

Point-of-Care Lung Ultrasound to Diagnose the Etiology of Acute Respiratory Failure in the PICU

BACKGROUND

- Point-of-care lung ultrasound (POC-LUS) is used as an alternative to chest radiograph in the initial assessment of adults with acute respiratory failure (ARF) because of significantly higher diagnostic accuracy
- Pediatric POC-LUS has a growing body of research supporting its use, yet it remains an understudied tool in the PICU
- Study objective: determine the sensitivity and specificity of POC-LUS in identifying the etiology of ARF on admission to the PICU
- Study hypothesis: POC-LUS would have a sensitivity and specificity of >90% in identifying the etiology of ARF

METHODS

- Children were prospectively enrolled from December 2018 to February 2020
- POC-LUS was conducted within 14 hours of PICU admission by physicians blinded to history and clinical course
- Another physician, blinded to all clinical information interpreted the POC-LUS to determine the ultrasound diagnosis
- The ultrasound diagnosis was compared to an independent, standardized review of the medical record following hospital discharge (final diagnosis) which served as the study reference standard
- The sensitivity and specificity of the ultrasound diagnosis was determined
- Kappa statistics adjusted for maximum attainable agreement were used to quantify agreement with the final diagnosis
- **Inclusion Criteria:** age >37 weeks and <19 years of age; study physician available to perform POC-LUS; admitted to PICU with diagnosis of ARF and need for respiratory support (defined by: HFNC >1 L/kg/min, CPAP, BiPAP, mechanical ventilation, or continuous nebulized medications)
- **Exclusion Criteria:** non-pulmonary etiology of ARF, known chronic respiratory disease, non-English speaking family/guardian

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Point-of-care lung ultrasound demonstrates moderate to low sensitivity and specificity in identifying the etiology of pediatric acute respiratory failure on admission to the PICU

RESULTS

- 88 patients were enrolled and participated in the study (Figure 1) 10 patients had a final diagnosis of status asthmaticus (11%), 48 had bronchiolitis/viral pneumonitis (55%), 29 had pneumonia (33%), and 1 was excluded from analysis because of an inability to differentiate the final diagnosis
- POC-LUS correctly identified the etiology of acute respiratory failure in 54% of patients; sensitivity and specificity of the POC-LUS compared to the final diagnosis is in table 1 and kappa statistics in table 2

	Status asthmaticus	Bronchiolitis	Pneumonia
Sensitivity	0.70 (95% CI 0.40–0.89)	0.46 (95% CI 0.33–0.60)	0.62 (95% CI 0.44–0.77)
Specificity	0.82 (95% CI 0.72–0.89)	0.72 (95% CI 0.56–0.83)	0.74 (95% CI 0.62–0.84)

Table 1. Sensitivity and specificity of POC-LUS diagnosis compared to final diagnosis

Final Diagnosis	Status Asthmaticus	Bronchiolitis ¹	Pneumonia
Status Asthmaticus, n=10	7	3	0
Bronchiolitis, n=48	11	22	15
Pneumonia, n=29	3	8	18

Table 2. POC-LUS demonstrates fair agreement with final diagnosis, k=0.28 (95% CI 0.11–0.43), $k_{max}=0.73$, $k/k_{max}=0.38$ (95% CI 0.16– 0.61).

DISCUSSION

	KEY INFORMATION & CONO	CLUSION			
	PICU admission included	respiratory failure,			
	n=732				
	Excluded, n=626				
	- Non-pulmonary etiology of ARF, n=270				
	- Sonographer unavailable, n=227				
	 Not on qualifying support, n=92 				
	- Chronic respiratory disease, n=17				
	- Non-English speaking, n=14				
	- Age <37 weeks or ≥19 years, n=6				
	Eligible for study, n=106				
	Approached & consent not granted, n=16				
Not allowed by PICU provider, n=2					
	Enrolled in study, n	=88			
	Removed for multiple final diagnoses, r	า=1			
	Analyzed in study, n	=87			
Figure 1. Patient inclusion and exclusion flowchart					
	- POC-LUS demonstrates moderate to	low sensitivity and			
	specificity in identifying the etiology	of pediatric ARF as a			
	stand alone exam technique on adm	ission to the PICU			
	- This contrasts to the high utility dem	onstrated in			
	differentiating the stieles of ADE in	critically ill adulta			
	unerentiating the etiology of ARF IN	cifically ill adults			

study

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Lichtenstein initially demonstrated >80% sensitivity and >90% specificity of POC-LUS to differentiate the etiology of adult ARF on admission to the medical ICU

Numerous researchers have substantiated these findings; however, adults have different etiologies of ARF (COPD exacerbation, pneumonia, acute congestive heart failure, and ARDS) compared to children (status asthmaticus, pneumonia, and bronchiolitis)

One prior study has examined POC-LUS in PICU patients showing moderate sensitivity (63.4%) using a a nonblinded study protocol (no specificity reported)

Determining the optimal role of POC-LUS as an adjunct in the care of pediatric patients with ARF requires further