Predictive performance of PiCCO system and blood gas parameters for early prognosis of patients with sepsis

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Research

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Abstract

**Purpose:** Invasive hemodynamics monitor directed fluids resuscitation remains misgiving issues. This study aims to explore the predictive value of the PiCCO system (pulse indicator continuous cardiac output device) and blood gas parameters on the early prognosis of patients with sepsis.

**Methods:** 42 patients with sepsis were included from January 2013 to January 2015. All patients were stratified into survivor group (n=29) and nonsurvivor group (n=13) based on seven day-mortality. The PiCCO and blood gas parameters at enrollment and 24 hours were compared between two groups. The predictive performance of these parameters was distinguished with Area Under the Receiver Operating Characteristic Curve (AUC).

**Results:** At 24 hours after enrollment, the HR (97.27±22.07 vs. 120.20±20.56), extravascular lung water index (EVLWI) (7.32±2.96 vs. 15.9±11.2), and lactic acid (Lac) (1.62±0.92 vs. 6.33±5.83) level were significantly lower in survivor group ($P < 0.05$), whereas the cardiac index (CI) (3.67±0.85 vs. 2.98±0.73) and PaO$_2$/FiO$_2$ (242.8±89.68 vs.136.07±78.01) increased significantly. Meanwhile PaO$_2$/FiO$_2$ was negatively correlated with EVLWI ($r = -0.673$, $P < 0.01$). The AUC of the combination of Lac with PaO$_2$/FiO$_2$, HR, EVLWI, pulmonary vascular permeability index (PVPI) and Lac at 24 hours were 0.853, 0.739, 0.776, 0.764, and 0.794.

**Conclusions:** The PiCCO and blood gas parameters exhibit superior predictive capability for early prognosis in patients with sepsis, and the combination Lac with PaO$_2$/FiO$_2$ was noninferior under the circumstance of unavailability with PiCCO.

Introduction

Although numerous therapeutic approaches have been employed, sepsis remains one of the major causes of death in the intensive care unit (ICU)[1]. As recommended by the Surviving Sepsis Campaign guidelines, early fluid resuscitation occupies the core of the therapeutic bundle[2]. Nevertheless, the contrary pieces of the evidence challenge the reliability of the fluid treatment. Fluid overload can increase the risk of organ dysfunction, including acute lung injury and acute renal injury, thus lead to high mortality[3]. Hence, it is crucial to ensure fluid balance based on the stable circulation system.

The PiCCO (Pulse index continuous cardiac output) system as the representative of invasive techniques permits the monitoring of hemodynamic status including vascular tone, fluid load and cardiac function, following responding comprehensively physiological condition, such as fluid responsiveness, oxygenation and pulmonary oedema. Although the application of PiCCO emerged promptly in recent times, some disputes remain yet clarified. Whether the static parameters derived from PiCCO can present full disclosure of the volume evolution, the threshold of some settings can be the best guidance to clinical practice, and this technique can authentically improve or predict the clinical outcomes[4]. Furthermore, the risk of invasive manipulation and high expense under some circumstance drive the implementation of PiCCO into irresolute. The blood gas analysis, as a routine laboratory test characterized by easy
accessibility, minimally invasiveness, and low price, still keep strong vitality to assess the oxygenation status and acid-base balance for critically illness patients[5].

We conducted this study to reflect the forecast value of PiCCO system on early clinical outcome in patients with sepsis and further compare the link between PiCCO with blood gas parameters.

**Methods**

**Study design**

This retrospective study was performed in a 29-bed mixed adult ICU at a tertiary teaching hospital from January 2015 to January 2018. The hospital ethics committee endorsed this study.

**Study Participants**

This study encompassed 51 adult patients (age ≥ 18 years) who met the clinical criteria of sepsis in Sepsis-2 consensus definitions[6]. Subjects were discarded meeting one of the following conditions: admission owing to trauma, pregnancy, or poison, under treatment with immunosuppressant agents, chemotherapy or radiotherapy within 30 days before inclusion, and refusal to cardiopulmonary resuscitation.

