

Evaluation of SIRS, pSOFA, and Phoenix Scores for Sepsis Diagnosis and Prognostic Assessment in Infected Children Admitted to the Pediatric Intensive Care Unit

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Abstract

Background

Sepsis remains a leading cause of death in the pediatric intensive care unit (PICU). This study compared the performance of the systemic inflammatory response syndrome (SIRS) criteria, the pediatric Sequential Organ Failure Assessment (pSOFA) score, and the Phoenix score for identifying sepsis and predicting outcomes.

Methods

Diagnostic performance was evaluated using receiver operating characteristic (ROC) curves and Kappa statistics; prognostic value was assessed using ROC analysis, Cox regression, survival analysis, and subgroup analyses.

Results

Among 401 infected children admitted to the PICU, 82 had adjudicated sepsis. For sepsis identification, the Phoenix score achieved the highest area under the curve (AUC = 0.756) and Kappa value (0.350). For mortality prediction, the AUCs were 0.927 for pSOFA, 0.901 for Phoenix, and 0.626 for SIRS. A pSOFA score > 5 predicted mortality with 81.82% sensitivity and 97.96% specificity; a Phoenix score > 5 had 69.70% sensitivity and 100.00% specificity. Both scores were independent risk factors for mortality and remained stable across subgroups.

Conclusions

All three scoring systems showed only limited agreement with the clinical reference standard, and none should replace comprehensive clinical assessment. The pSOFA and Phoenix scores demonstrated high prognostic value, whereas SIRS performed poorly.

Introduction

Sepsis—defined as life-threatening organ dysfunction caused by a dysregulated host response to infection—remains a leading cause of mortality in the pediatric intensive care unit (PICU) [1–4]. The clinical definition of sepsis has evolved from criteria based on the systemic inflammatory response syndrome (SIRS) toward frameworks centered on organ dysfunction, with each revision aiming to improve diagnostic accuracy and prognostic performance [5]. Although the SIRS criteria are highly sensitive, their specificity is limited. To reflect pediatric physiological characteristics, the Sequential Organ Failure Assessment score was adapted into the pediatric Sequential Organ Failure Assessment (pSOFA) score, which provides a validated tool for quantifying organ dysfunction and predicting mortality [6]. However, no unified international consensus exists regarding the use of the pSOFA score for the clinical diagnosis of pediatric sepsis.

In 2024, the Phoenix criteria were adopted by the international pediatric sepsis consensus as a new pediatric-specific standard [7–9]. However, few studies have directly compared the diagnostic and prognostic performance of the Phoenix, SIRS, and pSOFA scores. Therefore, we retrospectively analyzed infected children admitted to the PICU and compared these three scoring systems for sepsis identification and mortality prediction..

Materials and Methods

2.1. Study Design and Population

This retrospective cohort study included children admitted to the PICU between 1 June 2023, and 1 June 2024. Children were eligible if they were aged between 28 days and 18 years and had either suspected or confirmed infection—defined as the collection of microbiological specimens or the initiation of antimicrobial therapy. We excluded cases with unknown final outcomes or Incomplete clinical data prevented score calculation. This retrospective study was approved by the Ethics Committee of XXX (Approval No. 2025ETKLRK12004; Approval Date: December 29, 2025).

2.2. Data Collection and Sepsis Reference Standard

Demographic characteristics, vital signs, laboratory findings, and clinical interventions recorded within 24 hours of PICU admission were collected. The worst values recorded during this period were used to calculate the SIRS, pSOFA, and Phoenix scores.

A panel of three senior PICU physicians formed an adjudication committee to establish the clinical sepsis reference standard. Two adjudicators independently reviewed the medical records, laboratory findings (including C-reactive protein (CRP), procalcitonin (PCT), and T-helper cell type 1 and type 2 cytokines) [10], and the overall clinical course. They made a comprehensive clinical determination with reference to the 2024 international pediatric sepsis consensus framework. In cases of disagreement, a third blinded adjudicator made the final determination using the same clinical information. The SIRS-based sepsis definition followed the 2015 Expert Consensus on the Diagnosis and Treatment of Pediatric Septic Shock. Sepsis based on the pSOFA score was defined using the modified scoring system proposed by Matics and Sanchez-Pinto, whereby a pSOFA score ≥ 2 constituted a sepsis diagnosis [6]. Phoenix-criteria sepsis was defined according to the 2024 international consensus, with a Phoenix Sepsis Score ≥ 2 as the diagnostic cutoff [7].

2.3. Statistical Analysis

Statistical analyses were performed using SPSS version 27.0 and R software. Normally distributed continuous variables are presented as mean $\pm$ standard deviation, whereas non-normally distributed continuous variables are presented as median (P25, P75). Between-group comparisons were performed using the t-test, the Mann–Whitney U test, or the chi-square test, as appropriate. The performance of each score for identifying clinically adjudicated sepsis and predicting in-hospital mortality was assessed using receiver operating characteristic (ROC) curves. Areas under the curve (AUCs) were compared with the DeLong test. Agreement between each scoring system and the clinical reference standard was assessed using Kappa statistics. Survival curves were generated via the Kaplan-Meier method, and group differences were tested using the log-rank test. Associations between score and mortality were evaluated using univariable and multivariable Cox proportional-hazards regression models.

Results

3.1. Comparison of Clinical Characteristics Between Children With and Without Sepsis

Among the 401 infected children admitted to the PICU, 82 (20.4%) were classified as sepsis (Table 1). Compared with non-septic patients, those with sepsis experienced a far higher mortality rate (40.2% vs. 2.2%, $P < 0.05$). Median

SIRS, pSOFA, and Phoenix scores were higher in the sepsis group (all $P < 0.05$), as were PICU length of stay and hospital costs (both $P < 0.05$). These objectively reflect the substantial socioeconomic burden imposed by sepsis.

