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FULL RESEARCH ARTICLE

Diagnostic performance of lung POCUS in neonatal respiratory disorders in the neonatal intensive care unit: a new shortened protocol

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ABSTRACT

Introduction: *Lung point-of-care ultrasound (POCUS) has been useful in diagnosing neonatal respiratory disorders (NRDs); however, chest radiography (X-ray) is the most widely used imaging modality and the gold standard. This study aimed to determine the diagnostic performance of a new, shortened lung POCUS protocol compared with chest X-ray in NRD diagnosis.* **Materials and methods:** *This prospective cohort study was conducted from September 2023 to December 2024. Newborns from the neonatal intensive care unit (NICU) were consecutively included. A chest X-ray and a shortened lung POCUS protocol were performed. NRDs were recorded based on the imaging findings. The diagnostic performance of the shortened lung POCUS protocol was evaluated and compared with the gold standard, chest X-ray.* **Results:** *Sixty neonates were included; 14 (23.3%) had abnormal findings on chest X-ray, while 23 (38.3%) had abnormal findings on lung POCUS with the following NRD diagnoses: interstitial fluid overload (n = 9, 15.0%), respiratory distress syndrome (n = 7, 11.6%), pneumonia (n = 6, 10.0%), and transient tachypnea of the newborn (TTN) (n = 1, 1.6%). The shortened lung POCUS protocol had a sensitivity of 82.3% and a specificity of 79.1%, while chest X-ray had a sensitivity of 60.9% and a specificity of 91.9% for the diagnosis of NRDs in neonates in the NICU.* **Conclusion:** *This new shortened lung POCUS with an assessment of 10 lung areas had a higher sensitivity (82.3%) than chest X-ray (60.9%) for the diagnosis of NRDs in neonates in the NICU. To our knowledge, this study is the first in Mexico that focuses on comparing the performance of these two imaging modalities for diagnosing NRDs.*

Keywords: *Lung point-of-care ultrasound. Neonatal respiratory disorders. Neonatal intensive care unit. Diagnostic performance.*

INTRODUCTION

Neonatal respiratory disorders (NRDs) are a leading cause of morbidity and mortality in neonates (0-7 days of life), with an incidence between 40 and 45% in neonatal intensive care units (NICUs)[1-3]. NRDs include pneumonia (42.8%), respiratory distress syndrome (20.8%), transient tachypnea of the newborn (TTN) (13.6%), meconium aspiration syndrome (7.9%), atelectasis (7.7%), and pneumothorax (2.8%)[4-9]. Chest radiography (X-ray) is the most widely used imaging method and the gold standard for diagnosing NRDs. However, it has some disadvantages, such as ionizing radiation exposure[10], which due to the small size of the neonate and the proximity to radiosensitive tissues and organs, increases their susceptibility to radiation effects compared to other

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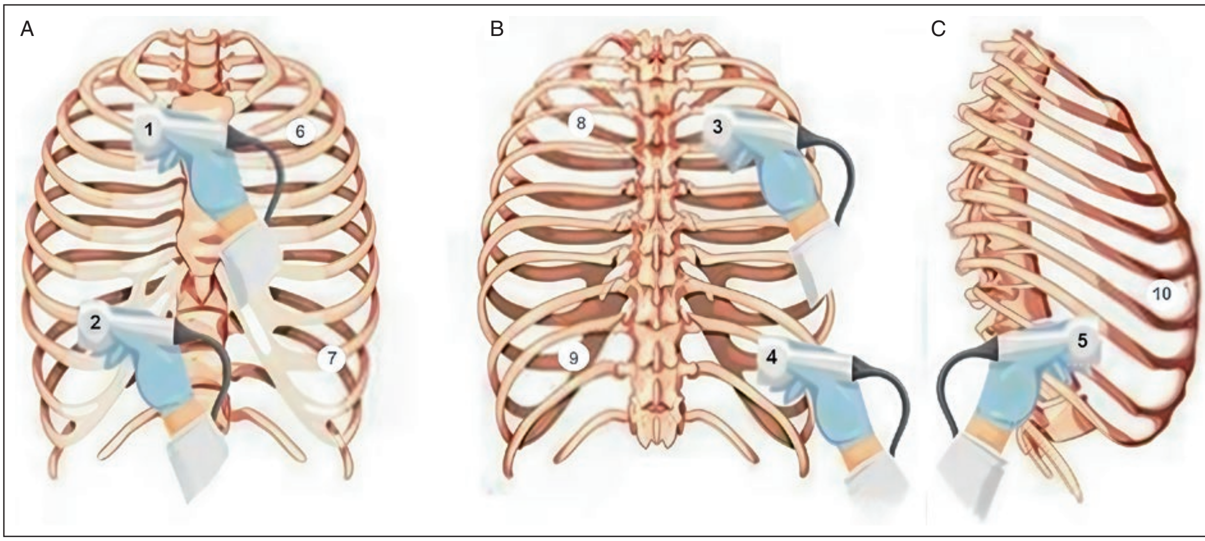

Figure 1. Shortened lung POCUS protocol. **A:** examination starts on the right side in the anterior apical region with the transducer oriented longitudinally in front of the anterior axillary line of the thorax (number 1). It continues with the anterior basal region. The transducer is oriented longitudinally at the level of the nipple at the base of the lung (number 2). **B:** the right posterior apical region is examined with the transducer oriented longitudinally in the paravertebral region in the interscapulovertebral space towards the apical zone of the chest (number 3). The right posterior basal region is examined with the transducer oriented longitudinally at the level of the inferior scapular angle (number 4). **C:** the right lateral basal region is examined with the transducer oriented longitudinally at the level of the mid-axillary line at the base of the lung (number 5). This shortened lung POCUS protocol is performed in the same order (number 6, 7, 8, 9 and 10) on the left side.

