

Supplementary Table 1. Institutional review boards numbers approved by each institution

No	Institution	IRB numbers	Approval date	Study title
1	Asan Medical Center	2016-0269	2016/03/10	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
2	Konkuk University Chungju Hospital	KUCH2016-03-014	2016/03/29	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
3	Chungbuk National University Hospital	CBNUH 2016-03-001	2016/05/19	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
4	Pusan National University Yangsan Hospital	05-2016-008	2016/01/21	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
5	Samsung Medical Center	SMC 2016-02-102-002	2016/03/11	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
6	Jeonbuk National University Hospital	CUH 2016-03-016-002	2016/05/05	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
7	Seoul National University Hospital	H-1605-107-763	2016/06/09	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
8	The Catholic University of Korea Incheon St. Mary's Hospital	OC16RNMI0028	2017/04/05	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
9	Hallym University Sacred Heart Hospital	2016-1051	2016/04/19	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
10	Seoul Boramae Hospital	20160223/26- 2016-19/032	2016/03/11	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
11	Dongguk University Ilsan Hospital	2016-30	2016/03/24	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
12	Gangdong Kyunghee University College of Medicine Hospital	KHNMC 2016-07-008	2016/07/19	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
13	Seoul National University Bundang Hospital	B-1503/292-004	2015/10/19	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
14	Soonchunhyang University Busok Seoul Hospital	SCHUH 2016-03-005-004	2016/05/26	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
15	University of Ulsan Hospital	UUH 2016-06-015	2016/06/23	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea
16	The Catholic University of Korea Seoul St. Mary's Hospital	KIRB-00590_1- 001	2016/06/02	Development of indication and assessment of clinical efficacy of ECMO for severe acute respiratory failure patients in Korea

Supplementary Table 2. Description of electronic health records (EHR) variables used in analysis

Category	Features	Definition	ALL (n = 51)	EHR (n = 40)
Demographic	Age	Age on admission to hospital	Y	Y
	Sex	Men/ Women	Y	Y
	Height	Height on admission to hospital	Y	Y
	Weight	Weight on admission to hospital	Y	Y
	Body mass index (BMI)	BMI on admission to hospital	Y	Y
	Body size are (BSA)	BSA on admission to hospital	Y	Y
Vital signs	Systolic blood pressure	Systolic blood pressure at the closest value to the moment of ECMO commencement	Y	Y
	Diastolic blood pressure	Diastolic blood pressure at the closest value to the moment of ECMO commencement	Y	Y
	Mean arterial pressure	Diastolic blood pressure + 1/3(systolic blood pressuer – diastolic blood pressure) at the closest value to the moment of ECMO commencement	Y	Y
	Heart rate	Heart rate at the closest value to the moment of ECMO commencement	Y	Y
	Respiratory rate	Respiratory rate at the closest value to the moment of ECMO placement	Y	Y
Laboratory tests	Hemoglobin	Hemoglobin at the closest value to the moment of ECMO commencement	Y	Y

	Sodium bicarbonate	Bicarbonate infusion before ECMO	Y	Y
	Sodium	Na at the closest value to the moment of ECMO commencement	Y	Y
	Potassium	K at the closest value to the moment of ECMO commencement	Y	Y
	Total bilirubin	Total bilirubin at the closest value to the moment of ECMO commencement	Y	Y
	Aspartate aminotransferase	Aspartate aminotransferase at the closest value to the moment of ECMO commencement	Y	Y
	Alanine aminotransferase	Alanine aminotransferase at the closest value to the moment of ECMO commencement	Y	Y
	Blood urea nitrogen	Blood urine nitrogen at the closest value to the moment of ECMO commencement	Y	Y
	Creatinine	Creatinine at the closest value to the moment of ECMO commencement	Y	Y
	Platelet	Platelets at the closest value to the moment of ECMO commencement	Y	Y
Comorbidities	Immunocompromised status	“Immunocompromised” is defined as hematological malignancies, solid tumor, solid organ transplantation, human immunodeficiency virus, and cirrhosis.	Y	Y

	Central nervous system dysfunction	“Central nervous system dysfunction” diagnosis combined neurotrauma, stroke, encephalopathy, cerebral embolism, and seizure and epileptic syndrome.	Y	Y
	Acute nonpulmonary infiltrates	Acute associated (nonpulmonary) infection” is defined as another bacterial, viral, parasitic, or fungal infection that did not involve the lung.	Y	N
	Neuromuscular blocking agents	Neuromuscular blockade agents before ECMO	Y	Y
	Respiratory diagnosis group	Etiology of respiratory failure	Y	Y
Blood gas	Arterial pressure CO2	PaCO2 at the closest value to the moment of ECMO placement	Y	Y
	Arterial pressure O2	PaO2 at the closest value to the moment of ECMO placement	Y	Y
	Bicarbonate	HCO3 at the closest value to the moment of ECMO placement	Y	Y
	Power of hydrogen	pH at the closest value to the moment of ECMO placement	Y	Y
	Arterial saturation O2%	SaO2% at the closest value to the moment of ECMO placement	Y	Y

	Mechanical ventilation	Use of mechanical ventilation before ECMO	Y	Y
	Minute ventilation	Tidal volume (Vt) in mL x respiratory rate in resp/min	Y	Y
	PF ratio	PaO ₂ / FIO ₂ at the closest value to the moment of ECMO placement	Y	Y
	Peak inspiratory pressure	Peak inspiratory pressure at the closest value to the moment of ECMO commencement	Y	Y
Mechanical ventilation	Positive end expiratory pressure	Positive end-expiratory pressure obtained at the closest value to the moment of ECMO commencement	Y	Y
	MV time before initiation of ECMO	Duration of mechanical ventilation before ECMO	Y	Y
	Plateau pressure >30cmH ₂ O	Plateau airway pressure greater than 30 cm H ₂ O before ECMO	Y	Y
	Year	Year of ECMO treatment	Y	N
	Center	ECMO centers	Y	N
ECMO management	High volume ECMO > 20 yr	Hospitals with more than 20 ECMO cases per year	Y	N
	APACHE II score	APACHE II score at the closest value to the moment of ECMO placement	Y	N
ICU mortality scores	Pre SOFA score	SOFA score before admission to intensive care unit	Y	N
	In-hospital mortality	Deaths occurring during the hospital stay	Y	Y
Outcome	90-day mortality	Deaths within 90 days after ECMO initiation	Y	Y
	Bridge to transplant	Patients who received ECMO as a bridge to transplant	Y	N
Others	Nitric oxide gas	Nitric oxide use before ECMO	Y	Y