**Intervention**

After all patients diagnosed with sepsis, the clinicians instantly initiated the treatment of Surviving Sepsis Campaign Bundle, including obtaining microbial samples from infectious sites, administration of broad-spectrum antibiotics, fluid resuscitation, commence a vasopressor titration et cetera. Prior to fluid infusion, all cases were implemented with PiCCO device, and the PiCCO survey was executed at least every 8 hours, or depended on the clinician decision when the drastic vital sign change. Blood gas analysis was obtained along with every PiCCO inquiry.

**Data collection**

According to seven day survival or not after enrollment, all patients were classified into survivor group (n=29) and nonsurvivor group (n=13). The following clinical characteristics were assembled: sex, age, infection position, underlying disease, such as hypertension, chronic cardiovascular disease, chronic obstructive pulmonary disease, chronic renal failure, and diabetes mellitus. Meanwhile the Acute physiology and chronic health practical guidance system II (APACHE II) and the Sequential Organ Failure Assessment (SOFA) score were calculated for patient within first 24 hours.

**Statistical analysis**

Data were represented with either frequency and percentage for categorical variables or mean and standard deviation (SD) and interquartile range (IQR) for continuous variables. Two groups were compared with the t test or the the non-parametric Mann-Whitney U test, as appropriate. Dependency
relationships among the hemodynamic and blood gas parameters were identified by person correlation analysis. All parameters exhibited significant difference in comparison were further evaluated for the predictive value via receiver-operating characteristic (ROC). All data processing and statistical analyses were performed with SPSS 13.0.

Results

After totally screening, 42 patients (29 males, 13 females) were fulfilled with inclusion criteria (Fig. 1), of whom 13 (30.1%) died after 7 days. And further follow-up revealed a 28-day mortality rate as 42.9% (18/42). Table 1 shows there are no significant differences between the survivors and nonsurvivors in terms of baseline demographic and clinical characteristics. Comparison to nosurvivor group, at 24 hours after enrollment, the HR (97.27±22.07 vs. 120.20±20.56), EVLWI (7.32±2.96 vs. 15.9±11.2), and Lac (1.62±0.92 vs. 6.33±5.83) level in survivor group exhibits considerably lower (P < 0.05), whereas the CI and PaO₂/FiO₂ were higher (Table 2). Person correlation analysis revealed PaO₂/FiO₂ was negatively correlated with EVLWI (r = -0.673, P < 0.01) at 24 hours (Fig. 2), in addition Lac was found no correlation with CI.

Table 1. Demographic data and clinical characteristics according to survival at day 7
|                                | Survivors (n=29) | Nonsurvivors (n=13) | P value |
|--------------------------------|------------------|---------------------|---------|
| Age (years)                    | 63 ± 13          | 66 ± 17             | 0.572   |
| Males, n (%)                   | 19 (65.5)        | 13 (76.9)           | 0.086   |
| APACHE II                      | 21 ± 3           | 25 ± 5              | 0.545   |
| SOFA                           | 11 ± 3           | 14 ± 3              | 0.152   |
| Underlying disease, n(%)       |                  |                     |         |
| Hypertension                   | 11 (37.9)        | 7 (53.8)            | 0.272   |
| Chronic cardiovascular disease | 15 (51.7)        | 8 (61.5)            | 0.742   |
| COPD                           | 3 (10.3)         | 1 (7.6)             | 0.520   |
| Chronic renal failure          | 4 (13.8)         | 4 (30.8)            | 0.221   |
| Diabetes mellitus              | 4 (13.8)         | 5 (38.4)            | 0.182   |
| Source of infection, n(%)      |                  |                     |         |
| Lungs                          | 15 (51.7)        | 9 (69.2)            | 0.284   |
| Abdomen                        | 11 (37.9)        | 3 (23.1)            | 0.709   |
| Soft tissue                    | 2 (6.9)          | 1 (7.7)             | 1.000   |
| Other                          | 1 (4.3)          | 0 (0)               | 0.485   |

APACHE II, Acute physiology and chronic health practical guidance system II; SOFA, Sequential Organ Failure Assessment; COPD, chronic obstructive pulmonary disease

