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Reply to the letter to the editor: 'Non-invasive ventilation outcome (NIVO) score for predicting in-hospital and late mortality of chronic obstructive pulmonary disease (COPD) patients with acute hypercapnia'

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Thank you very much for your detailed review and thoughtful comments on our study.^[1] The missing data referenced in the manuscript are now provided in Supplementary Tables 1 through 4.

This study aimed to assess the predictive value of the NIVO score^[2] for both in-hospital and 90-day mortality (referred to as late mortality in our study) among patients admitted with acute exacerbation of COPD and treated with non-invasive ventilation (NIV). Due to the clinical practices in our hospital and the structure of our national healthcare system, we believe that patients in our cohort had relatively easy access to both home mechanical ventilation (HMV) and NIV. Consequently, NIV may have been initiated not only when acidemia developed during hospitaliza-

tion but also at the point of hypercapnia detection during exacerbation—even in the absence of acidemia—to prevent progression to respiratory muscle fatigue and subsequent acidosis based on the patient's clinical status.

In this context, the presence of index acidemia may sometimes reflect deterioration due to comorbid conditions such as myocardial infarction, pulmonary embolism, or infection, which may, in turn, influence the predictive accuracy of the NIVO score in this patient population. Among our patients, 145 (58%) presented with acidemia at admission. Of these, 109 had a pH between 7.25 and 7.35. According to the original NIVO scoring, these individuals received a score of 0 for both the "time to acidemia" and "pH < 7.25" components.

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Based on this observation, we hypothesized that the clinical relevance of the “time to acidemia” parameter might differ in our patient population. Therefore, we modified the original definition of this component—without altering the original time window—while maintaining the overall structure of the NIVO score, which is known to be a valid predictor of mortality. We believe that this modification could enhance the score’s predictive utility in certain subgroups of patients. Because we did not develop a novel scoring system but instead adapted an existing one, we did not conduct methodological steps such as validation, which would be required in a developmental study. Thus, our study remained cross-sectional.

When analyzing all patients, there was no statistically significant difference between the original and modified NIVO scores in predicting either in-hospital or late mortality ($p = 0.5890$ and $p = 0.1270$, respectively) (Supplementary Tables 5-6, Supplementary Figures 1-2, respectively). Nevertheless, both versions of the score were effective predictors of mortality.

In the acidemic subgroup ($n = 145$), both the original and modified NIVO scores were significant predictors of in-hospital mortality. Although the modified score demonstrated a slightly higher area under the curve (AUC) compared to the original version, the difference was not statistically significant ($p = 0.2299$) (Supplementary Table 7, Supplementary Fig. 3).

A group-wise comparison was performed using SPSS’s Split File function to analyze patients with and without home mechanical ventilation (HMV) separately among those presenting with acidemia. Among patients who owned an HMV device, the modified NIVO score demonstrated a statistically significant improvement over the original score in predicting in-hospital mortality ($p = 0.0399$) (Supplementary Table 8, Supplementary Fig. 4).

Detailed subgroup ROC analyses are presented in Supplementary Tables 9 through 14, respectively, and the corresponding ROC curves are provided in Supplementary Figures 5 through 10.

Because the follow-up duration was not recorded during data entry, a Cox regression model could not be applied. Therefore, a limited analysis using logistic regression was conducted instead. After adjusting for age, sex, and duration of COPD, each one-point increase in the NIVO score

was associated with a 1.4-fold increase in the odds of in-hospital mortality, whereas the modified score was associated with a 1.7-fold increase among patients presenting with acidemia at admission (Supplementary Table 15).

In the subgroup of patients with acidemia at admission who had access to an HMV device, the odds of in-hospital mortality increased by 2.1 times with each point increase in the original NIVO score and by 3.3 times with the modified score (Supplementary Table 16). Additional regression analyses for the entire cohort and selected subgroups are presented in Supplementary Tables 17 through 20.

When analyzing the entire cohort, both the original and modified NIVO scores were effective predictors of the need for intubation (Supplementary Table 21, Supplementary Fig. 11).

In conclusion, although the overall predictive performance did not differ significantly, the modified NIVO score may offer improved prediction of in-hospital mortality among patients presenting with acidemia and those who own an HMV device. However, the reliability and generalizability of this modification should be further evaluated through prospective study designs and in other populations with similar access to treatment.

We sincerely appreciate your insightful comments and valuable contributions, which have provided meaningful guidance for refining our current work and informing future research.

Conflicts of Interest Statement

The authors have no conflicts of interest to declare.

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Use of AI for Writing Assistance

No AI technologies utilized.

Author Contributions

Concept – S.Y.Y., M.Ö.A., C.H.K.Y., M.A., D.E.; Design – S.Y.Y., M.Ö.A., C.H.K.Y., M.A., D.E.; Supervision – S.Y.Y., M.Ö.A., C.H.K.Y., M.A., D.E.; Resource – S.Y.Y., M.Ö.A.; Materials – S.Y.Y., M.Ö.A.; Data Collection and/or Processing – S.Y.Y., M.Ö.A., D.E.; Analysis and/or Interpretation – S.Y.Y., C.H.K.Y., D.E.; Literature Review – S.Y.Y., M.Ö.A., D.E.; Writing – S.Y.Y., D.E.; Critical Review – S.Y.Y., M.Ö.A., C.H.K.Y., M.A., D.E.