Table 1
Baseline Characteristics of Children With and Without Sepsis

Variable	sepsis(n = 82)	Nonsepsis(n = 319)	P value
Male, n (%)	39(47.5%)	192(60.1%)	0.03
Age (years)	4.0(1.0, 8.0)	2(0.6, 6.0)	0.05
Height (cm)	104.0(76.0, 127.0)	91.0(68.3, 118.8)	0.11
Weight (kg)	15.00(9.20, 24.00)	12.80(7.80, 20.38)	0.17
SIRS, median (IQR)	2.0(1.0, 3.0)	1.0(0.0, 2.0)	< 0.01
pSOFA, median (IQR)	3.0(2.0, 8.0)	2.0(0.0, 3.0)	< 0.01
Phoenix, median (IQR)	2.5(1.0, 6.0)	1.0(0.0, 1.7)	< 0.01
PICU length of stay(d)	5.0(2.0, 13.0)	4.0(2.0, 7.0)	0.01
Total hospital length of stay(d)	13.0(8.0, 25.0)	10.0(7.0, 17.0)	0.07
Hospital costs(CNY)	41491.975(19659.020, 106116.920)	16575.730(10385.198, 43663.640)	< 0.01
Mortality, n (%)	33(40.2%)	7(2.2%)	< 0.01

3.2. Factors Associated With Prognosis in Children With Sepsis

As shown in Table 2, of the 82 children with sepsis, 33 died (40.2%). Compared with survivors, non-survivors had lower admission temperature, respiratory rate, oxygenation index, and Glasgow Coma Scale (GCS), as well as significantly higher lactate, international normalized ratio (INR), D-dimer, and creatinine levels. Non-survivors also had higher rates of mechanical ventilation, vasoactive-agent use, and underlying diseases (all $P < 0.05$). Non-survivors had significantly higher pSOFA scores than survivors (10.0 [6.0, 14.5] vs. 2.0 [1.5, 3.0], $P < 0.01$) and higher Phoenix scores (7.0 [4.0, 9.0] vs. 2.0 [1.0, 3.0], $P < 0.01$).

Table 2
Clinical features of survivor and non-survivor septic children

Variable	Death group(n = 33)	Survival group(n = 49)	P value
Male (%)	15(45.5%)	24(49%)	0.75
Age (years)	5.0(2.0, 8.5)	3(0.6, 6.5)	0.07
Height (cm)	109.2 ± 31.0	95.0 ± 32.3	0.60
Weight (kg)	17.2(12.6, 27.5)	13.0(7.6, 20.5)	0.06
Temperature (°C)	37.0(35.3, 39.3)	38.8(38.3, 39.3)	< 0.01
Heart rate (beats/min)	133.7 ± 29.9	144.6 ± 34.3	0.52
Respiratory rate (breaths/min)	30.0(22.5, 36.5)	40.0(31.0, 50.0)	< 0.01
White blood cell count (×10 ⁹ /L)	8.31(4.53, 17.04)	12.61(7.50, 17.33)	0.13
PaO ₂ /FiO ₂	196.0(99.0, 362.5)	317.4(208.0, 427.4)	< 0.01
SpO ₂ /FiO ₂	184.0(113.0, 240.0)	240.0(228.3, 417.2)	< 0.01
Lactate (mmol/L)	6.20(1.25, 12.15)	1.10(0.80, 1.25)	< 0.01
Platelet count (×10 ⁹ /L)	130.0(29.5, 223.0)	278.0(195.0, 363.0)	< 0.01
INR	1.70(1.04, 3.66)	1.13(1.01, 1.26)	< 0.01
D-dimer (mg/L)	6.07(2.06, 20.0)	1.98(0.93, 3.35)	0.02
Fibrinogen (mg/dL)	2.27(1.08, 2.27)	4.9(3.52, 6.34)	< 0.01
GCS	3(3, 14)	15(13, 15)	< 0.01
Bilirubin (μmol/L)	8.3(4.2, 23.3)	6(4.6, 11.0)	0.26
Creatinine (μmol/L)	62.0(22.5, 132)	29(20.5, 43.5)	0.02
Mechanical ventilation	30(90%)	13(26.5%)	< 0.01
Vasoactive agents (or vasopressors/inotropes)	24(72.7%)	16(30.6%)	< 0.01
Underlying diseases	16(48.4%)	5(10.5%)	< 0.01
SIRS	2.0(1.0, 2.0)	2.0(1.0, 3.0)	0.046
pSOFA	10.0(6.0, 14.5)	2.0(1.5, 3.0)	< 0.01
Phoenix	7.0(4.0, 9.0)	2.0(1.0, 3.0)	< 0.01

3.3. Diagnostic Performance and Agreement of the Three Scoring Systems for Sepsis

As shown in Fig. 1, the Phoenix score had the highest AUC for identifying clinically adjudicated sepsis (AUC = 0.756; 95% CI, 0.711–0.798), which was significantly higher than those of the pSOFA score and SIRS criteria (**P** < 0.05).

Optimal cutoff values were determined using the maximum Youden index (Table 3). The Phoenix score yielded a sensitivity of 69.51%, meaning that nearly 30% of children with clinically adjudicated sepsis would be missed. Its

specificity was 74.92%, indicating that roughly 25% of non-septic children would be falsely classified as positive. The negative predictive value (NPV) was 90.81%, indicating high confidence (> 90%) in ruling out sepsis when the score was below 1. The positive likelihood ratio (LR+) was 2.77, indicating that children with a positive Phoenix score were 2.77 times more likely to develop sepsis than those with negative scores. The Phoenix score had a Kappa value of 0.350 ($P < 0.05$; Table 3), indicating limited agreement with the clinical reference standard.

Table 3
Diagnostic and prognostic performance of the SIRS, pSOFA, and Phoenix scores

