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Comparison of DECAF score and DECAF+Lactate score in the prediction of mortality in patients with acute exacerbation of COPD

Poređenje skora DECAF i skora DECAF+Laktat u predikciji mortaliteta kod bolesnika sa akutnim pogoršanjem HOBP

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Abstract

Background/Aim. Chronic obstructive pulmonary disease (COPD) is a chronic process that progresses with exacerbations. Various studies are carried out to predict mortality. Among the routine tests used to monitor and treat disease in the emergency department, special efforts are made to find those that are meaningful and diagnostic. The aim of the study was to compare the DECAF score and DECAF+Lactate score and examine the significance of the DECAF+Lactate score in predicting mortality in critically ill patients presenting with COPD exacerbation. **Methods**. This prospective multicentric study included 435 patients recruited from two centers. Patients who presented to the emergency department with acute COPD exacerbation and fit the definition of critically ill according to the quick Sequential Organ Failure Assessment (qSOFA) were included in the study. The prognostic values of the scores were compared using the receiver operating characteristic (ROC) curve analysis. The efficiency of scoring 28-day mortality was compared with logistic regression analysis. **Results**. For 435 patients, sensitivity, specificity, and area under the curve (AUC) were calculated for lactate, DECAF score, and DECAF+Lactate score, which were statistically significant in the ROC curve analysis for predicting mortality: 50%, 90.2%, 0.711, odds ratio (OR): 0.622 [95% confidence interval (CI): 1.573–2.203]; 57.6%, 64.3%, 0.654, OR: 0.618 (95%CI: 1.501–2.291); 60.1%, 75.4%, 0.744, OR: 0.790 (95%CI: 1.826–2.659), respectively. Each unit increase in the DECAF+Lactate score increased the risk of mortality by 2.203. **Conclusion**. As a result of our study, we believe that the DECAF+Lactate score is a more effective scoring system than the DECAF score as a predictor of mortality in critically ill patients with COPD exacerbation.

Key words:
critical illness; lactates; mortality; prognosis; pulmonary disease, chronic obstructive; sensitivity and specificity; severity of illness index.

Apstrakt

Uvod/Cilj. Hronična opstruktivna bolest pluća (HOBP) je hroničan proces koji napreduje sa egzacerbacijama. Da bi se predvidela smrtnost obolelih, sprovode se razne studije. Među rutinskim testovima koji se koriste za praćenje i lečenje bolesti u hitnoj pomoći, posebno se nastoji da se pronađu testovi koji su smisleni i dijagnostički. Cilj rada bio je da se uporedi skor DECAF i skor DECAF+Laktat i ispita značaj skora DECAF+Laktat u predikciji smrtnosti kritično obolelih bolesnika sa pogoršanjem HOBP. **Metode.** Prospektivnom multicentričnom studijom obuhvaćeno je 435 bolesnika iz dva centra. U studiju su uključeni bolesnici koji su se javili u odeljenje hitne pomoći sa akutnim pogoršanjem HOBP i koji su odgovarali definiciji kritično bolesnih prema skoru *quick Sequential Organ Failure Assessment* (qSOFA). Prognostičke vrednosti skorova upoređene su korišćenjem analize *receiver operating characteristic* (ROC) krive. Efikasnost bodovanja 28-dnevnog mortaliteta upoređena je korišćenjem logističke regresione analize. **Rezultati.** Za 435 bolesnika izračunati su osetljivost, specifičnost i *area under the curve* (AUC) za laktate, DECAF i DECAF+Laktat skorove, koji su bili statistički značajni u ROC analizi za predikciju mortaliteta: 50%, 90,2%, 0,711, *odds ratio* (OR):

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0,622 [95% *confidence interval* – CI: 1,573–2,203]; 57,6%, 64,3%, 0,654, OR: 0,618 (95%CI: 1,501–2,291%); 60,1%, 75,4%, 0,744, OR: 0,790 (95%CI: 1,826–2,659), redom. Svako povećanje jedinice u skoru DECAF+Laktat povećavalo je rizik od smrtnosti za 2,203. **Zaključak.** Kao rezultat naše studije, verujemo da je skor DECAF+Laktat efikasniji sistem bodovanja od skora DECAF, kao prediktor mortaliteta kod kritično obolelih osoba sa pogoršanjem HOBP.