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References

1. Yıldırım SY, Akbay MÖ, Kesen Yurtcanlı CH, Ağca M, Ernam D. Non-invasive Ventilation Outcome (NIVO) score for predicting in-
2. Hartley T, Lane ND, Steer J, Elliott MW, Sovani MP, Curtis HJ, et al. The Noninvasive Ventilation Outcomes (NIVO) score: prediction of in-hospital mortality in exacerbations of COPD requiring assisted ventilation. *Eur Respir J* 2021;58(2):2004042. Erratum in: *Eur Respir J* 2021;58(5):2054042. [\[CrossRef\]](#)

hospital and late mortality of chronic obstructive pulmonary disease (COPD) patients with acute hypercapnia. *Eurasian J Pulmonol* 2025;27(1):27–34. [\[CrossRef\]](#)

Supplementary Tables and Figures

Supplementary Table 1: (Extended Version of Table 6): Baseline Characteristics of the Patients and Their Relation with In-hospital and Late Mortality

	In-hospital Mortality			Late Mortality (90 Days)		
	Mortality Median (p25-p75)	Survival Median (p25-p75)	p Value*	Mortality Median (p25-p75)	Survival Median (p25-p75)	p Value*
Age (year)	77.0 (68.0-85.0)	69 (63.0-75.0)	<0.001	74.0 (67.0-83.0)	68.5 (63.0-75.0)	<0.001
Cigarette smoking (Pack/Year)	50.0 (40.0-60.0)	50 (30.0-60.0)	0.248	50.0 (35.0-60.0)	50.0 (30.0-60.0)	0.403
COPD duration (years)	10.0 (8.0-12.0)	9 (5.0-10.0)	0.047	10.0 (8.0-10.0)	8.0 (5.0-10.0)	0.014
Hospital Stay (days)	23 (14 -33)	9 (7-14)	<0.001	16 (10-27)	9.0 (7.0-14.0)	<0.001
WBC (10 ⁹ /L)	14.61 (9.64-18.69)	10.20 (8.09-12.54)	0.001	12.23 (8.85-16.20)	10.20 (8.14-12.53)	0.025
Hb (g/dL)	11.4 (9.8-13.5)	13.1 (11.5-14.7)	0.004	11.3 (9.8-13.3)	13.20 (11.6-14.9)	<0.001
PLT (10 ⁹ /L)	266.0 (209.0-379.0)	245.0 (196.0-312.0)	0.153	275.5 (216.0-341.0)	242.5 (195.5-309.0)	0.053
Eos# (10 ⁹ /L)	0.02 (0.01-0.12)	0.11 (0.03-0.22)	0.011	0.03 (0.01-0.13)	0.12 (0.03-0.24)	0.007
CRP (mg/dL)	67.45 (21.85-114.05)	22.5 (6.90-58.15)	0.001	54.90 (13.95-102.20)	22.5 (7.65-57.15)	0.011
Procalcitonin (ng/dL)	0.304 (0.166-1.060)	0.070 (0.041-0.126)	<0.001	0.203 (0.072-0.497)	0.071 (0.041-0.119)	<0.001
BUN (mg/dL)	54.0 (35.0-70.0)	40.0 (30.0-55.0)	0.021	48.5 (35.0-66.0)	40.0 (29.0-55.0)	0.014
Creatinine (mg/dL)	0.85 (0.64-1.05)	0.80 (0.62-0.98)	0.328	0.75 (0.62-1.05)	0.82 (0.62-0.99)	0.968
WBC, white blood cells; Hb, hemoglobin; PLT, thrombocyte count; Eos#, Eosinophil count; CRP, C reactive protein; BUN, Blood urea nitrogen						

*Mann-Whitney U Test

Supplementary Table 2: (Extended version of Table 5): Relationship Between Rehospitalization with Noninvasive Ventilation Outcome (NIVO) and Modified NIVO Scores

	Median Score(p25-p75) (Rehospitalized)	Median Score (p25-p75)	p
NIVO	3 (2–4)	3 (1-4)	0.029*
Modified NIVO	4 (2–5)	3 (1-4)	0.004*

*Mann-Whitney U Test

Supplementary Table 3: Sex and Comorbidities and Their Relation with In-hospital Mortality

In hospital mortality				
		Mortality	Survivor	
		n (%)	n(%)	p
Sex	female	10 (12.0)	73 (88.0)	0.704*
		23 (13.8)	144 (86.2)	
Diabetes Mellitus	yes	8 (11.1)	64 (88.9)	0.535*
		25 (14.0)	153 (86)	
Hypertension	yes	20 (11.1)	118 (88.9)	0.503*
		13 (14.0)	99 (86.0)	
Coronary Artery Disease	yes	12 (13.6)	76 (86.4)	0.881*
		21 (13.0)	141 (84)	
Congestive Heart Failure	yes	9 (17.3%)	43 (82.7)	0.325*
		24 (12.1)	174 (87.9)	
History of Pulmonary Embolism	yes	3 (21.4)	11 (78.6)	0.406**
		30 (12.7)	206 (87.3)	
Cancer	yes	3 (15.8)	16 (84.2)	0.724**
		30 (13.0)	201 (87)	
History of Cerebrovascular Accident	yes	3 (50)	3 (50)	0.032**
		30 (12.3)	214 (87.7)	
Bronchiectasis	yes	9 (14.1)	55 (85.9)	0.813*
		24 (12.9)	162 (87.1)	
Post-Tuberculosis Sequelae	yes	7 (17.1)	34 (82.9)	0.423*
		26 (12.4)	183 (87.6)	
Chronic Renal Disease or Insufficiency	yes	4 (21.1)	15 (78.9)	0.291**
		29 (12.6)	202 (87.4)	

*Chi-Square Test, **Fisher's Exact Test

Supplementary Table 4: Sex and Comorbidities and Their Relation with Late Mortality

