四川大学华西医院重症医学科读书报告

Pulmonary ultrasound and pulse oximetry versus chest radiography and arterial blood gas analysis for the diagnosis of acute respiratory distress syndrome: a pilot study

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Introduction:

In low-resource settings it is not always possible to acquire the information required to diagnose acute respiratory distress syndrome (ARDS). Ultrasound and pulse oximetry, however, maybe available in these settings. This study was designed to test whether pulmonary ultrasound and pulse oximetry could be used in place of traditional radiographic and oxygenation evaluation for ARDS

在资源欠缺的情况下往往不能够获得诊断急性呼吸窘迫综合征所需的诊断信息。不过超声和脉搏血氧饱和度也许可以满足相关信息的获取。本研究的目的是测试肺部超声和脉搏血氧仪能否代替传统的影像学和肺氧合来评估ARDS

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Methods:

This study was a prospective , single-center study in the ICU of Harborview Medical Center, a referral hospital in Seattle, Washington, U SA. Bedside pulmonary ultrasound was performed on ICU patients receiving invasive mechanical ventilation. Pulse oximetric oxygen saturation (SpO2), partial pressure of oxygen (PaO2), fraction of inspired oxygen (FiO2), provider diagnoses, and chest radiograph closest to time of ultrasound were recorded or interpreted.

该研究是在美国华盛顿西雅图Harborview转诊医疗中心进行的一项前瞻性，单中心研究，床边肺部超声对进行有创机械通气的重症患者进行监测。并记录脉搏血氧氧饱和度（SpO2），氧分压（PaO2），吸入氧浓度（FiO2）和最近的胸片情况。

Results

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One hundred and twenty three ultrasound assessments were performed on 77 consecutively enrolled patients with respiratory failure. Oxygenation and radiographic criteria for ARDS were met in 35 assessments . Where SpO2≤ 97%, the Spearman rank correlation coefficient between SpO2 /FiO2 and PaO2/FiO2 was 0.83, p < 0.0001. The sensitivity and specificity of the previously reported threshold of SpO2/FiO2≤ 315 for PaO2/FiO2≤ 30 0 was 83%(95 % confid ence interval (CI) 68–93), and 50 % (95 % CI 1 –9 9) , respectively . Sensitivity and specificity of SpO2/FiO2≤ 235 for PaO 2/FiO2≤ 200 was 70% (95 % CI 47–87), and 90 % (95 % CI 68–99), respectively. For pulmonary ultrasound assessments interpreted by the study physician, the sensitivity and specificity of ultrasound interstitial syndrome bilaterally and involving at least three lung fields were 80 % (95 % CI 63–92) and 62 % (95 % CI 49– 74)for radiographic criteria for ARDS. Co mbining SpO2/FiO2 with ultrasound to determine oxygenation and radiographic criteria for ARDS, the sensitivity was 83 % (95 % CI 52 –98) and specificity was 62 % (95 % CI 38–82) .For moderate –severe ARDS criteria (PaO2/FiO2≤ 200), sensitivity was 64 % (95 % CI 31–89) and specificity was 86%(95 % CI 65 –97). Excluding repeat assessments and independent interpretation of ultrasound images did not significantly alter the sensitivity measures.

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Conclusions:

Pulse oximetry and pulmonary ultrasound may be useful tools to screen for, or rule out, impaired oxygenation or lung abnormalitie s consistent with ARDS in under-resourced settings where arterial blood gas testing and chest radiography are not readily available.