Cardiac arrest	Cardiac arrest before ECMO	Y	N
Steroid	Steroid at the closest value to the moment of ECMO placement	Y	Y
Continuous renal replacement therapy	Continuous renal replacement therapy before ECMO	Y	Y
Prone positioning	Prone positioning before ECMO	Y	N
ECMO transfer	Transferred for ECMO	Y	N

Supplementary Table 3. Baseline characteristics of VV-ECMO treated patients in the internal and external validation set

	Internal validation (N = 111)	External validation (N = 78)	P-value
Age (years)	53.1 (14.7)	58.5 (13.7)	0.04
Sex (Male)	75 (67.6%)	49 (62.8%)	0.796
Height (cm)	166 (8.48)	164 (8.81)	0.289
Weight (kg)	63.7 (13.3)	66.2 (16.5)	0.512
Body mass index (kg/m ²)	23.1 (4.00)	24.6 (5.20)	0.098
BSA (m ²)	1.69 (0.257)	1.72 (0.241)	0.646
Immunocompromised status	30 (27.0%)	20 (25.6%)	0.96
CNS dysfunction	6 (5.4%)	10 (12.8%)	0.211
Sodium bicarbonate infusion	10 (9.0%)	17 (21.8%)	0.017
Cardiac arrest	14 (12.6%)	4 (5.1%)	0.226
Pre SOFA score	11.3 (3.97)	13.9 (2.89)	<0.001
NMB agent	47 (42.3%)	75 (96.2%)	<0.001
Etiology of respiratory failure			<0.001
Viral pneumonia	18 (16.2%)	27 (34.6%)	
Bacterial pneumonia	31 (27.9%)	4 (5.1%)	
COPD/ asthma	2 (1.8%)	1 (1.3%)	
Trauma/ burn	5 (4.5%)	0 (0%)	
Asphyxia	1 (0.9%)	4 (5.1%)	
AE-ILD	11 (9.9%)	0 (0%)	
Chronic respiratory failure	3 (2.7%)	0 (0%)	
Other respiratory failure	40 (36.0%)	42 (53.8%)	
Positive end-expiratory pressure (cm H ₂ O)	9.01 (3.55)	7.44 (2.92)	0.008
Peak inspiratory pressure (cm H ₂ O)	29.0 (6.06)	25.9 (9.03)	0.033
PF ratio	78.5 (38.4)	62.9 (31.9)	0.018
Minute ventilation (L/min)	9.96 (3.92)	9.45 (5.04)	0.777
Respiratory rate (/min)	23.2 (6.77)	24.6 (7.29)	0.383
MV time before ECMO			0.092
< 48 hrs	70 (63.1%)	34 (43.6%)	
> 7 days	22 (19.8%)	23 (29.5%)	

48 hrs - 7 days	17 (15.3%)	21 (26.9%)	
PaCO ₂ (mmHg)	57.3 (25.4)	53.1 (26.1)	0.558
PaO ₂ (mmHg)	70.0 (22.0)	96.9 (78.5)	0.006
SaO ₂ (%)	85.4 (12.9)	89.1 (11.6)	0.141
Hemoglobin (g/dL)	10.9 (2.28)	10.9 (2.28)	1
TBIL (μmol/L)	1.98 (2.87)	3.90 (13.2)	0.412
Creatinine (mg/dL)	1.36 (1.52)	1.73 (4.94)	0.793
Platelet count	155 (114)	174 (105)	0.547
In-hospital mortality	70 (63.1%)	40 (51.3%)	0.271
90-day mortality	64 (57.7%)	38 (48.7%)	0.479

Data are n(%) or mean (SD), unless otherwise specified.

MV time before ECMO = Mechanical Ventilation-ECMO interval

PF ratio = PaO₂/FiO₂ (mmHg)

TBIL (μmol/L) = Total bilirubin

PEEP = Positive end-expiratory pressure

Supplementary Table 4. Metrics for assessment of predictive performance of six ML algorithms with all features for prediction of 90-day mortality in the test set

Models	AUROC	AUPRC	Sensitivity	Specificity	PPV	NPV	F1-score
LR	0.73 (0.63 - 0.82)	0.79 (0.67 - 0.88)	0.73 (0.62 - 0.84)	0.64 (0.49 - 0.78)	0.73 (0.62 - 0.84)	0.64 (0.50 - 0.76)	0.73 (0.64 - 0.82)
SVM	0.76 (0.66 - 0.85)	0.77 (0.65 - 0.89)	0.73 (0.62 - 0.83)	0.60 (0.45 - 0.74)	0.71 (0.60 - 0.82)	0.62 (0.47 - 0.76)	0.72 (0.62 - 0.80)
RF	0.78 (0.69 - 0.87)	0.83 (0.73 - 0.91)	0.75 (0.63 - 0.86)	0.64 (0.50 - 0.79)	0.74 (0.63 - 0.85)	0.65 (0.51 - 0.79)	0.74 (0.65 - 0.82)
XGB	0.79 (0.69 - 0.87)	0.82 (0.72 - 0.91)	0.97 (0.91 - 1.0)	0.32 (0.19 - 0.46)	0.66 (0.56 - 0.76)	0.88 (0.69 - 1.0)	0.79 (0.71 - 0.85)
MLP	0.75 (0.64 - 0.84)	0.78 (0.66 - 0.89)	0.63 (0.50 - 0.73)	0.66 (0.52 - 0.81)	0.71 (0.59 - 0.83)	0.56 (0.43 - 0.69)	0.67 (0.56 - 0.76)
LGB	0.80 (0.71 - 0.88)	0.82 (0.71 - 0.91)	0.91 (0.83 - 0.97)	0.51 (0.37 - 0.66)	0.72 (0.61 - 0.82)	0.80 (0.65 - 0.94)	0.80 (0.72 - 0.87)

LR = Logistic Regression. SVM = Support Vector Machine. RF = Random Forest. XGB: Extreme Gradient Boosting. MLP: Multi-layer Perceptron. LGB: Light Gradient Boosting. AUROC: area under the receiver operating characteristic curve. AUPRC: area under the precision-recall curve. PPV: positive predictive value. NPV: negative predictive value. Better performance between models with EHR and all features is marked in bold. All numbers are presented with 95% confidence interval.