POCUS: point-of-care ultrasound.

age groups. There may also be false-positives, and limitations in interpretation due to anatomical and technical characteristics[11].

Neonatal point-of-care ultrasound (POCUS), first described in 1960, has been increasingly used over the last decade[2]. Lung POCUS allows real-time imaging without radiation exposure with high sensitivity in detecting lung abnormalities, such as B-lines, consolidations, and the absence of A-lines[10-14]. Lung POCUS diagnostic accuracy varies from 82.7% to 100%[2,4,7]. The conventional lung POCUS protocol evaluates 12 lung areas[15], but its clinical implementation is complex because it requires scanning multiple anatomic regions of the thorax in different positions (supine, prone, and lateral)[16-18]. This protocol may be impractical due to neonatal movement caused by crying, the presence of catheters, cannulas, tracheal tubes, and other medical devices that restrict mobility and access to some thoracic regions. Because of these limitations, we propose a new, shortened lung POCUS protocol for detecting NRDs that reduces neonatal manipulation. This study aimed to determine the diagnostic performance of this new, shortened lung POCUS protocol compared to chest X-ray in NRDs diagnosis.

MATERIAL AND METHODS

This prospective cohort study was conducted from September 2023 to December 2024 in the Department of Radiology and Imaging of the tertiary-care ISSSTE Hospital Regional Monterrey in Monterrey, Nuevo Leon, Mexico. Neonates aged 24 hours to 28 days admitted to the neonatal intensive care unit (NICU) were included. Neonates with thoracic surgery or skin conditions that prevented safe use of the ultrasound transducer were excluded. Informed consent was obtained from parents or guardians. The institutional research and research ethics committee approved the study.

Study development and variables

Neonates routinely admitted to the NICU were observed and assessed for at least 24 hours. Chest X-ray were routinely performed. The NRD diagnoses were based on chest X-ray findings and lung POCUS examination. Lung POCUS examination included variables such as the pleural line, A-line, B-line, white lung, consolidation, and the double lung point sign.

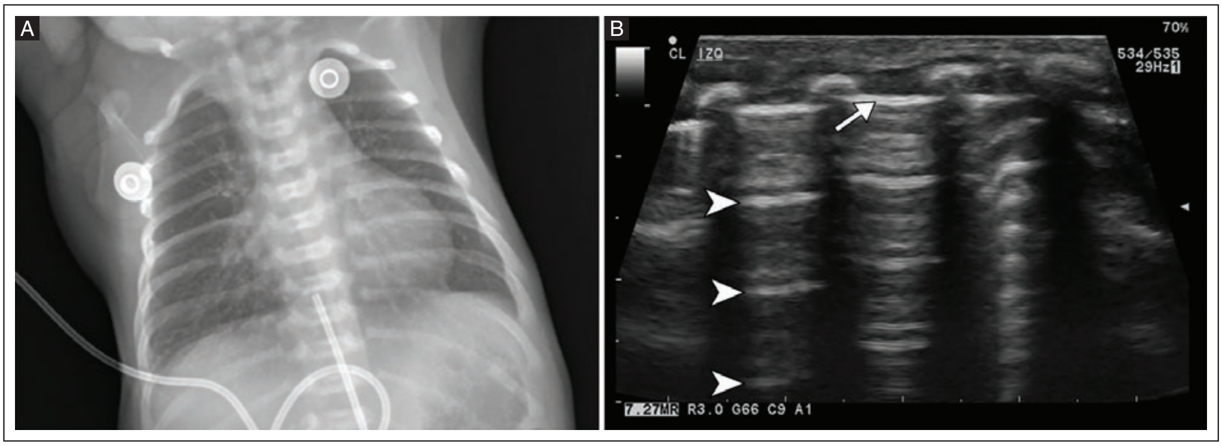

Figure 2. A healthy full-term neonate born by cesarean section at 39.5 weeks gestation with 24 hours of extrauterine life. **A:** a normal AP chest X-ray shows adequately expanded lungs with no abnormal findings. Umbilical catheter and electrodes are also visible. **B:** a normal lung POCUS shows a pleural line of normal thickness (white arrow) along with multiple A-lines (white arrowheads), which are typical findings in a normal lung.

AP: anteroposterior; POCUS: point-of-care ultrasound; X-ray: radiography.