**Table 2.** Comparison of hemodynamic parameters at beginning and 24 hours after enrollment between survivors and nonsurvivors
| Hemodynamic parameter | Time       | Survivors        | Nonsurvivors     | t       | P      |
|-----------------------|-----------|------------------|------------------|---------|--------|
|                       | (n=29)    | (n=13)           |                   |         |        |
| HR (bpm)              | Baseline  | 123.73 ± 17.56   | 123.93 ± 28.97    | 0.320   | 0.751  |
|                       | 24 h      | 97.27 ± 22.07    | 120.20 ± 20.56    | -2.945  | 0.006  |
| CI (ml·s\(^{-1}\)·m\(^{-2}\)) | Baseline  | 3.89 ± 1.48      | 3.62 ± 1.80       | 0.445   | 0.660  |
|                       | 24 h      | 3.67 ± 0.85      | 2.98 ± 0.73       | 2.395   | 0.024  |
| EVLWI (ml·kg\(^{-1}\)) | Baseline  | 8.98 ± 5.85      | 13.2 ± 7.39       | -1.162  | 0.120  |
|                       | 24 h      | 7.32 ± 2.96      | 15.9 ± 11.2       | -2.870  | 0.008  |
| SVI (ml·m\(^{-2}\))   | Baseline  | 31.67 ± 10.56    | 29.53 ± 13.95     | 0.472   | 0.640  |
|                       | 24 h      | 41.31 ± 14.93    | 45.51 ± 66.09     | -0.239  | 0.813  |
| GEF (%)               | Baseline  | 17.80 ± 4.74     | 15.80 ± 5.34      | 1.084   | 0.228  |
|                       | 24 h      | 19.40 ± 5.26     | 16.53 ± 5.29      | 1.488   | 0.148  |
| GEDVI (ml·m\(^{-2}\)) | Baseline  | 764.46 ± 89.13   | 787.57 ± 330.30   | -0.221  | 0.827  |
|                       | 24 h      | 898.07 ± 34.99   | 754.31 ± 166.55   | 1.821   | 0.081  |
| CVP (cmH\(_2\)O)      | Baseline  | 9.80 ± 4.20      | 9.33 ± 2.38       | 0.375   | 0.710  |
|                       | 24 h      | 9.33 ± 5.70      | 9.33 ± 2.74       | 0.000   | 0.740  |
| SVRI (kPa·s·L\(^{-1}\)·m\(^{-2}\)) | Baseline  | 1602.13 ± 647.15 | 1706.27 ± 1011.97 | -0.336  | 0.740  |
|                       | 24 h      | 1789.07 ± 419.84 | 1515.87 ± 612.63  | 1.425   | 0.165  |
| PVPI                  | Baseline  | 1.89 ± 0.94      | 2.43 ± 1.03       | -1.498  | 0.145  |
|                       | 24 h      | 1.30 ± 0.46      | 2.87 ± 1.89       | -3.119  | 0.004  |
| Lac (mmol/L)          | Baseline  | 5.61 ± 3.85      | 5.11 ± 2.94       | 0.385   | 0.703  |
|                       | 24 h      | 1.62 ± 0.92      | 6.33 ± 5.83       | -2.885  | 0.008  |
| PaO\(_2\)/FiO\(_2\) (mmHg) | Baseline  | 202.0 ± 148.0    | 233 ± 142.60      | -0.584  | 0.564  |
|                       | 24 h      | 242.8 ± 89.68    | 136.07 ± 78.01    | 3.478   | 0.002  |
| BE (mmol/L)           | Baseline  | -4.33 ± 4.72     | -4.08 ± 6.92      | -0.119  | 0.906  |
|                       | 24 h      | 1.47 ± 2.64      | -3.64 ± 6.99      | 2.650   | 0.013  |

HR, heart rate; CI, cardiac index; EVLWI, extravascular lung water index; SVI, stroke volume index;
GEF, global ejection fraction; GEDVI, global end-diastolic volume index; CVP, central venous pressure; SVRI, systemic vascular resistance index; PVPI, pulmonary vascular permeability index; BE, base excess

As shown in Table 3, the AUC-ROC of HR, EVLWI, PVPI, and Lac were 0.739, 0.776, 0.764, and 0.794. Compared to the single parameter, the combination of Lac and \( \text{PaO}_2/\text{FiO}_2 \) at 24 hours was superior for early prognosis. The AUC was 0.853, with a sensitivity of 83.3%, a specificity of 84.6%, and the Youden’s Index of 0.679, as seen in Figure 3.