Supplementary Table 5. Metrics for assessment of predictive performance of ML algorithms for prediction of in-hospital mortality in the test set

	Models	AUROC	AUPRC	Sensitivity	Specificity	PPV	NPV	F1-score
LR	EHR	0.75 (0.65 - 0.85)	0.80 (0.69 - 0.90)	0.94 (0.89 - 0.99)	0.41 (0.28 - 0.52)	0.72 (0.65 - 0.80)	0.81 (0.65 - 0.94)	0.82 (0.76 - 0.86)
	All	0.77 (0.68 - 0.86)	0.85 (0.77 - 0.92)	0.78 (0.68 - 0.87)	0.60 (0.45 - 0.74)	0.76 (0.66 - 0.86)	0.63 (0.48 - 0.77)	0.77 (0.69 - 0.84)
SVM	EHR	0.74 (0.63 - 0.83)	0.79 (0.68 - 0.89)	0.99 (0.95 - 1.00)	0.17 (0.07 - 0.28)	0.66 (0.57 - 0.75)	0.88 (0.57 - 1.00)	0.79 (0.72 - 0.85)
	All	0.75 (0.65 - 0.85)	0.81 (0.70 - 0.91)	0.96 (0.90 - 1.00)	0.31 (0.18 - 0.47)	0.70 (0.60 - 0.79)	0.81 (0.60 - 1.00)	0.81 (0.74 - 0.87)
RF	EHR	0.78 (0.68 - 0.87)	0.84 (0.74 - 0.92)	0.96 (0.90 - 1.00)	0.48 (0.33 - 0.64)	0.75 (0.66 - 0.84)	0.87 (0.71 - 1.00)	0.84 (0.78 - 0.90)
	All	0.81 (0.73 - 0.88)	0.86 (0.76 - 0.93)	0.97 (0.93 - 1.00)	0.26 (0.14 - 0.41)	0.68 (0.59 - 0.78)	0.85 (0.62 - 1.00)	0.80 (0.73 - 0.87)
XGB	EHR	0.80 (0.70 - 0.88)	0.85 (0.74 - 0.93)	0.87 (0.78 - 0.94)	0.57 (0.32 - 0.63)	0.73 (0.64 - 0.82)	0.69 (0.50 - 0.85)	0.79 (0.72 - 0.86)
	All	0.83 (0.74 - 0.91)	0.88 (0.79 - 0.95)	0.88 (0.80 - 0.95)	0.52 (0.38 - 0.68)	0.75 (0.66 - 0.84)	0.73 (0.56 - 0.88)	0.81 (0.74 - 0.88)
MLP	EHR	0.77 (0.68 - 0.86)	0.82 (0.71 - 0.91)	0.90 (0.83 - 0.97)	0.41 (0.26 - 0.56)	0.71 (0.62 - 0.81)	0.71 (0.53 - 0.90)	0.80 (0.72 - 0.86)
	All	0.77 (0.68 - 0.86)	0.83 (0.72 - 0.92)	0.88 (0.81 - 0.96)	0.52 (0.38 - 0.68)	0.75 (0.66 - 0.84)	0.73 (0.57 - 0.88)	0.81 (0.67 - 0.83)
LGB	EHR	0.79 (0.70 - 0.88)	0.84 (0.75 - 0.93)	0.91 (0.84 - 0.97)	0.48 (0.32 - 0.64)	0.74 (0.64 - 0.83)	0.77 (0.63 - 0.90)	0.82 (0.75 - 0.88)
	All	0.80 (0.71 - 0.88)	0.86 (0.78 - 0.93)	0.90 (0.82 - 0.96)	0.48 (0.33 - 0.63)	0.74 (0.64 - 0.83)	0.74 (0.56 - 0.90)	0.81 (0.74 - 0.87)

LR = Logistic Regression. SVM = Support Vector Machine. RF = Random Forest. XGB: Extreme Gradient Boosting. MLP: Multi-layer Perceptron. LGB: Light Gradient Boosting. AUROC: area under the receiver operating characteristic curve. AUPRC: area under the precision-recall curve. PPV: positive predictive value. NPV: negative predictive value. All numbers are presented with 95% confidence interval.

Supplementary Table 6. Previous studies on prognosis prediction models for patients undergoing VV or VA ECMO

Model or Author name (year)	Country	Study Setting	ECMO mode	Patients Number	MV-related features	Comorbidity related features	Blood gas related features	Lab tests	Other features	Internal/External AUROC
Regression based models										
PRESERVE; Schemidt et al. (2013)	France	Population based	VV & VA	140	Days of MV PEEP Plateau MV +/-*	Immunocompromised status	PaO2* FiO2* Platelets*	Bilirubin* Mean arterial pressure* Creatinine*	Age BMI Prone positioning Sepsis-related organ failure Glasgow Comma Scale	0.89 / 0.59 - 0.80
PRESET; Hlinder et al. (2017)	Germany	Hospital based	VV	108	No	No	No	Platelets Lactate	Mean arterial pressure concentration pH Hospital day pre ECMO	0.85 / 0.70
ECMO net; Pappalardo et al. (2012)	Italy	Population based	VV & VA	60	No	No	No	Bilirubin Creatinine Hematocrit	Pre ECMO hospital length of day Mean arterial pressure	0.86 / 0.51 - 0.70
RESP; Schemidt et al. (2020)	Global	Population based	VV & VA	2,355	Days of MV PIP	Immunocompromised status Acute respiratory diagnosis group Central nervous system dysfunction Acute nonpulmonary infection	PaCO2	No	Age Nueromuscular blockage agents Nitric oxide use Bicarbonate Cardiac arrest	0.74 / 0.44 - 0.92
APACHE II; Knaus et al. (1985)	US	Population based	No	5,030	No	Immunocomprised status Acute renal failure (acute kidney injury)	FiO2	Sodium Potassium Creatinine Hematocrit White blood cell count	Age History or severe organ failure Temperature pH Heart rate/pulse Respiratory rate Glasgow Coma Scale	No / 0.63 - 0.88