在血气分析和胸部影像不是现成可用的情况下，脉搏血氧仪和肺超声可作为有用的工具，以筛查，或排除ARDS受损的氧合及肺部异常情况

纳入与排除条件

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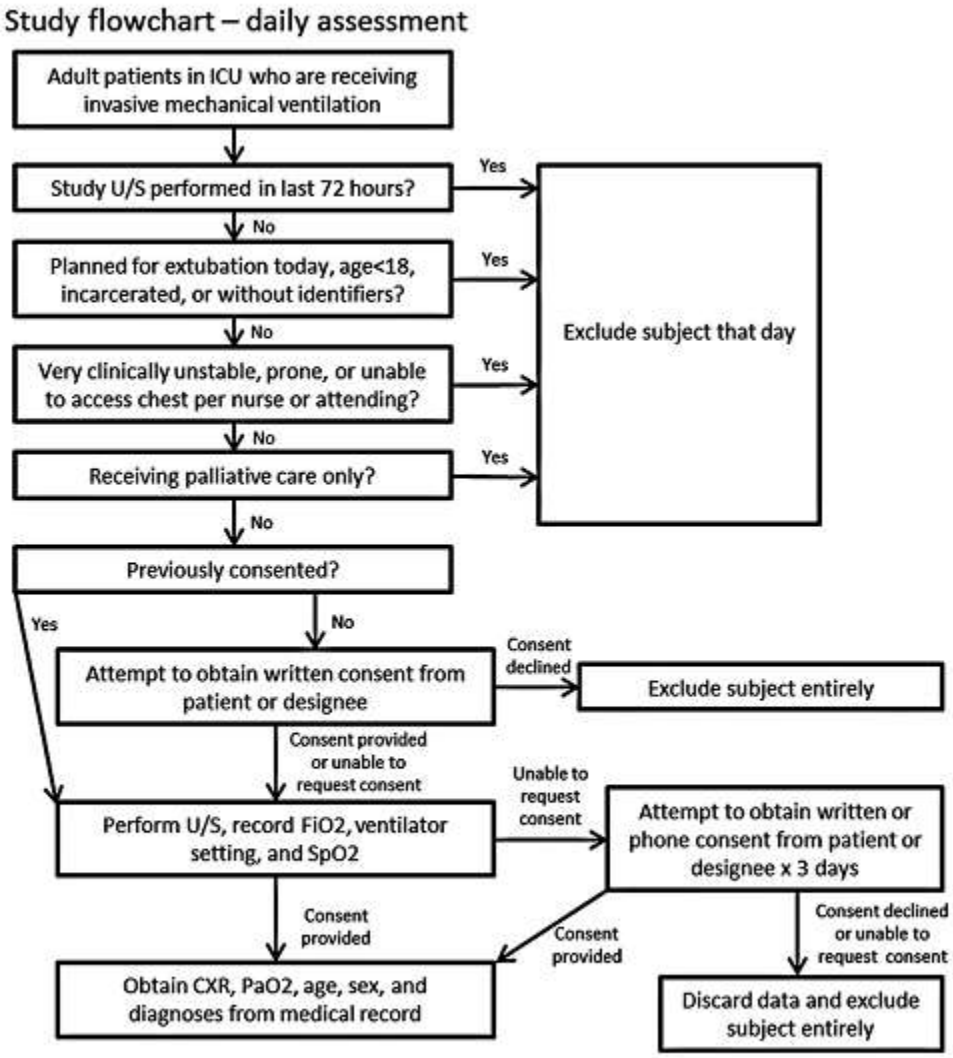

Fig. 1 Study flow chart. *CXR* chest x-ray, *FiO2* fraction of inspired oxygen, *PaO2* partial pressure of oxygen, *SpO2* pulse oximetric oxygen saturation, *U/S* ultrasound