Ključne reči:
kritična stanja; laktati; mortalitet; prognoza; pluća, opstruktivne bolesti, hronične; osetljivost i specifičnost; bolest, indeks težine.

Introduction

Chronic obstructive pulmonary disease (COPD) is a treatable and preventable respiratory disease characterized by airflow limitation and respiratory symptoms due to permanent damage to the airway and alveoli, which may also be caused by exposure to harmful particles and/or gases and lung development abnormalities [1]. COPD is a chronic process that progresses with exacerbations. An exacerbation is an acute increase or worsening of the symptoms of the disease [2]. Although COPD exacerbation is a generalization by definition, COPD and COPD exacerbation is a condition that differs according to time and patient and has different treatment options.

Various studies are carried out to predict mortality and morbidity and to regulate treatment options for this disease, which has high mortality and morbidity and is increasing day by day. Studies are trying to find easier and cheaper methods. In these studies, researchers are especially trying to find meaningful and diagnostic tests, among the routine ones, for monitoring and treating the disease in the emergency department.

Lactate from laboratory tests is one of the most used parameters for mortality and morbidity [3]. It is also used in critical patients, sepsis, septic shock patients, hemorrhagic shock due to trauma or various reasons, evaluation of the patient, prediction of mortality, and evaluation of response to treatment [4]. In the patient follow-ups, lactate, which tends to increase, should be remarkable. For clinicians, lactate levels of 4 and above are associated with high-risk mortality [5].

In all studies, it was aimed to predict the clinical course and mortality with the blood values performed on the patients. Mortality is divided into short-term and long-term mortality according to the time of occurrence. DECAF (Dyspnea, Eosinopenia, Consolidation, Acidemia, atrial Fibrillation) score is a prognostic tool for routine estimation of mortality and morbidity in COPD [6]. DECAF score provides superiority in clinical decision and prognostic performance [7].

The aim of this study was to compare the DECAF score and DECAF+Lactate score and examine the effectiveness of the DECAF+Lactate score in predicting the mortality of critically ill patients with COPD exacerbation.

Methods

Study design and data collection

The Ethics Committee of the Istanbul Kanuni Sultan Suleyman Research and Training Hospital approved the study (Decision No. KAEK/2020.07.154). The study was performed according to the recommendations set by the Declaration of Helsinki on Medical Research involving Human Subjects and Good Clinical Practice guidelines. The study involved recruited patients from August 1, 2020, to December 31, 2021. Informed consent was obtained from all patients included in the study. Data and materials are reachable from hospital automation information systems.

As a criterion for inclusion in the study, the qSOFA score of the patients at the time of admission was accepted as 2 or above. Patients with worsening treatment for an existing infection, known malignant disease, renal failure, hematological or rheumatological disease, or additional diagnoses that could change the lactate value were excluded from the study.

A total of 502 patients with acute exacerbation of COPD who met the definition of critically ill (qSOFA $\geq$ 2), 228 from one and 274 from the other center, were included in the study. Eighteen of 502 patients were excluded from the study because they did not want treatment for various reasons, and their relatives left the emergency department to apply to another center. Twenty-eight of them could not be diagnosed with COPD from e-pulse (personal health record system in our country) or their past records, and 21 of them could not be found to have a mortality status. A total of 435 patients who met the inclusion criteria were included in the study (Figure 1).

Gender, background (chronic diseases), drug use, clinical follow-up, and 28-day mortality information of the patients were recorded.

On the first admission, fever, pulse, systolic and diastolic pressures, respiratory rates, Glasgow Coma Scale (GCS) values, and fingertip oxygen saturation (SpO_2) measurements of the patients taken before treatment were recorded. Furthermore, eosinophil values from hemogram parameters obtained from patients on the first admission and lactate and pH values obtained from arterial blood gas were recorded.

Score calculations

When calculating the DECAF score of the patients, the presence of dyspnea, eosinopenia, consolidation, acidosis, and atrial fibrillation (AF) was scored. Patients with a respiratory rate of 30 and above were included in the 5b group in the expanded modified Medical Research Council scale, and those below 30 were included in the 5a group. For eosinophil count, values < 0.05×10^9/L were accepted as eosinopenia.