									Mean arterial pressure	
SOFA; Vincent et al. (1996)	Europe North America	Population based	No	1,643	MV +/-	No	PaO2 FiO2	Platelets Bilirubin Creatinine	Glasgow Coma Scale Administration of vasoactive agents Mean arterial pressure	No / 0.49 – 0.79
SAVE; Schmidt et al. (2015)	Global	Population based	VA	3,846	Days of MV PIP	Myocarditis Congenital heart disease Acute renal failure Chronic renal failure Liver failure	HCO3		Cardiac arrest Age Weight Refractory (VT/VF) Post heart or lung transplantation CNS dysfunction Diastolic blood pressure	0.68 / 0.90
Enger et al. (2014)	Germany	Hospital based	VV	304	Minute ventilation	Immunocompromised status (model1, model2)	FiO2 (model 2) Fibrinogen (model 2) norepinephrine (model 2) C-reactive protein (model 2)	Hemoglobin (model1, model2) Lactate	Age	0.75 - 0.79 / None (only internal validation done)
Roch et al. (2013)	France	Hospital based	VV & VA	85	MV +/-	influenza pneumonia	PaO2* FiO2* Platelets*	Bilirubin* Creatinine*	Age Mean arterial pressure*	0.80 / 0.56 - 0.62
Hsin et al. (2016)	China	Hospital based	VV	107	Days of MV MV +/-	Immunocompromised status	PaO2 FiO2 Platelets	Bilirubin* Creatinine*	Mean arterial pressure*	0.78 / None (only internal validation done)

Cheng et al. (2016)	China	Hospital based	VV	116	Days of MV MV +/-*	Immunocompromised status	PaO2* FiO2* Platelets*	Bilirubin* Creatinine*	Mean arterial pressure*	0.76 / None (only internal validation done)
Liu et al. (2016)	China	Hospital based	VV	38	No	Barotrauma Underlying lung disease	No	No	No	No / None (only internal validation done)
ENCOUR AGE; Muller et al. (2016)	France	Hospital based	VA	138	No	No	No	Creatinine Prothrombin Lactate	Age Sex BMI Glasgow coma scale	0.84 / None (only internal validation done)
PREDICT; Wengenmayer et al. (2019)	Germany	Hospital based	VA	205	No	No	pH	Lactate	Bicarbonate	0.82 - 0.84 / 0.72 -0.74
Magunia et al. (2021)	Germany	Population based	VV & VA	1,039	MV intubated, PEEP+, PaO2/FiO2 ratio+, Compliance (ml/cm H2O) +	No	No	No	Age, ICU admission, consolidation on chest x-ray +, hypoxemia +, external transfer, Murray lung injury score	0.73 (balanced accuracy) 0.69 (AUPRC) / None (only internal validation done)
Machine Learning-Based models other than regression										
Ayers et al. (2020)	US	Hospital based	VA	282	No	Post cardiotomy, PreECMO CPR	pH	Bilirubin, ALT, AST, Platelet, Phosphorous, WBC, Sodium, Magnesium, Hemoglobin, Hematocrit, Alk phos	Age, Sex	0.95 / None (only internal validation done)

* Variables included in SOFA model

+ Variables included in Murray lung injury score

Glasgow coma scale: Assessment of the level of consciousness in patients with traumatic brain injury

MV = mechanical ventilation. VV = venovenous. VA = venoarterial. ECMO = extracorporeal membrane oxygenation. AUROC = area under receiver operating characteristic curve. AUPRC = area under precision recall curve. PRESERVE = predicting death for severe acute respiratory distress syndrome on VV ECMO. PRESET = prediction of survival on ECMO therapy-score. RESP = respiratory. VT = Ventricular tachycardia. VF = Ventricular fibrillation. PIP = Peak inspiratory pressure. PEEP = Positive end-expiratory pressure. CNS = Central nervous system.

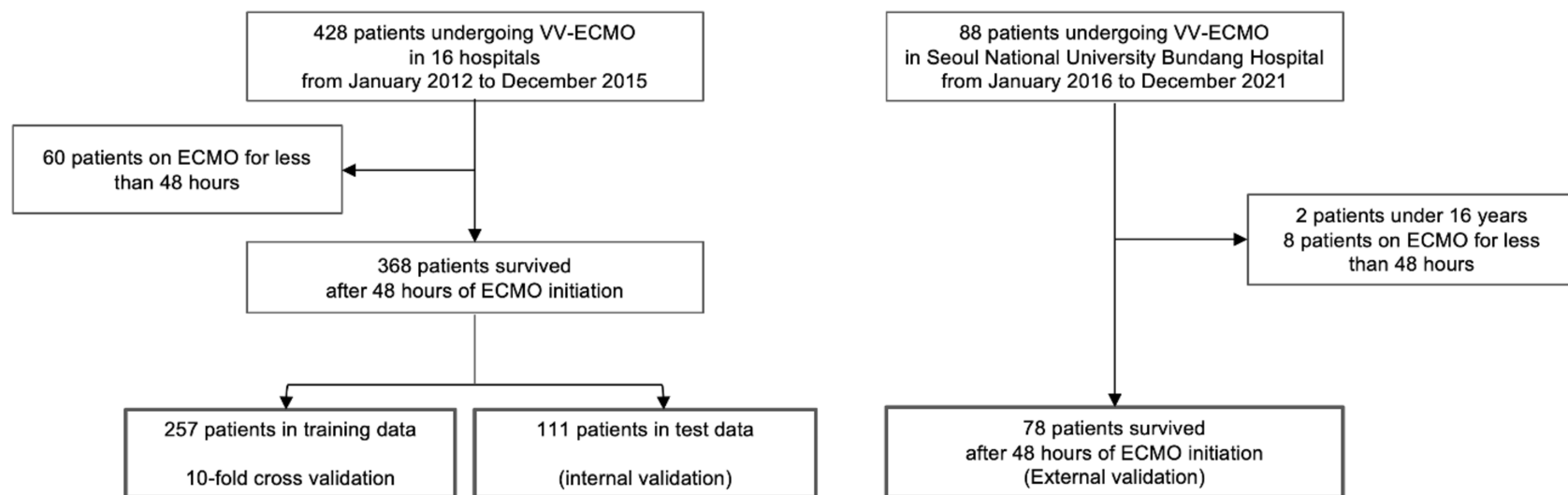
extracorporeal membrane oxygenation. APACHE II = acute physiology and chronic health evaluation. SOFA: Sepsis-related organ failure assessment score. Acute respiratory diagnosis group: viral pneumonia; bacterial pneumonia; asthma; trauma and burn; aspiration pneumonitis; other acute respiratory diagnoses; nonrespiratory and chronic respiratory diagnoses.