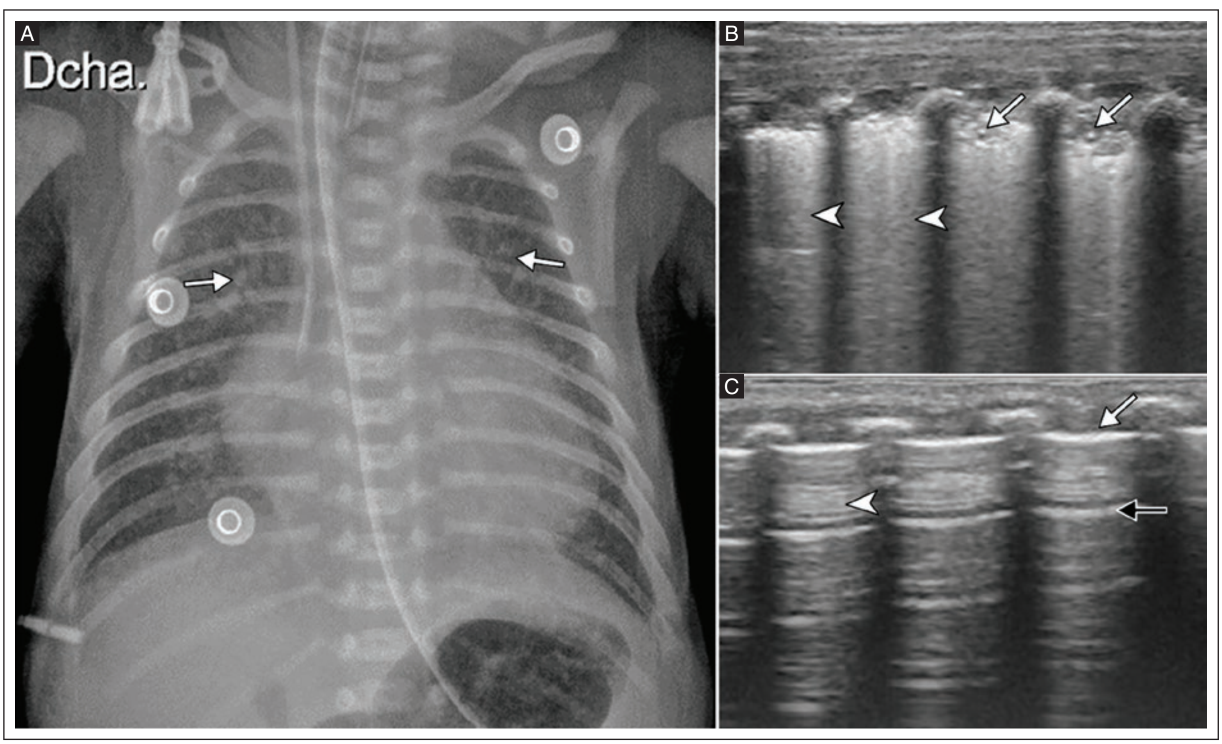

Figure 3. Male preterm neonate born by cesarean section at 30 weeks gestation with 24 hours of extrauterine life with an NRD requiring endotracheal ventilation. **A:** AP chest x-ray shows diffuse bilateral alveolar opacities (white arrows). An endotracheal tube, feeding tube, and central venous catheter are seen with the catheter tip projecting at the cavoatrial junction. **B:** lung POCUS of the left posterior-inferior quadrant shows loss of normal pleural line morphology and echogenicity due to subpleural focal atelectasis (white arrows) and an increased number of B-lines forming a "white lung pattern" (white arrowheads). **C:** lung POCUS of the right posterior-inferior quadrant shows a pleural line with normal echogenicity and thickness (white arrow), the presence of B-lines (white arrowhead), and preserved A-lines with a normal appearance (black arrow). The diagnosis was subpleural atelectasis on chest X-ray and shortened lung POCUS.

AP: anteroposterior; NRD: neonatal respiratory disorder; POCUS: point-of-care ultrasound; X-ray: radiography.

Table 1. Chest X-ray and shortened lung POCUS findings in 23 neonates diagnosed with NRDs in the NICU

Case	Chest X-ray findings	Radiological diagnosis	Lung POCUS findings						Lung POCUS diagnosis
			Pleural line	A line	B line	Consolidation	White lung	Double lung point	
1	Normal	Normal	Normal	Present	Present	Present	Absent	Absent	Respiratory distress syndrome
2	Apex consolidation	Pneumonia	Normal	Present	Present	Present	Absent	Absent	Respiratory distress syndrome
3	Reticular pattern	Interstitial fluid overload	Thickened	Absent	Present	Present	Present	Absent	Pneumonia
4	Consolidation with air bronchogram	Pneumonia	Thickened	Absent	Present	Present	Absent	Absent	Pneumonia
5	Reticular pattern	Interstitial fluid overload	Normal	Absent	Present	Absent	Present	Absent	Interstitial fluid overload
6	Normal	Normal	Normal	Present	Absent	Present	Absent	Absent	Respiratory distress syndrome
7	Reticular pattern	Interstitial fluid overload	Normal	Absent	Present	Absent	Present	Absent	Respiratory distress syndrome
8	Reticular pattern	Interstitial fluid overload	Normal	Absent	Present	Absent	Present	Absent	Respiratory distress syndrome
9	Reticular pattern	Interstitial fluid overload	Normal	Absent	Present	Absent	Present	Absent	Respiratory distress syndrome
10	Normal	Normal	Normal	Present	Present	Absent	Absent	Present	TTN
11	Consolidation	Pneumonia	Normal	Present	Present	Present	Absent	Absent	Pneumonia
12	Normal	Normal	Normal	Present	Present	Present	Absent	Absent	Respiratory distress syndrome
13	Reticular pattern	Interstitial fluid overload	Normal	Absent	Present	Absent	Present	Absent	Interstitial fluid overload
14	Reticular pattern	Interstitial fluid overload	Normal	Absent	Present	Absent	Present	Absent	Interstitial fluid overload
15	Normal	Normal	Normal	Absent	Present	Absent	Present	Absent	Interstitial fluid overload
16	Consolidation with air bronchogram	Pneumonia	Thickened	Absent	Present	Present	Absent	Absent	Pneumonia
17	Normal	Normal	Normal	Absent	Present	Absent	Present	Absent	Interstitial fluid overload
18	Consolidation with air bronchogram	Pneumonia	Thickened	Absent	Present	Present	Absent	Absent	Pneumonia
19	Normal	Normal	Normal	Absent	Present	Absent	Present	Absent	Interstitial fluid overload
20	Consolidation with air bronchogram	Pneumonia	Thickened	Absent	Present	Present	Absent	Absent	Pneumonia
21	Normal	Normal	Normal	Absent	Present	Absent	Present	Absent	Interstitial fluid overload
22	Normal	Normal	Normal	Absent	Present	Absent	Present	Absent	Interstitial fluid overload
23	Reticular pattern	Interstitial fluid overload	Normal	Absent	Present	Absent	Present	Absent	Interstitial fluid overload