Metric	SIRS	pSOFA	Phoenix
A.Diagnosis of sepsis			
AUC(95% CI)	0.622(0.573–0.670)	0.725(0.679–0.768)	0.756(0.711–0.798)
Sensitivity	67.07	65.85	69.51
Specificity	56.74	66.77	74.92
Youden index	0.23	0.32	0.44
Optimal cutoff value	≥ 2	≥ 2	≥ 1
P value	< 0.01	< 0.01	< 0.01
PPV	27.80	32.99	40.77
NPV	87.39	88.72	90.81
LR+(95% CI)	1.55(1.27–1.89)	1.98(1.59–2.47)	2.77(2.19–3.52)
LR-(95% CI)	0.58(0.42–0.80)	0.51(0.37–0.70)	0.41(0.29–0.57)
Kappa coefficient	0.158	0.205	0.350
B. Prediction of mortality			
AUC(95% CI)	0.626	0.927(0.847–0.973)	0.901(0.815–0.956)
Sensitivity	84.85	81.82	69.70
Specificity	40.82	97.96	100.00
Youden's index	0.25	0.79	0.69
Optimal cutoff value	≤ 2	> 5	> 5
P value	0.03	< 0.01	< 0.01
PPV	48.87	96.39	100.00
NPV	80.16	88.98	83.19
LR+(95% CI)	1.43(1.09–1.88)	40.09(5.72-280.82)	-
LR-(95% CI)	0.37(0.15–0.89)	0.19(0.090–0.38)	0.30(0.18–0.51)
C. Cox regression			
Univariate Cox regression, HR (95% CI), P	0.804(0.586–1.103), 0.17	1.122(1.071–1.175), < 0.01	1.247(1.148–1.353), < 0.01
Multivariate Cox regression, HR (95% CI), P	0.871(0.630–1.204), 0.40	1.112(1.055–1.171), < 0.01	1.221(1.118–1.333), < 0.01
Note: Multivariable models were separately adjusted for sex and underlying disease for each score. In univariate analysis, male sex, age, height, and weight were not significantly associated with mortality (P > 0.05), whereas underlying disease was associated with mortality (HR 2.519, 95% CI 1.250–5.007, P = 0.01).			

3.4. Prognostic Performance of the Three Scoring Systems for Mortality in Children With Sepsis

As shown in Fig. 2, both the pSOFA score (AUC = 0.927) and Phoenix score (AUC = 0.901) showed excellent predictive value for in-hospital mortality ($P < 0.05$). Both scores performed substantially better than the SIRS criteria, which had an AUC of 0.626.

the optimal cutoff values were > 5 for both pSOFA and Phoenix, using the maximum Youden index. At this threshold, the Phoenix provided perfect specificity (100.00%) but only 69.70% sensitivity, while the pSOFA predicted mortality with a sensitivity of 81.82% and a specificity of 97.96% (Table 3). It demonstrated excellent predictive value for in-hospital mortality, with outstanding specificity, whereas the SIRS criteria were essentially of no clinical utility.

Cox regression analyses show that every unit rise in pSOFA corresponded to a 12.2% elevation in death hazard. For Phoenix score, a one-point increment conferred a 24.7% higher hazard for fatal outcome. Further multivariable Cox regression, after adjusting for sex and underlying comorbidities, identified the two scores as independent predictors of mortality (Table 3).

Kaplan–Meier survival analysis was performed in patients with sepsis. The survival curves stratified by pSOFA score are shown in Fig. 3A. Based on Fig. 3A, patients were divided into three groups according to their pSOFA score: a high-score group (≥ 14), an intermediate-score group (8–13), and a low-score group (≤ 7). Kaplan–Meier analysis demonstrated significant differences in survival among the pSOFA score groups (Fig. 3B). Patients in the high-score group had a cumulative 1-day survival rate of only 30–60%, with the 28-day cumulative survival rate approaching 0%. In contrast, the low-score group demonstrated a 1-day survival rate exceeding 95% and a 28-day survival rate of over 75%, indicating a significantly better prognosis. The Log-rank test showed that the survival curves among the different pSOFA score groups were statistically significantly different. In contrast, the Phoenix and SIRS scores showed slightly inferior discriminative ability for identifying high-risk patients compared with the pSOFA score (Figs. 3C and 3D).

3.5. Subgroup Analysis

3.5.1 Subgroup Analysis of Sepsis Versus Septic Shock

Mortality was significantly higher in the septic shock subgroup than in the sepsis subgroup without shock (61.5% vs. 20.0%, $P < 0.01$). The pSOFA and Phoenix scores were also significantly higher in children with septic shock (Table 4). Both pSOFA and Phoenix showed good mortality prediction in the sepsis and septic shock subgroups (Table 4; Fig. 4). The AUCs for pSOFA were 0.926 in the sepsis subgroup and 0.911 in the septic shock subgroup ($P = 0.8165$). The Phoenix AUCs were 0.901 and 0.908, respectively ($P = 0.6674$). Univariable Cox regression showed that the pSOFA and Phoenix scores were associated with mortality in both subgroups (Table 4).

Table 4
Subgroup analysis: sepsis versus septic shock

Mortality, P		Sepsis(n = 43)			Septic Shock(n = 39)		
		9(20.0%)			24(61.5%), < 0.01		
	SIRS	pSOFA	Phoenix	SIRS	pSOFA	Phoenix	
score	2.0(1.0, 3.0)	2.0(1.0, 3.0)	1.0(1.0, 2.0)	2.0(1.0, 3.0), 0.81	6.0(3.0, 11.0), < 0.01	6.0(3.0, 8.0), < 0.01	
A Prediction of mortality							
AUC(95% CI)	0.719(0.561–0.845)	0.926(0.804–0.984)	0.901(0.815–0.956)	0.603(0.434–0.756)	0.911(0.804–0.984)	0.908(0.772–0.977)	
Sensitivity	66.67	66.67	69.70	83.33	66.67	83.33	
Specificity	70.59	100.00	100.00	40.00	100.00	100.00	
Youden index	0.37	0.66	0.69	0.2333	0.6667	0.8333	
Optimal cutoff value	≤ 1	> 4	> 5	≤ 2	> 4	> 5	
P value	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	
PPV	36.17	100.00	100.00	68.92	100.00	100.00	
NPV	89.44	92.30	92.95	60.03	65.25	78.97	
LR+(95% CI)	2.27(1.13–4.55)	-	-	1.39(0.89–2.18)	-	-	
LR-(95% CI)	0.47(0.18–1.22)	0.33(0.18–0.51)	0.30(0.18–0.51)	0.42(0.14–1.24)	0.33(0.13–0.84)	0.17(0.068–0.41)	
B Cox regression							
Univariate Cox regression, HR (95% CI), P	0.054(0.303–1.012), 0.05	1.799(1.323–2.446), < 0.01	1.900(1.376–2.623), < 0.01	0.872(0.574–1.326), 0.52	1.079(1.016–1.145), 0.01	1.175(1.054–1.310), 0.04	

3.5.2 Subgroup Analysis of Infants/Toddlers Versus Children

Mortality was significantly higher among children aged ≥ 3 years than among infants and toddlers aged < 3 years (48.0% vs. 25.0%, $P < 0.05$). The pSOFA and Phoenix scores were also significantly higher in the older-child group. For mortality prediction, pSOFA had AUCs of 0.807 in the infant/toddler subgroup and 0.965 in the child subgroup ($P = 0.1340$). Phoenix had AUCs of 0.792 and 0.941, respectively ($P = 0.2062$). In both age groups, the pSOFA and Phoenix scores were significantly associated with mortality in univariable Cox regression analyses (Table 5; Fig. 5).

