

The Use of Ultrasound in the Diagnosis of Acute Dyspnea in the Emergency Department



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Background

- Point-of-care ultrasound (POCUS) offers a fast, cheap, and safe way to evaluate patients¹
- Dyspnea, or shortness of breath, is one of the most common presentations to the ED
- Many etiologies → dyspnea work up can be expensive and time-intensive → POCUS could be a solution
- Mixed results on diagnostic accuracy of POCUS for dyspnea² → need further study
- No studies examining diagnostic accuracy of POCUS conducted by a medical student

Population

- Inclusion criteria:** adults (≥18 yo) who present to the MetroHealth ED with shortness of breath
- Exclusion criteria:** altered mental status, pregnant patients, prisoners, non-English speakers

Learning Objectives

- Develop proficiency in sonography technique and interpretation of images
- Determine the diagnostic accuracy of POCUS for asthma, COPD, acute heart failure, pneumonia, pulmonary embolism, pneumothorax, and rule-out cases

POCUS 101

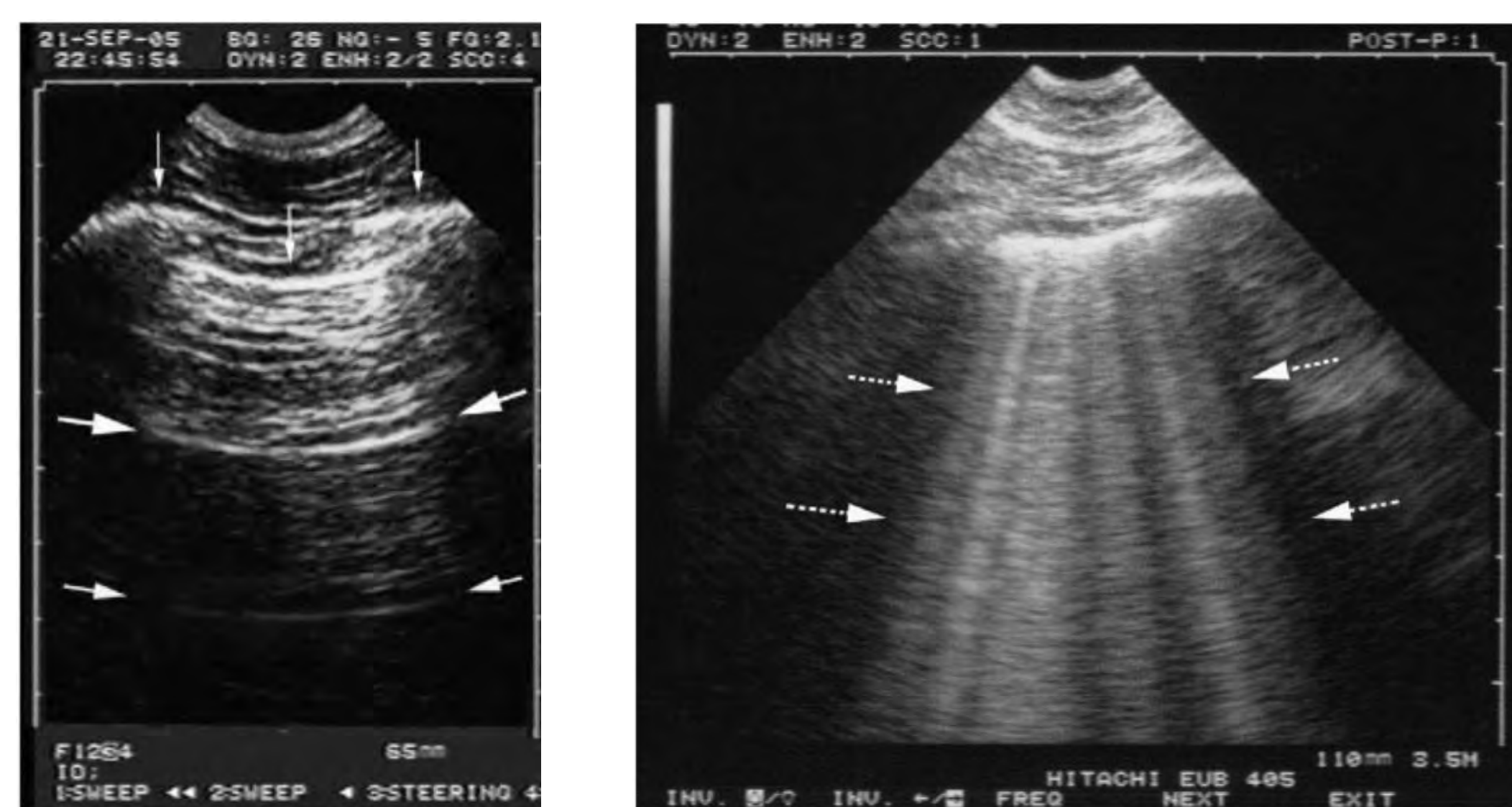


Figure 1: POCUS characteristics in lung pathology. Left panel: A-Profile appearance, indicating healthy aerated lung. Right panel: B-profile appearance. These vertical comet-tail artifacts exclusively originate from the pleural line, possess clear delineation (laser-like), appear hyperechoic, exhibit movement with lung sliding, extend to the edge of the screen without attenuation, and obscure A lines. Image taken from Lichtenstein & Meziere (2008).³

Methods

- 250 patients enrolled
- Study investigator blinded to patient's clinical work up
- POCUS examination findings, demographic, clinical data, interventions, and outcomes collected
- POCUS examination findings compared to clinical diagnosis as the gold standard
- Ultrasound protocol was standardized using a modified BLUE protocol (Figure 2)