POCUS: point-of-care ultrasound; NRDs: neonatal respiratory disorders; NICU; neonatal intensive care unit: TTN: transient tachypnea of the newborn.

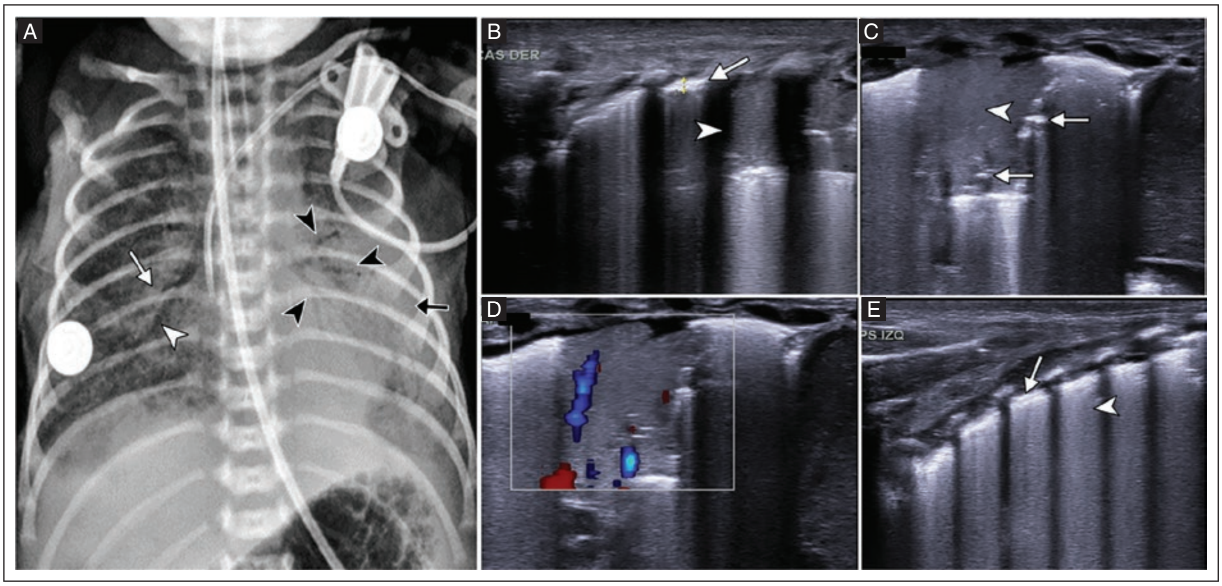

Figure 4. Full-term neonate at 37 weeks gestation with 5 days of extrauterine life with an NRD and fever. **A:** AP chest X-ray shows an area of consolidation in the right middle lobe (white arrow) with air bronchograms (white arrowhead). There are more areas of consolidation in the lingula and the posterior segment of the left lower lobe (black arrowheads) with air bronchograms (black arrowhead). A central venous catheter with a tip at the cavoatrial junction and an orogastric tube and electrodes can be seen. **B:** lung POCUS of the right anterior upper quadrant with pleural line thickening (white arrow) next to the consolidation area (white arrowhead). **C:** lung POCUS of the left hemithorax in the lateral quadrant with a focal subpleural parenchymal consolidation (white arrowhead) with air bronchograms (white arrows). Hepatization of the lung parenchyma was noted. **D:** lung POCUS, with color Doppler showing vascular flow in the same area of consolidation. **E:** lung POCUS of the left posterior upper quadrant showing pleural line thickening (white arrow) and increased B-lines corresponding to a "white lung pattern" (white arrowhead). The diagnosis was pneumonia on the chest X-ray and shortened lung POCUS.

AP: anteroposterior; NRD: neonatal respiratory disorder; POCUS: point-of-care ultrasound; X-ray: radiography.