Table 5
Subgroup analysis: infants versus older children

Mortality, P		Infant/Toddler Group(n = 32)			Child Group (n = 50)		
		8(25.0%)			24(48.0%), 0.02		
	SIRS	pSOFA	Phoenix	SIRS	pSOFA	Phoenix	
score	2.0(1.0, 3.0)	2.0(2.5, 4.0)	2.0(1.0, 3.0)	2.0(1.0, 2.3), 0.13	4.0(2.7, 10.0), 0.01	4.0(2.0, 8.0), < 0.01	
A Prediction of mortality							
AUC(95% CI)	0.747(0.563–0.884)	0.807(0.630–0.925)	0.792(0.612–0.914)	0.544(0.397–0.686)	0.965(0.870–0.997)	0.941(0.836–0.988)	
Sensitivity	100.00	62.50	87.50	40.00	88.00	80.00	
Specificity	54.17	100.00	58.33	68.00	96.00	100.00	
Youden's index	0.54	0.62	0.45	0.080	0.84	0.80	
Optimal cutoff value	≤ 2	> 5	> 1	≤ 1	> 5	> 5	
P	< 0.01	< 0.01	< 0.01	0.58	< 0.01	< 0.01	
PPV	42.10	100.00	41.17	53.57	95.31	100.00	
NPV	100.00	88.88	93.33	55.11	89.66	84.42	
LR+(95% CI)	2.18(1.41–3.37)	-	2.10(1.22–3.61)	1.25(0.59–2.64)	22.00(3.21–150.94)	-	
LR-(95% CI)	-	0.38(0.15–0.92)	0.21(0.033–1.38)	0.88(0.58–1.34)	0.13(0.043–0.36)	0.20(0.033–1.38)	
B Cox regression							
Univariate Cox regression, HR (95% CI), P	0.507(0.267–0.963), 0.03	1.373(1.126–1.674), < 0.01	1.482(1.093–2.009), 0.01	0.991(0.662–1.484), 0.966	1.107(1.049–1.169), < 0.01	1.237(1.120–1.367), < 0.01	

Discussion

Sepsis remains a major global threat to child health, with substantial morbidity, mortality, and healthcare costs. The incidence of sepsis in intensive care units worldwide has been estimated at 8.2%, with mortality as high as 24% [11]. In China, the reported prevalence of sepsis among children admitted to PICUs is 5.63%, with an overall case-fatality rate of 11.9% [12]. Consistent with these reports, children with sepsis in the present cohort had longer hospital stays, higher healthcare costs, and substantially higher mortality than children without sepsis. In this cohort, sepsis-associated encephalopathy (SAE) was present in 13.41% (11/82) of sepsis patients, and hematological diseases were present in 19.51% (16/82). Previous studies have reported high mortality in children with sepsis-associated encephalopathy and in critically ill children with hematological malignancies or other hematological diseases. For instance, children with hematological diseases may have immune dysfunction caused—including neutropenia and

impaired humoral and cellular immunity—an increased risk of infection associated with repeated hospitalizations and invasive procedures. Consequently, once sepsis develops in these patients, disease progression is more rapid, organ dysfunction is more severe, and the risk of death is significantly higher than in previously healthy children [13–16].

4.1. Diagnostic Performance of the Scores

The present study demonstrated that the Phoenix score outperformed both the pSOFA and SIRS scores, as reflected by a higher AUC and Kappa agreement. However, even as the latest sepsis criteria, the Phoenix showed only modest diagnostic performance (Kappa < 0.40). Its sensitivity was 69.51%, meaning that nearly 30% of children with “true sepsis” would be missed, potentially depriving them of timely and effective treatment. Its specificity was 74.92%, indicating that approximately 25% of children without sepsis would be misclassified as positive, leading to overtreatment. A possible explanation for this finding is that only data collected within the first 24 hours of admission were included in the present study, whereas sepsis-associated organ dysfunction follows a dynamic trajectory. In some of the “missed” cases, organ injury—such as a progressively declining oxygenation index or platelet count—may not peak until 24 to 48 hours after admission, and early scores fail to capture such “delayed” dysfunction. Among the “misclassified” cases, children with conditions such as severe trauma, or severe rheumatic disease may present with both infection and organ dysfunction, yielding a Phoenix score ≥ 2 and thus leading to a “false-positive” diagnosis. In this study, 81 children were classified as having sepsis by the Phoenix score but ruled out by the clinical reference standard, accounting for 20.2% of all infected children. Among these false positives, the proportion with underlying comorbidities was as high as 61.7% (50/81), representing a substantial share. This highlights that, in clinical practice, no scoring system can replace the comprehensive judgment of the physician; the final diagnosis of sepsis still requires integration of the patient’s clinical presentation, laboratory findings, and the dynamic evolution of the disease.

Furthermore, the limitations of the SIRS criteria were again underscored in the contemporary PICU setting. A systematic review and meta-analysis showed that the SIRS criteria have high sensitivity (up to 85%) but low specificity (41%) in predicting sepsis. Other authors have also reported that the SIRS criteria have low sensitivity and specificity, as some sepsis patients do not present with SIRS manifestations [17, 18]. In the present study, the sensitivity and specificity of the SIRS criteria were lower than those of the pSOFA and Phoenix scores. A possible reason is that our study used data from the first 24 hours of admission. However, among the 33% (27/82) of sepsis patients who were SIRS-negative, 55.55% (15/27) were transferred to our hospital with existing multiple organ dysfunction; their body temperature had stabilized, and repeat white blood cell counts were within the normal range on admission. Given the retrospective nature of the study, it was difficult to capture real-time dynamic changes in maximal heart rate and respiratory rate. Nevertheless, temperature, heart rate, respiratory rate, and white blood cell count can fluctuate rapidly in the early phase of sepsis. However, the SIRS criteria may still serve as an early warning indicator for sepsis.