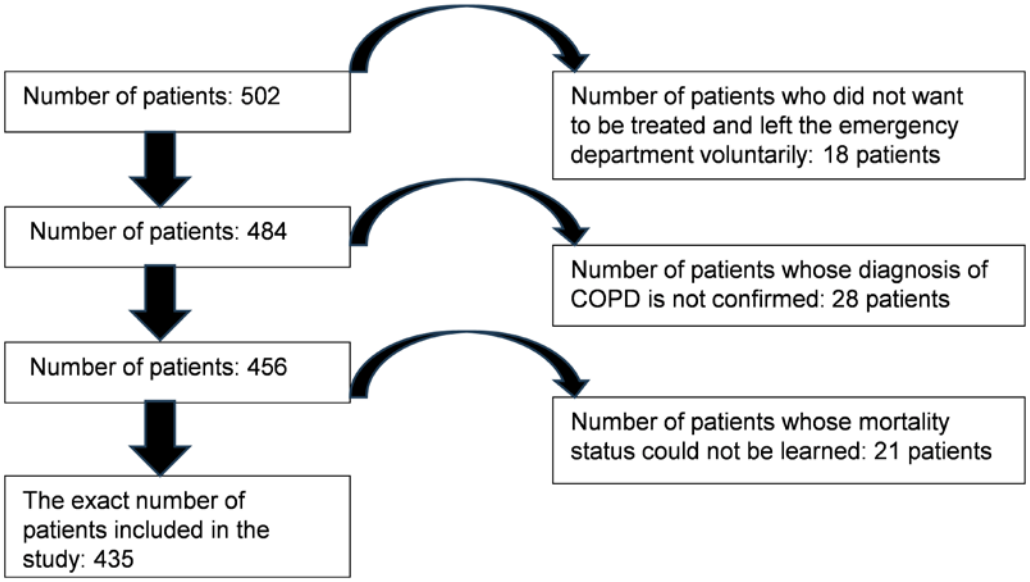

Fig. 1 – Flow chart of patients.

The performed posterior-anterior chest radiographs were evaluated by emergency medicine specialists for consolidation. A pH value below 7.3 was considered significant for acidosis. Electrocardiograms (ECGs) taken for the detection of AF were evaluated by emergency medicine specialists. DECAF score was calculated by adding one point each for 5a dyspnea, eosinopenia, consolidation, acidosis, and AF detection, and two points for the 5b dyspnea group. Patients with a DECAF score between 0–1 were included in the mild risk group, those with a score of 2 were included in the intermediate risk group, and patients with a score of 3 and above were included in the high-risk patient group for mortality. Lactate values for the DECAF+Lactate score, which we planned in order to have a more effective scoring than the DECAF score in our study, were calculated by adding 0 points for the score 0–2, 1 point for 2–4, and 2 points for > 4 to the DECAF scores.

Statistical analysis

The obtained data were analyzed in the SPSS Statistics 26.0 (IBM Inc., New York, USA) program. The Kolmogorov-Smirnov test was used to test the normality of the distribution of data. Categorical data are displayed as numbers and percentages. Continuous variables that comply with normal distribution are shown as mean ± standard deviation, and continuous variables that do not comply with normal distribution are shown as median (interquartile range). Pearson's Chi-square test was used to compare categorical data. Continuous variables were subjected to pairwise group analysis using the Mann-Whitney *U* test and independent sample *t*-test. Logistic regression analysis and receiver operating characteristic (ROC) curve analyses were performed to determine the effect of independent variables, found to be significant between groups, on mortality. The value of $p < 0.05$ was considered statistically significant.

Results

A total of 435 patients, 261 (60%) men and 174 (40%) women, whose vital signs met the criteria of critically ill patients [quick Sequential Organ Failure Assessment (qSOFA) ≥ 2] with COPD exacerbation and who applied to the emergency medicine clinic of the two tertiary care training and research hospitals, were included in our study. When the known chronic comorbidities of the patients were examined, we found that the most common diseases were hypertension in 220 (50.6%) patients, diabetes mellitus in 120 (27.6%) patients, and congestive heart failure in 82 (18.9%) patients.