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肺部超声手法

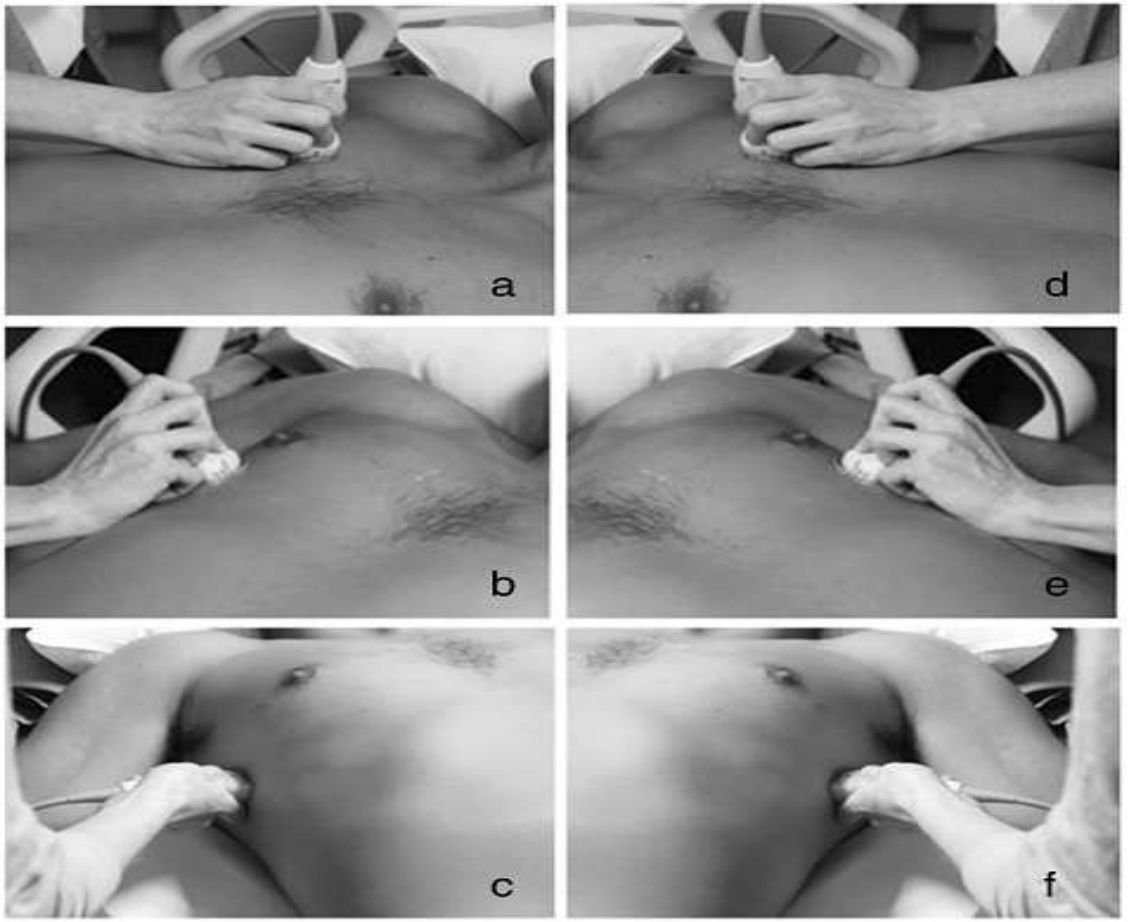

Fig. 2 Placement of the ultrasound probe at six locations on the chest. **a** zone 1 is 2 cm below the anterior mid-clavicular line on the right side of the chest; **b** zone 2 is 4 cm inferior and 4 cm lateral to zone 1; **c** zone 3 is 2 cm inferior to zone 2 along the mid-axillary line. **d**–**f** The identical positions on the left side of the chest