New shortened lung POCUS protocol

Acuson NX3 equipment (Siemens Healthineers, Erlangen, Germany) with a linear transducer of 5-13 MHz was used. The technical parameters, previously described by Liu et al.[9], were (a) 4-5 cm depth, (b) 1-2 focal zones close to the pleural line, (c) fundamental frequency imaging, (d) 2-3 speckle reduction imaging (SRI), (e) spatial compounding function (SCF), (f) and a time-gain compensation (TGC) setting. A pediatric radiologist (SET) with 11 years of experience assessed the chest X-ray and the shortened lung POCUS protocol.

The new, shortened lung POCUS protocol proposed by the author (SET) consists of assessing 10 areas in the thorax bilaterally at the anterosuperior, anteroinferior, lateral, posterosuperior, and posteroinferior levels, as described below.

Examination starts on the right side in the anterior apical region with the transducer oriented longitudinally in front of the anterior axillary line in the apical region of the thorax (Figure 1A) (number 1). It continues with the anterior basal region, with the transducer oriented longitudinally at the level of the nipple at the base of the lung (number 2). The right posterior apical region is examined with the transducer oriented longitudinally in the paravertebral region in the interscapulovertebral space towards the apical region of the chest (Figure 1B) (number 3). The right posterior basal region is examined with the transducer oriented longitudinally at the level of the inferior scapular angle (number 4). The right lateral basal region is examined with the transducer oriented longitudinally at the level of the mid-axillary line at the base of the lung (Figure 1C) (number 5). This protocol is performed on the left side in the same order (numbers 6, 7, 8, 9, and 10).

Statistical analysis

Numerical variables are described with measures of central tendency and dispersion. Categorical variables as absolute numbers and percentages. A receiver operating characteristic (ROC) curve assessed the discriminatory ability of a dichotomous diagnosis. Sensitivity, specificity, positive predictive value (PPV), negative

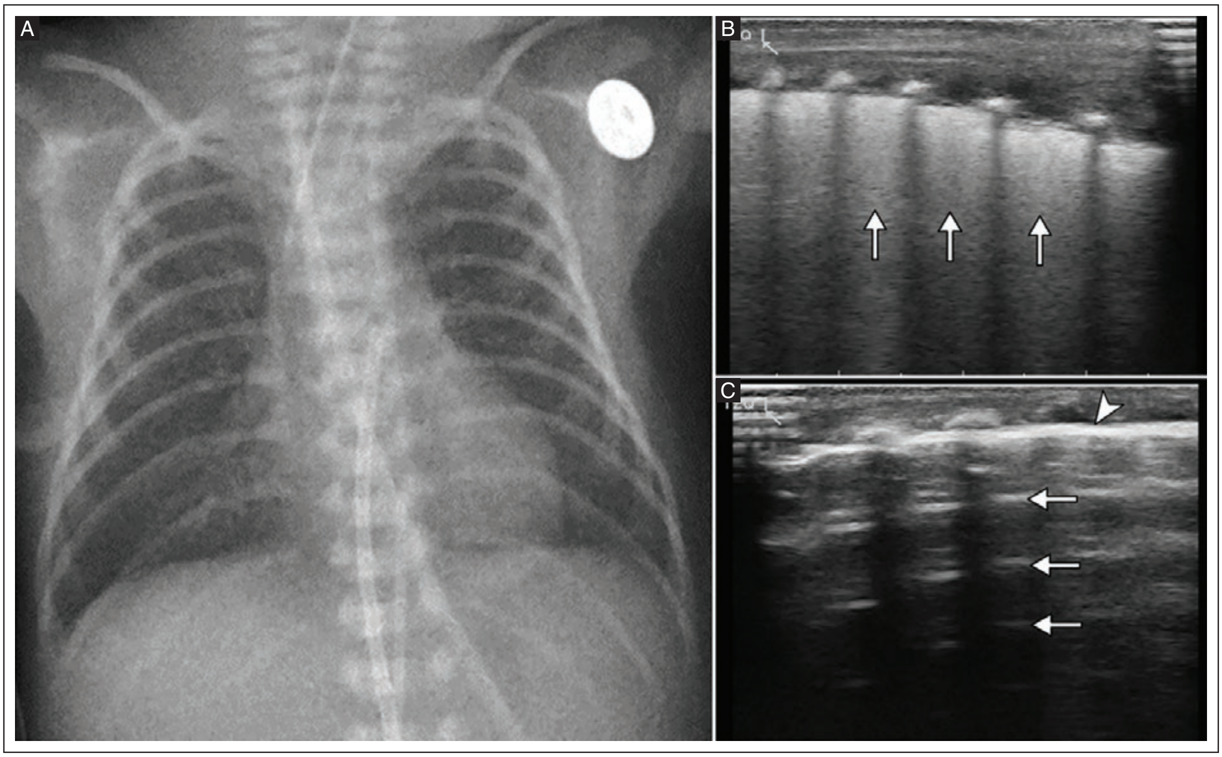

Figure 5. Full-term male neonate born by cesarean section at 38 weeks gestation with 24 hours of extrauterine life with an NRD and clinical suspicion of TTN. **A:** AP chest X-ray showing adequately expanded lung fields with no pathologic abnormalities. An endotracheal tube, an umbilical catheter and a gastric tube are visible. **B:** lung POCUS of the left posterior-inferior quadrant shows an increased number of B-lines resulting in a "white lung" appearance (wet lung pattern) (white arrows), along with obliteration of the A-lines, a finding consistent with interstitial fluid overload. **C:** lung POCUS of the left anterior-inferior quadrant with preserved A-lines (white arrows) and normal appearance of the pleural line (white arrowhead), consistent with a normal ultrasound pattern. The chest X-ray was normal. Shortened lung POCUS diagnosis was interstitial fluid overload.