When the regular drug use of the patients was questioned, we found that 388 (89.2%) patients used it for their chronic diseases, and 47 (10.8%) did not use it at all. During the follow-up, we found that 37 (8.5%) patients died in the emergency department, 268 (61.6%) were admitted to the intensive care unit, 28 (6.4%) were discharged, and 38 (8.7%) left the hospital for different reasons. When the 28-day mortality status of the patients was examined, we found that 158 (36.3%) patients died and 277 (63.7%) survived. In the analysis of patients' DECAF parameters, we found dyspnea in 116 patients, eosinopenia in 115, consolidation in 301, acidosis in 398, and AF in 120 patients (Table 1).

When we calculate the DECAF scores of the patients, 3 (0.7%) patients were in the mild-risk group, 78 (17.9%) were in the medium-risk group, and 354 (81.4%) were in the high-risk group.

When we grouped the patients according to mortality, we found a significant relationship between these groups and the DECAF risk group and its subgroups ($p < 0.001$). Again, we found a statistically significant relationship between mortality and dyspnea, eosinopenia, consolidation, and acidosis ($p < 0.001$, $p < 0.001$, $p < 0.001$, $p = 0.021$, respectively). No significant correlation was found between the presence of AF and mortality in the patients ($p = 0.325$) (Table 1).

When we examined the vital parameters and scores of the patients, we found that in the "survivors" group, heart rate, respiratory rate, lactate, DECAF, and DECAF+Lactate scores were statistically significantly higher than in the "non-survivors" group ($p < 0.001$). Again, we found statistically significantly lower systolic and diastolic blood pressures, SpO_2, GCS, and eosinophil values in the group with mortality compared to the group without mortality ($p < 0.001$). When we compared the high-risk group with 3 or more points according to the DECAF score and other patients, we found that body temperature, heart rate, respiratory rate, lactate, and DECAF+Lactate values in the high-risk group were statistically significantly higher compared to the group with lower DECAF score ($p = 0.01$, $p = 0.001$, $p < 0.001$, $p = 0.016$, $p < 0.001$, respectively). We found that the systolic and diastolic blood pressures, SpO_2, GCS, and eosinophil counts of the patients in the high-risk group were statistically significantly lower than in the other group ($p < 0.001$) (Table 2).

ROC curve analysis was performed for independent variables with statistical significance for the presence of mortality. Cut-off, sensitivity, and specificity values of variables with the statistically significant area under the curve (AUC) were calculated (Tables 3 and 4). It was observed that the AUC of the DECAF+Lactate score was higher than DECAF and lactate, and the odds ratio (OR) was higher. It was determined that each unit increase in the DECAF+Lactate score increased the mortality risk by 2.203 (OR: 2.203; 95% CI: 1.826–2.659).

Table 1

Characteristics of the study participants

Parameter	Survivors (n = 277)	Non-Survivors (n = 158)	*p*-value
Gender			
male	165 (37.9)	96 (22.1)	0.807
female	112 (25.7)	62 (14.3)	
Diabetes melllitus	69 (15.9)	51 (11.7)	0.098
Hypertensio arterialis	135 (31)	85 (19.5)	0.310
Coronary artery disease	67 (15.4)	50 (11.5)	0.092
Congestive heart failure	40 (9.2)	42 (9.7)	**0.002**
Acute renal failure	7 (1.6)	4 (0.9)	0.613*
Chronic renal failure	26 (6)	20 (4.6)	0.286
DECAF score			
0–2	67 (15.4)	14 (3.2)	**< 0.001**
≥ 3	210 (48.3)	144 (33.1)	
Dyspnea (respiratory rate), ≥ 30/min	56 (12.9)	60 (13.8)	**< 0.001**
Eosinopenia (eosinophils < 0.05×10^9/L)	55 (12.6)	60 (13.8)	**< 0.001**
Consolidation	178 (40.9)	123 (28.3)	**0.003**
Acidosis (pH < 7.3)	247 (56.8)	151 (34.7)	**0.021**
AF (including history of AF)	72 (16.6)	48 (11)	0.325

DECAF – Dyspnea, Eosinopenia, Consolidation, Acidemia, atrial Fibrillation; AF – atrial fibrillation. All values are given as numbers (percentages). Pearson Chi-square test; *Fisher's exact test.

