



The use of the pulse oximetric saturation/fraction of inspired oxygen ratio for risk stratification of patients with severe sepsis and septic shock[☆]

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Abstract

Purpose: Our aims were to determine whether the pulse oximetric saturation/fraction of inspired oxygen (S/F) can be used for the early identification of patients with sepsis who are at increased risk for death and to compare the S/F ratio with the PaO₂/fraction of inspired oxygen (P/F) ratio.

Materials and Methods: This is a retrospective cohort study in 260 patients admitted to 2 tertiary mixed intensive care units (ICUs) with severe sepsis or septic shock. We studied the association between tertiles of S/F ratio and ICU mortality using Cox regression. Subsequently, we compared corresponding measurements of S/F ratio and P/F ratio upon ICU admission using Pearson correlation coefficient (*r*).

Results: We observed an overall case fatality of 72 (28%) of 260. After adjustment for severity of the illness, the lowest tertile (S/F, <164) at ICU admission was associated with increased mortality (hazard ratio, 1.87 [95% confidence interval, 1.02-3.41]) comparing to the highest tertile (S/F, >236). The S/F ratio was correlated with P/F ratio (*r* = 0.48; *P* < .0001).

Conclusion: A low S/F at ICU admission is associated with increased risk of death in patients with severe sepsis or septic shock.

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1. Introduction

Severe sepsis and septic shock are commonly complicated by acute hypoxic respiratory failure, even in patients without a primary pulmonary source of infection. It is associated with in-hospital mortality ranging from 34% to 58% [1]. Early recognition of pulmonary dysfunction in severe sepsis and septic shock can lead to preventive and therapeutic measures and may improve prognosis of this severe syndrome.

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Acute hypoxic respiratory failure is evidenced by a low PaO₂ to fraction of inspired oxygen (FIO₂) (P/F) ratio. According to the 1994 American European Consensus Conference, P/F ratios 300 or less and 200 or less are used to define acute lung injury and acute respiratory distress syndrome (ARDS), respectively [2]. Although information on PaO₂ is currently essential for the diagnosis of hypoxic respiratory failure, concerns about anemia due to excessive blood draws and tendency toward less invasive approaches have led to fewer arterial blood gas measurements in critically ill patients [3,4]. Furthermore, it is suggested that the requirement for invasive sampling may cause underdiagnosis of hypoxic respiratory failure [5].

In healthy subjects, changes in PaO₂ closely correlate with changes in pulse oximetric saturation (SpO₂) for saturations in the range of 80% to 100% [6]. Based on this correlation, threshold values for SpO₂/FIO₂ (S/F) ratio have recently been determined to assist in the diagnosis of acute lung injury and ARDS [3,6].

The aims of this study were to determine whether noninvasive measurement of the S/F ratio upon intensive care unit (ICU) admission in patients with severe sepsis and septic shock could predict hospital mortality and to compare its prognostic power with that of invasive measurements of

P/F ratio. In addition, we sought to derive and validate the previously described relationship between S/F and P/F ratios in a cohort of sepsis patients.

2. Methods

2.1. Study design

This is a 2-center retrospective cohort study conducted between 2008 and 2009 in a mixed 11-beds ICU in a University Hospital in Brazil and between 2011 and 2012 in a mixed 32-bed ICU in a university hospital in the Netherlands. The informed consent was waived because the observational nature of this study posed no burden to patients.

2.2. Study population

We included consecutive patients, older than 18 years, who were admitted to the ICU with severe sepsis or septic shock. *Severe sepsis* was defined as systemic inflammatory response syndrome with evidence of infection and signs of

Table 1 Baseline characteristics of the study patients stratified by S/F tertile

Patient characteristics	No. (%) of patients ^a				P
	All patients (n = 260)	Tertile 1 ^b (n = 86)	Tertile 2 ^c (n = 86)	Tertile 3 ^d (n = 88)	
Age, y (mean ± SD)	62.80 ± 15.03	62.26 ± 12.10	60.06 ± 16.64	66.47 ± 15.00	.061
Female sex	102 (39.2)	30 (34.8)	32 (37.2)	40 (45.4)	.030
Baseline P/F ratio (mean ± SD)	232.99 ± 119.8	163.94 ± 110.1	222.52 ± 110.6	299.32 ± 89.46	<.0001
Baseline S/F ratio (mean ± SD)	201.29 ± 72.62	123.81 ± 27.24	199.97 ± 21.71	278.31 ± 50.80	<.0001
SOFA score (mean ± SD)	10.89 ± 6.16	11.34 ± 5.36	11.27 ± 8.31	10.08 ± 4.37	.338
APACHE IV score (mean ± SD)	83.58 ± 29.96	87.05 ± 30.41	84.45 ± 29.69	78.66 ± 29.39	.310
Arterial pH	7.32 ± 0.13	7.31 ± 0.13	7.32 ± 0.16	7.34 ± 0.12	.280
PaCO ₂ , mm Hg	42.41 ± 14.42	46.86 ± 16.56	40.63 ± 10.92	39.82 ± 15.00	.002
HCO ₃ ⁻ , mEq/L	22.05 ± 6.54	23.05 ± 6.29	21.65 ± 6.48	21.45 ± 7.12	.227
Arterial lactate, mmol/L	3.32 ± 3.63	3.44 ± 4.57	3.71 ± 3.89	2.61 ± 2.07	.182
FIO ₂ , %	53.46 ± 20.21	75.99 ± 17.5	48.27 ± 5.66	35.70 ± 5.70	<.0001
Pulse oximetry, %	94.35 ± 8.42	90.90 ± 13.53	95.38 ± 3.49	96.56 ± 2.45	<.0001
Alveolar-arterial gradient, mm Hg	275.49 ± 157.26	407.00 ± 130.31	254.18 ± 108.3	180.94 ± 138.44	<.0001
Chronic comorbidities					
Chronic heart failure	51 (19.6)	9 (10.4)	19 (22.0)	23 (26.1)	.052
COPD	48 (18.4)	17 (19.7)	15 (17.4)	16 (18.1)	.213
Condition					
Septic shock	215 (82.6)	73 (84.8)	67 (77.9)	75 (85.2)	.092
Mortality					
In-ICU	63 (25)	27 (31.3)	17 (19.7)	15 (17)	.352
In-hospital	72 (28)	31 (36)	21 (24.4)	21 (23.8)	.046
Length of stay, median (IQR) (h)					
ICU	174.5 (93.2-353.2)	202.5 (97-445)	182 (72-354)	140 (83-291)	.092
Hospital	432 (240-846)	444 (264-942)	432 (240-768)	408 (204-768)	.825

COPD indicates chronic obstructive pulmonary disease; IQR, interquartile range.

^a Unless otherwise indicated.

^b S/F less than 164.

^c S/F 164 to 236.

^d S/F more than 236.

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