Late mortality				
		Mortality	Survivor	
		n (%)	n (%)	p
Sex	female	16 (19.3)	67(80.7)	0.840*
		34 (20.4)	133 (79.6)	
Diabetes Mellitus	yes	14 (19.4)	58 (80.6)	0.889*
		36 (20.2)	142 (79.8)	
Hypertension	yes	31 (22.5)	107 (77.5)	0.280*
		19 (17.0)	93 (83.0)	
Coronary Artery Disease	yes	17 (19.3)	71 (80.7)	0.843*
		33 (20.4)	129 (79.6)	
Congestive Heart Failure	yes	13 (25.0)	39 (75.0)	0.311*
		37 (18.7)	161 (81.3)	
History of Pulmonary Embolism	yes	6 (42.9)	8 (57.1)	0.039**
		44 (18.6)	192 (81.4)	
Cancer	yes	6 (31.6)	13 (68.4)	0.229**
		44 (19.0)	187 (81.0)	
History of Cerebrovascular Accident	yes	3 (50.0)	3 (50.0)	0.096**
		47 (19.3)	197 (80.7)	
Bronchiectasis	yes	12 (18.8)	52 (81.3)	0.772*
		38 (20.4)	148 (79.6)	
Post-Tuberculosis Sequelae	yes	9 (22.0)	32 (78.0)	0.733*
		41 (19.6)	168 (80.4)	
Chronic Renal Disease or Insufficiency	yes	4 (21.1)	15 (78.9)	0.550**
		46 (19.9)	185 (81.1)	

*Chi-Square Test, **Fisher's Exact Test

Supplementary Table 5: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting In-hospital Mortality Using NIVO and Modified NIVO Scores

	AUC	Standard Error	p	95% Confidence Interval (C.I.)	p*
Total NIVO	0.729	0.048	0.000	0.634- 0.823	0.5890
Total Modified NIVO	0.708	0.047	0.000	0.615- 0.801	

*DeLong's Test (DeLong et al., 1988)

Supplementary Table 6: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting Late Mortality Using NIVO and Modified NIVO Scores

	AUC	Standard Error	p	95% Confidence Interval	p*
Total NIVO	0.724	0.041	0.000	0.643- 0.805	0.1270
Total Modified NIVO	0.679	0.043	0.000	0.594- 0.764	

*DeLong's Test (DeLong et al., 1988)

Supplementary Table 7: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting In-hospital Mortality Using NIVO and Modified NIVO Scores in Cases with pH < 7.35

	AUC	Standard Error	p	95% Confidence Interval	p*
Total NIVO	0.697	0.065	0.007	0.569- 0.826	0.2299
Total Modified NIVO	0.743	0.063	0.001	0.620- 0.866	

*DeLong's Test (DeLong et al., 1988)

Supplementary Table 8: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting In-hospital Mortality Using NIVO and Modified NIVO Scores in Cases with pH < 7.35 and Home Mechanical Ventilation (HMV)

	AUC	Standard Error	p	95% Confidence Interval	p*
Total NIVO	0.779	0.058	0.010	0.665- 0.892	0.0399
Total Modified NIVO	0.896	0.039	0.000	0.820- 0.972	

*DeLong's Test (DeLong et al., 1988)

Supplementary Table 9: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting Late Mortality Using NIVO and Modified NIVO Scores in Cases with pH < 7.35

	AUC	Standard Error	p	95% Confidence Interval	p*
Total NIVO	0.763	0.052	0.000	0.662- 0.864	0.9362
Total Modified NIVO	0.765	0.050	0.000	0.666- 0.864	

*DeLong's Test (DeLong et al., 1988)

Supplementary Table 10: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting In-hospital Mortality Using NIVO and Modified NIVO Scores in Cases with $7.25 \leq \text{pH} < 7.35$

	AUC	Standard Error	p	95% Confidence Interval	p*
Total NIVO	0.778	0.072	0.001	0.637- 0.919	0.5093
Total Modified NIVO	0.805	0.068	0.000	0.672- 0.938	

*DeLong's Test (DeLong et al., 1988)

Supplementary Table 11: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting Late Mortality Using NIVO and Modified NIVO Scores in Cases with $7.25 \leq \text{pH} < 7.35$

	AUC	Standard Error	p	95% Confidence Interval	p*
Total NIVO	0.832	0.054	0.000	0.726- 0.938	0.5719
Total Modified NIVO	0.813	0.054	0.000	0.708- 0.919	

*DeLong's Test (DeLong et al., 1988)

Supplementary Table 12: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting Late Mortality Using NIVO and Modified NIVO Scores in Cases with pH < 7.35 and Home Mechanical Ventilation (HMV)

	AUC	Standard Error	p	95% Confidence Interval	p*
Total NIVO	0.827	0.049	0.000	0.731- 0.923	0.8105
Total Modified NIVO	0.837	0.054	0.000	0.731- 0.943	

*DeLong's Test (DeLong et al., 1988)

Supplementary Table 13: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting In-hospital Mortality Using NIVO and Modified NIVO Scores in Cases with pH< 7.35 and without Home Mechanical Ventilation (HMV)

	AUC	Standard Error	p	95% Confidence Interval	p*
Total NIVO	0.695	0.087	0.052	0.525- 0.864	0.9332
Total Modified NIVO	0.699	0.085	0.046	0.532- 0.866	

*DeLong's Test (DeLong et al., 1988)

Supplementary Table 14: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting Late Mortality Using NIVO and Modified NIVO Scores in Cases with pH< 7.35 and without Home Mechanical Ventilation (HMV)