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A、B线定义

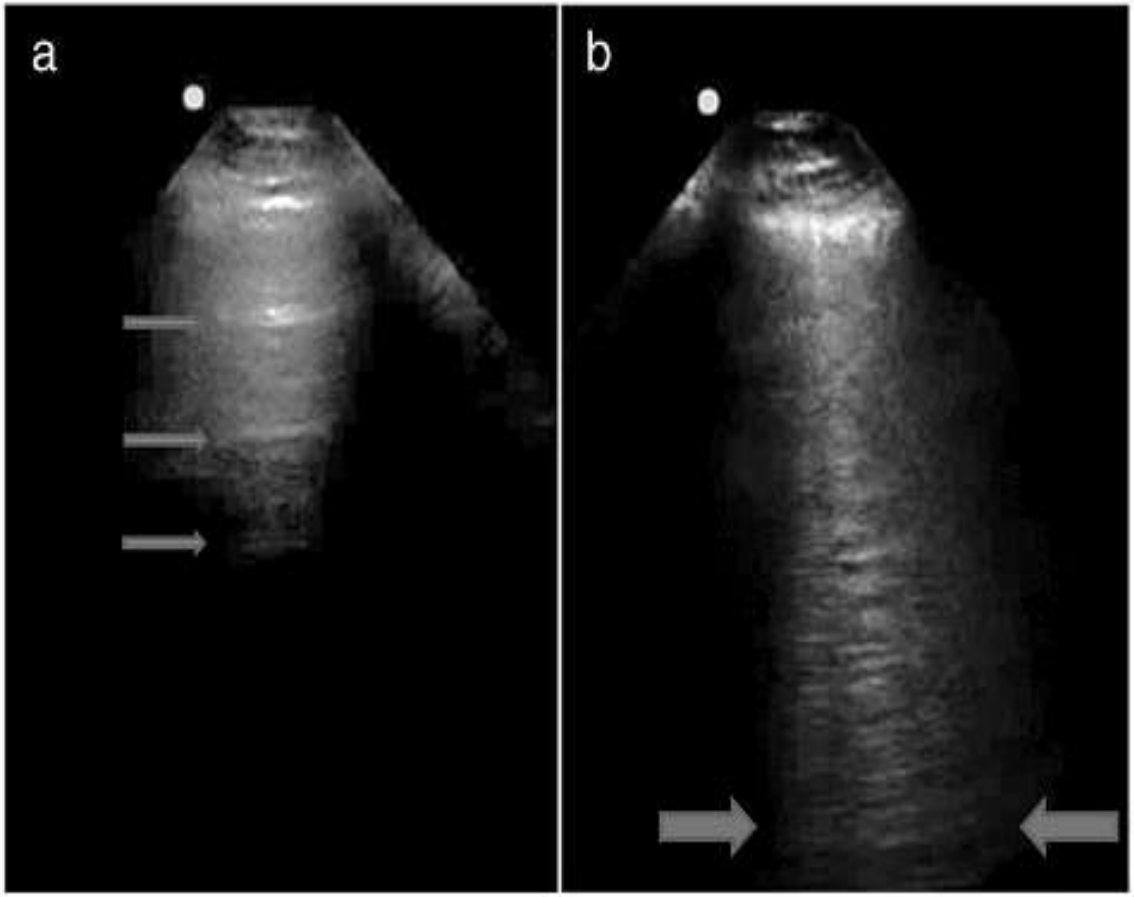

Fig. 3 **a** "A lines": distinct horizontal reflections in a patient with normal lungs (*arrows*). **b** "B lines": three vertical lines in a single frame extending from the pleura to the bottom of the screen in a patient with ultrasound interstitial syndrome (between *arrows*)

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基线情况

Table 1 Baseline characteristics of subjects and study assessments

Characteristic	Number	Percent
Patients	77	
Male	52	68
Age, median (IQR)	56 (41–67)	
Number undergoing 2 assessments	13	17
Number undergoing 3 assessments	3	4
Number undergoing ≥4 assessments	8	10
Assessments	123	
Site:		
MICU	45	37
SICU	49	40
NICU	29	24
Diagnosis:		
Sepsis	36	29
Trauma	31	25
Postsurgery	24	20
CVA	21	17
Cardiogenic pulmonary edema	21	17
Pneumonia	20	16
PEA or VF arrest	13	11
PE	10	8
ARDS	10	8
Overdose	9	7
Seizure	7	6
Pancreatitis	7	6
COPD	6	5
FiO_2 at time of ABG, median (IQR)	0.40 (0.30–0.50)	
PaO_2/FiO_2, median (IQR)	250 (180–337)	
SpO_2 % at time of ABG, median (IQR)	99 (97–100)	
Bilateral opacities on CXR	42	34

Patients may have more than one diagnosis at the time of assessment. *ABG* arterial blood gas, *ARDS* acute respiratory distress syndrome, *COPD* chronic obstructive pulmonary disease, *CVA* Cerebrovascular Accident, *CXR* chest x-ray, *IQR* interquartile range, *MICU* Medical Intensive Care Unit, *NICU* Neurological Intensive Care Unit, *PE* Pulmonary Embolism, *PEA* Pulseless Electrical Activity, *SICU* Surgical Intensive Care Unit, *SpO2* pulse oximetric oxygen saturation, *VF* Ventricular Fibrillation