4.2. Analysis of the Prognostic Value of the Scores

Both the pSOFA score (AUC = 0.927) and the Phoenix score (AUC = 0.901) demonstrated excellent predictive value for in-hospital mortality. Furthermore, multivariable Cox regression analysis revealed that both the pSOFA and Phoenix scores remained independent risk factors for death. These findings further confirm the robustness of the two scoring systems in prognostic evaluation. Following age adaptation based on the adult Sepsis-3 framework, the pSOFA score has been repeatedly validated as an effective tool for mortality prediction, with reported AUCs ranging from 0.82 to 0.89 [19–21]. In pediatric populations with infection in the PICU, the Phoenix score has also been

validated in multicenter studies conducted in South Korea, the United States, and other countries, demonstrating mortality prediction performance comparable or even superior to that of pSOFA, with AUCs reaching 0.85–0.89 [22–25]. This indicates that the development of multiple organ dysfunction syndrome (MODS) is a critical factor driving clinical deterioration and death in children with sepsis.

Some authors have argued that the Phoenix score lacks renal assessment indicators such as creatinine, which may increase the risk of adverse events in children [26–28]. In contrast, the pSOFA score fully retains the six-system framework of the adult SOFA score and, by incorporating indicators such as creatinine and bilirubin, may provide a more comprehensive assessment of MODS. The slightly superior mortality prediction observed for the pSOFA score in the present study suggests that, in prognostic evaluation, the "coverage" and "comprehensiveness" of organ dysfunction assessment may be more advantageous than "simplicity." In particular, the prognostic value of renal function as an independent predictor in patients with sepsis should not be overlooked. The development of acute kidney injury in septic patients significantly increases the risk of death [29, 30]. This finding underscores the need for vigilant monitoring of renal function in septic children, with timely adjustment of therapeutic strategies based on dynamic assessments of organ dysfunction.

4.3. Survival Analysis

The survival analysis further confirmed the value of both scores in risk stratification. The 28-day survival rate in the high pSOFA score group (≥ 14) was close to 0%, whereas that in the low-score group (≤ 7) exceeded 75%, demonstrating a strong gradient in risk discrimination. Clinicians may consider adopting a high cutoff value (e.g., ≥ 14) to help clinicians recognize the severity of illness more promptly and provide a basis for decisions on initiating extraordinary resuscitative measures such as extracorporeal membrane oxygenation (ECMO). For children in the intermediate-score group (8–13), more intensive monitoring (e.g., assessment of vital signs, blood gas, and lactate every 1–2 hours), more aggressive organ support and urgent multidisciplinary team consultation should be initiated immediately to achieve optimal allocation of limited medical resources.

4.4. Subgroup Analysis

In this study, the correlation between the pSOFA score and the Phoenix score remained above 0.9 in both the sepsis group and the septic shock group. Both pSOFA and Phoenix stably predicted mortality risk in both early sepsis and shock stages. In other words, even when a child is already in a state of shock, clinicians can continue to use the pSOFA and Phoenix scores for dynamic monitoring and risk assessment, and their validity will not be attenuated by worsening disease severity. In the age-stratified analysis, we found that the AUC in the infant/toddler group (< 3 years) was slightly lower than that in the child group (≥ 3 years), suggesting that when using the pSOFA and Phoenix scores to evaluate infants and toddlers, a comprehensive assessment that integrates medical history and dynamic changes in the scores is warranted. However, in all the subgroup analyses described above, the differences in AUC between the pSOFA and Phoenix scores were not statistically significant, and further large-sample studies are needed.

4.5. Limitations and Future Research

First, as a single-center retrospective study, the sample size was relatively limited, and the findings are subject to a certain degree of selection bias; therefore, the generalizability of the conclusions should be interpreted with caution. Future large-sample, multicenter, prospective studies are warranted to further validate these results and to evaluate the applicability of the scores across other subgroups (e.g., different etiologies, different routes of infection, finer age stratifications, and underlying disease categories). Second, sepsis is a dynamic and evolving process, and this study did not evaluate the relationship between temporal trends in the scores and prognosis. Moreover, combining

the scores with novel biomarkers or specific clinical indicators, with the aid of artificial intelligence, could further enhance their diagnostic and predictive performance. Finally, as the Phoenix score is a newly released standard in 2024, its applicability in the Chinese pediatric population requires further support from real-world data. With the advancement of artificial intelligence, exploring the application and refinement of this scoring system in special subgroups, such as children with different underlying diseases, represents an important direction for future research.

Nevertheless, the present study has important clinical and academic significance. The findings affirm the robust performance of the pSOFA and Phoenix scores in prognostic assessment, providing a reference for PICU clinicians to select the optimal tool according to different clinical purposes (screening, diagnosis, or prognostic stratification). For the newly released Phoenix criteria, our study offers evidence-based support for their application in the diagnosis and prognostic evaluation of pediatric sepsis.

Conclusions

The Phoenix score demonstrated the best diagnostic performance for sepsis; however, the agreement of all three scoring systems with the clinical reference standard remained low, and none can replace comprehensive clinical judgment. Both the pSOFA and Phoenix scores showed high predictive value for in-hospital mortality, with the pSOFA score exhibiting slightly superior risk stratification ability, whereas the SIRS criteria had poor predictive performance. The predictive value of the pSOFA and Phoenix scores remained stable in the sepsis and septic shock subgroups; in the age-stratified subgroups, it was slightly lower among infants and toddlers, suggesting that combining the scores with biomarkers or dynamic monitoring of score changes may further improve predictive accuracy.

Abbreviations

The following abbreviations are used in this manuscript (alphabetical order):

AUC: area under the curve; CRP: C-reactive protein; ECMO: extracorporeal membrane oxygenation; GCS: Glasgow Coma Scale; INR: international normalized ratio; MODS: multiple organ dysfunction syndrome; NPV: negative predictive value; PICU: pediatric intensive care unit; pSOFA: pediatric Sequential Organ Failure Assessment; PPV: positive predictive value; ROC: receiver operating characteristic; SIRS: systemic inflammatory response syndrome.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Fujian Children's Hospital (protocol code 2025ETKLRK12004, approved on 4 January 2026).