	AUC	Standard Error	p	95% Confidence Interval	p*
Total NIVO	0.712	0.081	0.027	0.554- 0.870	0.9195
Total Modified NIVO	0.707	0.079	0.031	0.551- 0.863	

*DeLong's Test (DeLong et al., 1988)

Supplementary Table 15: Multivariate Logistic Regression Analysis* of In-hospital Mortality According to Total NIVO and Total Modified NIVO Scores in Cases with pH< 7.35

			95% CI for OR	
	p Value	OR	Lower	Upper
Total NIVO score	0.044	1.432	1.009	2.033
Total Modified NIVO score	0.005	1.718	1.173	2.518

*Adjusted for Age, Sex, COPD duration

Supplementary Table 16: Multivariate Logistic Regression Analysis* of In-hospital Mortality According to Total NIVO and Total Modified NIVO Scores in Cases with pH< 7.35 and with HMV

			95% CI for OR	
	p Value	OR	Lower	Upper
Total NIVO score	0.035	2.097	1.053	4.176
Total Modified NIVO score	0.012	3.294	1.306	8.306

*Adjusted for Age, Sex, COPD duration

Supplementary Table 17: Multivariate Logistic Regression Analysis* of In-Hospital Mortality According to Total NIVO and Total Modified NIVO Scores

			95% CI for OR	
	p Value	OR	Lower	Upper
Total NIVO score	0.005	1.429	1.115	1.830
Total Modified NIVO score	0.003	1.484	1.143	1.928

*Adjusted for Age, Sex, COPD duration

Supplementary Table 18: Multivariate Logistic Regression Analysis* of Late Mortality According to Total NIVO and Total Modified NIVO Scores

			95% CI for OR	
	p Value	OR	Lower	Upper
Total NIVO score	0.001	1.522	1.244	1.863
Total Modified NIVO score	0.004	1.357	1.121	1.642

*Adjusted for Age, Sex, COPD duration

Supplementary Table 19: Multivariate Logistic Regression Analysis* of Late Mortality According to Total NIVO and Total Modified NIVO Scores in Cases with pH< 7.35

			95% CI for OR	
	p Value	OR	Lower	Upper
Total NIVO score	0.001	1.623	1.208	2.182
Total Modified NIVO score	0.001	1.528	1.164	2.006

*Adjusted for Age, Sex, COPD duration

Supplementary Table 20: Multivariate Logistic Regression Analysis* of Late Mortality According to Total NIVO and Total Modified NIVO Scores in Cases with pH< 7.35 and with HMV

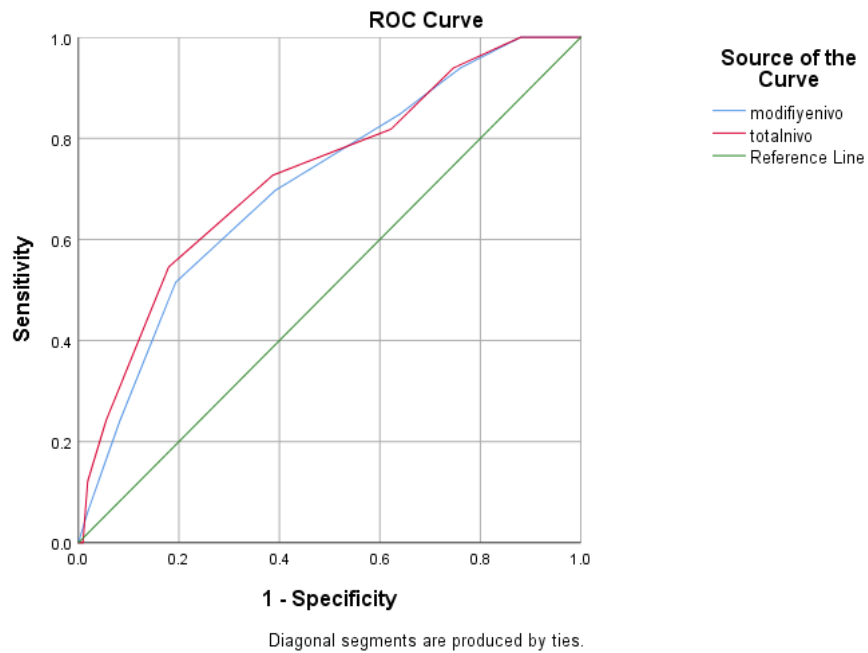
			95% CI for OR	
	p Value	OR	Lower	Upper
Total NIVO score	0.002	2.113	1.239	3.605
Total Modified NIVO score	0.003	1.770	1.161	2.697

