108)	0.00104	0.000571	0.134
BIDMC	Pulmonary embolism	0.4112 (0.3992– 0.4232)	-1.6994 (-1.7788–1.6200)	0.009449	0.006227	0.0542
BIDMC	COPD/asthma exacerbation	0.5222 (0.5139– 0.5305)	-0.8607 (-0.9001–0.8213)	0.016565	0.007671	0.1088
BIDMC	Acute coronary syndrome	0.5353 (0.5244– 0.5463)	-1.2260 (-1.2738–1.1782)	0.020318	0.011639	0.1582
BIDMC	Acute kidney injury	0.7385 (0.7301– 0.7469)	0.1699 (0.1423– 0.1975)	0.063762	0.037999	0.2424

Cohort	Endpoint	Calibration slope (95% CI)	Calibration intercept (95% CI)	Brier score	Expected calibration error	Alert rate
BIDMC	Hospitalization	0.6119 (0.6060– 0.6178)	1.0708 (1.0578– 1.0838)	0.312045	0.295498	0.3198
BIDMC	Critical outcome	0.4926 (0.4851– 0.5002)	0.0777 (0.0377– 0.1178)	0.063223	0.0574	0.176
Stanford	Sepsis	0.9416 (0.8983– 0.9849)	-1.4907 (-1.6165–1.3649)	0.008627	0.016997	0.2086
Stanford	Viral pneumonia	0.7159 (0.6534– 0.7784)	-2.3576 (-2.6315–2.0837)	0.003014	0.006354	0.1662
Stanford	ARDS	0.6678 (0.5391– 0.7966)	-2.9270 (-3.7189–2.1352)	0.000385	0.000942	0.1437
Stanford	Pulmonary embolism	0.7313 (0.6962– 0.7664)	-1.5899 (-1.7149–1.4649)	0.004813	0.00586	0.0574
Stanford	COPD/asthma exacerbation	0.7239 (0.6901– 0.7578)	-1.5616 (-1.6747–1.4486)	0.005986	0.007601	0.0844
Stanford	Acute coronary syndrome	0.9128 (0.8765– 0.9491)	-1.1352 (-1.2438–1.0265)	0.008195	0.009792	0.1605
Stanford	Acute kidney injury	0.6714 (0.6224– 0.7205)	-2.6365 (-2.7918–2.4813)	0.009756	0.027741	0.2393
Stanford	Hospitalization	0.5367 (0.5250– 0.5485)	-0.1598 (-0.1832–0.1365)	0.180353	0.087156	0.3088
Stanford	Critical outcome	0.5675 (0.5460– 0.5889)	-0.7366 (-0.8414–0.6318)	0.022295	0.013635	0.1813

Notes: A slope of 1 indicates perfect calibration. Slopes are 0.93 to 1.20 in domain, 0.41 to 0.83 at BIDMC and 0.54 to 0.94 at Stanford. Slope and intercept both depart from their ideal values, so the miscalibration is not a pure prevalence shift.

eTable 15. Transfer of a threshold set for 90% sensitivity on the UMN variable-selection split.

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV	Threshold (logit)
UMN variable selection	Sepsis	MultiDiseasePred (ours)	0.9	0.6172	0.0582	0.9958	-4.5465
		XGBoost	0.9	0.6158	0.058	0.9958	0.0121
		Logistic Regression	0.9	0.5913	0.0547	0.9956	0.0124
UMN variable selection	Viral pneumonia	MultiDiseasePred (ours)	0.9002	0.6403	0.0217	0.9986	-5.5716
		XGBoost	0.9002	0.6216	0.0207	0.9986	0.0037
		Logistic Regression	0.9002	0.555	0.0177	0.9984	0.0045
UMN variable selection	ARDS	MultiDiseasePred (ours)	0.9015	0.799	0.0045	0.9999	-7.4376
		XGBoost	0.9015	0.7869	0.0042	0.9999	0.0005
		Logistic Regression	0.9015	0.7607	0.0038	0.9999	0.0007
UMN variable selection	Pulmonary embolism	MultiDiseasePred (ours)	0.9	0.9451	0.1042	0.9992	-3.7845
		XGBoost	0.9	0.9451	0.1042	0.9992	0.0216
		Logistic Regression	0.9	0.946	0.1057	0.9992	0.022
UMN variable selection	COPD/asthma exacerbation	MultiDiseasePred (ours)	0.9001	0.8806	0.1502	0.9974	-3.4583
		XGBoost	0.9001	0.8805	0.1501	0.9974	0.0284
		Logistic Regression	0.9001	0.8728	0.1423	0.9973	0.0361
UMN variable selection	Acute coronary syndrome	MultiDiseasePred (ours)	0.9001	0.7622	0.0677	0.9975	-4.5195
		XGBoost	0.9001	0.7621	0.0677	0.9975	0.0105
		Logistic Regression	0.9001	0.707	0.0557	0.9973	0.0086
UMN variable selection	Acute kidney injury	MultiDiseasePred (ours)	0.9	0.6571	0.1031	0.9934	-3.8036
		XGBoost	0.9	0.6543	0.1024	0.9934	0.0233
		Logistic Regression	0.9	0.6246	0.095	0.993	0.0212
UMN variable selection	Hospitalization	MultiDiseasePred (ours)	0.9	0.4291	0.2877	0.9437	-2.3511

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV	Threshold (logit)
UMN variable selection	Critical outcome	XGBoost	0.9	0.4349	0.2898	0.9444	0.0937
		Logistic Regression	0.9	0.3863	0.2731	0.9378	0.0971
		MultiDiseasePred (ours)	0.9002	0.6109	0.0205	0.9985	-5.6448
		XGBoost	0.9002	0.6162	0.0208	0.9985	0.0042
		Logistic Regression	0.9002	0.5041	0.0162	0.9982	0.0037
UMN internal validation	Sepsis	MultiDiseasePred (ours)	0.9018	0.5761	0.0552	0.9953	-4.5465
		XGBoost	0.903	0.5721	0.0548	0.9954	0.0121
		Logistic Regression	0.8973	0.5601	0.0531	0.995	0.0124
UMN internal validation	Viral pneumonia	MultiDiseasePred (ours)	0.9189	0.5965	0.0087	0.9995	-5.5716
		XGBoost	0.9196	0.5706	0.0082	0.9995	0.0037
		Logistic Regression	0.9055	0.522	0.0072	0.9993	0.0045
UMN internal validation	ARDS	MultiDiseasePred (ours)	0.8342	0.7774	0.0021	0.9999	-7.4376
		XGBoost	0.8894	0.7655	0.0022	0.9999	0.0005
		Logistic Regression	0.8442	0.7456	0.0019	0.9999	0.0007
UMN internal validation	Pulmonary embolism	MultiDiseasePred (ours)	0.8871	0.9441	0.1058	0.9991	-3.7845
		XGBoost	0.884	0.9441	0.1054	0.9991	0.0216
		Logistic Regression	0.8825	0.9453	0.1074	0.9991	0.022
UMN internal validation	COPD/asthma exacerbation	MultiDiseasePred (ours)	0.9135	0.8727	0.1535	0.9975	-3.4583
		XGBoost	0.9145	0.8711	0.152	0.9975	0.0284
		Logistic Regression	0.9055	0.8666	0.1465	0.9972	0.0361
UMN internal validation	Acute coronary syndrome	MultiDiseasePred (ours)	0.9125	0.7348	0.0736	0.9973	-4.5195
		XGBoost	0.9114	0.7337	0.0733	0.9972	0.0105
		Logistic Regression	0.8882	0.686	0.0613	0.9962	0.0086

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV	Threshold (logit)
UMN internal validation	Acute kidney injury	MultiDiseasePred (ours)	0.894	0.6246	0.1166	0.9907	-3.8036
		XGBoost	0.8958	0.6209	0.1158	0.9908	0.0233
		Logistic Regression	0.8962	0.5972	0.1098	0.9904	0.0212
UMN internal validation	Hospitalization	MultiDiseasePred (ours)	0.9201	0.3782	0.2671	0.9505	-2.3511
		XGBoost	0.9193	0.3804	0.2676	0.9504	0.0937
		Logistic Regression	0.9184	0.3527	0.2589	0.9461	0.0971
UMN internal validation	Critical outcome	MultiDiseasePred (ours)	0.9655	0.5716	0.0089	0.9998	-5.6448
		XGBoost	0.9713	0.5762	0.0091	0.9998	0.0042
		Logistic Regression	0.9598	0.471	0.0072	0.9997	0.0037
BIDMC	Sepsis	MultiDiseasePred (ours)	0.8344	0.6529	0.0625	0.993	-4.5465
		XGBoost	0.8416	0.6468	0.062	0.9933	0.0121
		Logistic Regression	0.8809	0.6042	0.0581	0.9946	0.0124
BIDMC	Viral pneumonia	MultiDiseasePred (ours)	0.6573	0.7145	0.0081	0.9983	-5.5716
		XGBoost	0.6546	0.7048	0.0078	0.9983	0.0037
		Logistic Regression	0.7258	0.5675	0.0059	0.9983	0.0045
BIDMC	ARDS	MultiDiseasePred (ours)	0.5757	0.8253	0.0034	0.9995	-7.4376
		XGBoost	0.5138	0.8183	0.0029	0.9994	0.0005
		Logistic Regression	0.6376	0.7582	0.0027	0.9995	0.0007
BIDMC	Pulmonary embolism	MultiDiseasePred (ours)	0.2385	0.9613	0.0559	0.9924	-3.7845
		XGBoost	0.2365	0.9609	0.0549	0.9924	0.0216
		Logistic Regression	0.2345	0.9626	0.0568	0.9924	0.022
BIDMC	COPD/asthma exacerbation	MultiDiseasePred (ours)	0.5489	0.9255	0.1272	0.9905	-3.4583

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV	Threshold (logit)
BIDMC	Acute coronary syndrome	XGBoost	0.5561	0.9221	0.1237	0.9906	0.0284
		Logistic Regression	0.5617	0.9095	0.1092	0.9906	0.0361
		MultiDiseasePred (ours)	0.5956	0.7803	0.0539	0.9892	-4.5195
		XGBoost	0.6008	0.7766	0.0535	0.9893	0.0105
		Logistic Regression	0.7639	0.6665	0.0459	0.9926	0.0086
BIDMC	Acute kidney injury	MultiDiseasePred (ours)	0.7784	0.6911	0.1677	0.975	-3.8036
		XGBoost	0.7752	0.6854	0.1646	0.9744	0.0233
		Logistic Regression	0.8081	0.6544	0.1575	0.9771	0.0212
BIDMC	Hospitalization	MultiDiseasePred (ours)	0.7403	0.5253	0.5894	0.6873	-2.3511
		XGBoost	0.7407	0.5166	0.5851	0.684	0.0937
		Logistic Regression	0.7768	0.4556	0.5677	0.6892	0.0971
BIDMC	Critical outcome	MultiDiseasePred (ours)	0.6098	0.6696	0.116	0.9602	-5.6448
		XGBoost	0.5882	0.6675	0.1117	0.958	0.0042
		Logistic Regression	0.7994	0.492	0.1006	0.9718	0.0037
Stanford	Sepsis	MultiDiseasePred (ours)	0.9288	0.6323	0.018	0.9992	-4.5465
		XGBoost	0.9217	0.6287	0.0177	0.9991	0.0121
		Logistic Regression	0.93	0.5992	0.0166	0.9992	0.0124
Stanford	Viral pneumonia	MultiDiseasePred (ours)	0.7724	0.6756	0.0059	0.9992	-5.5716
		XGBoost	0.7586	0.6664	0.0056	0.9991	0.0037
		Logistic Regression	0.8172	0.5324	0.0043	0.9992	0.0045
Stanford	ARDS	MultiDiseasePred (ours)	0.7838	0.8164	0.0014	0.9999	-7.4376
		XGBoost	0.7297	0.8065	0.0012	0.9999	0.0005
		Logistic Regression	0.8649	0.7386	0.001	0.9999	0.0007

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV	Threshold (logit)
Stanford	Pulmonary embolism	MultiDiseasePred (ours)	0.8013	0.958	0.0719	0.9992	-3.7845
		XGBoost	0.797	0.958	0.0716	0.9991	0.0216
		Logistic Regression	0.8013	0.9594	0.074	0.9992	0.022
Stanford	COPD/asthma exacerbation	MultiDiseasePred (ours)	0.7512	0.938	0.0616	0.9986	-3.4583
		XGBoost	0.7385	0.9364	0.0592	0.9985	0.0284
		Logistic Regression	0.7654	0.9265	0.0535	0.9986	0.0361
Stanford	Acute coronary syndrome	MultiDiseasePred (ours)	0.8127	0.7647	0.0269	0.998	-4.5195
		XGBoost	0.8148	0.7612	0.0266	0.9981	0.0105
		Logistic Regression	0.8816	0.6255	0.0185	0.9985	0.0086
Stanford	Acute kidney injury	MultiDiseasePred (ours)	0.7876	0.66	0.0145	0.998	-3.8036
		XGBoost	0.7862	0.6526	0.0142	0.9979	0.0233
		Logistic Regression	0.8038	0.6332	0.0137	0.998	0.0212
Stanford	Hospitalization	MultiDiseasePred (ours)	0.7655	0.4701	0.3247	0.8576	-2.3511
		XGBoost	0.7669	0.4646	0.3228	0.8569	0.0937
		Logistic Regression	0.7921	0.4009	0.3055	0.8528	0.0971
Stanford	Critical outcome	MultiDiseasePred (ours)	0.6904	0.646	0.0448	0.9886	-5.6448
		XGBoost	0.6955	0.6435	0.0448	0.9888	0.0042
		Logistic Regression	0.7243	0.4749	0.0321	0.9862	0.0037

Notes: Thresholds were derived on the 20% variable-selection split of the UMN development cohort and applied unchanged elsewhere. PPV, positive predictive value; NPV, negative predictive value.

eTable 16. Full operating characteristics under the 90%-sensitivity threshold rule, twelve variables.