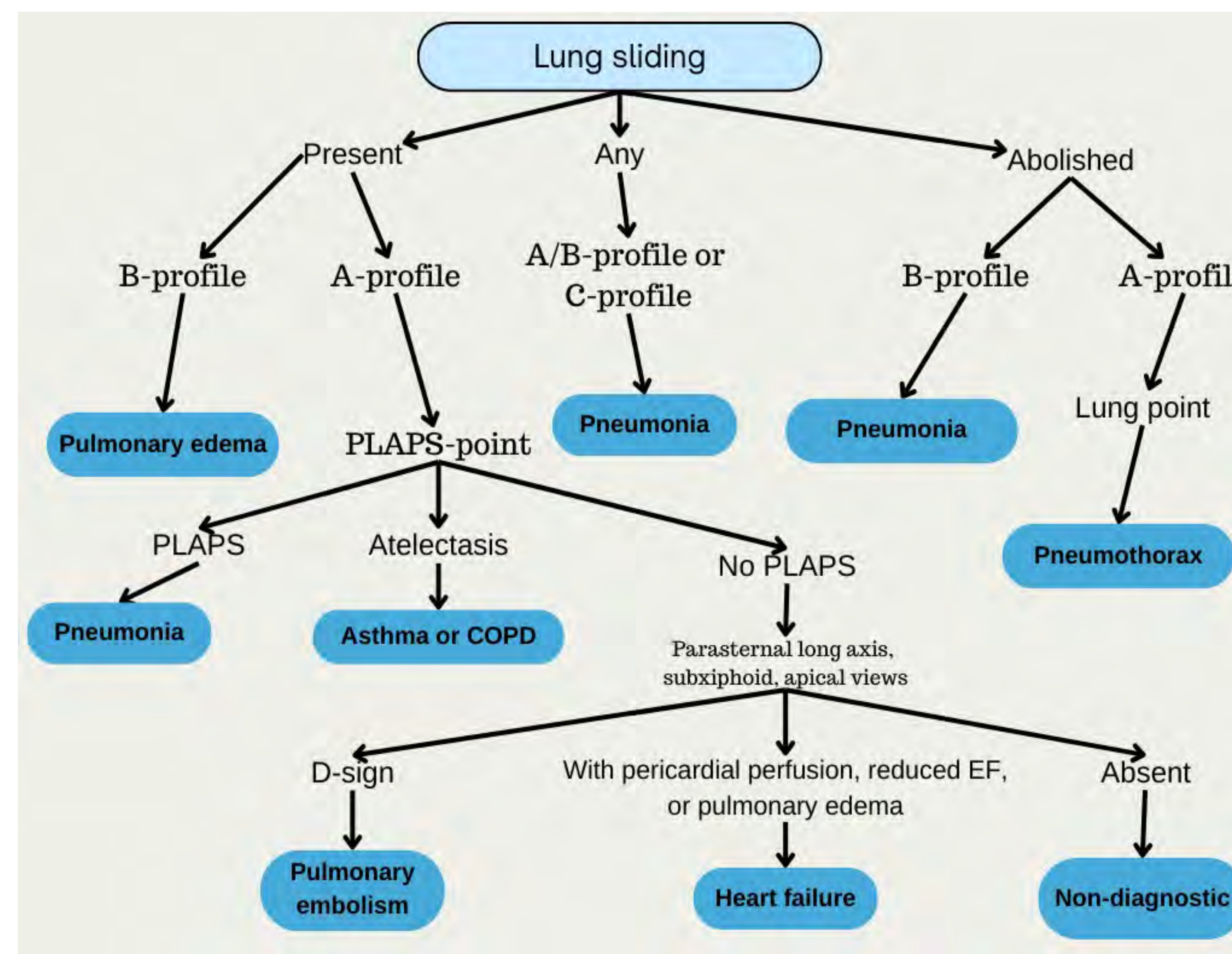


Figure 2: Ultrasound scanning protocol.

Characteristic	Values
Age (years)	56.6 ± 16.02
Men—no. (%)	99 (39.6)
Race	
Black	136 (54.4)
White	99 (39.6)
Hispanic	24 (9.6)
Other	14 (5.6)
Short of breath duration (days)	3 (5.75)
Systolic blood pressure (mmHg)	142.3 ± 24.3
Diastolic blood pressure (mmHg)	84.5 ± 15.2
Heart rate (bpm)	89.4 ± 18.5
Respiratory rate (breathes/min)	19.4 ± 3.79
Oxygen saturation (%)	95.8 ± 7.6
BMI (kg/m ²)	32.3 ± 10.2
Comorbidities	
Asthma—no (%)	92 (36.8)
Alcohol use disorder—no (%)	45 (18.0)
CABG—no (%)	5 (2.0)
Coronary artery disease (CAD)—no (%)	39 (15.6)
Congestive heart failure (CHF)—no (%)	51 (20.4)
COPD—no (%)	76 (30.4)
Hyperlipidemia—no (%)	113 (45.2)
Hypertension—no (%)	151 (60.4)
Percutaneous intervention—no (%)	15 (6.0)
Pericarditis—no (%)	14 (5.6)
Pleural effusion—no (%)	67 (26.8)
Pneumonia—no (%)	116 (46.4)
Pneumothorax—no (%)	8 (3.2)
Pulmonary embolism—no (%)	34 (13.6)
Pulmonary edema—no (%)	59 (23.6)
Substance use disorder—no (%)	51 (20.4)
Positive ultrasound findings—no (%)	98 (39.2)
Ultrasound examination length (minutes)	10.4 ± 4.1
Time to CXR (minutes)	102.1 ± 88.8

Table 1: Baseline characteristics of study population.

Results

Primary Diagnosis	Sensitivity	Specificity	PPV	NPV	Positive Likelihood Ratio	Negative Likelihood Ratio	Accuracy