AP: anteroposterior; NRD: neonatal respiratory disorder; POCUS: point-of-care ultrasound; TTN: transient tachypnea of the newborn; X-ray: radiography.

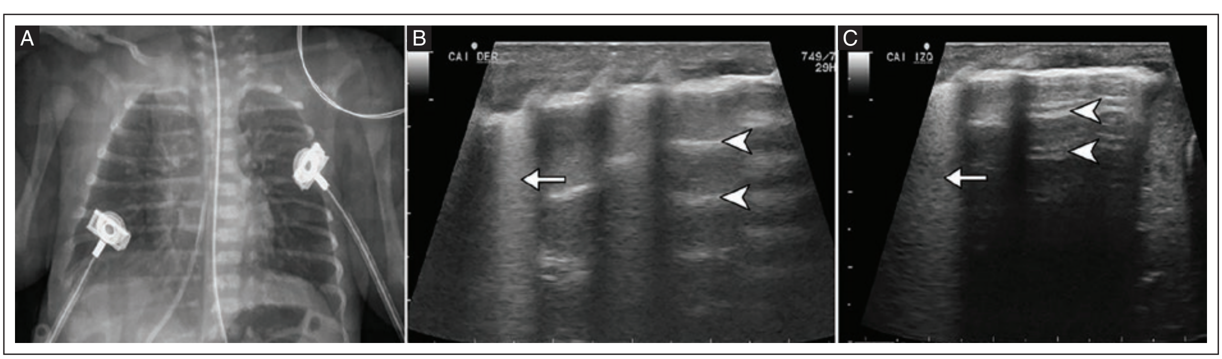

Figure 6. Preterm male neonate born at 32 weeks gestation with 24 hours of extrauterine life. **A:** AP chest X-ray showing normal lung fields. An umbilical catheter, electrodes and a feeding tube are seen. **B:** lung POCUS of the anterior and lower right quadrant shows a focal increase in B-lines (white arrow) with preservation of A-lines (white arrowheads), which together form the double lung point sign. **C:** lung POCUS of the anterior and lower left quadrant shows a focal increase of the B-lines (white arrow) with preservation of A-lines (white arrowheads) which together form the double lung point sign. The chest X-ray was normal. Shortened lung POCUS diagnosis was TTN.

AP: anteroposterior; POCUS: point-of-care ultrasound; TTN: transient tachypnea of the newborn; X-ray: radiography.

predictive value (NPV), and accuracy were calculated to determine the diagnostic performance of the shortened lung POCUS protocol compared to chest X-ray as the gold standard, and chest X-ray with the shortened lung POCUS protocol as the gold standard. Agreement between lung POCUS findings and chest X-ray findings was assessed with Cohen´s kappa coefficient. The 95% confidence interval (CI) was calculated and a value of $p < 0.05$ was significant. Data analysis was performed with SPSS v.25.0 (IBM Corp., Armonk NY, USA).

RESULTS

Sixty neonates were included, 27 (45.0%) females and 33 (55.0%) males. The mean gestational week was 35.4 ± 2.5. Forty-four (73.3%) were preterm neonates with a mean gestational week of 34.5 ± 2.0; 16 (26.7%) neonates were term with a mean gestational week of 38.4 ± 0.8. The mean chronological age of the neonates at which the shortened lung POCUS protocol was performed was 36.8 ± 48.9 hours. In neonates without an NRD diagnosis, the examination was performed on average at 24 hours of life. In contrast, neonates with an NRD, lung POCUS was performed with a mean at 57.3 ± 75.4 hours.

Chest X-ray and lung POCUS findings in 23 neonates with NRDs

Abnormal chest X-ray findings were found in 14 (23.3%) of 60 neonates, while 23 (38.3%) had abnormal lung POCUS findings (Table 1). Of the 23 neonates with lung POCUS abnormalities, 18 (78.3%) were preterm and 5 (21.7%) were term.

The chest X-ray and lung POCUS were normal in 34 (56.7%) of the 60 neonates. Figure 2 shows a normal chest X-ray and lung POCUS of a healthy full-term neonate at 39.5 gestational weeks and 24 hours of extrauterine life. The AP chest X-ray shows adequately expanded lungs. The lung POCUS shows a pleural line of normal thickness along with several A-lines, typical findings of a normal lung.

Nine (15.0%) neonates with an abnormal lung POCUS had a normal chest X and only 3 (5.0%) with an abnormal chest X ray had a normal lung POCUS. In 14 (23.3%) neonates, the chest X ray and the lung POCUS were abnormal. The agreement between chest X-ray and lung POCUS was $k = 0.555$ (95% CI 0.330-0.780) ($p < 0.001$). Diagnostic NRDs were interstitial fluid overload (n = 9, 15.0%), respiratory distress syndrome (n = 7, 11.6%), pneumonia (n = 6, 10.0%), and TTN (n = 1, 1.6%).