*Adjusted for Age, Sex, COPD duration

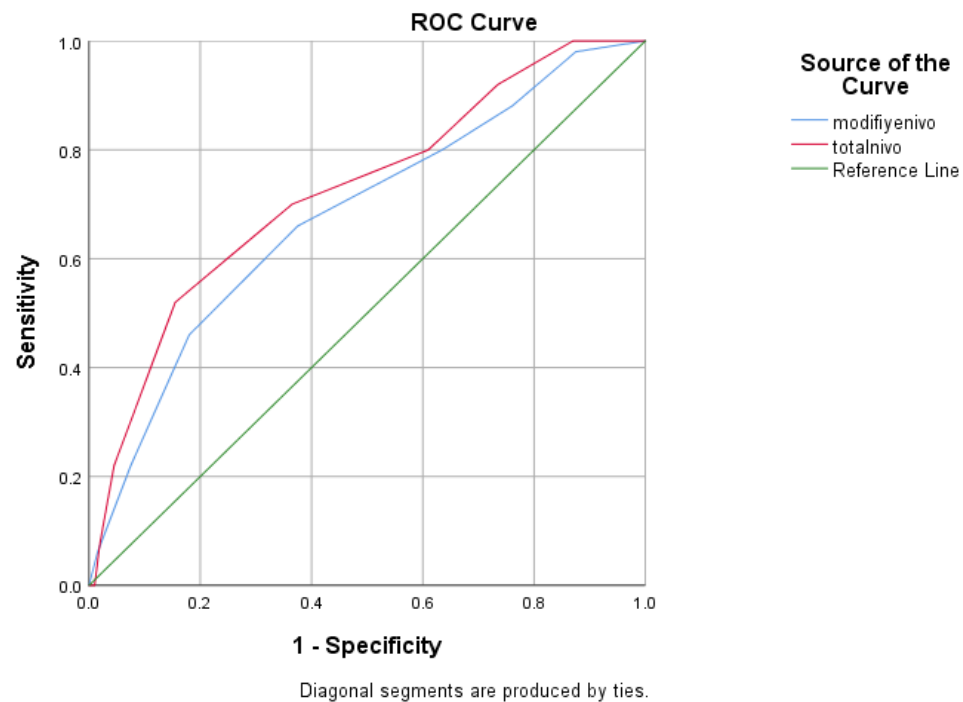
Supplementary Table 21: Area Under the Receiver Operating Characteristic Curve (AUC) for Predicting Intubation Using NIVO and Modified NIVO Scores

	AUC	Standard Error	p	95% Confidence Interval
Total NIVO	0.748	0.043	0.000	0.663- 0.833
Total Modified NIVO	0.726	0.043	0.000	0.642- 0.810

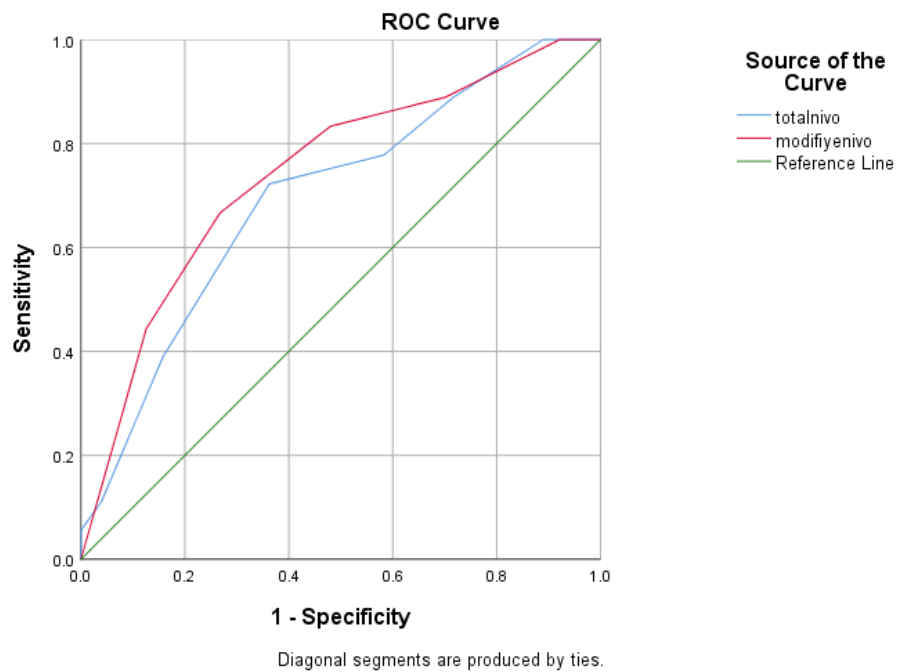
Supplementary Figure 1: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting In-hospital Mortality



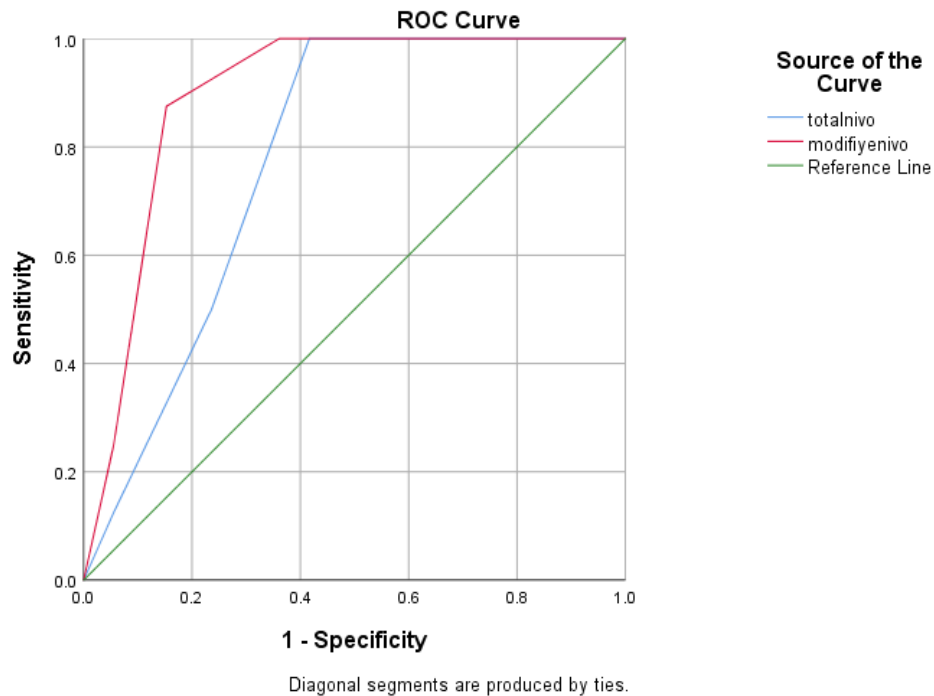
Supplementary Figure 2: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting Late Mortality