a. Validation on a cohort of 41 patients with acute respiratory distress syndrome (ARDS) b. Validation on a cohort of 99 patients with ARDS. c. Validation on a cohort of 50 patients who underwent ECMO support d. Validation on a cohort of 127 patients who treated with VV-ECMO. e. Validation on a cohort of 122 patients who treated with VV-ECMO for ARDS.

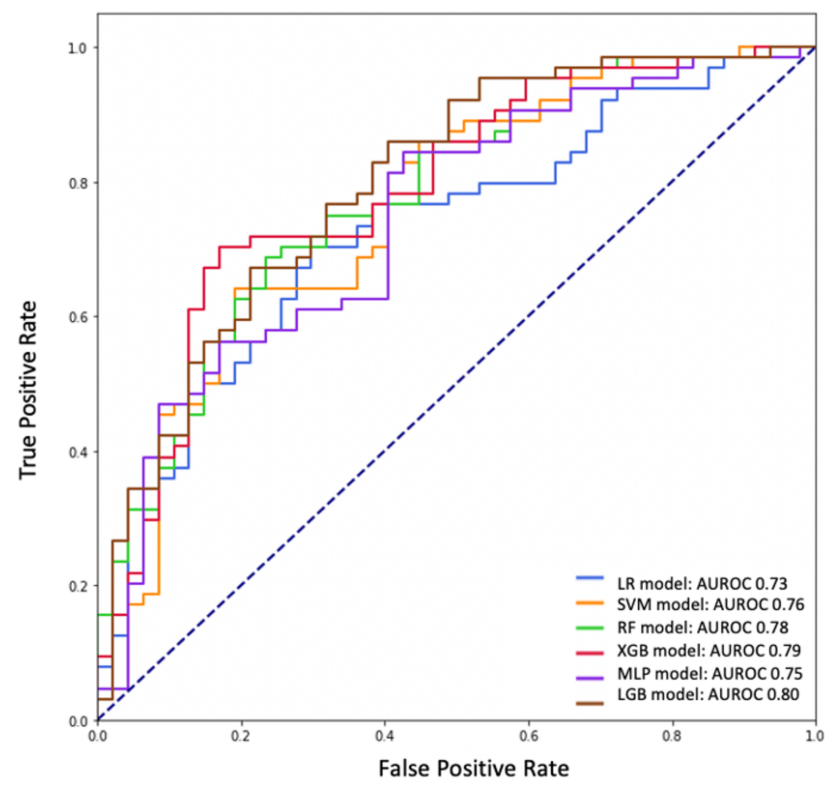
f. Validation on a cohort of 51 patients who received ECMO therapy for ARDS. g. Validation on a cohort of 111 patients who underwent VV-ECMO for ARDS with influenza and non-influenza etiologies. h. Validation on a cohort of 108 patients who underwent VV-ECMO for ARDS. i. Validation on a cohort of 629 patients who underwent VA and VV ecmo therapy. j. Validation on a cohort of 107 patients who received VV-ECMO. k. Validation on a cohort of all patients (n = 23) and pneumonia subgroup (n = 18) who underwent ECMO therapy for ARDS. l. Validation on a cohort of 163 patients in the emergency department and in the intensive care unit (ICU). m. Validation on a cohort of 300 patients in the surgical and medical ICUs. n. Validation on a cohort of COVID-19 patients (n = 103) and subgroup (n = 57) who received intensified thromboprophylaxis. o. Validation on a cohort of 3,008 patients who admitted to surgical ICU. p. Validation on a cohort of 166 patients who received VV-ECMO for acute respiratory failure (ARF). q. Validation on a cohort of 161 patients who received ECMO therapy in the ICU. r. Validation on a cohort of 244 patients who received VA-ECMO therapy. s. Validation on a cohort of 43,823 patients who enrolled in MIMIC-III database. t. Validation on a cohort of 78 patients who received ECMO support

Supplementary Table 7. Youden index thresholds for each machine learning models

Models	Youden index thresholds
Logistic Regression	0.51
Support Vector Machine	0.55
Random Forest	0.55
Extreme Gradient Boosting	0.61
Light Gradient Boosting	0.57
Multilayer Perceptron	0.49