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV
UMN variable selection	Hospitalization	MultiDiseasePred (ours)	0.9	0.4291	0.2877	0.9437
UMN variable selection	Critical outcome	MultiDiseasePred (ours)	0.9002	0.6109	0.0205	0.9985
UMN variable selection	Sepsis	MultiDiseasePred (ours)	0.9	0.6172	0.0582	0.9958
UMN variable selection	Viral pneumonia	MultiDiseasePred (ours)	0.9002	0.6403	0.0217	0.9986
UMN variable selection	ARDS	MultiDiseasePred (ours)	0.9015	0.799	0.0045	0.9999
UMN variable selection	Pulmonary embolism	MultiDiseasePred (ours)	0.9	0.9451	0.1042	0.9992
UMN variable selection	COPD/asthma exacerbation	MultiDiseasePred (ours)	0.9001	0.8806	0.1502	0.9974
UMN variable selection	Acute coronary syndrome	MultiDiseasePred (ours)	0.9001	0.7622	0.0677	0.9975
UMN variable selection	Acute kidney injury	MultiDiseasePred (ours)	0.9	0.6571	0.1031	0.9934
UMN variable selection	Macro average, acute	MultiDiseasePred (ours)	0.9003	0.7573	0.0728	0.9974
UMN variable selection	Hospitalization	XGBoost	0.9	0.4349	0.2898	0.9444
UMN variable selection	Critical outcome	XGBoost	0.9002	0.6162	0.0208	0.9985
UMN variable selection	Sepsis	XGBoost	0.9	0.6158	0.058	0.9958
UMN variable selection	Viral pneumonia	XGBoost	0.9002	0.6216	0.0207	0.9986
UMN variable selection	ARDS	XGBoost	0.9015	0.7869	0.0042	0.9999
UMN variable selection	Pulmonary embolism	XGBoost	0.9	0.9451	0.1042	0.9992
UMN variable selection	COPD/asthma exacerbation	XGBoost	0.9001	0.8805	0.1501	0.9974
UMN variable selection	Acute coronary syndrome	XGBoost	0.9001	0.7621	0.0677	0.9975
UMN variable selection	Acute kidney injury	XGBoost	0.9	0.6543	0.1024	0.9934
UMN variable selection	Macro average, acute	XGBoost	0.9003	0.7523	0.0725	0.9974
UMN variable selection	Hospitalization	LightGBM	0.9	0.4336	0.2893	0.9442
UMN variable selection	Critical outcome	LightGBM	0.9002	0.607	0.0203	0.9985
UMN variable selection	Sepsis	LightGBM	0.9	0.6143	0.0578	0.9957
UMN variable selection	Viral pneumonia	LightGBM	0.9002	0.6184	0.0205	0.9986
UMN variable selection	ARDS	LightGBM	0.9015	0.7478	0.0036	0.9999
UMN variable selection	Pulmonary embolism	LightGBM	0.9	0.9442	0.1028	0.9992

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV
UMN variable selection	COPD/asthma exacerbation	LightGBM	0.9001	0.8813	0.1509	0.9974
UMN variable selection	Acute coronary syndrome	LightGBM	0.9001	0.7586	0.0668	0.9975
UMN variable selection	Acute kidney injury	LightGBM	0.9	0.6539	0.1022	0.9934
UMN variable selection	Macro average, acute	LightGBM	0.9003	0.7455	0.0721	0.9974
UMN variable selection	Hospitalization	Random Forest	0.9	0.4234	0.2857	0.9429
UMN variable selection	Critical outcome	Random Forest	0.9002	0.5782	0.0189	0.9984
UMN variable selection	Sepsis	Random Forest	0.9	0.5984	0.0556	0.9956
UMN variable selection	Viral pneumonia	Random Forest	0.9002	0.5892	0.0191	0.9985
UMN variable selection	ARDS	Random Forest	0.9015	0.7322	0.0034	0.9999
UMN variable selection	Pulmonary embolism	Random Forest	0.9	0.9455	0.1049	0.9992
UMN variable selection	COPD/asthma exacerbation	Random Forest	0.9001	0.8786	0.1482	0.9973
UMN variable selection	Acute coronary syndrome	Random Forest	0.9001	0.7435	0.0631	0.9974
UMN variable selection	Acute kidney injury	Random Forest	0.9	0.6464	0.1003	0.9933
UMN variable selection	Macro average, acute	Random Forest	0.9003	0.7334	0.0706	0.9973
UMN variable selection	Hospitalization	Logistic Regression	0.9	0.3863	0.2731	0.9378
UMN variable selection	Critical outcome	Logistic Regression	0.9002	0.5041	0.0162	0.9982
UMN variable selection	Sepsis	Logistic Regression	0.9	0.5913	0.0547	0.9956
UMN variable selection	Viral pneumonia	Logistic Regression	0.9002	0.555	0.0177	0.9984
UMN variable selection	ARDS	Logistic Regression	0.9015	0.7607	0.0038	0.9999
UMN variable selection	Pulmonary embolism	Logistic Regression	0.9	0.946	0.1057	0.9992
UMN variable selection	COPD/asthma exacerbation	Logistic Regression	0.9001	0.8728	0.1423	0.9973
UMN variable selection	Acute coronary syndrome	Logistic Regression	0.9001	0.707	0.0557	0.9973
UMN variable selection	Acute kidney injury	Logistic Regression	0.9	0.6246	0.095	0.993
UMN variable selection	Macro average, acute	Logistic Regression	0.9003	0.7225	0.0678	0.9972
UMN variable selection	Hospitalization	HistGradientBoosting	0.9	0.4348	0.2898	0.9444
UMN variable selection	Critical outcome	HistGradientBoosting	0.9002	0.6109	0.0205	0.9985
UMN variable selection	Sepsis	HistGradientBoosting	0.9	0.6124	0.0575	0.9957

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV
UMN variable selection	Viral pneumonia	HistGradientBoosting	0.9002	0.6185	0.0205	0.9986
UMN variable selection	ARDS	HistGradientBoosting	0.9015	0.7589	0.0038	0.9999
UMN variable selection	Pulmonary embolism	HistGradientBoosting	0.9	0.9434	0.1014	0.9992
UMN variable selection	COPD/asthma exacerbation	HistGradientBoosting	0.9001	0.8779	0.1474	0.9973
UMN variable selection	Acute coronary syndrome	HistGradientBoosting	0.9001	0.7608	0.0674	0.9975
UMN variable selection	Acute kidney injury	HistGradientBoosting	0.9	0.6574	0.1032	0.9934
UMN variable selection	Macro average, acute	HistGradientBoosting	0.9003	0.747	0.0716	0.9974
UMN variable selection	Hospitalization	NEWS (abbreviated)	0.9999	0	0.204	
UMN variable selection	Critical outcome	NEWS (abbreviated)	0.9999	0	0.009	
UMN variable selection	Sepsis	NEWS (abbreviated)	0.9999	0	0.0256	
UMN variable selection	Viral pneumonia	NEWS (abbreviated)	0.9999	0	0.0088	
UMN variable selection	ARDS	NEWS (abbreviated)	0.9999	0	0.001	
UMN variable selection	Pulmonary embolism	NEWS (abbreviated)	0.9999	0	0.007	
UMN variable selection	COPD/asthma exacerbation	NEWS (abbreviated)	0.9999	0	0.0229	
UMN variable selection	Acute coronary syndrome	NEWS (abbreviated)	0.9999	0	0.0188	
UMN variable selection	Acute kidney injury	NEWS (abbreviated)	0.9999	0	0.042	
UMN variable selection	Macro average, acute	NEWS (abbreviated)	0.9999	0	0.018	
UMN internal validation	Hospitalization	MultiDiseasePred (ours)	0.9201	0.3782	0.2671	0.9505
UMN internal validation	Critical outcome	MultiDiseasePred (ours)	0.9655	0.5716	0.0089	0.9998
UMN internal validation	Sepsis	MultiDiseasePred (ours)	0.9018	0.5761	0.0552	0.9953
UMN internal validation	Viral pneumonia	MultiDiseasePred (ours)	0.9189	0.5965	0.0087	0.9995
UMN internal validation	ARDS	MultiDiseasePred (ours)	0.8342	0.7774	0.0021	0.9999
UMN internal validation	Pulmonary embolism	MultiDiseasePred (ours)	0.8871	0.9441	0.1058	0.9991
UMN internal validation	COPD/asthma exacerbation	MultiDiseasePred (ours)	0.9135	0.8727	0.1535	0.9975
UMN internal validation	Acute coronary syndrome	MultiDiseasePred (ours)	0.9125	0.7348	0.0736	0.9973
UMN internal validation	Acute kidney injury	MultiDiseasePred (ours)	0.894	0.6246	0.1166	0.9907
UMN internal validation	Macro average, acute	MultiDiseasePred (ours)	0.8946	0.7323	0.0737	0.997

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV
UMN internal validation	Hospitalization	XGBoost	0.9193	0.3804	0.2676	0.9504
UMN internal validation	Critical outcome	XGBoost	0.9713	0.5762	0.0091	0.9998
UMN internal validation	Sepsis	XGBoost	0.903	0.5721	0.0548	0.9954
UMN internal validation	Viral pneumonia	XGBoost	0.9196	0.5706	0.0082	0.9995
UMN internal validation	ARDS	XGBoost	0.8894	0.7655	0.0022	0.9999
UMN internal validation	Pulmonary embolism	XGBoost	0.884	0.9441	0.1054	0.9991
UMN internal validation	COPD/asthma exacerbation	XGBoost	0.9145	0.8711	0.152	0.9975
UMN internal validation	Acute coronary syndrome	XGBoost	0.9114	0.7337	0.0733	0.9972
UMN internal validation	Acute kidney injury	XGBoost	0.8958	0.6209	0.1158	0.9908
UMN internal validation	Macro average, acute	XGBoost	0.9026	0.7254	0.0731	0.997
UMN internal validation	Hospitalization	LightGBM	0.92	0.3788	0.2673	0.9506
UMN internal validation	Critical outcome	LightGBM	0.9741	0.5666	0.0089	0.9998
UMN internal validation	Sepsis	LightGBM	0.9016	0.5712	0.0546	0.9953
UMN internal validation	Viral pneumonia	LightGBM	0.9167	0.5662	0.0081	0.9994
UMN internal validation	ARDS	LightGBM	0.799	0.7194	0.0016	0.9998
UMN internal validation	Pulmonary embolism	LightGBM	0.8837	0.9433	0.1041	0.9991
UMN internal validation	COPD/asthma exacerbation	LightGBM	0.9134	0.8717	0.1525	0.9975
UMN internal validation	Acute coronary syndrome	LightGBM	0.9123	0.7295	0.0723	0.9972
UMN internal validation	Acute kidney injury	LightGBM	0.8954	0.6201	0.1156	0.9907
UMN internal validation	Macro average, acute	LightGBM	0.8888	0.7173	0.0727	0.997
UMN internal validation	Hospitalization	Random Forest	0.9192	0.3762	0.2663	0.9497
UMN internal validation	Critical outcome	Random Forest	0.9619	0.545	0.0084	0.9997
UMN internal validation	Sepsis	Random Forest	0.896	0.5621	0.0532	0.9949
UMN internal validation	Viral pneumonia	Random Forest	0.9092	0.5504	0.0077	0.9994
UMN internal validation	ARDS	Random Forest	0.8694	0.7182	0.0018	0.9999
UMN internal validation	Pulmonary embolism	Random Forest	0.8802	0.9455	0.1074	0.9991
UMN internal validation	COPD/asthma exacerbation	Random Forest	0.9061	0.8722	0.1519	0.9973

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV
UMN internal validation	Acute coronary syndrome	Random Forest	0.908	0.7197	0.0696	0.997
UMN internal validation	Acute kidney injury	Random Forest	0.8925	0.6178	0.1146	0.9904
UMN internal validation	Macro average, acute	Random Forest	0.8945	0.7123	0.0723	0.9969
UMN internal validation	Hospitalization	Logistic Regression	0.9184	0.3527	0.2589	0.9461
UMN internal validation	Critical outcome	Logistic Regression	0.9598	0.471	0.0072	0.9997
UMN internal validation	Sepsis	Logistic Regression	0.8973	0.5601	0.0531	0.995
UMN internal validation	Viral pneumonia	Logistic Regression	0.9055	0.522	0.0072	0.9993
UMN internal validation	ARDS	Logistic Regression	0.8442	0.7456	0.0019	0.9999
UMN internal validation	Pulmonary embolism	Logistic Regression	0.8825	0.9453	0.1074	0.9991
UMN internal validation	COPD/asthma exacerbation	Logistic Regression	0.9055	0.8666	0.1465	0.9972
UMN internal validation	Acute coronary syndrome	Logistic Regression	0.8882	0.686	0.0613	0.9962
UMN internal validation	Acute kidney injury	Logistic Regression	0.8962	0.5972	0.1098	0.9904
UMN internal validation	Macro average, acute	Logistic Regression	0.8885	0.7032	0.0696	0.9967
UMN internal validation	Hospitalization	HistGradientBoosting	0.9195	0.3813	0.2679	0.9506
UMN internal validation	Critical outcome	HistGradientBoosting	0.967	0.571	0.0089	0.9998
UMN internal validation	Sepsis	HistGradientBoosting	0.9025	0.5725	0.0548	0.9953
UMN internal validation	Viral pneumonia	HistGradientBoosting	0.9174	0.5712	0.0082	0.9994
UMN internal validation	ARDS	HistGradientBoosting	0.8593	0.7432	0.0019	0.9999
UMN internal validation	Pulmonary embolism	HistGradientBoosting	0.8806	0.9426	0.1026	0.9991
UMN internal validation	COPD/asthma exacerbation	HistGradientBoosting	0.9129	0.8688	0.1496	0.9975
UMN internal validation	Acute coronary syndrome	HistGradientBoosting	0.9105	0.7352	0.0736	0.9972
UMN internal validation	Acute kidney injury	HistGradientBoosting	0.8931	0.6251	0.1167	0.9906
UMN internal validation	Macro average, acute	HistGradientBoosting	0.8966	0.7227	0.0725	0.997
UMN internal validation	Hospitalization	NEWS (abbreviated)	0.9999	0	0.1976	
UMN internal validation	Critical outcome	NEWS (abbreviated)	0.9999	0	0.004	
UMN internal validation	Sepsis	NEWS (abbreviated)	0.9999	0	0.0268	
UMN internal validation	Viral pneumonia	NEWS (abbreviated)	0.9999	0	0.0038	