Table 3. The predictive value of hemodynamic parameters for early prognosis

| Parameter               | AUC  | Critical value | Sensitivity (%) | Specificity (%) | Youden’s index | P    |
|-------------------------|------|----------------|-----------------|-----------------|----------------|------|
| HR (24h)                | 0.739| 116.5          | 66.7            | 86.7            | 0.534          | 0.007|
| CI (24h)                | 0.302| 2.94           | 33.3            | 13.3            | -0.534         | 0.065|
| EVLWI (24h)             | 0.776| 9.2            | 53.3            | 86.7            | 0.534          | 0.010|
| PVPI (24h)              | 0.764| 2.05           | 57.1            | 93.3            | 0.504          | 0.015|
| Lac (24h)               | 0.794| 2.75           | 66.7            | 92.3            | 0.590          | 0.002|
| \( \text{PaO}_2/\text{FiO}_2 \) (24h) | 0.171| 141.0          | 33.3            | 70.0            | -0.600         | 0.002|
| BE (24h)                | 0.267| -3.1           | 46.7            | 0.0             | 0.533          | 0.029|

HR, heart rate; CI, cardiac index; EVLWI, extravascular lung water index;

PVPI, pulmonary vascular permeability index; BE, base excess

Discussion

The main fact of this study is that certain hemodynamic or blood gas parameters measured at 24 h after sepsis onset were associated with worse early clinical outcomes.

Although the absolute mortality has decreased from 35.0% to 18.4% in patients with severe sepsis in the areas of Australia and New Zealand during the last decades[7], one recent systematic review revealed the ICU mortality of sepsis in Europe and North America remains 37.3%, where the morbidity was estimated at 10.4%[8]. It is similar to these studies that the 28-day mortality was 42.9% in our study. The factor that average age over 65 in our patient population could contribute to the relatively high mortality, according to the results from some surveys launched in China[1,9].

To date, the lack of recognition in the underlying pathophysiology mechanism falls us into the dilemma of treatments for sepsis, of which to maintain the stable hemodynamics occupy the critical core in the early period. In order to achieve the goal of volume status fulfilled with oxygen delivery-consumption
balance, active fluid resuscitation is always the basis of treatment bundle; meanwhile, the varied methods to monitor the fluid infusion could overcome some side-effects perhaps to follow, such as pulmonary edema or cardiac overload.

Due to those significant drawbacks, including air embolism, permanent occlusion, pseudoaneurysm and so on, occurred in fewer than 1% of the clinical procedures, PiCCO has been the invasive hemodynamic monitor system generally accepted[10]. The fluid challenge strategics directed via PiCCO present fully compatible with the philosophy of titration therapy. It is a remarkable fact that numerous actively advocated studies virtually focus on one or more specific parameters yield from the PiCCO techniques rather than itself[11]. Theoretically, the ability to integrate a series of hemodynamic data provide the most valuable advantage of PiCCO; however, the misinterpretation of these data causes the wrong direction of treatment. Zhang et al. asserted that the fluid management schedule based on PiCCO parameters couldn't improve the clinical outcome in patients with sepsis and/or acute respiratory distress syndrome[4]. Conversely, Sánchez-Sánchez argued that the improper diagnostic criteria for the intrathoracic blood volume index (ITBVI) led the negative conclusion in Zhang's study[12], which alert the clinical practitioners should be cautious about PiCCO data analysis. But as shown in our research and the other similar studies, the EVLWI and PVPI among the PiCCO parameters exhibited the outstanding predictive power for the prognosis in patients with sepsis[13].

Despite many apparent advantages of the invasive hemodynamic monitor, it doesn't mean that inexpensive examination could be neglected. We found that EVLWI exerted significant correlation with oxygenation index, which calculated based on the data from blood gas. EVLWI reflects the situation that the liquid content extravasate outside of the pulmonary vasculature into pulmonary alveolar and interstitium, following by ventilation-perfusion imbalance. Some pathophysiological factors, including lung resection, pulmonary vessels obstruction, and higher positive end-expiratory pressure, may potentially generate the trust-less data of EVLWI[14]. PaO₂/FiO₂ and Lac widely verified in the multiple intensive care scenarios[15-17], likewise present the affordable alternatives to invasive methods in our results, especially combined both themselves.