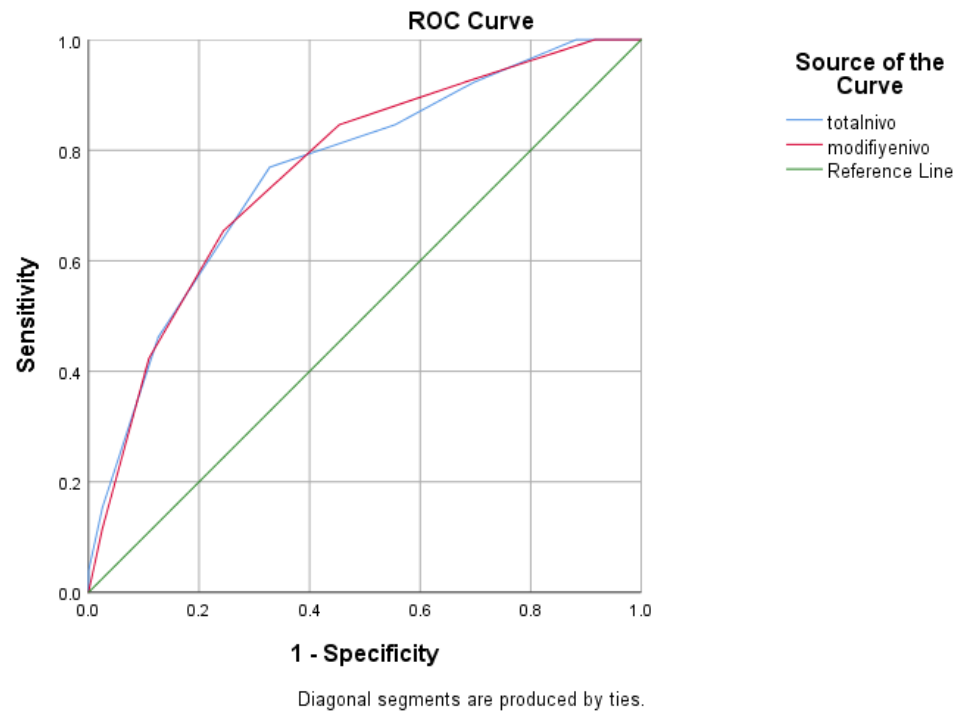
Supplementary Figure 3: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting In-hospital Mortality in Cases with pH < 7.35



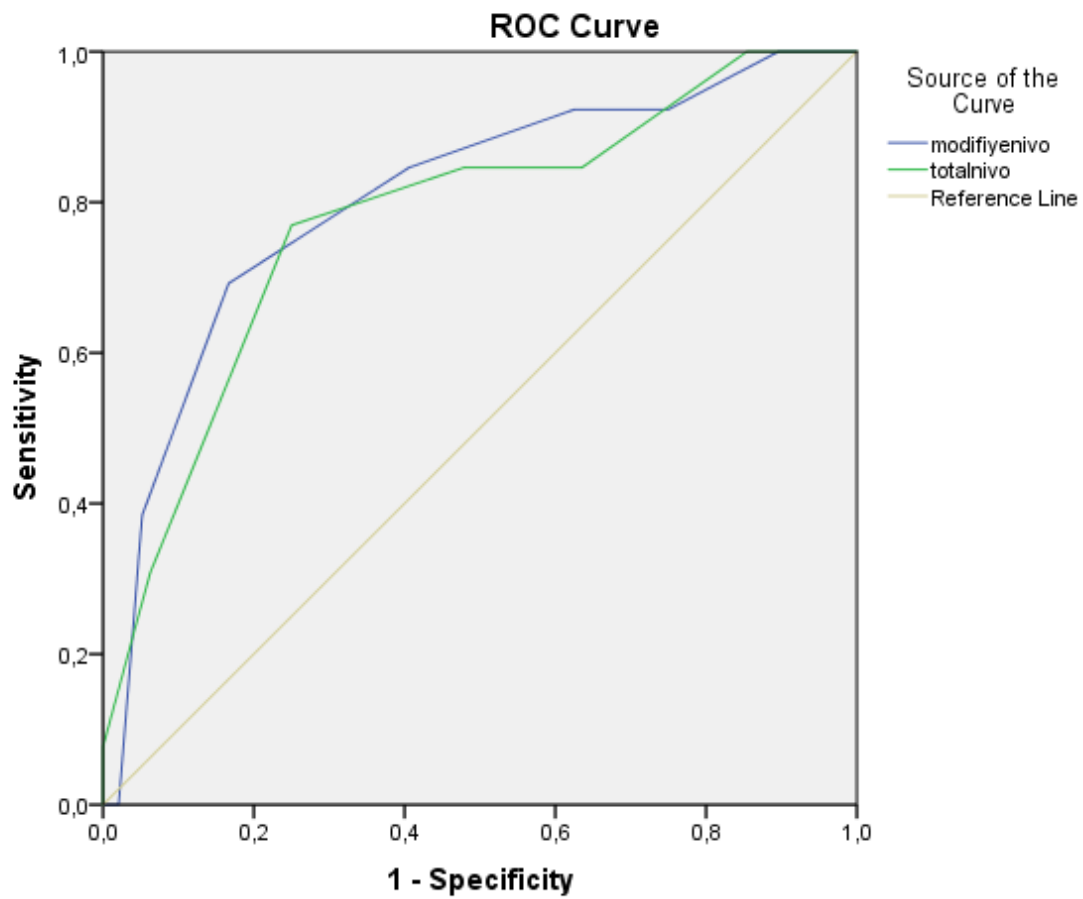
Supplementary Figure 4: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting In-hospital Mortality in Cases with pH < 7.35 and Home Mechanical Ventilation (HMV)