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV
UMN internal validation	ARDS	NEWS (abbreviated)	0.9999	0	0.0006	
UMN internal validation	Pulmonary embolism	NEWS (abbreviated)	0.9999	0	0.0074	
UMN internal validation	COPD/asthma exacerbation	NEWS (abbreviated)	0.9999	0	0.0246	
UMN internal validation	Acute coronary syndrome	NEWS (abbreviated)	0.9999	0	0.0226	
UMN internal validation	Acute kidney injury	NEWS (abbreviated)	0.9999	0	0.0525	
UMN internal validation	Macro average, acute	NEWS (abbreviated)	0.9999	0	0.0198	
BIDMC	Hospitalization	MultiDiseasePred (ours)	0.7403	0.5253	0.5894	0.6873
BIDMC	Critical outcome	MultiDiseasePred (ours)	0.6098	0.6696	0.116	0.9602
BIDMC	Sepsis	MultiDiseasePred (ours)	0.8344	0.6529	0.0625	0.993
BIDMC	Viral pneumonia	MultiDiseasePred (ours)	0.6573	0.7145	0.0081	0.9983
BIDMC	ARDS	MultiDiseasePred (ours)	0.5757	0.8253	0.0034	0.9995
BIDMC	Pulmonary embolism	MultiDiseasePred (ours)	0.2385	0.9613	0.0559	0.9924
BIDMC	COPD/asthma exacerbation	MultiDiseasePred (ours)	0.5489	0.9255	0.1272	0.9905
BIDMC	Acute coronary syndrome	MultiDiseasePred (ours)	0.5956	0.7803	0.0539	0.9892
BIDMC	Acute kidney injury	MultiDiseasePred (ours)	0.7784	0.6911	0.1677	0.975
BIDMC	Macro average, acute	MultiDiseasePred (ours)	0.6041	0.793	0.0684	0.9911
BIDMC	Hospitalization	XGBoost	0.7407	0.5166	0.5851	0.684
BIDMC	Critical outcome	XGBoost	0.5882	0.6675	0.1117	0.958
BIDMC	Sepsis	XGBoost	0.8416	0.6468	0.062	0.9933
BIDMC	Viral pneumonia	XGBoost	0.6546	0.7048	0.0078	0.9983
BIDMC	ARDS	XGBoost	0.5138	0.8183	0.0029	0.9994
BIDMC	Pulmonary embolism	XGBoost	0.2365	0.9609	0.0549	0.9924
BIDMC	COPD/asthma exacerbation	XGBoost	0.5561	0.9221	0.1237	0.9906
BIDMC	Acute coronary syndrome	XGBoost	0.6008	0.7766	0.0535	0.9893
BIDMC	Acute kidney injury	XGBoost	0.7752	0.6854	0.1646	0.9744
BIDMC	Macro average, acute	XGBoost	0.5969	0.7878	0.067	0.9911
BIDMC	Hospitalization	LightGBM	0.7409	0.5162	0.585	0.684
BIDMC	Critical outcome	LightGBM	0.5863	0.6593	0.109	0.9573
BIDMC	Sepsis	LightGBM	0.8453	0.6439	0.0618	0.9934
BIDMC	Viral pneumonia	LightGBM	0.6438	0.7034	0.0076	0.9982
BIDMC	ARDS	LightGBM	0.4794	0.7986	0.0025	0.9993
BIDMC	Pulmonary embolism	LightGBM	0.2328	0.9599	0.0529	0.9924

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV
BIDMC	COPD/asthma exacerbation	LightGBM	0.5548	0.9227	0.1242	0.9906
BIDMC	Acute coronary syndrome	LightGBM	0.6064	0.7716	0.0528	0.9894
BIDMC	Acute kidney injury	LightGBM	0.7771	0.6848	0.1646	0.9746
BIDMC	Macro average, acute	LightGBM	0.5914	0.7836	0.0666	0.9911
BIDMC	Hospitalization	Random Forest	0.7538	0.5117	0.5869	0.6931
BIDMC	Critical outcome	Random Forest	0.6319	0.6151	0.1045	0.9592
BIDMC	Sepsis	Random Forest	0.8583	0.6173	0.0585	0.9937
BIDMC	Viral pneumonia	Random Forest	0.7157	0.6341	0.0069	0.9984
BIDMC	ARDS	Random Forest	0.6697	0.7359	0.0026	0.9995
BIDMC	Pulmonary embolism	Random Forest	0.2397	0.9606	0.0552	0.9924
BIDMC	COPD/asthma exacerbation	Random Forest	0.5721	0.9157	0.1182	0.9908
BIDMC	Acute coronary syndrome	Random Forest	0.6355	0.7464	0.05	0.9898
BIDMC	Acute kidney injury	Random Forest	0.7913	0.6702	0.161	0.9757
BIDMC	Macro average, acute	Random Forest	0.6404	0.7543	0.0646	0.9915
BIDMC	Hospitalization	Logistic Regression	0.7768	0.4556	0.5677	0.6892
BIDMC	Critical outcome	Logistic Regression	0.7994	0.492	0.1006	0.9718
BIDMC	Sepsis	Logistic Regression	0.8809	0.6042	0.0581	0.9946
BIDMC	Viral pneumonia	Logistic Regression	0.7258	0.5675	0.0059	0.9983
BIDMC	ARDS	Logistic Regression	0.6376	0.7582	0.0027	0.9995
BIDMC	Pulmonary embolism	Logistic Regression	0.2345	0.9626	0.0568	0.9924
BIDMC	COPD/asthma exacerbation	Logistic Regression	0.5617	0.9095	0.1092	0.9906
BIDMC	Acute coronary syndrome	Logistic Regression	0.7639	0.6665	0.0459	0.9926
BIDMC	Acute kidney injury	Logistic Regression	0.8081	0.6544	0.1575	0.9771
BIDMC	Macro average, acute	Logistic Regression	0.6589	0.7318	0.0623	0.9922
BIDMC	Hospitalization	HistGradientBoosting	0.7428	0.518	0.5865	0.6863
BIDMC	Critical outcome	HistGradientBoosting	0.5865	0.6686	0.1117	0.9579
BIDMC	Sepsis	HistGradientBoosting	0.8323	0.6492	0.0617	0.9929
BIDMC	Viral pneumonia	HistGradientBoosting	0.6452	0.7091	0.0078	0.9982
BIDMC	ARDS	HistGradientBoosting	0.6216	0.7828	0.003	0.9995
BIDMC	Pulmonary embolism	HistGradientBoosting	0.2402	0.9571	0.0511	0.9924
BIDMC	COPD/asthma exacerbation	HistGradientBoosting	0.5598	0.9201	0.1216	0.9906
BIDMC	Acute coronary syndrome	HistGradientBoosting	0.6269	0.7683	0.0538	0.9899
BIDMC	Acute kidney injury	HistGradientBoosting	0.787	0.6844	0.1662	0.9757
BIDMC	Macro average, acute	HistGradientBoosting	0.6161	0.7816	0.0665	0.9913
BIDMC	Hospitalization	NEWS (abbreviated)	0.9999	0	0.4793	

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV
BIDMC	Critical outcome	NEWS (abbreviated)	0.9999	0	0.0664	
BIDMC	Sepsis	NEWS (abbreviated)	0.9999	0	0.027	
BIDMC	Viral pneumonia	NEWS (abbreviated)	0.9999	0	0.0035	
BIDMC	ARDS	NEWS (abbreviated)	0.9999	0	0.001	
BIDMC	Pulmonary embolism	NEWS (abbreviated)	0.9999	0	0.0095	
BIDMC	COPD/asthma exacerbation	NEWS (abbreviated)	0.9999	0	0.0194	
BIDMC	Acute coronary syndrome	NEWS (abbreviated)	0.9999	0	0.0206	
BIDMC	Acute kidney injury	NEWS (abbreviated)	0.9999	0	0.074	
BIDMC	Macro average, acute	NEWS (abbreviated)	0.9999	0	0.0222	
Stanford	Hospitalization	MultiDiseasePred (ours)	0.7655	0.4701	0.3247	0.8576
Stanford	Critical outcome	MultiDiseasePred (ours)	0.6904	0.646	0.0448	0.9886
Stanford	Sepsis	MultiDiseasePred (ours)	0.9288	0.6323	0.018	0.9992
Stanford	Viral pneumonia	MultiDiseasePred (ours)	0.7724	0.6756	0.0059	0.9992
Stanford	ARDS	MultiDiseasePred (ours)	0.7838	0.8164	0.0014	0.9999
Stanford	Pulmonary embolism	MultiDiseasePred (ours)	0.8013	0.958	0.0719	0.9992
Stanford	COPD/asthma exacerbation	MultiDiseasePred (ours)	0.7512	0.938	0.0616	0.9986
Stanford	Acute coronary syndrome	MultiDiseasePred (ours)	0.8127	0.7647	0.0269	0.998
Stanford	Acute kidney injury	MultiDiseasePred (ours)	0.7876	0.66	0.0145	0.998
Stanford	Macro average, acute	MultiDiseasePred (ours)	0.8054	0.7778	0.0286	0.9989
Stanford	Hospitalization	XGBoost	0.7669	0.4646	0.3228	0.8569
Stanford	Critical outcome	XGBoost	0.6955	0.6435	0.0448	0.9888
Stanford	Sepsis	XGBoost	0.9217	0.6287	0.0177	0.9991
Stanford	Viral pneumonia	XGBoost	0.7586	0.6664	0.0056	0.9991
Stanford	ARDS	XGBoost	0.7297	0.8065	0.0012	0.9999
Stanford	Pulmonary embolism	XGBoost	0.797	0.958	0.0716	0.9991
Stanford	COPD/asthma exacerbation	XGBoost	0.7385	0.9364	0.0592	0.9985
Stanford	Acute coronary syndrome	XGBoost	0.8148	0.7612	0.0266	0.9981
Stanford	Acute kidney injury	XGBoost	0.7862	0.6526	0.0142	0.9979
Stanford	Macro average, acute	XGBoost	0.7924	0.7728	0.028	0.9988
Stanford	Hospitalization	LightGBM	0.7667	0.4629	0.322	0.8564
Stanford	Critical outcome	LightGBM	0.6937	0.6377	0.044	0.9886
Stanford	Sepsis	LightGBM	0.917	0.6258	0.0175	0.999
Stanford	Viral pneumonia	LightGBM	0.7414	0.6676	0.0055	0.999
Stanford	ARDS	LightGBM	0.4865	0.7932	0.0007	0.9998

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV
Stanford	Pulmonary embolism	LightGBM	0.7949	0.9571	0.0699	0.9991
Stanford	COPD/asthma exacerbation	LightGBM	0.7338	0.936	0.0585	0.9985
Stanford	Acute coronary syndrome	LightGBM	0.8159	0.7562	0.0261	0.9981
Stanford	Acute kidney injury	LightGBM	0.7862	0.6535	0.0142	0.9979
Stanford	Macro average, acute	LightGBM	0.7537	0.7699	0.0275	0.9988
Stanford	Hospitalization	Random Forest	0.7867	0.4554	0.3246	0.8652
Stanford	Critical outcome	Random Forest	0.7603	0.5853	0.0422	0.9902
Stanford	Sepsis	Random Forest	0.9395	0.5931	0.0165	0.9993
Stanford	Viral pneumonia	Random Forest	0.8103	0.5912	0.0049	0.9992
Stanford	ARDS	Random Forest	0.8919	0.7113	0.001	0.9999
Stanford	Pulmonary embolism	Random Forest	0.7992	0.9573	0.0705	0.9992
Stanford	COPD/asthma exacerbation	Random Forest	0.7623	0.929	0.055	0.9986
Stanford	Acute coronary syndrome	Random Forest	0.8202	0.7264	0.0234	0.998
Stanford	Acute kidney injury	Random Forest	0.7984	0.6347	0.0137	0.998
Stanford	Macro average, acute	Random Forest	0.8317	0.7347	0.0264	0.9989
Stanford	Hospitalization	Logistic Regression	0.7921	0.4009	0.3055	0.8528
Stanford	Critical outcome	Logistic Regression	0.7243	0.4749	0.0321	0.9862
Stanford	Sepsis	Logistic Regression	0.93	0.5992	0.0166	0.9992
Stanford	Viral pneumonia	Logistic Regression	0.8172	0.5324	0.0043	0.9992
Stanford	ARDS	Logistic Regression	0.8649	0.7386	0.001	0.9999
Stanford	Pulmonary embolism	Logistic Regression	0.8013	0.9594	0.074	0.9992
Stanford	COPD/asthma exacerbation	Logistic Regression	0.7654	0.9265	0.0535	0.9986
Stanford	Acute coronary syndrome	Logistic Regression	0.8816	0.6255	0.0185	0.9985
Stanford	Acute kidney injury	Logistic Regression	0.8038	0.6332	0.0137	0.998
Stanford	Macro average, acute	Logistic Regression	0.8378	0.7164	0.026	0.9989
Stanford	Hospitalization	HistGradientBoosting	0.7664	0.4667	0.3235	0.8572
Stanford	Critical outcome	HistGradientBoosting	0.6937	0.6512	0.0457	0.9888
Stanford	Sepsis	HistGradientBoosting	0.9253	0.6321	0.0179	0.9991
Stanford	Viral pneumonia	HistGradientBoosting	0.7552	0.6678	0.0056	0.9991
Stanford	ARDS	HistGradientBoosting	0.8108	0.7933	0.0012	0.9999
Stanford	Pulmonary embolism	HistGradientBoosting	0.8013	0.9558	0.0685	0.9992
Stanford	COPD/asthma exacerbation	HistGradientBoosting	0.7544	0.9323	0.0569	0.9986
Stanford	Acute coronary syndrome	HistGradientBoosting	0.8159	0.7589	0.0264	0.9981
Stanford	Acute kidney injury	HistGradientBoosting	0.7794	0.6592	0.0143	0.9979
Stanford	Macro average, acute	HistGradientBoosting	0.806	0.7714	0.0273	0.9988

Cohort	Endpoint	Model	Sensitivity	Specificity	PPV	NPV
Stanford	Hospitalization	NEWS (abbreviated)	0.9999	0	0.2497	
Stanford	Critical outcome	NEWS (abbreviated)	0.9999	0	0.0235	
Stanford	Sepsis	NEWS (abbreviated)	0.9999	0	0.0072	
Stanford	Viral pneumonia	NEWS (abbreviated)	0.9999	0	0.0025	
Stanford	ARDS	NEWS (abbreviated)	0.9999	0	0.0003	
Stanford	Pulmonary embolism	NEWS (abbreviated)	0.9999	0	0.004	
Stanford	COPD/asthma exacerbation	NEWS (abbreviated)	0.9999	0	0.0054	
Stanford	Acute coronary syndrome	NEWS (abbreviated)	0.9999	0	0.0079	
Stanford	Acute kidney injury	NEWS (abbreviated)	0.9999	0	0.0063	
Stanford	Macro average, acute	NEWS (abbreviated)	0.9999	0	0.0048	

Notes: Thresholds were set to the highest value reaching 90% sensitivity for each endpoint on the UMN variable-selection split and applied unchanged to every other cohort. AUROC and AUPRC do not depend on the threshold and are therefore not repeated here; they are reported for the seven acute endpoints in eTable 5 and for the two disposition endpoints in eTable 7. Sensitivity is reported as achieved rather than as targeted, because the threshold is chosen on a grid of observed scores and cannot always land exactly on 90%.

eTable 17. Subgroup AUROC for MultiDiseasePred by age band, sex and Emergency Severity Index.