Consent for publication

Patient consent was waived due to the retrospective nature of the study. The research involved the analysis of clinical and laboratory data previously collected during routine medical care, and the study protocol was reviewed and approved by the local institutional ethics committee. The requirement for informed consent was waived in accordance with the principles of the Declaration of Helsinki regarding retrospective data analysis.

Availability of data and materials

The data presented in this study are not publicly available due to patient confidentiality and privacy protection. Requests for access to de-identified data may be directed to the corresponding authors and will be considered upon reasonable request, subject to institutional ethics approval.

Conflict of interest

The authors declare that they have no conflict of interest.

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Author Contributions

Conceptualization, Botao Ning; Analysis or interpretation of data, Haibo Li; Acquisition of data, Yuanxiong Zeng, Liangwei Dong, Xianglan Kong, Figure preparation, Hailun Cai, writing—original draft preparation, Yuanxiong Zeng and Sheng Lin; writing—review and editing, Shibiao Wang and Botao Ning. All authors have read and agreed to the published version of the manuscript.

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Figures

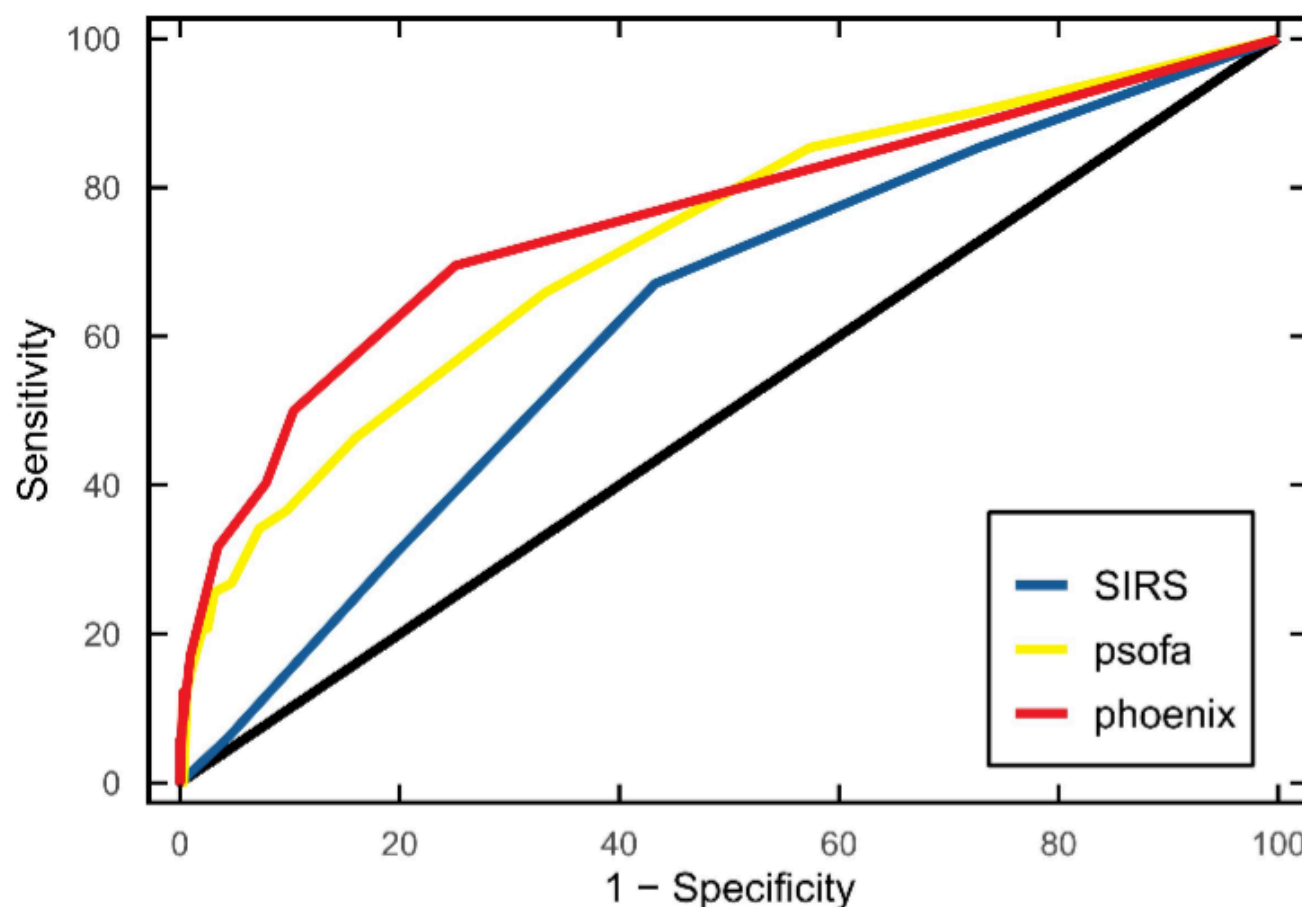


Figure 1

Receiver operating characteristic (ROC) curves of the three scoring systems for identifying clinically adjudicated sepsis.