Supplementary Figure 5: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting Late Mortality in Cases with pH < 7.35

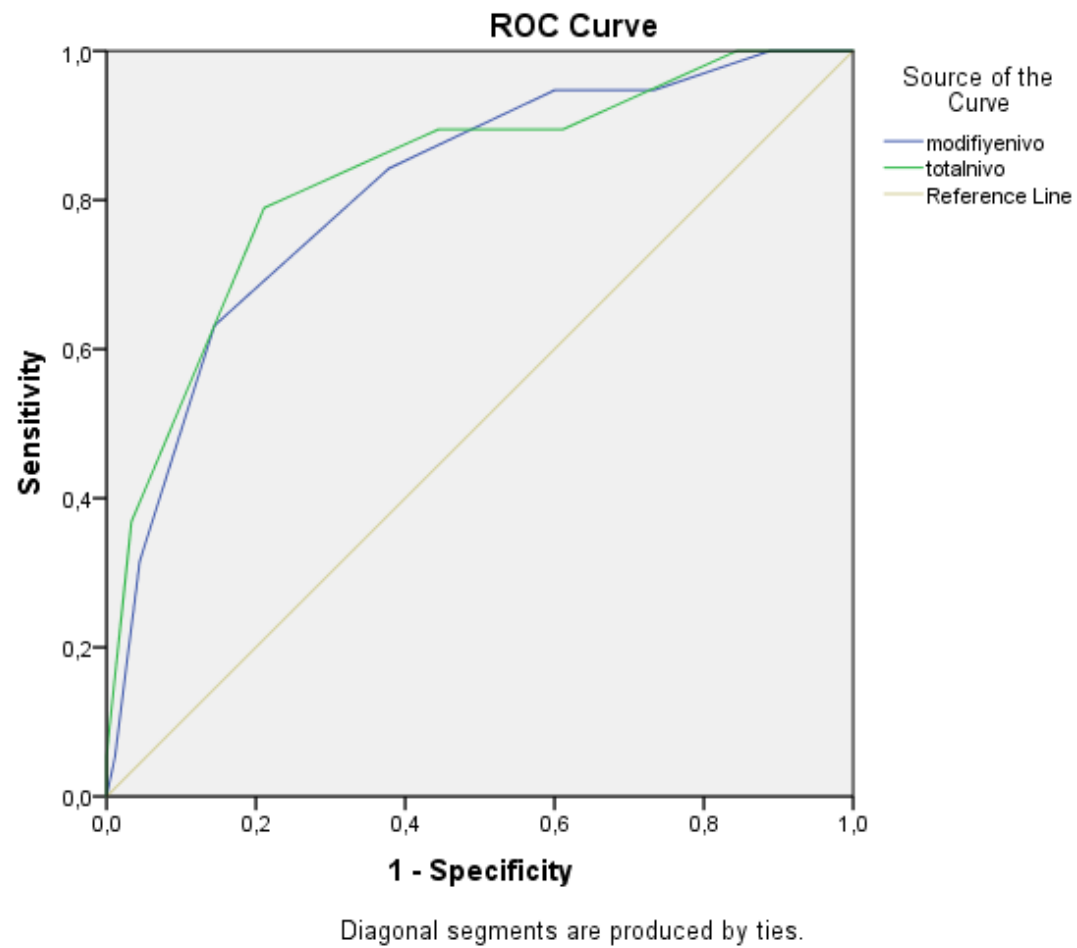


Supplementary Figure 6: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting In-hospital Mortality in Cases with $7.25 \leq \text{pH} < 7.35$

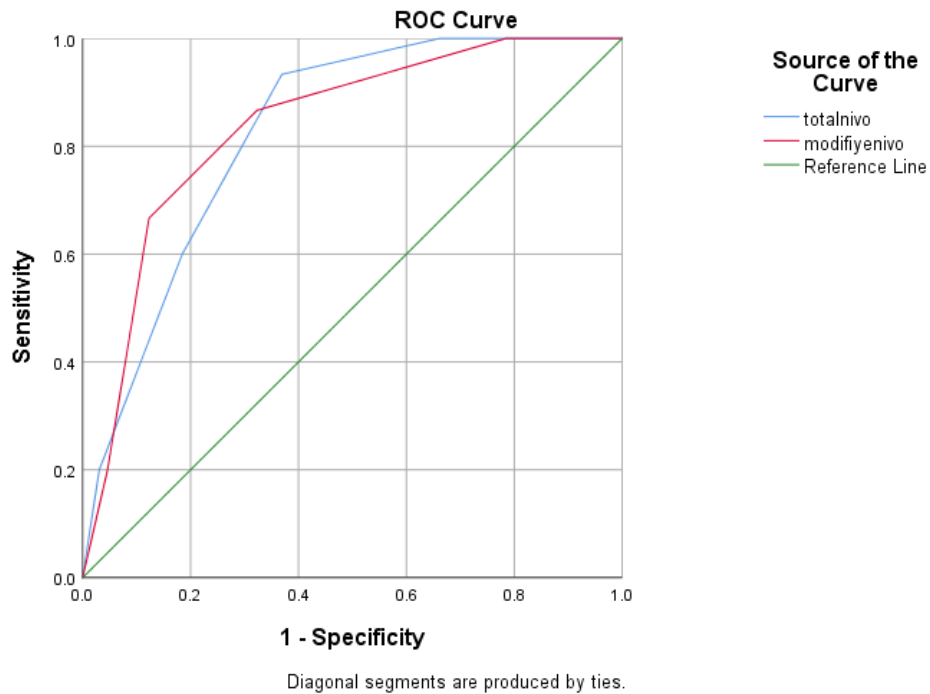


Diagonal segments are produced by ties.