Cohort	Stratum	Endpoint	AUROC (95% CI)	Events
UMN internal validation	age 18-39	Hospitalization	0.7267 (0.7217–0.7318)	11291
UMN internal validation	age 18-39	Critical outcome	0.8701 (0.8196–0.9206)	51
UMN internal validation	age 18-39	Sepsis	0.8197 (0.8055–0.8338)	1057
UMN internal validation	age 18-39	Viral pneumonia	0.8668 (0.8358–0.8977)	139
UMN internal validation	age 18-39	ARDS	0.9272 (0.8949–0.9595)	28
UMN internal validation	age 18-39	Pulmonary embolism	0.9827 (0.9747–0.9907)	267
UMN internal validation	age 18-39	COPD/asthma exacerbation	0.9776 (0.9751–0.9800)	1372
UMN internal validation	age 18-39	Acute coronary syndrome	0.9219 (0.9013–0.9425)	232
UMN internal validation	age 18-39	Acute kidney injury	0.8422 (0.8305–0.8539)	1384
UMN internal validation	age 18-39	Macro average, acute	0.9054	4479
UMN internal validation	age 40-64	Hospitalization	0.7513 (0.7476–0.7549)	20786
UMN internal validation	age 40-64	Critical outcome	0.8995 (0.8826–0.9165)	298
UMN internal validation	age 40-64	Sepsis	0.8284 (0.8208–0.8359)	2942
UMN internal validation	age 40-64	Viral pneumonia	0.8744 (0.8558–0.8931)	359
UMN internal validation	age 40-64	ARDS	0.9055 (0.8759–0.9351)	84
UMN internal validation	age 40-64	Pulmonary embolism	0.9634 (0.9564–0.9705)	877
UMN internal validation	age 40-64	COPD/asthma exacerbation	0.9629 (0.9604–0.9654)	2581
UMN internal validation	age 40-64	Acute coronary syndrome	0.9032 (0.8964–0.9100)	2009
UMN internal validation	age 40-64	Acute kidney injury	0.8193 (0.8134–0.8251)	5125
UMN internal validation	age 40-64	Macro average, acute	0.8939	13977
UMN internal validation	age 65-79	Hospitalization	0.7449 (0.7410–0.7489)	20690
UMN internal validation	age 65-79	Critical outcome	0.8787 (0.8636–0.8937)	492
UMN internal validation	age 65-79	Sepsis	0.8046 (0.7972–0.8121)	3243
UMN internal validation	age 65-79	Viral pneumonia	0.8286 (0.8091–0.8482)	447
UMN internal validation	age 65-79	ARDS	0.8629 (0.8161–0.9097)	64

Cohort	Stratum	Endpoint	AUROC (95% CI)	Events
UMN internal validation	age 65-79	Pulmonary embolism	0.9463 (0.9389–0.9536)	929
UMN internal validation	age 65-79	COPD/asthma exacerbation	0.9480 (0.9451–0.9510)	3076
UMN internal validation	age 65-79	Acute coronary syndrome	0.8444 (0.8373–0.8516)	3000
UMN internal validation	age 65-79	Acute kidney injury	0.7680 (0.7623–0.7738)	6624
UMN internal validation	age 65-79	Macro average, acute	0.8576	17383
UMN internal validation	age 80+	Hospitalization	0.7353 (0.7305–0.7402)	16564
UMN internal validation	age 80+	Critical outcome	0.8339 (0.8169–0.8510)	551
UMN internal validation	age 80+	Sepsis	0.7646 (0.7545–0.7748)	2144
UMN internal validation	age 80+	Viral pneumonia	0.7941 (0.7731–0.8152)	399
UMN internal validation	age 80+	ARDS	0.7959 (0.6995–0.8923)	23
UMN internal validation	age 80+	Pulmonary embolism	0.9224 (0.9118–0.9331)	523
UMN internal validation	age 80+	COPD/asthma exacerbation	0.9394 (0.9345–0.9443)	1618
UMN internal validation	age 80+	Acute coronary syndrome	0.7832 (0.7744–0.7921)	2681
UMN internal validation	age 80+	Acute kidney injury	0.7361 (0.7293–0.7430)	5296
UMN internal validation	age 80+	Macro average, acute	0.8194	12684
UMN internal validation	male	Hospitalization	0.7893 (0.7866–0.7921)	32242
UMN internal validation	male	Critical outcome	0.9073 (0.8974–0.9172)	721
UMN internal validation	male	Sepsis	0.8416 (0.8362–0.8470)	4867
UMN internal validation	male	Viral pneumonia	0.8695 (0.8559–0.8831)	622
UMN internal validation	male	ARDS	0.8898 (0.8635–0.9162)	109
UMN internal validation	male	Pulmonary embolism	0.9625 (0.9571–0.9678)	1203
UMN internal validation	male	COPD/asthma exacerbation	0.9664 (0.9644–0.9683)	3612
UMN internal validation	male	Acute coronary syndrome	0.9028 (0.8989–0.9068)	4256
UMN internal validation	male	Acute kidney injury	0.8355 (0.8318–0.8393)	9928
UMN internal validation	male	Macro average, acute	0.8955	24597
UMN internal validation	female	Hospitalization	0.7910 (0.7884–0.7936)	37089
UMN internal validation	female	Critical outcome	0.9219 (0.9127–0.9310)	671
UMN internal validation	female	Sepsis	0.8467 (0.8412–0.8523)	4519
UMN internal validation	female	Viral pneumonia	0.8747 (0.8627–0.8867)	722
UMN internal validation	female	ARDS	0.9050 (0.8759–0.9342)	90
UMN internal validation	female	Pulmonary embolism	0.9663 (0.9621–0.9704)	1393
UMN internal validation	female	COPD/asthma exacerbation	0.9612 (0.9594–0.9630)	5035
UMN internal validation	female	Acute coronary syndrome	0.9166 (0.9128–0.9204)	3666
UMN internal validation	female	Acute kidney injury	0.8642 (0.8607–0.8677)	8501
UMN internal validation	female	Macro average, acute	0.9050	23926
UMN internal validation	ESI 1-2	Hospitalization	0.7611 (0.7578–0.7645)	29968
UMN internal validation	ESI 1-2	Critical outcome	0.8650 (0.8541–0.8759)	926
UMN internal validation	ESI 1-2	Sepsis	0.8109 (0.8051–0.8167)	5095
UMN internal validation	ESI 1-2	Viral pneumonia	0.8459 (0.8328–0.8589)	698
UMN internal validation	ESI 1-2	ARDS	0.8501 (0.8188–0.8815)	132
UMN internal validation	ESI 1-2	Pulmonary embolism	0.9477 (0.9420–0.9533)	1316
UMN internal validation	ESI 1-2	COPD/asthma exacerbation	0.9597 (0.9577–0.9618)	4242

Cohort	Stratum	Endpoint	AUROC (95% CI)	Events
UMN internal validation	ESI 1-2	Acute coronary syndrome	0.8672 (0.8625–0.8719)	5037
UMN internal validation	ESI 1-2	Acute kidney injury	0.8015 (0.7970–0.8060)	8749
UMN internal validation	ESI 1-2	Macro average, acute	0.8690	25269
UMN internal validation	ESI 3	Hospitalization	0.7672 (0.7645–0.7698)	38148
UMN internal validation	ESI 3	Critical outcome	0.9108 (0.8987–0.9228)	457
UMN internal validation	ESI 3	Sepsis	0.8159 (0.8095–0.8224)	4194
UMN internal validation	ESI 3	Viral pneumonia	0.8611 (0.8476–0.8747)	597
UMN internal validation	ESI 3	ARDS	0.8854 (0.8511–0.9198)	65
UMN internal validation	ESI 3	Pulmonary embolism	0.9656 (0.9605–0.9708)	1231
UMN internal validation	ESI 3	COPD/asthma exacerbation	0.9585 (0.9565–0.9606)	4066
UMN internal validation	ESI 3	Acute coronary syndrome	0.9096 (0.9052–0.9140)	2843
UMN internal validation	ESI 3	Acute kidney injury	0.8410 (0.8373–0.8448)	9465
UMN internal validation	ESI 3	Macro average, acute	0.8910	22461
UMN internal validation	ESI 4-5	Hospitalization	0.8037 (0.7909–0.8165)	1215
UMN internal validation	ESI 4-5	Critical outcome	0.9010 (0.7826–0.9999)	9
UMN internal validation	ESI 4-5	Sepsis	0.8515 (0.8131–0.8900)	97
UMN internal validation	ESI 4-5	Viral pneumonia	0.7747 (0.7019–0.8476)	49
UMN internal validation	ESI 4-5	ARDS	0.8745 (0.6290–0.9999)	2
UMN internal validation	ESI 4-5	Pulmonary embolism	0.9651 (0.9274–0.9999)	49
UMN internal validation	ESI 4-5	COPD/asthma exacerbation	0.9505 (0.9433–0.9578)	339
UMN internal validation	ESI 4-5	Acute coronary syndrome	0.9443 (0.9255–0.9631)	42
UMN internal validation	ESI 4-5	Acute kidney injury	0.8722 (0.8492–0.8952)	215
UMN internal validation	ESI 4-5	Macro average, acute	0.8904	793
BIDMC	age 18-39	Hospitalization	0.5622 (0.5586–0.5658)	35421
BIDMC	age 18-39	Critical outcome	0.5974 (0.5859–0.6090)	3077
BIDMC	age 18-39	Sepsis	0.8545 (0.8403–0.8687)	884
BIDMC	age 18-39	Viral pneumonia	0.7366 (0.7114–0.7618)	356
BIDMC	age 18-39	ARDS	0.6932 (0.6121–0.7743)	43
BIDMC	age 18-39	Pulmonary embolism	0.7339 (0.7081–0.7598)	499
BIDMC	age 18-39	COPD/asthma exacerbation	0.8066 (0.7924–0.8207)	1284
BIDMC	age 18-39	Acute coronary syndrome	0.7383 (0.6926–0.7840)	153
BIDMC	age 18-39	Acute kidney injury	0.7528 (0.7389–0.7668)	1654
BIDMC	age 18-39	Macro average, acute	0.7594	4873
BIDMC	age 40-64	Hospitalization	0.6224 (0.6196–0.6251)	77136
BIDMC	age 40-64	Critical outcome	0.6580 (0.6521–0.6639)	9638
BIDMC	age 40-64	Sepsis	0.8235 (0.8167–0.8303)	3819
BIDMC	age 40-64	Viral pneumonia	0.7743 (0.7546–0.7941)	482
BIDMC	age 40-64	ARDS	0.7497 (0.7121–0.7873)	172
BIDMC	age 40-64	Pulmonary embolism	0.7180 (0.7044–0.7317)	1610
BIDMC	age 40-64	COPD/asthma exacerbation	0.8534 (0.8456–0.8612)	3011
BIDMC	age 40-64	Acute coronary syndrome	0.6851 (0.6741–0.6960)	2515