Table 2

Analysis of vital signs, DECAF, and DECAF+Lactate scores according to the presence of mortality

Parameters	Survivors (n = 277)	Non-survivors (n = 158)	*p*-value	[1]DECAF score 0–2 (n = 81)	[2]DECAF score ≥ 3 (n = 354)	*p*-value
Body temperature (°C)	36.70 [0.60]	36.70 [0.80]	0.636	36.70 [0.45]	36.80 [0.80]	**0.010**
Heart rate (*per* minute)	87 [20]	96 [24.25]	**< 0.001**	84 [17]	90 [22]	**0.001**
Systolic blood pressure (mmHg)	125.36 ± 27.01	110.37 ± 28.04	**< 0.001**	130.20 ± 22.28	117.56 ± 29.02	**< 0.001**
Diastolic blood pressure (mmHg)	80.45 ± 14.75	73.68 ± 17.83	**< 0.001**	82.44 ± 13.27	76.98 ± 16.70	**0.002**
SpO_2 (%)	88 [9]	80 [15]	**< 0.001**	90 [8]	84 [12.25]	**< 0.001**
Respiration rate (*per* min)	27 [4]	28 [6]	**< 0.001**	26 [3]	28 [4]	**< 0.001**
Glasgow Coma Scale	13 [1]	13 [1]	**< 0.001**	14 [1]	13 [2]	**0.001**
Eosinophil count (10^3 µL)	0.71 ± 0.63	0.37 ± 0.47	**< 0.001**	0.81 ± 0.68	0.53 ± 0.57	**0.001**
Lactate (mmol/L)	1.84 [1.01]	2.98 [3.13]	**< 0.001**	1.84 [1.05]	2.14 [1.65]	**0.016**
DECAF Score	3.19 ± 0.93	3.80 ± 1.05	**< 0.001**	1.96 ± 0.19	3.75 ± 0.82	**< 0.001**
DECAF+Lactate score	3.66 ± 1.10	4.87 ± 1.39	**< 0.001**	2.46 ± 0.65	4.47 ± 1.17	**< 0.001**

Data that were not normally distributed were shown as median [interquartile range] and the Mann-Whitney *U* test was used. Normally distributed data are given as mean ± standard deviation and an Independent sample *t*-test was used.

SpO_2 – oxygen saturation. For other abbreviations, see Table 1.

[1] – mild/intermediate risk group of patients; [2] – high-risk patient group.

Table 3

ROC curve analysis results of scorings and lactate values

Test variables (cut-off)	AUC	Sensitivity %	Specificity %	NPD %	PPD %	*p*-value	Accuracy %
DECAF (≥ 3.5)	0.654	57.59	64.26	72.65	47.89	< **0.001**	61.84
Lactate (≥ 3.07 mmol/L)	0.711	50.00	90.25	75.99	74.53	< **0.001**	75.63
DECAF+Lactate (≥ 4.5)	0.744	60.13	75.45	76.84	58.28	< **0.001**	69.89

ROC – receiver operating characteristic; AUC – area under the ROC curve; NPD – negative predictive value; PPD – positive predictive value

Table 4

Logistic regression analysis results of scorings and lactate values

Test variables (cut-off)	β	*p*-value	OR	95% CI	
				lower bound	upper bound
DECAF	0.618	< **0.001**	1.855	1.501	2.291
Lactate	0.622	< **0.001**	1.862	1.573	2.203
DECAF+Lactate	0.790	< **0.001**	2.203	1.826	2.659

OR – odds ratio; CI – confidence interval.

Discussion

Lactate is one of the parameters used in the diagnosis and treatment effectiveness of critically ill patients. In our study, the effectiveness of lactate in demonstrating mortality in patients presenting with COPD exacerbation was discussed. DECAF+Lactate scoring is formed by adding lactate to the DECAF scoring, which is used to predict mortality in critically ill patients presenting with COPD exacerbation. The effectiveness of the DECAF+Lactate scoring in predicting mortality was investigated. DECAF+Lactate score was found to be more effective in predicting mortality.

In a study in which mortality scoring of 2,645 COPD patients was performed, it was found that 47% of the patients could not leave their homes without assistance, 29.8% had consolidation, and 17.9% had acidosis [6]. In a study examining patients diagnosed with COPD exacerbation, the prevalence of arrhythmia was reported as 97%. In the study where 24-hour Holter ECG monitoring results were recorded, the most common arrhythmias were ventricular premature beats, while permanent AF was detected in 30.3% of patients [8]. We think the presence of consolidation and acidosis in our study differs from the literature because we included only critical patients in the study rather than all COPD exacerbations.