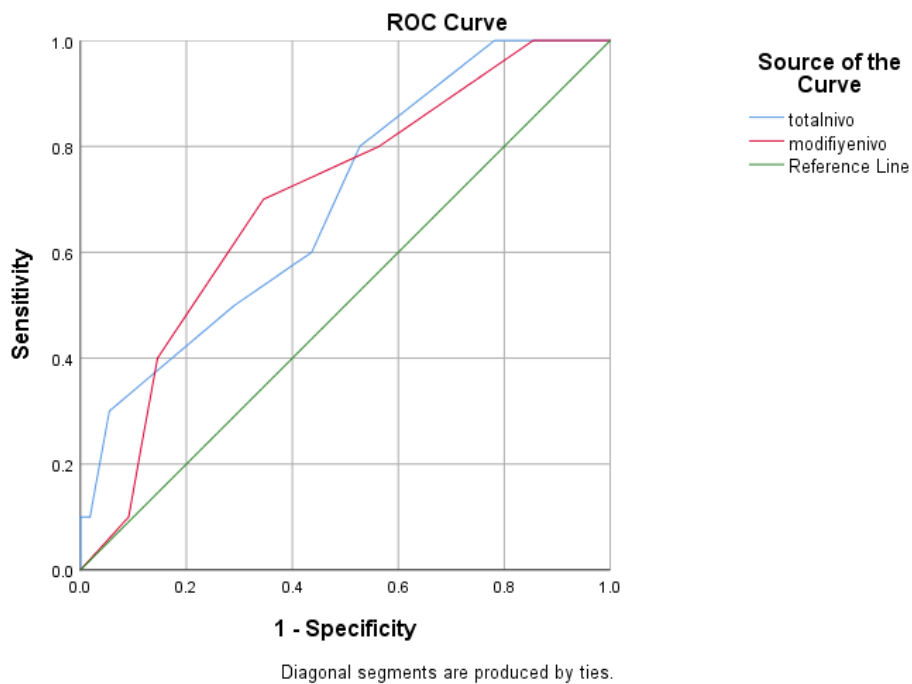
Supplementary Figure 7: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting Late Mortality in Cases with $7.25 \leq \text{pH} < 7.35$



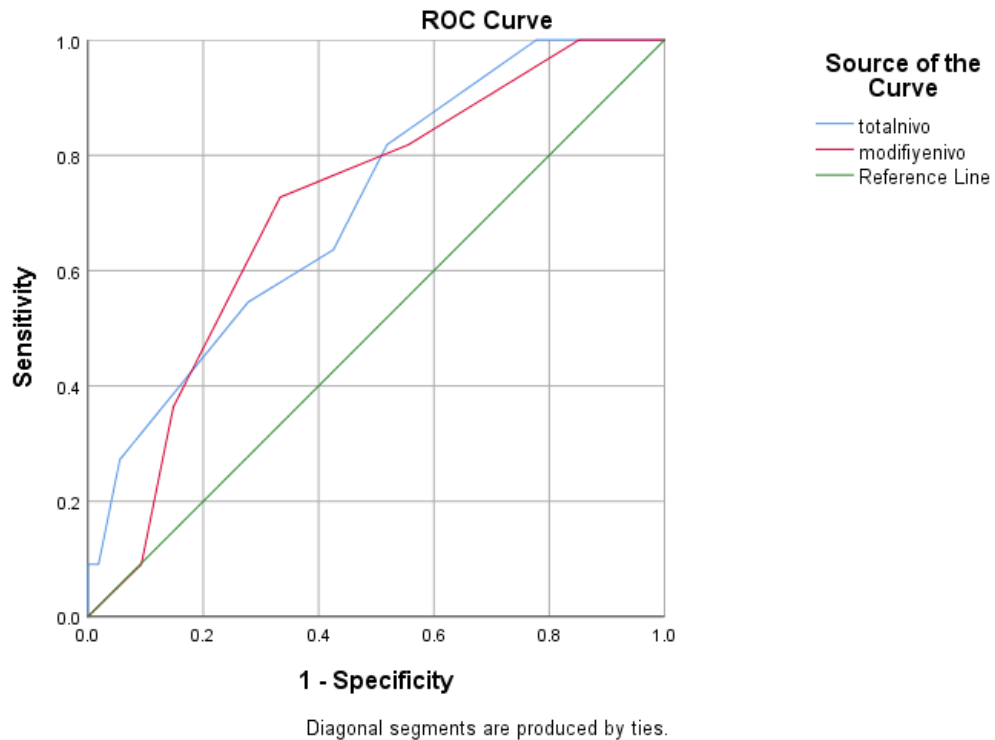
Supplementary Figure 8: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting Late Mortality in Cases with pH < 7.35 and Home Mechanical Ventilation (HMV)



Supplementary Figure 9: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting In-hospital Mortality in Cases with pH < 7.35 and without Home Mechanical Ventilation (HMV)



Supplementary Figure 10: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting Late Mortality in Cases with pH < 7.35 and without Home Mechanical Ventilation (HMV)



Supplementary Figure 11: Receiver Operating Characteristic (ROC) Curves of NIVO and Modified NIVO Scores for Predicting Intubation