Cohort	Stratum	Endpoint	AUROC (95% CI)	Events
BIDMC	age 40-64	Acute kidney injury	0.7605 (0.7553–0.7657)	9694
BIDMC	age 40-64	Macro average, acute	0.7664	21303
BIDMC	age 65-79	Hospitalization	0.6082 (0.6043–0.6121)	52417
BIDMC	age 65-79	Critical outcome	0.6156 (0.6088–0.6223)	8528
BIDMC	age 65-79	Sepsis	0.7789 (0.7712–0.7865)	3811
BIDMC	age 65-79	Viral pneumonia	0.7514 (0.7268–0.7760)	372
BIDMC	age 65-79	ARDS	0.7559 (0.7112–0.8007)	127
BIDMC	age 65-79	Pulmonary embolism	0.6755 (0.6603–0.6907)	1308
BIDMC	age 65-79	COPD/asthma exacerbation	0.8668 (0.8589–0.8746)	2513
BIDMC	age 65-79	Acute coronary syndrome	0.6301 (0.6191–0.6411)	3291
BIDMC	age 65-79	Acute kidney injury	0.6965 (0.6912–0.7019)	10722
BIDMC	age 65-79	Macro average, acute	0.7364	22144
BIDMC	age 80+	Hospitalization	0.5734 (0.5679–0.5790)	37330
BIDMC	age 80+	Critical outcome	0.5840 (0.5762–0.5919)	6770
BIDMC	age 80+	Sepsis	0.7332 (0.7230–0.7435)	2874
BIDMC	age 80+	Viral pneumonia	0.7593 (0.7303–0.7883)	278
BIDMC	age 80+	ARDS	0.7268 (0.6708–0.7829)	94
BIDMC	age 80+	Pulmonary embolism	0.6478 (0.6254–0.6702)	600
BIDMC	age 80+	COPD/asthma exacerbation	0.8564 (0.8458–0.8670)	1374
BIDMC	age 80+	Acute coronary syndrome	0.6272 (0.6154–0.6390)	2728
BIDMC	age 80+	Acute kidney injury	0.6545 (0.6482–0.6607)	9179
BIDMC	age 80+	Macro average, acute	0.7150	17127
BIDMC	male	Hospitalization	0.6838 (0.6814–0.6861)	100335
BIDMC	male	Critical outcome	0.6862 (0.6818–0.6907)	15196
BIDMC	male	Sepsis	0.8362 (0.8314–0.8410)	6150
BIDMC	male	Viral pneumonia	0.7662 (0.7476–0.7848)	647
BIDMC	male	ARDS	0.7493 (0.7163–0.7823)	227
BIDMC	male	Pulmonary embolism	0.7331 (0.7214–0.7448)	1800
BIDMC	male	COPD/asthma exacerbation	0.8626 (0.8553–0.8700)	3246
BIDMC	male	Acute coronary syndrome	0.7711 (0.7654–0.7768)	5217
BIDMC	male	Acute kidney injury	0.7884 (0.7851–0.7916)	17487
BIDMC	male	Macro average, acute	0.7867	34774
BIDMC	female	Hospitalization	0.6985 (0.6963–0.7007)	101969
BIDMC	female	Critical outcome	0.7319 (0.7275–0.7362)	12817
BIDMC	female	Sepsis	0.8398 (0.8348–0.8449)	5238
BIDMC	female	Viral pneumonia	0.7336 (0.7161–0.7511)	841
BIDMC	female	ARDS	0.7988 (0.7678–0.8298)	209
BIDMC	female	Pulmonary embolism	0.7524 (0.7418–0.7629)	2217
BIDMC	female	COPD/asthma exacerbation	0.8373 (0.8308–0.8438)	4936
BIDMC	female	Acute coronary syndrome	0.8148 (0.8088–0.8207)	3470
BIDMC	female	Acute kidney injury	0.8304 (0.8273–0.8336)	13762
BIDMC	female	Macro average, acute	0.8010	30673

Cohort	Stratum	Endpoint	AUROC (95% CI)	Events
BIDMC	ESI 1-2	Hospitalization	0.6624 (0.6595–0.6652)	114930
BIDMC	ESI 1-2	Critical outcome	0.6633 (0.6594–0.6671)	21760
BIDMC	ESI 1-2	Sepsis	0.8138 (0.8092–0.8183)	8057
BIDMC	ESI 1-2	Viral pneumonia	0.7863 (0.7704–0.8023)	694
BIDMC	ESI 1-2	ARDS	0.7527 (0.7253–0.7800)	332
BIDMC	ESI 1-2	Pulmonary embolism	0.6902 (0.6802–0.7002)	2785
BIDMC	ESI 1-2	COPD/asthma exacerbation	0.8806 (0.8755–0.8857)	4645
BIDMC	ESI 1-2	Acute coronary syndrome	0.7234 (0.7179–0.7289)	7134
BIDMC	ESI 1-2	Acute kidney injury	0.7659 (0.7626–0.7691)	20095
BIDMC	ESI 1-2	Macro average, acute	0.7733	43742
BIDMC	ESI 3	Hospitalization	0.6721 (0.6698–0.6744)	85997
BIDMC	ESI 3	Critical outcome	0.6307 (0.6238–0.6375)	6242
BIDMC	ESI 3	Sepsis	0.8070 (0.8001–0.8140)	3317
BIDMC	ESI 3	Viral pneumonia	0.7013 (0.6823–0.7203)	780
BIDMC	ESI 3	ARDS	0.6860 (0.6378–0.7342)	104
BIDMC	ESI 3	Pulmonary embolism	0.7372 (0.7219–0.7525)	1204
BIDMC	ESI 3	COPD/asthma exacerbation	0.7928 (0.7840–0.8016)	3462
BIDMC	ESI 3	Acute coronary syndrome	0.7976 (0.7879–0.8073)	1550
BIDMC	ESI 3	Acute kidney injury	0.8060 (0.8021–0.8099)	11085
BIDMC	ESI 3	Macro average, acute	0.7611	21502
BIDMC	ESI 4-5	Hospitalization	0.6697 (0.6536–0.6858)	1377
BIDMC	ESI 4-5	Critical outcome	0.7903 (0.6902–0.8903)	11
BIDMC	ESI 4-5	Sepsis	0.8563 (0.7690–0.9437)	14
BIDMC	ESI 4-5	Viral pneumonia	0.6389 (0.4849–0.7928)	14
BIDMC	ESI 4-5	ARDS	not estimable	0
BIDMC	ESI 4-5	Pulmonary embolism	0.8165 (0.7172–0.9159)	28
BIDMC	ESI 4-5	COPD/asthma exacerbation	0.6600 (0.5868–0.7333)	75
BIDMC	ESI 4-5	Acute coronary syndrome	0.9193 (0.8892–0.9495)	3
BIDMC	ESI 4-5	Acute kidney injury	0.8319 (0.7767–0.8872)	69
BIDMC	ESI 4-5	Macro average, acute	0.7872	203
Stanford	age 18-39	Hospitalization	0.5744 (0.5646–0.5841)	4580
Stanford	age 18-39	Critical outcome	0.7684 (0.7428–0.7940)	407
Stanford	age 18-39	Sepsis	0.8886 (0.8542–0.9230)	73
Stanford	age 18-39	Viral pneumonia	0.8135 (0.7691–0.8580)	111
Stanford	age 18-39	ARDS	0.9730 (0.9510–0.9950)	4
Stanford	age 18-39	Pulmonary embolism	0.9433 (0.9097–0.9769)	53
Stanford	age 18-39	COPD/asthma exacerbation	0.9005 (0.8658–0.9352)	137
Stanford	age 18-39	Acute coronary syndrome	0.9224 (0.8839–0.9608)	32
Stanford	age 18-39	Acute kidney injury	0.7252 (0.6455–0.8048)	58
Stanford	age 18-39	Macro average, acute	0.8809	468
Stanford	age 40-64	Hospitalization	0.6397 (0.6333–0.6460)	10528

Cohort	Stratum	Endpoint	AUROC (95% CI)	Events
Stanford	age 40-64	Critical outcome	0.7305 (0.7124–0.7486)	888
Stanford	age 40-64	Sepsis	0.8841 (0.8652–0.9029)	262
Stanford	age 40-64	Viral pneumonia	0.8433 (0.8023–0.8842)	105
Stanford	age 40-64	ARDS	0.8552 (0.7654–0.9450)	10
Stanford	age 40-64	Pulmonary embolism	0.9273 (0.9053–0.9493)	184
Stanford	age 40-64	COPD/asthma exacerbation	0.9248 (0.9030–0.9465)	223
Stanford	age 40-64	Acute coronary syndrome	0.8570 (0.8303–0.8837)	304
Stanford	age 40-64	Acute kidney injury	0.7856 (0.7565–0.8146)	250
Stanford	age 40-64	Macro average, acute	0.8682	1338
Stanford	age 65-79	Hospitalization	0.6121 (0.6046–0.6196)	8409
Stanford	age 65-79	Critical outcome	0.6724 (0.6513–0.6936)	818
Stanford	age 65-79	Sepsis	0.8487 (0.8267–0.8707)	276
Stanford	age 65-79	Viral pneumonia	0.8812 (0.8211–0.9413)	45
Stanford	age 65-79	ARDS	0.8547 (0.6955–0.9999)	11
Stanford	age 65-79	Pulmonary embolism	0.9214 (0.8952–0.9475)	173
Stanford	age 65-79	COPD/asthma exacerbation	0.9335 (0.9090–0.9580)	178
Stanford	age 65-79	Acute coronary syndrome	0.8339 (0.8053–0.8625)	330
Stanford	age 65-79	Acute kidney injury	0.6895 (0.6578–0.7212)	242
Stanford	age 65-79	Macro average, acute	0.8518	1255
Stanford	age 80+	Hospitalization	0.5985 (0.5891–0.6080)	5707
Stanford	age 80+	Critical outcome	0.6341 (0.6095–0.6587)	636
Stanford	age 80+	Sepsis	0.8222 (0.7935–0.8508)	232
Stanford	age 80+	Viral pneumonia	0.8664 (0.7840–0.9487)	29
Stanford	age 80+	ARDS	0.7373 (0.5657–0.9089)	12
Stanford	age 80+	Pulmonary embolism	0.9317 (0.8935–0.9699)	63
Stanford	age 80+	COPD/asthma exacerbation	0.9289 (0.9020–0.9558)	93
Stanford	age 80+	Acute coronary syndrome	0.8133 (0.7793–0.8472)	263
Stanford	age 80+	Acute kidney injury	0.6382 (0.5982–0.6783)	189
Stanford	age 80+	Macro average, acute	0.8197	881
Stanford	male	Hospitalization	0.6772 (0.6721–0.6824)	14933
Stanford	male	Critical outcome	0.7292 (0.7166–0.7417)	1620
Stanford	male	Sepsis	0.8787 (0.8646–0.8927)	475
Stanford	male	Viral pneumonia	0.8305 (0.7861–0.8749)	129
Stanford	male	ARDS	0.8453 (0.7722–0.9185)	22
Stanford	male	Pulmonary embolism	0.9404 (0.9228–0.9580)	235
Stanford	male	COPD/asthma exacerbation	0.9140 (0.8912–0.9368)	265
Stanford	male	Acute coronary syndrome	0.8714 (0.8545–0.8883)	528
Stanford	male	Acute kidney injury	0.7750 (0.7554–0.7945)	461
Stanford	male	Macro average, acute	0.8650	2115
Stanford	female	Hospitalization	0.6775 (0.6723–0.6826)	14291
Stanford	female	Critical outcome	0.7605 (0.7464–0.7746)	1129
Stanford	female	Sepsis	0.8849 (0.8692–0.9005)	368

Cohort	Stratum	Endpoint	AUROC (95% CI)	Events
Stanford	female	Viral pneumonia	0.7844 (0.7462–0.8227)	161
Stanford	female	ARDS	0.8630 (0.7393–0.9867)	15
Stanford	female	Pulmonary embolism	0.9243 (0.9040–0.9446)	238
Stanford	female	COPD/asthma exacerbation	0.9146 (0.8962–0.9330)	366
Stanford	female	Acute coronary syndrome	0.9093 (0.8938–0.9248)	401
Stanford	female	Acute kidney injury	0.7974 (0.7728–0.8221)	278
Stanford	female	Macro average, acute	0.8683	1827
Stanford	ESI 1-2	Hospitalization	0.6366 (0.6301–0.6431)	12237
Stanford	ESI 1-2	Critical outcome	0.6553 (0.6434–0.6671)	2243
Stanford	ESI 1-2	Sepsis	0.8287 (0.8140–0.8433)	598
Stanford	ESI 1-2	Viral pneumonia	0.8883 (0.8535–0.9231)	91
Stanford	ESI 1-2	ARDS	0.8039 (0.7308–0.8771)	31
Stanford	ESI 1-2	Pulmonary embolism	0.9486 (0.9330–0.9641)	208
Stanford	ESI 1-2	COPD/asthma exacerbation	0.9499 (0.9380–0.9618)	242
Stanford	ESI 1-2	Acute coronary syndrome	0.8738 (0.8524–0.8953)	366
Stanford	ESI 1-2	Acute kidney injury	0.7556 (0.7250–0.7862)	200
Stanford	ESI 1-2	Macro average, acute	0.8641	1736
Stanford	ESI 3	Hospitalization	0.6722 (0.6675–0.6768)	16764
Stanford	ESI 3	Critical outcome	0.6923 (0.6692–0.7153)	496
Stanford	ESI 3	Sepsis	0.8609 (0.8382–0.8835)	242
Stanford	ESI 3	Viral pneumonia	0.7656 (0.7261–0.8050)	189
Stanford	ESI 3	ARDS	0.7431 (0.5606–0.9256)	6
Stanford	ESI 3	Pulmonary embolism	0.9100 (0.8885–0.9314)	261
Stanford	ESI 3	COPD/asthma exacerbation	0.8988 (0.8783–0.9193)	373
Stanford	ESI 3	Acute coronary syndrome	0.8857 (0.8706–0.9007)	559
Stanford	ESI 3	Acute kidney injury	0.7838 (0.7652–0.8023)	534
Stanford	ESI 3	Macro average, acute	0.8354	2164
Stanford	ESI 4-5	Hospitalization	0.6691 (0.6303–0.7079)	223
Stanford	ESI 4-5	Critical outcome	0.7882 (0.6257–0.9507)	10
Stanford	ESI 4-5	Sepsis	0.9006 (0.8633–0.9378)	3
Stanford	ESI 4-5	Viral pneumonia	0.8140 (0.6844–0.9436)	10
Stanford	ESI 4-5	ARDS	not estimable	0
Stanford	ESI 4-5	Pulmonary embolism	0.9787 (0.9470–0.9999)	4
Stanford	ESI 4-5	COPD/asthma exacerbation	0.7062 (0.5326–0.8798)	16
Stanford	ESI 4-5	Acute coronary syndrome	0.7492 (0.4936–0.9999)	4
Stanford	ESI 4-5	Acute kidney injury	0.9735 (0.9524–0.9946)	5
Stanford	ESI 4-5	Macro average, acute	0.8537	42

Notes: The spread across sex is 0.003 to 0.014 and across age bands 0.051 to 0.086. Within an age band, hospitalization reaches only 0.56 to 0.64 at the external sites.

eTable 18. Architecture ablation: fourteen arms, three seeds each.