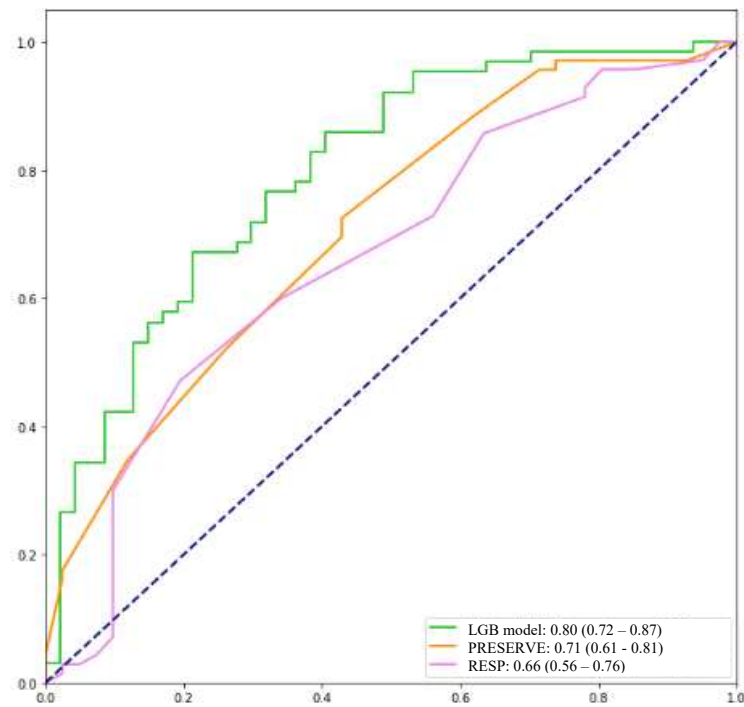


Supplementary Figure 1. Enrollment of study population

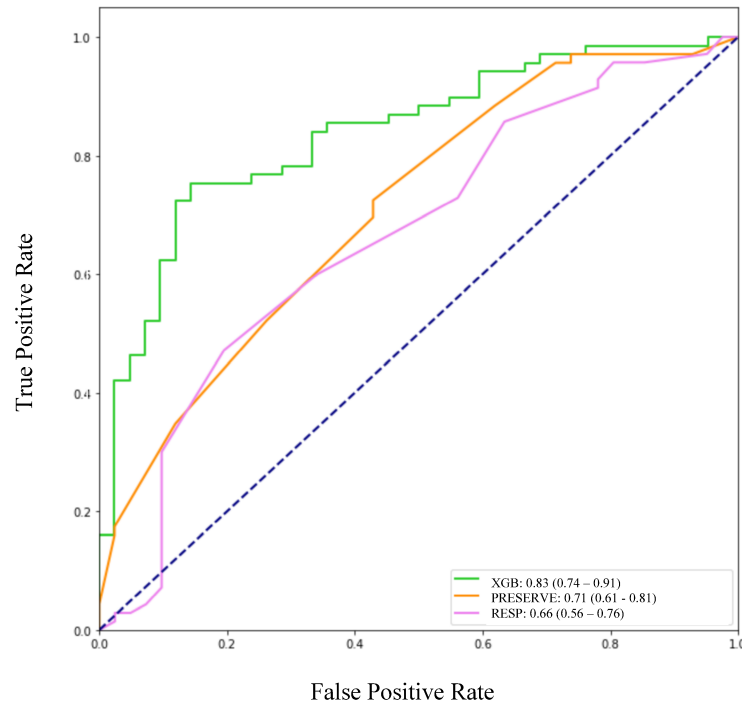


Supplementary Figure 2. Discrimination performance of prediction models with all features for 90-day mortality

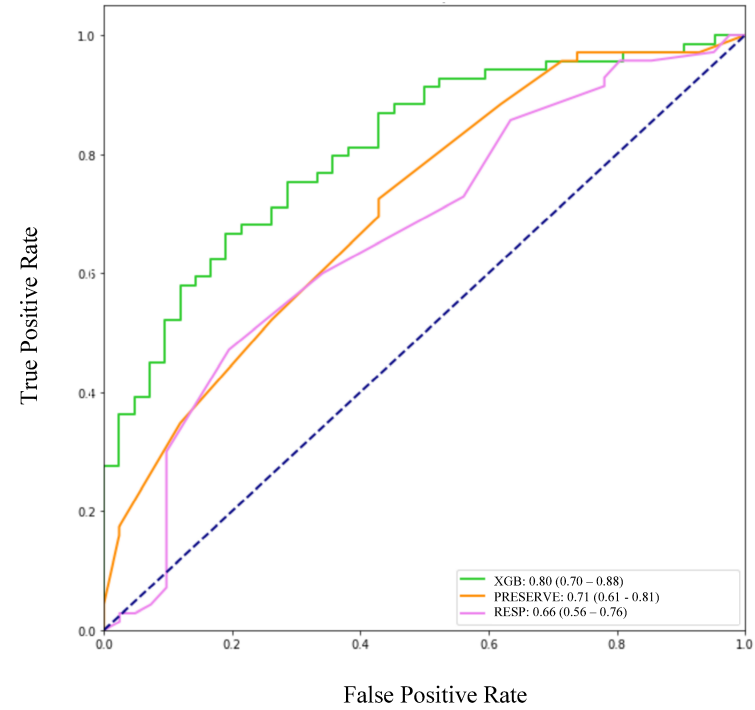
AUROC: Area Under Receiver-operating characteristics



Supplementary Figure 3. Receiver operating curve comparing 90-day mortality prediction (LGB) model with all features and the RESP and PRESERVE scores applied to the testing cohort