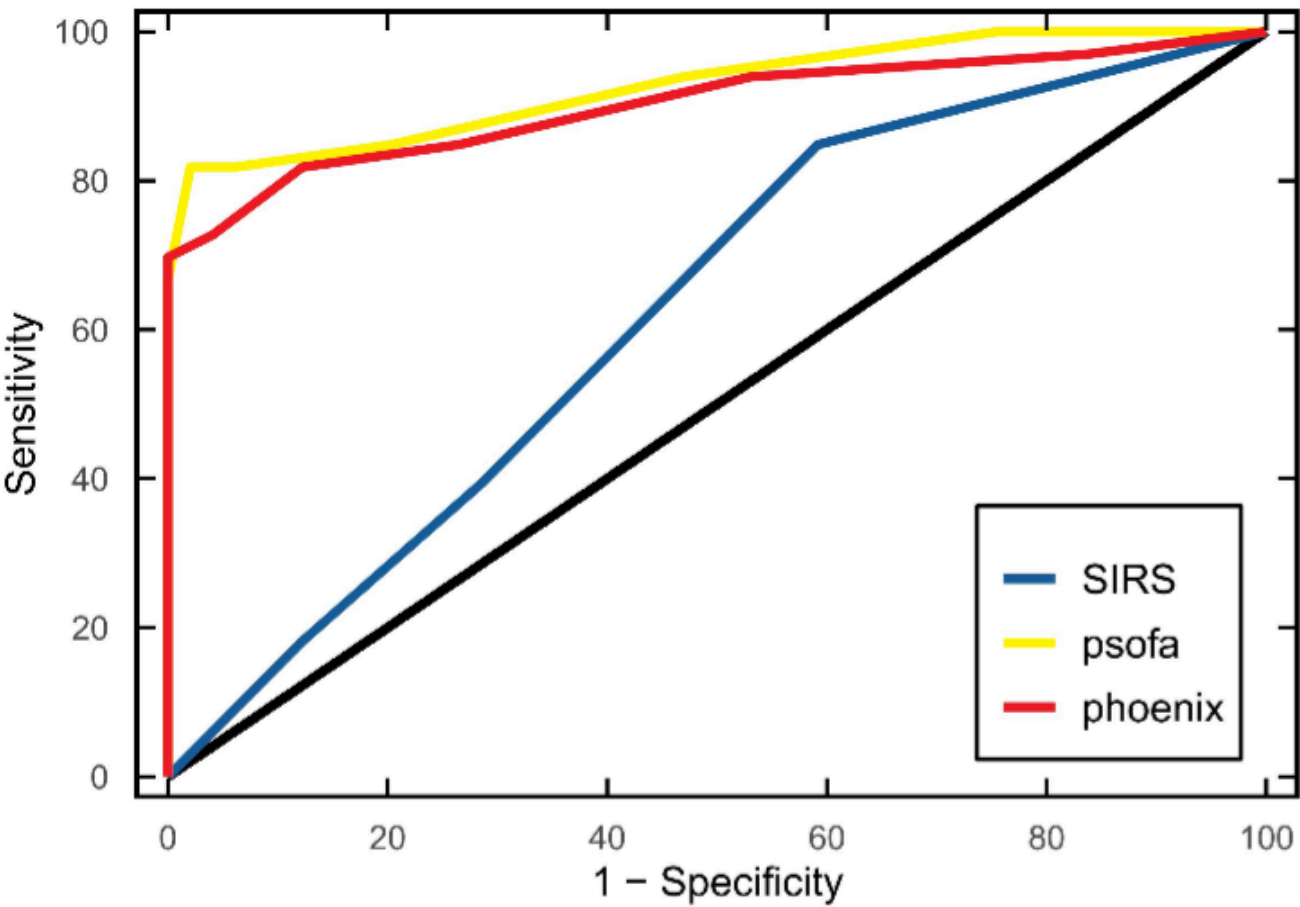


Figure 2

ROC analysis of the three scores for predicting sepsis-related mortality.

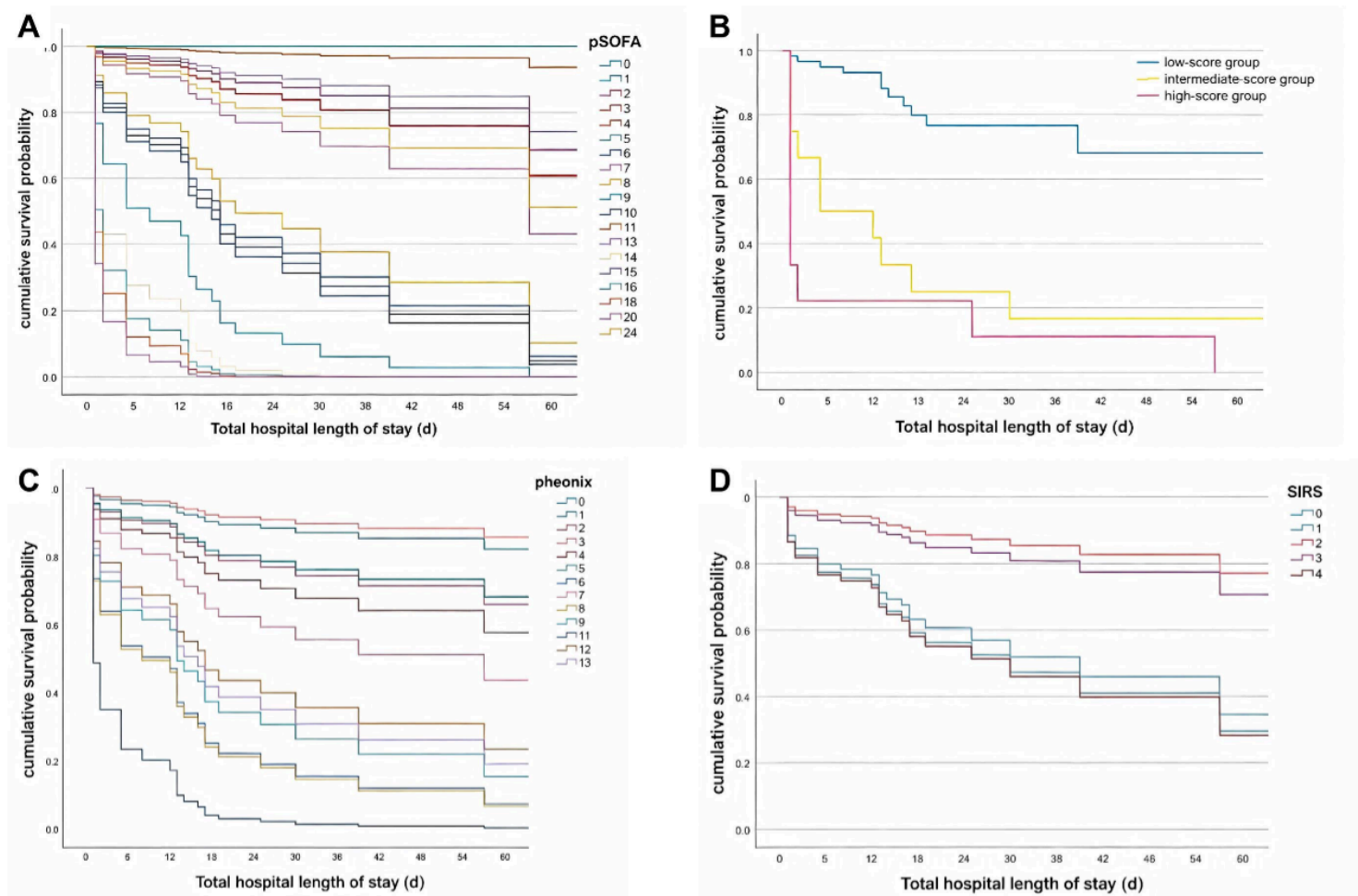


Figure 3

Kaplan–Meier survival curves of children with sepsis stratified by pSOFA score (A), pSOFA score category (B), Phoenix score (C), and SIRS score (D).