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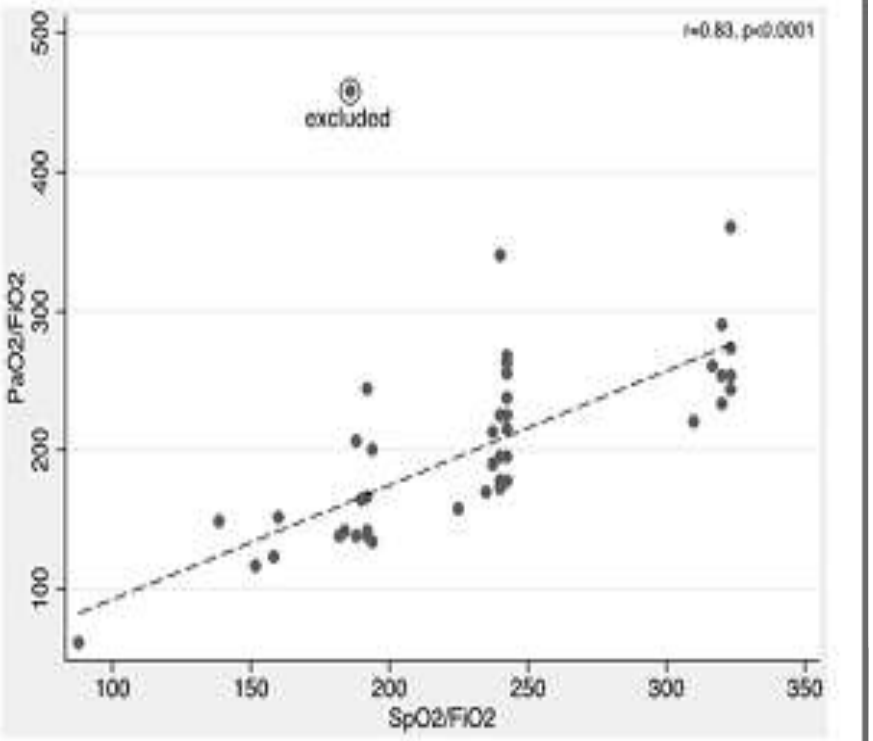

Fig. 4 Correlation between SpO_2/FiO_2 and PaO_2/FiO_2 when $SpO_2 \leq 97$ %. *FiO2* fraction of inspired oxygen, *PaO2* partial pressure of oxygen, *SpO2* pulse oximetric oxygen saturation

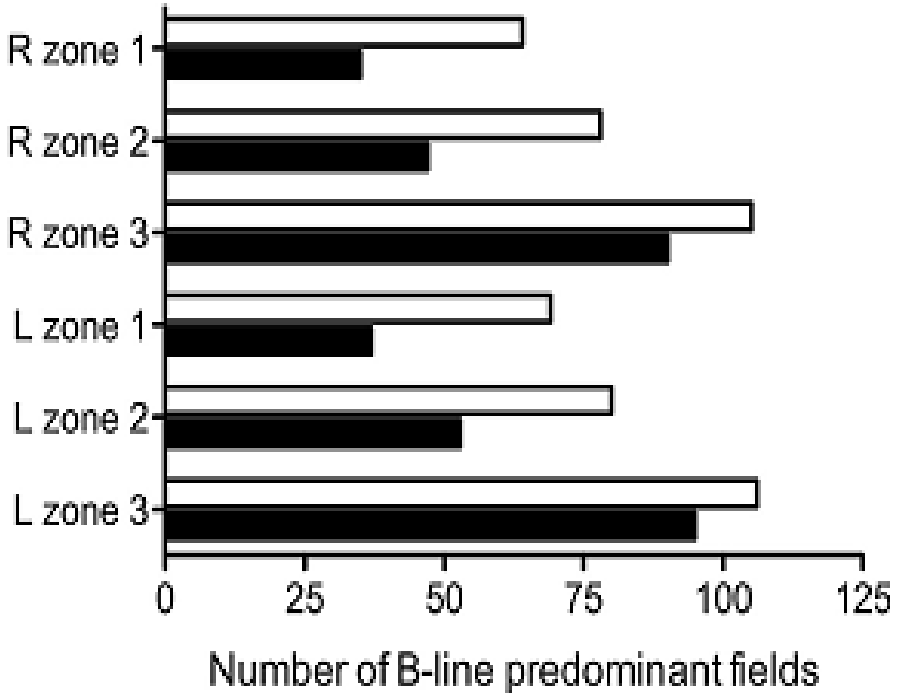

Fig. 5 Distribution of B line-predominant lung fields. *Black bars* indicate reads by the study physician; *white bars* indicate reads by the independent physician. For right (*R*) and left (*L*), zones correspond to locations shown in Fig. 2