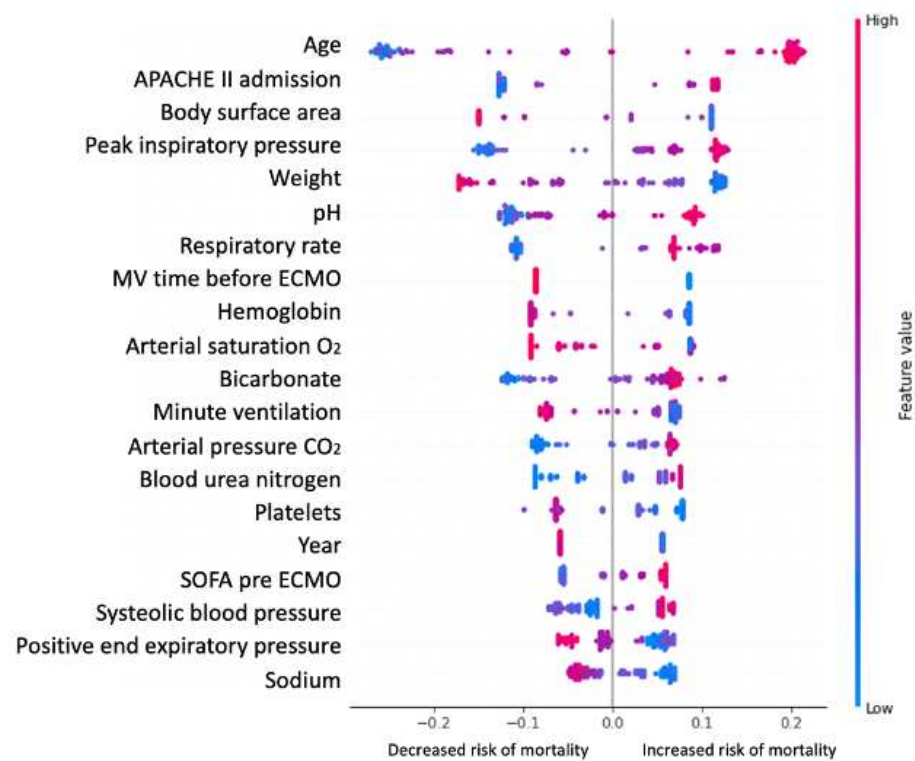


a. model with all features

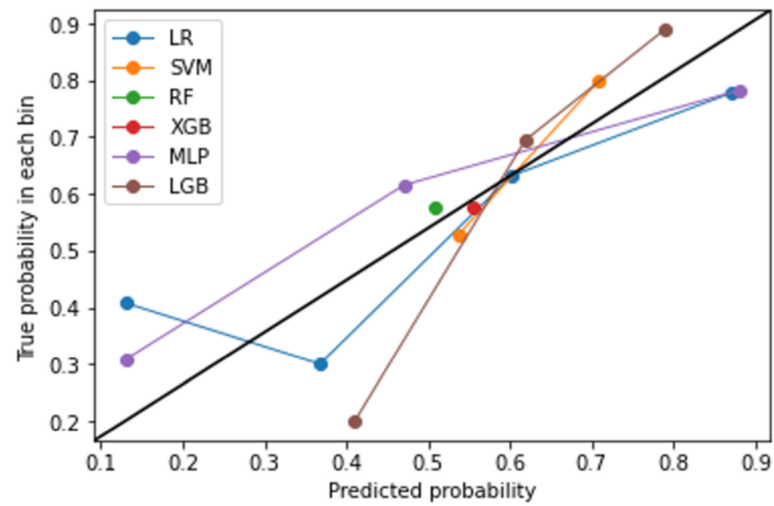


b. model with EHR features

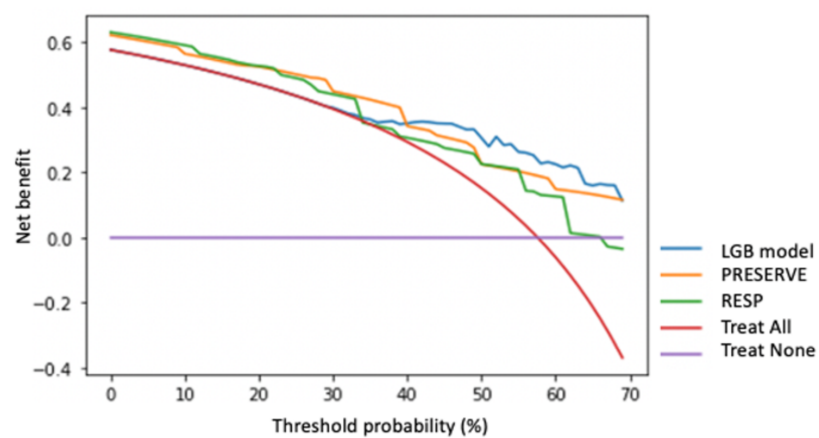
Supplementary Figure 4. Receiver operating curve comparing in-hospital mortality prediction (XGB) model with the RESP and PRESERVE scores applied to the testing cohort



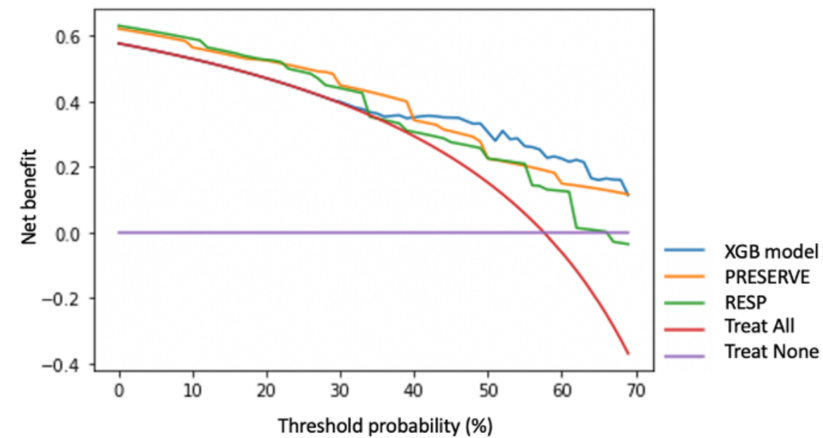
Supplementary Figure 5. SHAP analysis of 90-day mortality prediction with all features



Supplementary Figure 6. Calibration performance of 90-day mortality prediction models with all features