Asthma	86.36	99.12	90.48	98.69	98.45	0.14	98.00
COPD	90.91	98.06	90.91	98.06	46.82	0.09	96.80
Acute Heart Failure	81.25	99.08	92.86	97.30	88.56	0.19	96.80
Pneumonia	80.00	97.33	76.92	97.77	30.00	0.21	95.60
Pulmonary embolism	60.00	99.18	60.00	99.18	73.50	0.40	98.40
Pneumothorax	100.00	99.20	33.33	100.00	124.50	0.00	99.20
Non-diagnostic	83.47	93.02	91.82	85.71	11.96	0.18	88.40

Table 2: Diagnostic accuracy of POCUS for dyspnea etiologies.

Conclusion

- POCUS demonstrated moderate sensitivity and high specificity for diagnosing asthma, acute heart failure, pneumonia, pulmonary embolism, and rule-out negative cases
- POCUS demonstrated high sensitivity and specificity for identifying COPD, pneumothorax
- Out of 250 scans, 210 (84%) correctly identified the underlying cause
- POCUS was significantly faster ($P < 0.0001$) than Chest X-Ray

Public Health Implications

- POCUS is cheap, portable, safe technology
- Demonstrated reasonable prognostic value for evaluating etiology of dyspnea
- POCUS can be used in disaster settings, or in remote/rural health care settings to aid diagnosis, inform timely treatment
- Future work should investigate the diagnostic accuracy of Butterfly iQ3 ultrasound probes

References

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