Table 2. Abnormal shortened lung POCUS findings in 23 neonates with NRDs in the NICU

Description	n (%)
Thickened pleural line	5 (21.7)
Absence of A line	17 (73.9)
Presence of B line	20 (86.9)
Consolidation	10 (43.4)
White lung	13 (56.5)
Double lung point	1 (4.3)

[a]Some neonates had two or more findings.
POCUS: point of care ultrasound; NRDs: neonatal respiratory disorders; NICU: neonatal intensive care unit.

Table 3. Diagnostic performance of shortened lung POCUS compared to chest X-ray as the gold standard for diagnosing NRDs in the NICU

Description	Parameter
Sensitivity, % (95% CI)	82.3 (56.6-96.2)
Specificity, % (95% CI)	79.1 (64.0-90.0)
PPV, % (95%CI)	70.7 (56.4.-81.8)
NPV, % (95% CI)	88.0 (72.1-95.4)
Accuracy, % (95% CI)	80.3 (68.0-89.5)

POCUS: point-of-care ultrasound; NRDs: neonatal respiratory disorders; NICU: neonatal intensive care unit; CI: confidence interval; PPV: positive predictive value; NPV: negative predictive value.

Abnormal lung POCUS findings in 23 neonates with NRDs

The lung POCUS findings highlight ultrasound patterns indicating respiratory impairment in more than one third of neonates, with a predominance of signs consistent with interstitial fluid overload and pneumonia, such as white lung disease (n = 13, 56.5%) and consolidation (n = 10, 43.4%). In 55 (91.7%) of 60 neonates, the lung POCUS showed a normal pleural line, and in 5 (8.3%), it was thickened (Table 2).

Figure 3 shows a male preterm neonate born at 30 weeks gestation with 24 hours of extrauterine life with NRD requiring endotracheal ventilation. The chest X-ray shows bilateral alveolar opacities. Lung POCUS of the left posterior-inferior quadrant shows a loss of normal morphology and echogenicity of the pleural line due to subpleural focal atelectasis and an increased

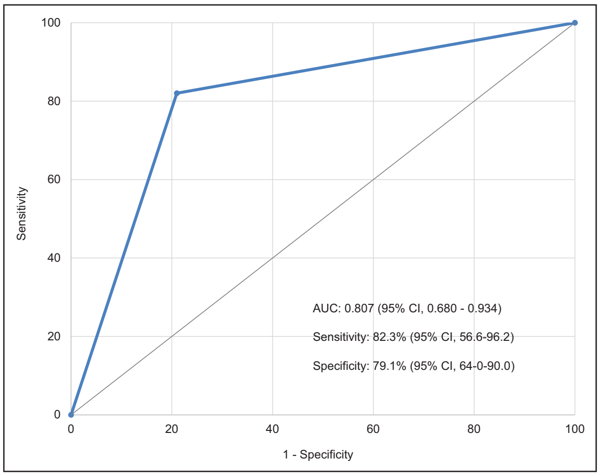

Figure 7. ROC curve showing the diagnostic performance of the shortened lung POCUS protocol in 60 neonates with NRDs. The shortened lung POCUS protocol discriminates cases with and without NRDs with a high AUC value (0.807, 95% CI 0.680-0.934).

AUC: area under the curve; NRDs: neonatal respiratory disorders; POCUS: point-of-care ultrasound; ROC: receiver operating characteristic.

Table 4. Diagnostic performance of chest X-ray compared to shortened lung POCUS as the gold standard for diagnosing NRDs in neonates in the NICU

Description	Parameter
Sensitivity, % (95% CI)	60.9 (38.5-80.3)
Specificity, % (95% CI)	91.8 (78.0-98.3)
PPV, % (95%CI)	82.1 (59.7-93.5)
NPV, % (95% CI)	79.3 (69.5-86.5)
Accuracy, % (95% CI)	80.1 (67.8-89.3)

POCUS: point-of-care ultrasound; NRDs: neonatal respiratory disorders; NICU: neonatal intensive care unit; CI: confidence interval; PPV: positive predictive value; NPV: negative predictive value.

number of B-lines forming a "white lung pattern". The diagnosis was subpleural atelectasis on chest X-ray and lung POCUS.

Figure 4 shows a full-term neonate at 37 weeks gestation with 5 days of extrauterine life presenting an NRD and fever. The chest X-ray shows bilateral consolidation with air bronchograms, lung POCUS of the right quadrant with consolidation and a thickened pleural line. The lateral quadrant in the left hemithorax shows focal subpleural parenchymal consolidation with air bronchogram and vascular flow in the consolidation area. Hepatization of the lung parenchyma was noted. The left posterior upper quadrant shows thickening of the pleural line and increased B-lines corresponding to a "white lung pattern". The diagnosis was pneumonia on chest X-ray and shortened lung POCUS.

Figure 5 shows a full-term male neonate born at 38 weeks gestation with 24 hours of extrauterine life with an NRD and clinical suspicion of TTN and a normal chest X-ray. Lung POCUS of the left posterior-inferior quadrant showed an increased number of B-lines resulting in a "white lung" (wet lung pattern), along with obliteration of the A-lines, a finding consistent with interstitial fluid overload.