Arm	Seed	Acute AUROC	Acute AUPRC	Disposition AUROC	Disposition AUPRC	Gate cosine	Effective experts	Training minutes
G1_no_l1	42	0.86785	0.14941	0.88133	0.3635	0.86453	11.7114	8.215
G1_no_l1	43	0.86706	0.14981	0.87959	0.35564	0.85234	11.6011	8.3518
G1_no_l1	44	0.86735	0.14937	0.88039	0.36183	0.8176	11.1842	8.4454
G2_no_l1_no_drop	42	0.86736	0.14922	0.88179	0.36438	0.74318	10.3166	8.1451
G2_no_l1_no_drop	43	0.86923	0.15036	0.88023	0.3625	0.79444	10.8004	8.2828
G2_no_l1_no_drop	44	0.86878	0.14874	0.88015	0.35758	0.69528	10.2507	8.2668
D_moe_router	42	0.86714	0.14928	0.88133	0.3638	0.99999	12.9783	10.8992
D_moe_router	43	0.86949	0.14992	0.87997	0.36092	0.99998	12.8735	9.16
D_moe_router	44	0.86915	0.14806	0.87977	0.35842	0.99999	12.977	9.0915
E_moe_norouter	42	0.86762	0.14999	0.88165	0.3627	0.99995	12.9996	8.8649
E_moe_norouter	43	0.86661	0.14963	0.87997	0.35567	0.99996	12.9997	9.8005
E_moe_norouter	44	0.86769	0.14869	0.8787	0.36058	0.99997	12.9998	10.0392
B_shared	42	0.86633	0.14839	0.88106	0.36052			3.0267
B_shared	43	0.86603	0.14905	0.87919	0.35614			3.2263
B_shared	44	0.86843	0.14627	0.87807	0.34936			3.1484
A1_independent	42	0.86504	0.14619	0.88008	0.36007			5.892
A1_independent	43	0.86454	0.14784	0.87932	0.36279			5.8122
A1_independent	44	0.86599	0.14737	0.87825	0.35396			5.8862
C_mmoe	42	0.86309	0.14805	0.88013	0.35813	0.51354	8.5256	8.2526
C_mmoe	43	0.86507	0.14724	0.87735	0.35236	0.5087	8.2257	9.0105
C_mmoe	44	0.86503	0.14636	0.87759	0.3529	0.54802	8.7029	8.4601
F2_topk5	42	0.86671	0.14625	0.87865	0.35391	0.36663	5	8.7012
F2_topk5	43	0.86651	0.14792	0.87674	0.35132	0.37771	5	8.6019
F2_topk5	44	0.86641	0.14754	0.88065	0.35874	0.37692	4.9025	8.1425
F1_topk3	42	0.86504	0.14593	0.87588	0.33816	0.2592	3	8.3952
F1_topk3	43	0.86517	0.1451	0.8785	0.35401	0.21275	3	8.4898
F1_topk3	44	0.86592	0.14728	0.88016	0.36281	0.23909	2.9235	8.2544
F3_topk7	42	0.86759	0.14834	0.88041	0.36048	0.58386	7	8.7974
F3_topk7	43	0.86577	0.14895	0.87959	0.3571	0.5755	7	8.3196
F3_topk7	44	0.86797	0.14756	0.87885	0.35518	0.52769	7	8.2943

Arm	Seed	Acute AUROC	Acute AUPRC	Disposition AUROC	Disposition AUPRC	Gate cosine	Effective experts	Training minutes
A2_xgb_sub	42	0.86707	0.14853	0.88246	0.36788			0.341
A2_xgb_sub	43	0.86703	0.14843	0.88193	0.36874			0.3122
A2_xgb_sub	44	0.867	0.14857	0.88181	0.367			0.3085
A2_xgb	42	0.86721	0.14873	0.88184	0.36837			0.3059
A2_xgb	43	0.86731	0.1487	0.88196	0.3674			0.8789
A2_xgb	44	0.86731	0.1487	0.88196	0.3674			0.7759
A2_histgb	42	0.86081	0.14374	0.88027	0.34584			0.6576
A2_histgb	43	0.85675	0.14333	0.87974	0.3436			0.6532
A2_histgb	44	0.86097	0.14252	0.87971	0.34299			0.6533
A2_rf	42	0.85724	0.14787	0.87849	0.36216			4.5143
A2_rf	43	0.85806	0.14775	0.87849	0.36168			4.5246
A2_rf	44	0.85967	0.1479	0.87786	0.36105			4.5398

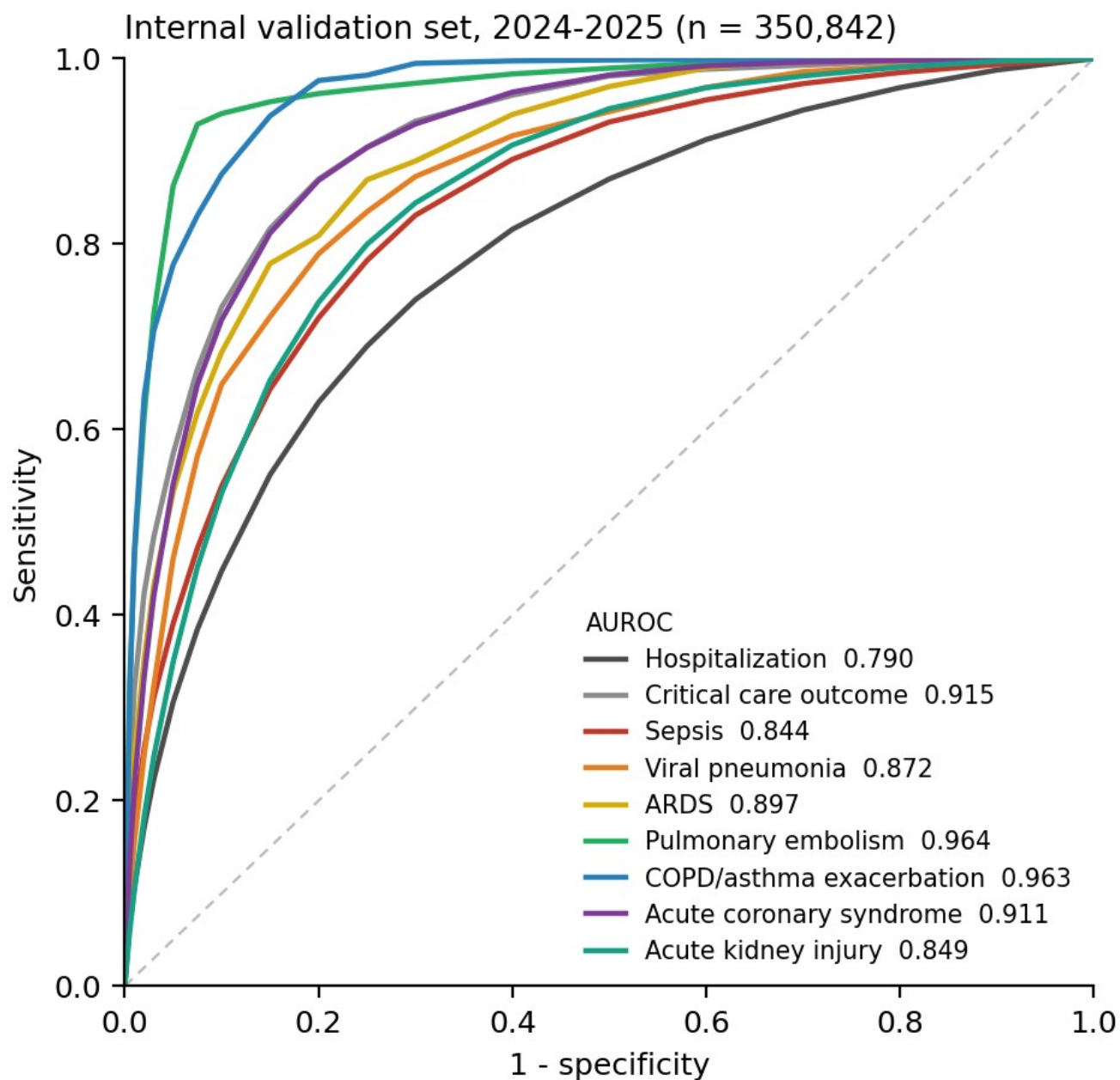
Notes: Gate cosine and effective experts are blank for the tree-based arms (random forest, XGBoost, HistGradientBoosting), which have no gate. The fourteen arms span 0.0103 in acute macro AUROC. MultiDiseasePred exceeds nine independent single-task models by 0.0033. Gradient boosting exceeds every neural arm on the disposition macro average. Forcing sparsity degrades performance monotonically: 0.8654 at top-3, 0.8665 at top-5, 0.8671 at top-7 and 0.8685 unconstrained.

eTable 19. Three-seed mean against three-seed ensemble.

Arm	Description	Acute macro AUROC, mean	Acute macro AUROC, ensemble	Disposition macro AUROC, mean	Disposition macro AUROC, ensemble
D_moe_router	mixture of experts with a router	0.8686	0.8701	0.8803	0.8814
G2_no_l1_no_dropout	no L1, no expert dropout	0.8684	0.8701	0.8807	0.8818
G1_no_l1	no L1 on the gate	0.8674	0.8694	0.8804	0.8817
E_moe_norouter	mixture of experts, no router	0.8673	0.8692	0.8801	0.8812
A2_xgb	XGBoost	0.8672	0.8676	0.8819	0.8820
F3_topk7	top-7 expert routing	0.8671	0.8693	0.8796	0.8810
A2_xgb_sub	XGBoost, subsampled	0.8670	0.8680	0.8820	0.8825
B_shared	shared bottom, no gate	0.8669	0.8691	0.8794	0.8810
F2_topk5	top-5 expert routing	0.8665	0.8689	0.8786	0.8802
F1_topk3	top-3 expert routing	0.8653	0.8679	0.8781	0.8804
A1_independent	nine separate single-task models	0.8651	0.8670	0.8792	0.8806
C_mmoe	multi-gate mixture of experts	0.8644	0.8687	0.8783	0.8804
A2_histgb	HistGradientBoosting	0.8595	0.8631	0.8799	0.8806
A2_rf	random forest	0.8583	0.8617	0.8782	0.8791

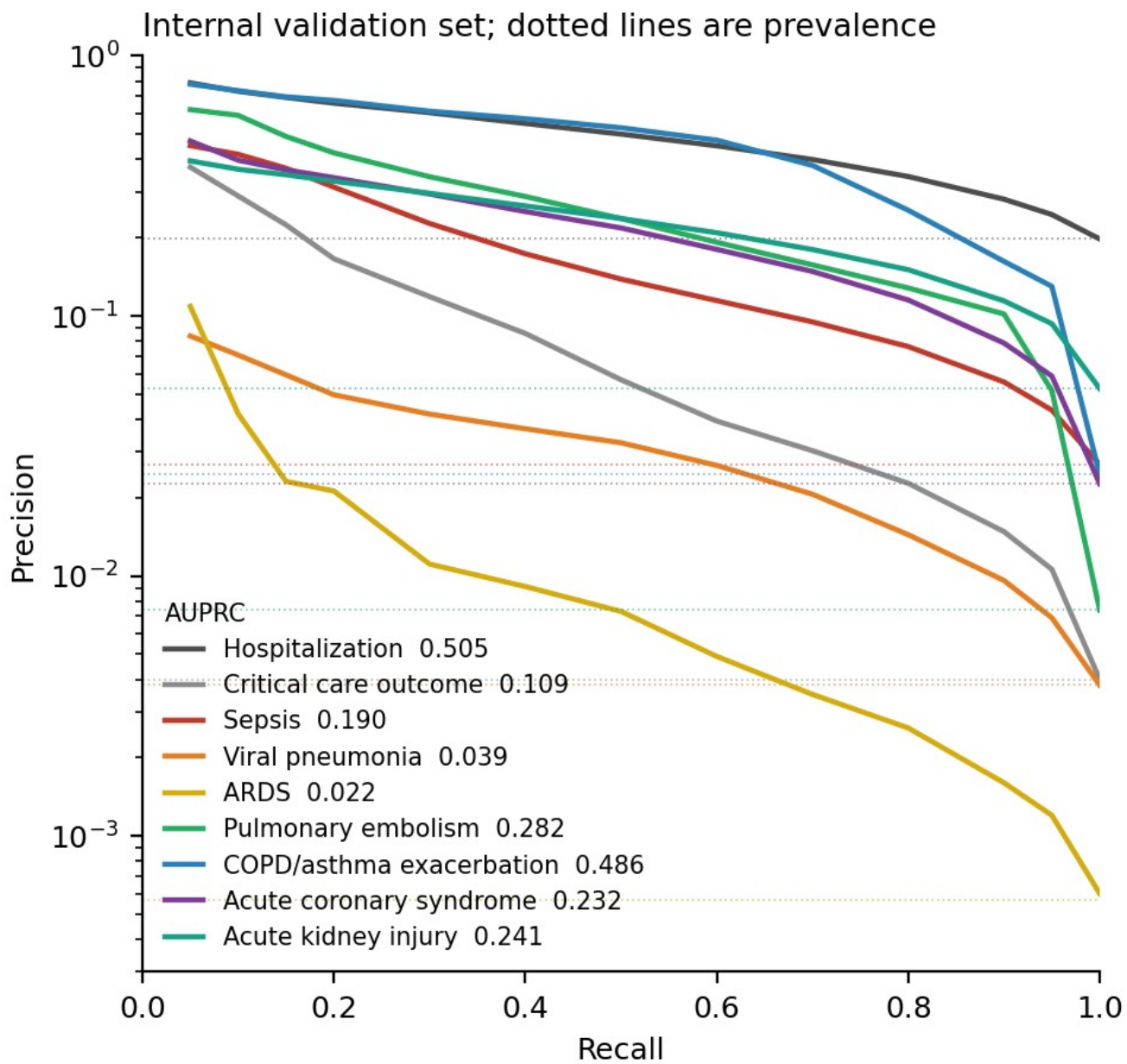
Notes: Averaging the probabilities of the three seeds gains 0.0017 to 0.0043 in acute macro AUROC over the mean of the three single-seed models, in every arm. The ordering of the arms is unchanged, so the architecture comparison in eTable 18 does not depend on whether seeds are averaged or ensembled.

eFigure 1. Receiver operating characteristic curves for the nine prediction targets, UMN internal validation set.