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Table 2 Performance of SpO_2/FiO_2 as a marker of PaO_2/FiO_2 when $SpO_2 \leq 97$ %

Number of observations (n = 43)				Test characteristic		95 % CI
		PaO_2/FiO_2				
		≤300	>300	Sensitivity	83 %	68–93
SpO_2/FiO_2	≤315	34	1	Specificity	50 %	1–99
	>315	7	1	PPV	97 %	85–100
				NPV	13 %	0–53
		PaO_2/FiO_2				
		≤200	>200	Sensitivity	70 %	47–87
SpO_2/FiO_2	≤235	16	2	Specificity	90 %	68–99
	>235	7	18	PPV	89 %	65–99
				NPV	72 %	51–88

CI confidence interval, *FiO_2* fraction of inspired oxygen, *NPV* negative predictive value, *PaO_2* partial pressure of oxygen, *PPV* positive predictive value, *SpO_2* pulse oximetric oxygen saturation

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Table 3 Performance of ultrasound diagnosis of ultrasound interstitial syndrome (UIS) as a marker of bilateral pulmonary opacities consistent with acute respiratory distress syndrome

UIS threshold		Number of observations (n = 101)			Test characteristic		95 % CI
1 lung field bilaterally			Bilateral opacities on chest radiograph				
			Present	Absent	Sensitivity	86 %	70–95
	UIS	Present	30	41	Specificity	38 %	26–51
		Absent	5	25	PPV	42 %	31–55
					NPV	83 %	65–94
Bilateral; 3 lung fields minimum			Bilateral opacities on chest radiograph				
			Present	Absent	Sensitivity	80 %	63–92
	UIS	Present	28	25	Specificity	62 %	49–74
		Absent	7	41	PPV	53 %	39–67
					NPV	85 %	72–94
2 lung fields bilaterally			Bilateral opacities on chest radiograph				
			Present	Absent	Sensitivity	60 %	42–76
	UIS	Present	21	15	Specificity	77 %	65–87
		Absent	14	51	PPV	58 %	41–75
					NPV	79 %	67–88

CI confidence interval, *NPV* negative predictive value, *PPV* positive predictive value

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Table 4 Performance of SpO_2/FiO_2 and ultrasound interstitial syndrome (UIS) as a marker for with acute respiratory distress syndrome (ARDS) criteria when $SpO_2 \leq 97$ %

		Number of observations (n = 33)		Test characteristic		95 % CI
Study physician		Oxygenation and radiographic criteria for ARDS				
		Present	Absent	Sensitivity	83 %	52–98
$SpO_2/FiO_2 \leq 315$ and UIS	Present	10	8	Specificity	62 %	38–82
	Absent	2	13	PPV	56 %	31–79
				NPV	87 %	60–98
		Oxygenation and radiographic criteria for moderate–severe ARDS				
		Present	Absent	Sensitivity	64 %	31–89
$SpO_2/FiO_2 \leq 235$ and UIS	Present	7	3	Specificity	86 %	65–97
	Absent	4	19	PPV	70 %	35–93
				NPV	83 %	61–95
Independent physician		Oxygenation and radiographic criteria for ARDS				
		Present	Absent	Sensitivity	91 %	62–100
$SpO_2/FiO_2 \leq 315$ and UIS	Present	11	11	Specificity	48 %	26–70
	Absent	1	10	PPV	50 %	28–72
				NPV	91 %	59–100
		Oxygenation and radiographic criteria for moderate–severe ARDS				
		Present	Absent	Sensitivity	73 %	39–94
$SpO_2/FiO_2 \leq 235$ and UIS	Present	8	5	Specificity	77 %	55–92
	Absent	3	17	PPV	62 %	32–86
				NPV	85 %	62–97

UIS defined as 3 or more B lines bilaterally and involving a minimum of three lung fields. *CI* confidence interval, FiO_2 fraction of inspired oxygen, *NPV* negative predictive value, PaO_2 partial pressure of oxygen, *PPV* positive predictive value, SpO_2 pulse oximetric oxygen saturation

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Thank you