Limitations And Strengths

Several limitations should be clarified when the application of our instructional results, containing retrospective study design, small sample size, and patients population confined to sepsis. Even if considering these deficiencies, our study offers another non-inferior choice for prediction of the patients with sepsis under the circumstance without costly PiCCO system.

Conclusions

The hemodynamic parameters including HR, EVLWI, and PVPI exhibit superior predictive performance for early prognosis in patients with sepsis, and the combination Lac with PaO₂/FiO₂ possess identical diagnostic value.
Declarations

Availability of data and materials

All data generated or analyzes during this study are included in this article.

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Authors’ information

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Contributions

Y. and Z.W. designed the present study. Data analysis was conducted by J.Y. and XM.Q. All the authors were involved in the execution of the present study. All the authors participated in preparation of the manuscript and approved its final version for publication.

Ethics approval and consent to participate

Ethical approval was obtained from Scientific Research IRB of Wannan Medical College Yijishan Hospital (number: 2015018; approved Nov 18, 2015). Each participant provided written informed consent, and our study conformed to the Declaration of Helsinki.

Consent for publication

Not applicable.

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Conflicts of interest

The authors declare that they have no competing interests.

References

1. Weng, L., Zeng, X.Y., Yin, P., Wang, L.J., Wang, C.Y., Jiang, W., Zhou, M.G., Du B: Sepsis-related mortality in China: a descriptive analysis. Intensive Care Med, 44(7), 1071-1080 (2018). doi: 10.1007/s00134-018-5203-z

2. Rhodes, A., Evans, L.E., Alhazzani, W., Levy, M.M., Antonelli, M., Ferrer, R., Kumar, A., Sevransky, J.E., Sprung, C.L., Nunnally, M.E., Rochwerg, B., Rubenfeld, G.D., Angus, D.C., Annane, D., Beale, R.J., Bellinghan, G.J., Bernard, G.R., Chiche, J.D., Coopersmith, C., De Backer, D.P., French, C.J., Fujishima, S., Gerlach, H., Hidalgo, J.L., Hollenberg, S.M., Jones, A.E., Karnad, D.R., Kleinpell, R.M., Koh, Y., Lisboa, T.C., Machado, F.R., Marini, J.J., Marshall, J.C., Mazuski, J.E., McIntyre, L.A., McLean, A.S., Mehta, S., Moreno, R.P., Myburgh, J., Navalese, P., Nishida, O., Osborn, T.M., Perner, A., Plunkett, C.M., Ranieri, M., Schorr, C.A., Seckel, M.A., Seymour, C.W., Shieh, L., Shukri, K.A., Simpson, S.Q., Singer, M., Thompson, B.T., Townsend, S.R., Van der Poll, T., Vincent, J.L., Wiersinga, W.J., Zimmerman, J.L., Dellinger, R.P.: Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and sepsis: 2016. CRIT CARE MED, 45(3), 486-552 (2017). doi: 10.1097/CCM.0000000000002255

3. Hernandez, G., Cavalcanti, A.B., Ospona-Tascon, G., Zampieri, F.G., Dubin, A., Hurtado, F.J., Friedman, G., Castro, R., Alegria, L., Ceconi, M., Teboul, J.L., Bakker, J.: Early goal-directed therapy using a physiological holistic view: the ANDROMEDA-SHOCK-a randomized controlled trial. ANN INTENSIVE CARE, 8(1), 52 (2018). doi: 10.1186/s13631-018-0398-2

4. Zhang, Z., Ni, H., Qian, Z.: Effectiveness of treatment based on PiCCO parameters in critically ill patients with sepsis and/or acute respiratory distress syndrome: a randomized controlled trial. Intensive Care Med, 41(3), 444-451 (2015). doi: 10.1007/s00134-014-3638-4

5. Boulain, T., Garot, D., Vignon, P., Lascalour, J.B., Benzekri-Levevre, D., Dequin, P.F.: Predicting arterial blood gas and lactate from central venous blood analysis in critically ill patients: a multicentre, prospective, diagnostic accuracy study. Br J Anaesth, 117(3), 341-349 (2016). doi: 10.1093/bja/aew261

6. Levy, M.M., Fink, M.P., Marshall, J.C., Abraham, E., Angus, D., Cook, D., Cohen, J., Opal, S.M., Vincent, J.L., Ramsay, G.: 2001 SCCM/ESICM/ACCP/ATS/SIS International Sepsis Definitions Conference. CRIT CARE MED, 31(4), 1250-1256 (2003). doi: 10.1097/01.CCM.0000050454.01978.3B