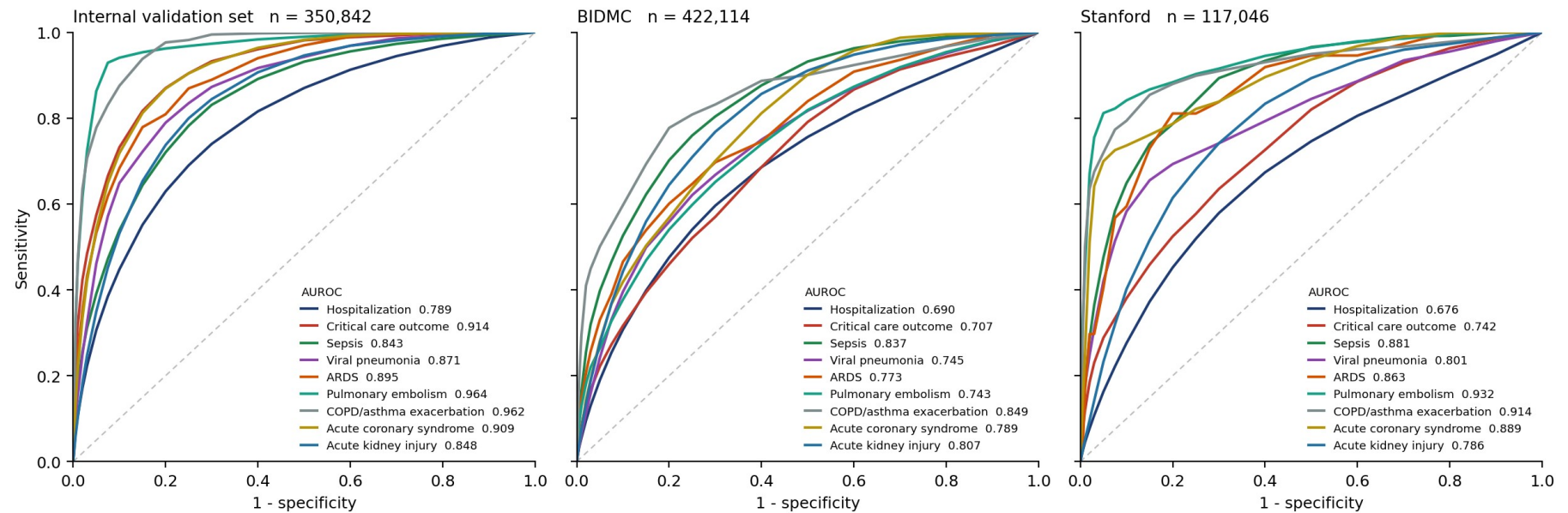
Notes: Curves are for MultiDiseasePred on the twelve-variable feature set, n = 350,842. The diagonal marks chance.

eFigure 2. Precision–recall curves for the nine prediction targets, UMN internal validation set.



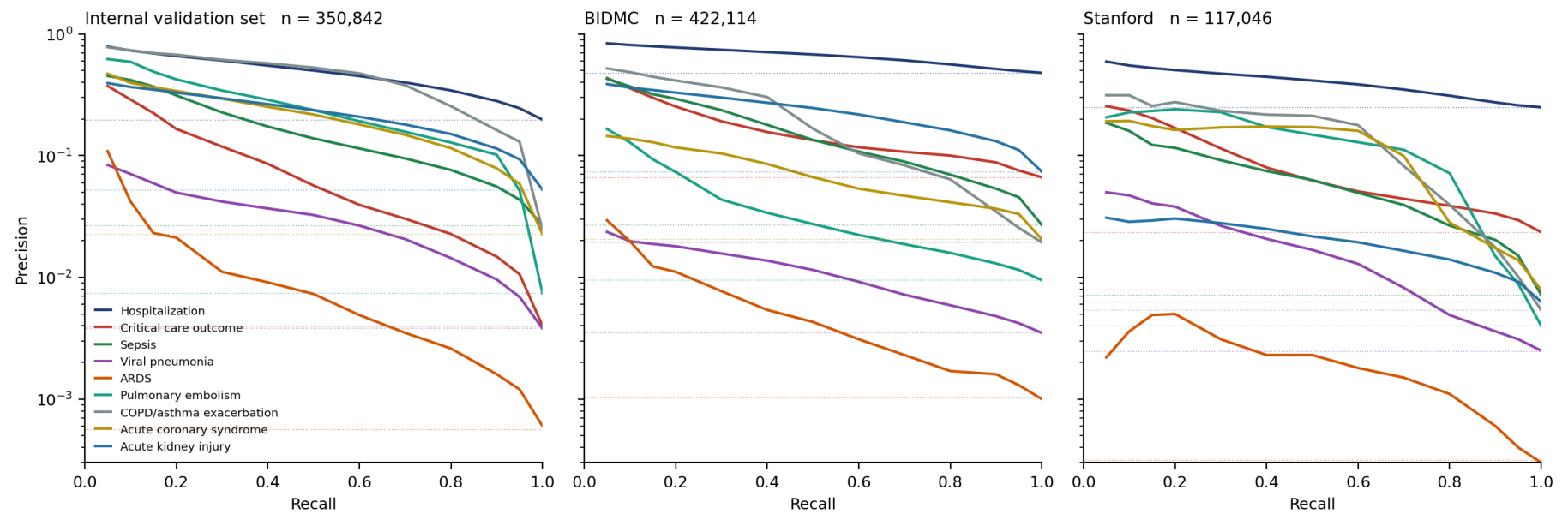
Notes: The horizontal reference line in each panel is the prevalence of that endpoint, which is the precision of a random classifier.

eFigure 3. Receiver operating characteristic curves across the three cohorts.



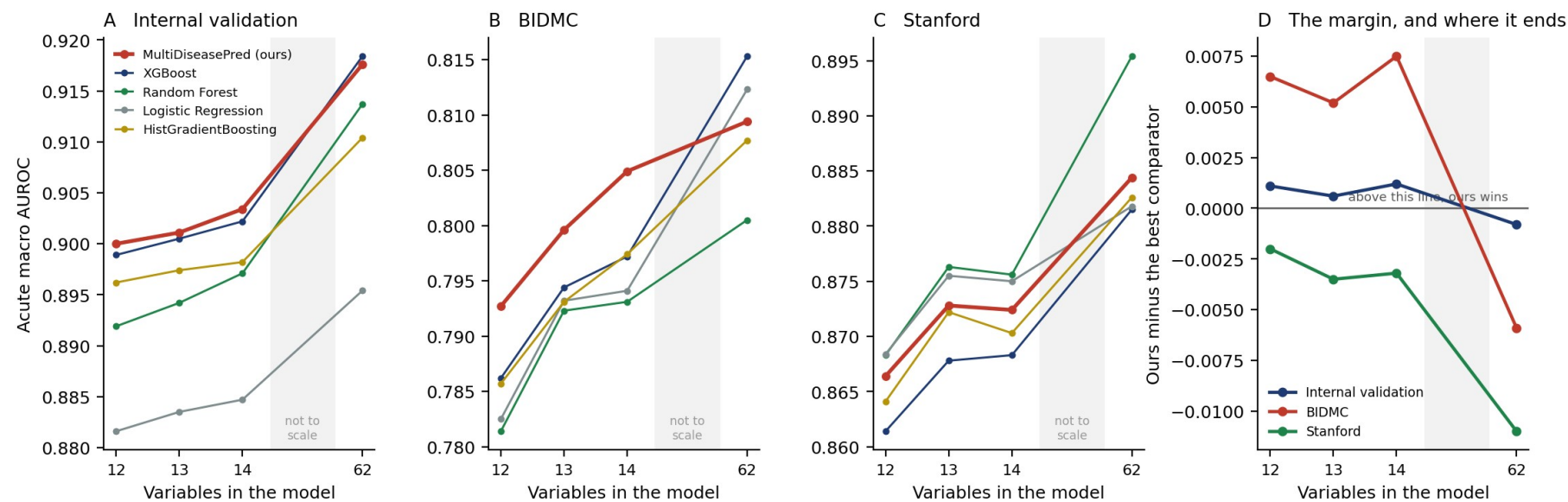
Notes: One panel per endpoint, one curve per cohort. The model was applied to the external cohorts without local retraining or recalibration.

eFigure 4. Precision–recall curves across the three cohorts.



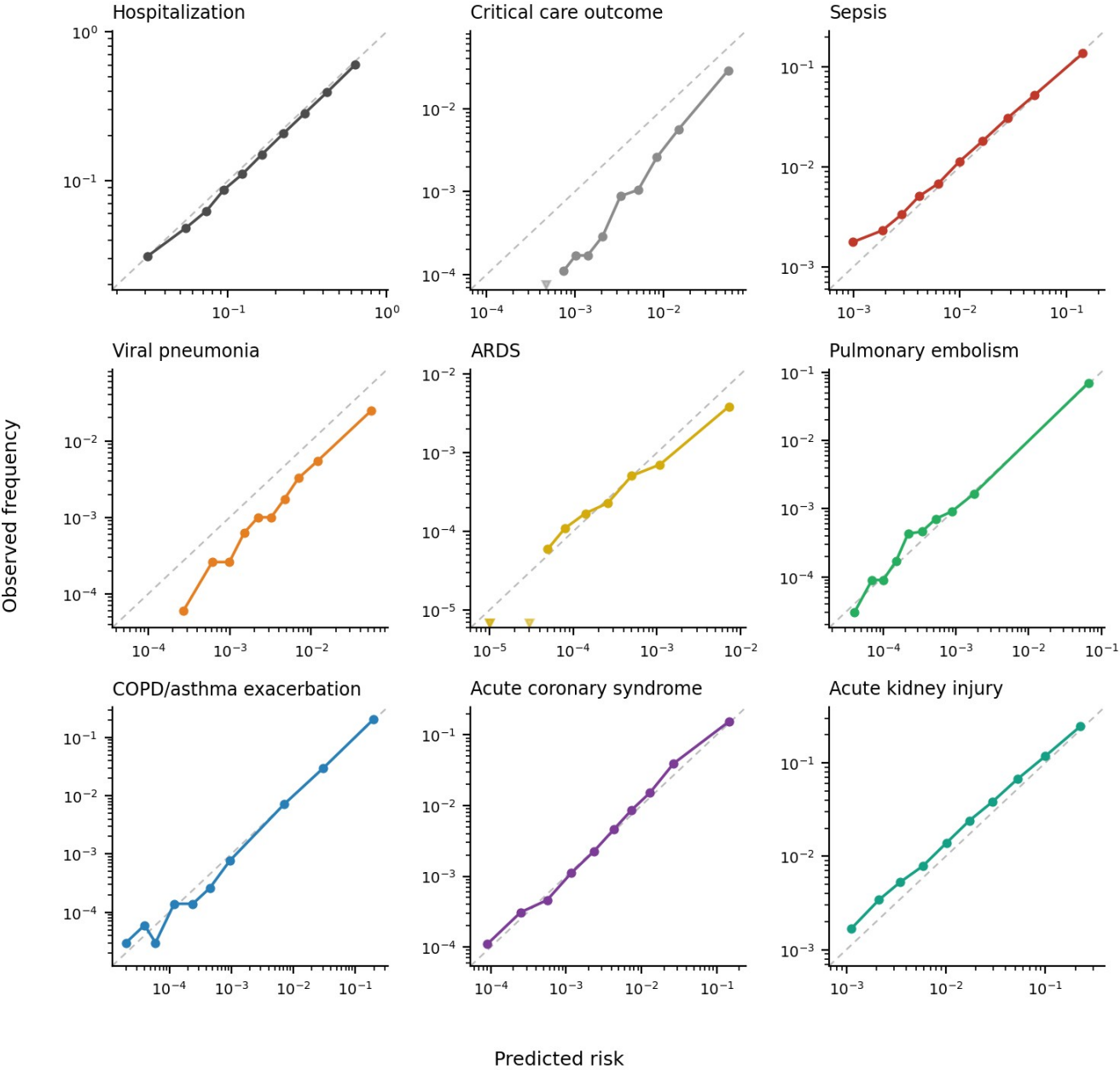
Notes: Precision is bounded by prevalence, which differs by up to an order of magnitude between cohorts, so the panels are not comparable in absolute terms.

eFigure 5. Macro-AUROC over the acute conditions against the variable budget k.