It has been observed that the DECAF score can be scored on admission and can accurately predict the risk of death [6]. In a cohort study, the DECAF score was found to be a better predictor of mortality than the CURB-65 score [9]. In COPD exacerbations with pneumonia, DECAF was also reported as a stronger score for predicting hospital mortality [10]. In a study examining COPD exacerbation, DECAF and CURB-65 were found to have similar sensitivity, but DECAF was shown to be more specific for mortality than CURB-65 [11]. In our study, the DECAF score was significantly higher in the mortality group, and the fact that we used it instead of CURB-65 also receives support from the literature.

When we grouped the patients according to the presence of mortality, it was found that the heart rate, respiratory rate, lactate, DECAF, and DECAF+Lactate scores were statistically significantly higher in the group with mortality compared to the group without mortality. Again, systolic and diastolic blood pressures, SpO_2, GCS, and eosinophil values were found to be statistically significantly lower in the group with mortality compared to the group without mortality. In a systematic review, it was reported that the target systolic blood pressure was 70 mmHg and above in critically ill patients, and hypotension lasting longer than 24 hrs was found to be associated with increased mortality [12]. It is more clearly mentioned in the literature that hypotension causes an increase in myocardial damage, acute kidney injury, and death rates in critically ill and septic shock patients [13]. In a study conducted with 736 intensive care patients, intermittent systolic, diastolic, and mean blood pressures were measured. In critically ill hypotensive adult patients, the mean blood pressure of 65 mmHg and below has been shown to be excessive [14].

It has been reported that the risk of cardiovascular events is higher in patients diagnosed with COPD compared to the other population. That being said, approximately 30% of patients with COPD die for these reasons, and the risk of myocardial infarction in these patients increases in the days following acute exacerbation [15]. It has been observed that increased oxidative stress and inflammation during exacerbation may lead to an increased incidence of cardiovascular events. Additionally, DM, which is frequently seen with COPD, has been associated with high mortality in hospitalizations [16]. We think that the comorbidities present in COPD patients are the main reason for the high mortality of the disease.

When we compare the high-risk group with 3 or more points according to the DECAF score and the other patients, body temperature, heart rate, respiratory rate, and lactate values in the high-risk group were found to be statistically significantly higher when compared to the group with a low-

er DECAF score. The systolic and diastolic blood pressures, SpO_2, GCS, and eosinophil counts of the patients in the high-risk group were found to be statistically significantly lower than the other group. DECAF is a risk stratification tool designed to estimate the risk of death in COPD patients in acute exacerbation [10]. The fact that the DECAF score was designed for mortality estimation explains these statistical differences. In our study, a significant correlation was found between mortality and DECAF score.

In a meta-analysis, sensitivity, specificity, and AUC of the DECAF score for 30-day mortality were calculated and reported to be 71%, 75%, and 0.79, respectively [7]. In our study, the sensitivity and specificity values of the DECAF score for the estimation of mortality were 57.6% and 64.3%, respectively, and AUC was 0.65. In our study with critically ill patients, we think the difference in results depends on our patient group.

ORs were determined by performing ROC curve analysis for the independent variables and regression analysis for mortality for the independent variables that we found statistically significant for the presence of mortality. It was determined that the DECAF+Lactate score, which we designed as a predictor of mortality in COPD exacerbation patients, had higher AUC and ORs than the DECAF score and lactate. It was found that each unit increase in the DECAF+Lactate score increased the mortality risk by 2.203.

The limitations of our study include the evaluation of the direct radiographs of the patients by emergency medicine specialists, the lack of standardization, and the inability to perform Cox regression analysis due to the lack of daily mortality follow-up of the patients. The fact that the number of patient applications due to the COVID-19 pandemic continued to rise during the period when the study was conducted can also be considered a limitation. It should also be acknowledged that more comprehensive studies are needed to add a new scoring system to the literature.

Conclusion

Each unit increase in the DECAF+Lactate score increases the risk of mortality by 2.203. As a result of our study, we believe that the DECAF+Lactate score is a more effective scoring system than the DECAF score as a predictor of mortality in critically ill patients with COPD exacerbation.

Conflict of interest

The authors of this paper have no conflict of interest, including specific financial interests, relationships, and/or affiliations relevant to the subject matter or materials included.

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