7. Kaukonen, K.M., Bailey, M., Suzuki, S., Pilcher, D., Bellomo, R.: Mortality related to severe sepsis and sepsis among critically ill patients in Australia and New Zealand, 2000-2012. JAMA, 311(13), 1308-
1316 (2014). doi: 10.1001/jama.2014.2637

8. Vincent, J.L., Jones, G., David, S., Olariu, E., Cadwell, K.K.: Frequency and mortality of sepsis in Europe and North America: a systematic review and meta-analysis. CRIT CARE, 23(1), 196 (2019). doi: 10.1186/s13054-019-2478-6

9. Chen, X.C., Yang, Y.F., Wang, R., Gou, H.F., Chen, X.Z.: Epidemiology and microbiology of sepsis in mainland China in the first decade of the 21st century. INT J INFECT DIS, 31, 9-14 (2015). doi: 10.1016/j.ijid.2014.11.027

10. Scheer, B., Perel, A., Pfeiffer, U.J.: Clinical review: complications and risk factors of peripheral arterial catheters used for haemodynamic monitoring in anaesthesia and intensive care medicine. CRIT CARE, 6(3), 199-204 (2002)

11. Magder, S.: Invasive hemodynamic monitoring. CRIT CARE CLIN, 31(1), 67-87 (2015). doi: 10.1016/j.ccc.2014.08.004

12. Sanchez-Sanchez, M., Garcia-de-Lorenzo, A., Asensio, M.J., Herrero, E., Cachafeiro, L., Agrifoglio, A.: Effectiveness of treatment based on transpulmonary thermodilution in critically ill patients. Intensive Care Med, 41(6), 1154-1155 (2015). doi: 10.1007/s00134-015-3761-x

13. Wang, H., Cui, N., Su, L., Long, Y., Wang, X., Zhou, X., Chai, W., Liu, D.: Prognostic value of extravascular lung water and its potential role in guiding fluid therapy in sepsis after initial resuscitation. J CRIT CARE, 33, 106-113 (2016). doi: 10.1016/j.jcrc.2016.02.011

14. Tagami, T., Ong, M.: Extravascular lung water measurements in acute respiratory distress syndrome: why, how, and when? CURR OPIN CRIT CARE, 24(3), 209-215 (2018). doi: 10.1097/MCC.0000000000000503

15. Brown, S.M., Grissom, C.K., Moss, M., Rice, T.W., Schoenfeld, D., Hou, P.C., Thompson, B.T., Brower, R.G.: Nonlinear Imputation of PaO2/FIO2 From SpO2/FIO2 Among Patients With Acute Respiratory Distress Syndrome. CHEST, 150(2), 307-313 (2016). doi: 10.1016/j.chest.2016.01.003

16. Brown, S.M., Duggal, A., Hou, P.C., Tidswell, M., Khan, A., Exline, M., Park, P.K., Schoenfeld, D.A., Liu, M., Grissom, C.K., Moss, M., Rice, T.W., Hough, C.L., Rivers, E., Thompson, B.T., Brower, R.G.: Nonlinear Imputation of PaO2/FIO2 From SpO2/FIO2 Among Mechanically Ventilated Patients in the ICU: A Prospective, Observational Study. CRIT CARE MED, 45(8), 1317-1324 (2017). doi: 10.1097/CCM.0000000000002514

17. Bakker, J.: Lactate levels and hemodynamic coherence in acute circulatory failure. Best Pract Res Clin Anaesthesiol, 30(4), 523-530 (2016). doi: 10.1016/j.bpa.2016.11.001

Figures
Figure 1

Flow chart of patient inclusion
Fig. 2 Scatter plot of correlation between PaO2/FiO2 and EVLWI at 24 hours after enrollment

Figure 2

Scatter plot of correlation between PaO2/FiO2 and EVLWI at 24 hours after enrollment
Fig. 3  ROC cure of the predictive value of combination of Lac and PaO₂/FiO₂ at 24 hours after enrollment for early prognosis

Figure 3

ROC cure of the predictive value of combination of Lac and PaO₂/FiO₂ at 24 hours after enrollment for early prognosis