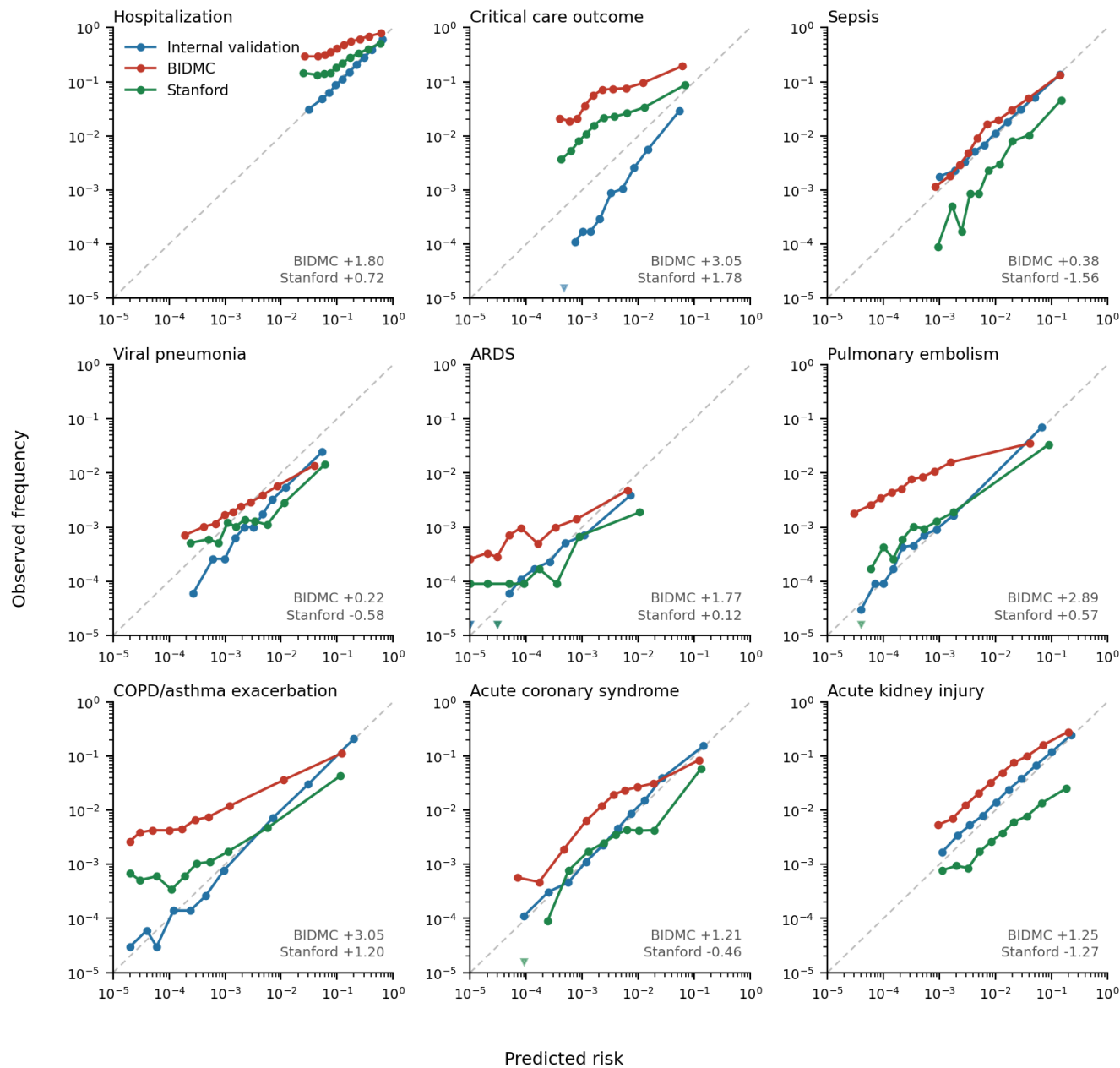
Notes: MultiDiseasePred against single-task baselines at each k, in all three cohorts. Tabulated in eTable 10.

eFigure 6. Calibration curves for the nine prediction targets, UMN internal validation set.



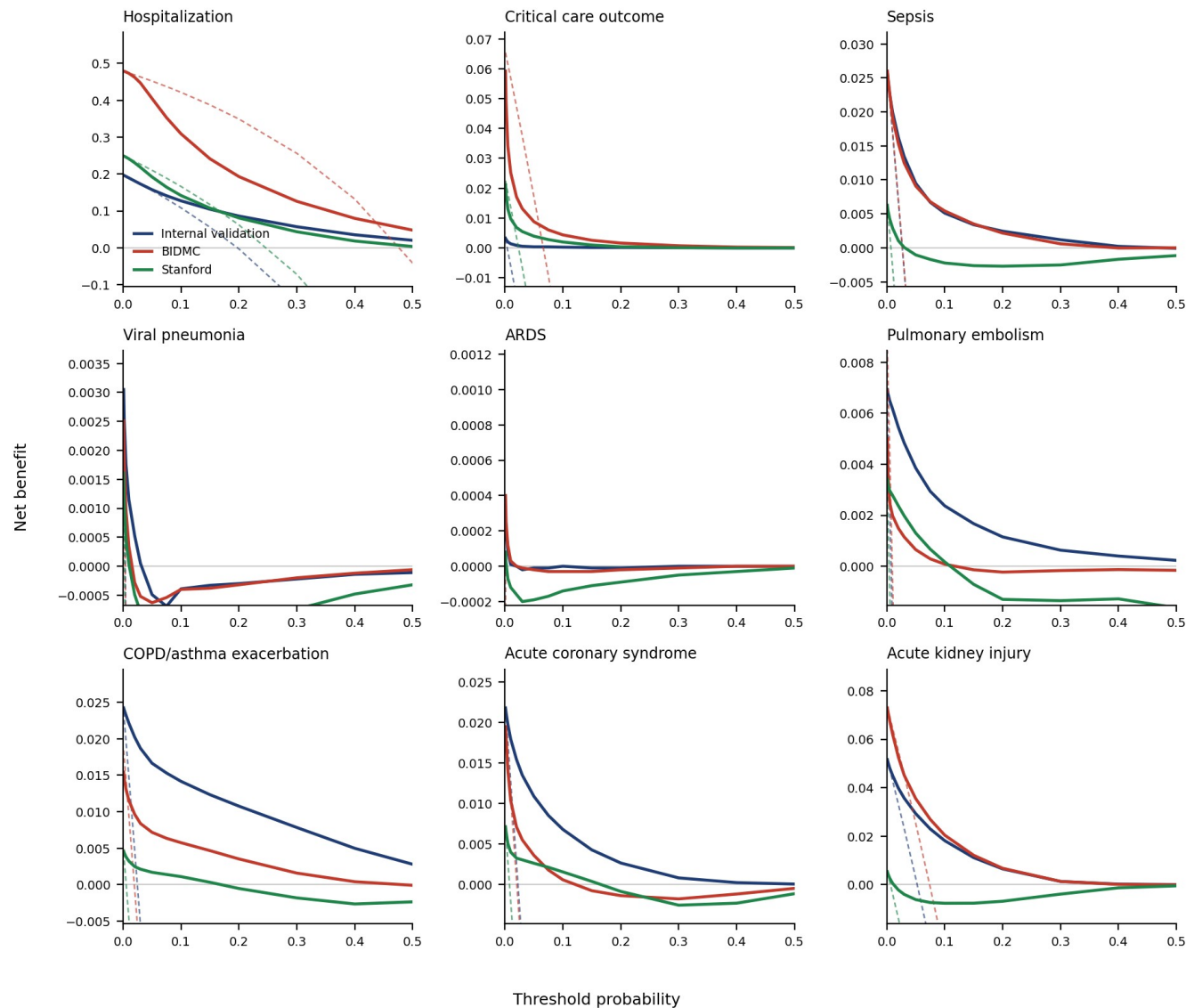
Notes: Ten equal-sized bins with the diagonal drawn. Rare endpoints are shown on the same axes as common ones. Slopes and intercepts are in eTable 14.

eFigure 7. Calibration curves across the three cohorts.



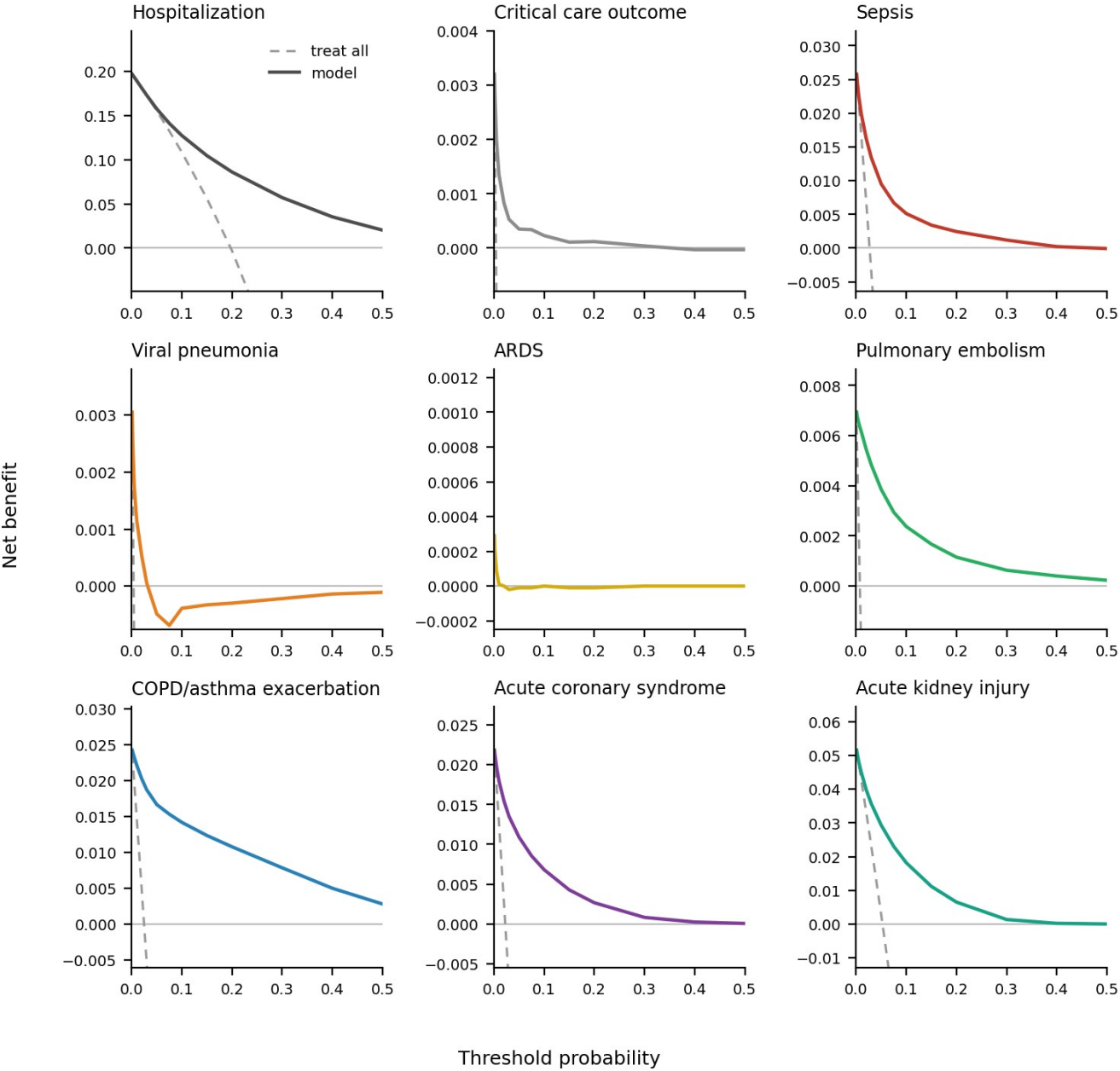
Notes: Predicted against observed risk on log-log axes, ten equal-sized bins. The external cohorts received no local recalibration.

eFigure 8. Decision curves and net benefit across the three cohorts.



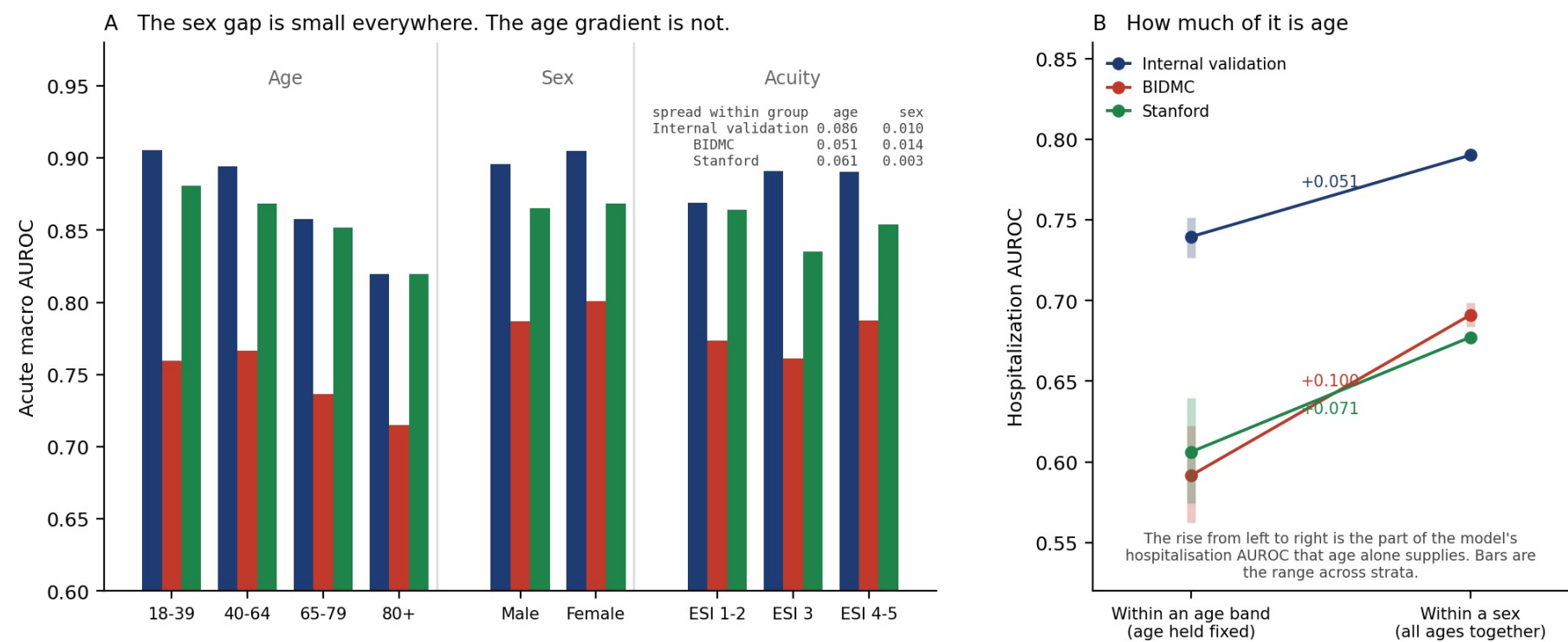
Notes: Net benefit against threshold probability, with treat-all and treat-none references drawn per cohort. Treat-all moves with prevalence, so the same model clears a higher bar at a site that admits more patients.

eFigure 9. Decision curves and net benefit, UMN internal validation set.



Notes: As eFigure 8, for the internal validation set alone.

eFigure 10. Subgroup AUROC by age band, sex and Emergency Severity Index.



Notes: Points are subgroup AUROC with 95% confidence intervals; the vertical line is the whole-cohort value for that endpoint. Triage acuity is a stratifying variable here and is not a model input. Tabulated in eTable 17.