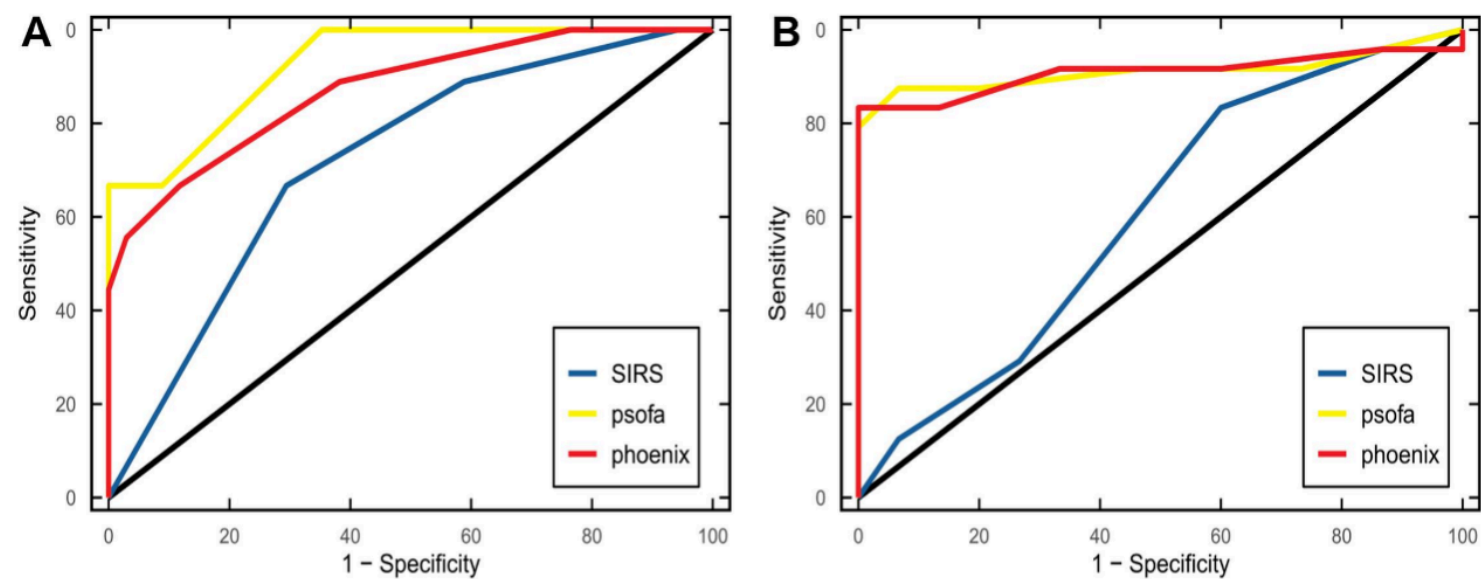


Figure 4

ROC curves of the three scoring systems for predicting mortality in the sepsis subgroup (A) and septic shock subgroup (B).

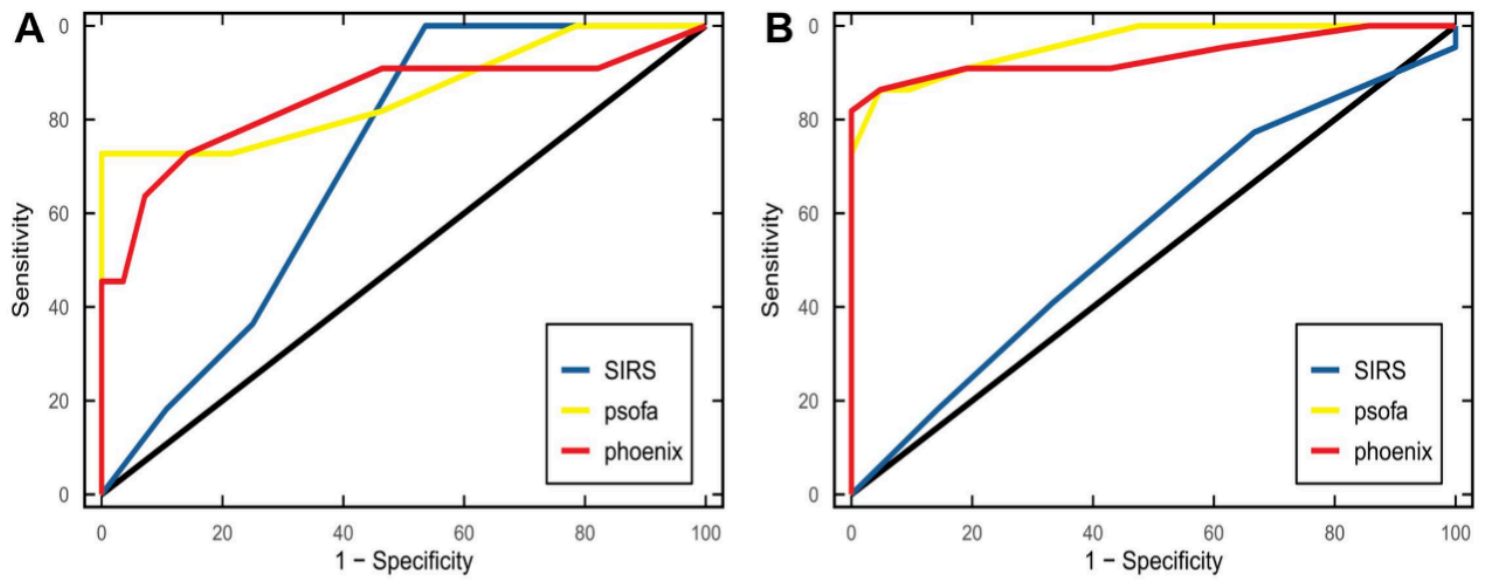


Figure 5

ROC curves of the three scoring systems for predicting mortality in the infant/toddler subgroup (A) and children subgroup (B).