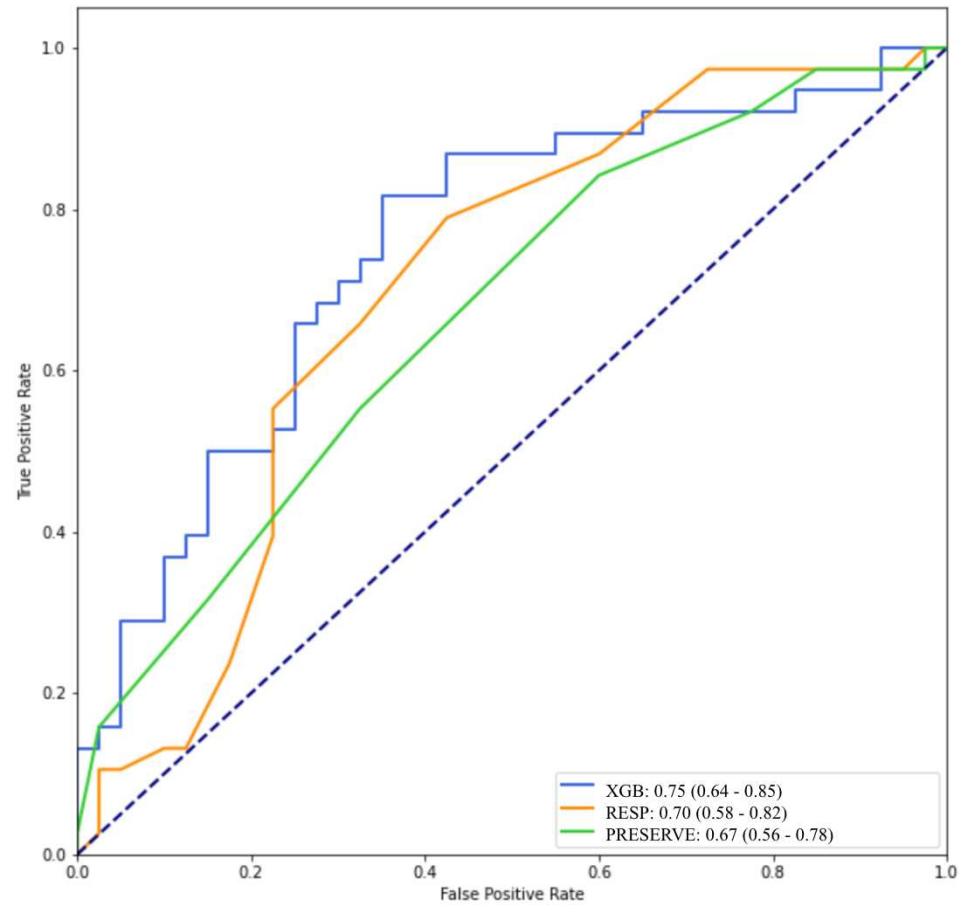


a. Model with all features



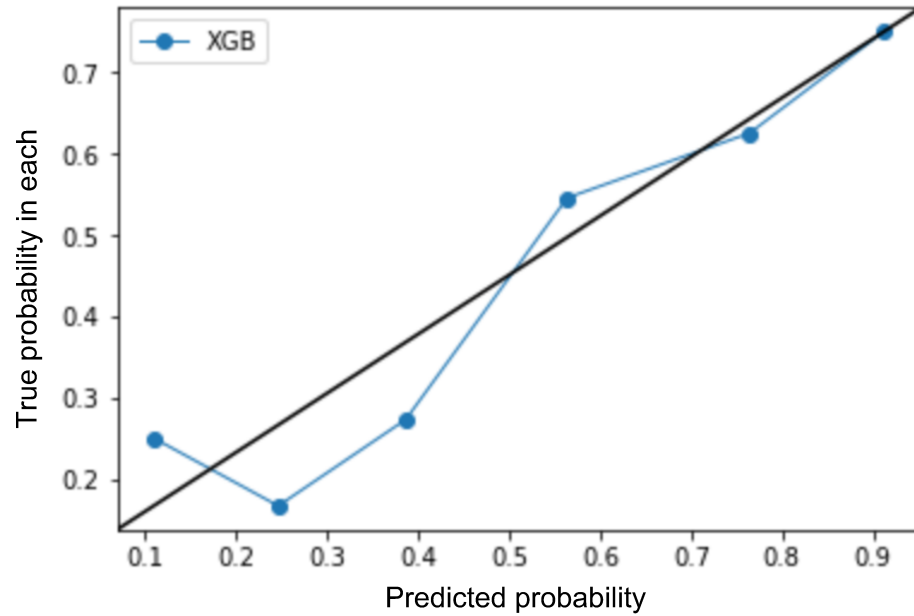
b. Model with EHR features

Supplementary Figure 7. Decision curve analysis of 90-day mortality prediction model with RESP and PRESERVE

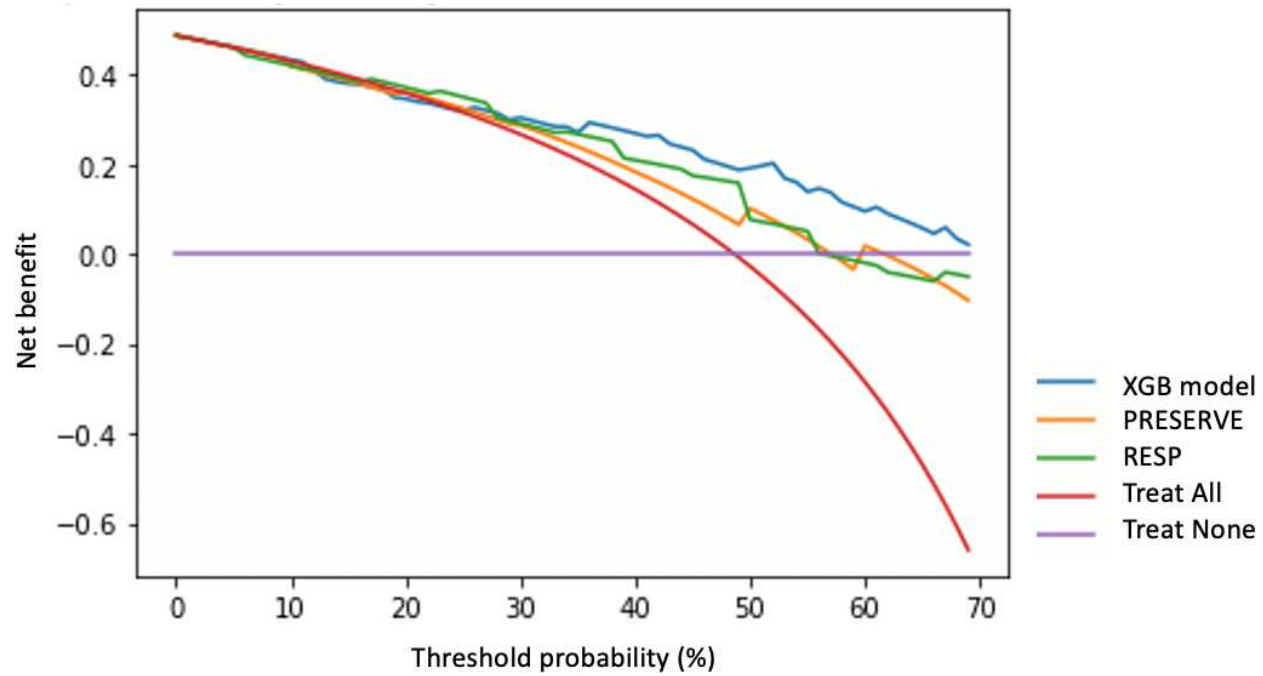


Supplementary Figure 8. External validation of 90-day mortality prediction model with EHR features with conventional models.

ROC: Receiver-operating characteristics



Supplementary Figure 9. Calibration performance of 90-day mortality prediction model with EHR features in the external validation set



Supplementary Figure 10. External validation of 90-day mortality prediction model with EHR features using decision curve analysis