Figure 6 shows a preterm male neonate born at 32 weeks gestation with 24 hours of extrauterine life. A normal chest X-ray is normal. Lung POCUS of the anterior and lower right quadrant shows a focal increase in B-lines with preservation of A-lines which together form the double lung point sign. The anterior and lower left quadrant show a focal increase in B-lines with preservation of A-lines which together form the double lung point sign. TTN was the diagnosis of the shortened lung POCUS.

Diagnostic performance of lung POCUS for diagnosing NRDs compared to chest X-ray as the gold standard

The shortened lung POCUS protocol showed a sensitivity of 82.3% and a specificity of 79.1% for diagnosing NRDs in neonates in the NICU (Table 3). There were 3 false-negatives, 9 false-positives, 14 true-positives, and 34 true-negative lung POCUS results. The PPV was 70.7%, while the NPV was 88.0%. The accuracy was 80.3%. The area under the curve in the ROC was 0.807 (95% CI 0.680-0.934) (Figure 7).

Diagnostic performance of chest X-ray for diagnosing NRDs compared to lung POCUS as the gold standard

The chest X-ray showed a sensitivity of 60.9% and a specificity of 91.8% for diagnosing NRDs in neonates (Table 4). There were 9 false-negatives, 3 false-positives, 14 true-positives and 34 true-negative results on chest X-ray. The PPV was 82.1%, while the NPV was 79.3%. The accuracy was 80.1%.

DISCUSSION

The new shortened lung POCUS protocol that assesses 10 lung areas showed a higher sensitivity (82.3%) than chest X-ray (60.9%) for diagnosing NRDs in neonates in the NICU. Lung POCUS examination in neonates has the advantage of providing real-time imaging, no ionizing radiation, and can be performed at the patient's bedside. To our knowledge, this study is the first in Mexico that focuses on comparing the diagnostic performance of these two imaging modalities for NRDs in neonates.

Lung POCUS has been shown to have high accuracy in the diagnosis and follow-up of NRDs[3,19]. In this study, the new, shortened lung POCUS protocol showed a higher sensitivity (82.3%) than chest X-ray (60.9%), while specificity was 79.1% and 91.9%, respectively. Ismail et al.[3] reported the diagnostic performance of a conventional lung POCUS protocol in 100 neonates in a cross-sectional study in Egypt. The sensitivity and specificity of lung POCUS in diagnosing respiratory distress syndrome was 94.7/100%, for pneumonia, 97.5/95.0%, for meconium aspiration syndrome, 92.3/100%, for pneumothorax, 90.9/98.9% and for pulmonary atelectasis, 100/97.0%. The overall agreement between lung POCUS and chest X-ray was 98.5% (95% CI 0.88 to 0.92). Gupta et al.[19] conducted a cross-sectional study in India of 244 neonates in the NICU, 77 (31.5%) had NRDs. They were examined by the conventional lung POCUS and chest X-ray. For the diagnosis of respiratory distress syndrome, the sensitivity and specificity of lung POCUS were 87.7% and 89.2%, while chest X-ray was 81.6% and 96.4%, respectively. For TTN diagnosis, the sensitivity and specificity of lung POCUS were 91.6% and 90.5%, while chest X-ray was 79.1% and 98.1%, respectively. In a prospective single-center study in Italy, Corsini et al.[20] examined 196 neonates in the NICU, 124 (63.3%) had respiratory distress syndrome. The agreement between chest X-ray and conventional lung POCUS was almost perfect (k = 0.88, 95% CI 0.81-0.94). In our study, the agreement between chest X-ray and lung POCUS was moderate (k = 0.555, 95% CI 0.330-0.780) ($p < 0.001$). Although our new, shortened lung POCUS protocol had better sensitivity than chest X-ray for diagnosing NRDs, it was lower than in other reports using the conventional lung POCUS protocol.

In 2004, Lichtenstein[15] proposed a protocol for lung evaluation that consisted of dividing the lung into 3 segments (anterior, lateral, and posterior). Each segment is divided into superior and inferior, with 6 areas per lung (anterior-superior, anterior-inferior, superior lateral, inferior lateral, posterosuperior and posteroinferior), giving a total of 12 in both lungs. This conventional lung ultrasound is currently used for evaluation in neonates. In 2025, Dong et al.[21] proposed another lung POCUS protocol with 14 lung areas in which the parasternal region and adjacent to the spine were added. The study included 89 Chinese neonates with respiratory distress syndrome comparing the 12-area protocol with a 14-area protocol using chest X-ray as the gold standard. The 14-area showed higher diagnostic performance (sensitivity of 94.0% and specificity of 91.0%) than the 12-area protocol (sensitivity of 91.0% and specificity of 64.0%). Chest X-ray had a sensitivity of 88.0% and a specificity of 64.0%. This study demonstrated that more extensive protocols are better for the assessment of neonates with respiratory distress syndrome. However, the practical application of these protocols can have limitations in their implementation in NICU because neonates usually have several external auxiliary devices such as venous catheters, probes, electrodes, and ventilatory support, among others. Our shortened lung POCUS protocol examines a total of 10 anatomical areas of the chest with a reduction in the manipulation of neonates which simplifies the procedure and may be less invasive for the neonate. However, its diagnostic performance is lower than the conventional lung POCUS protocol.

The strengths of this study are related to the imaging modality, which is accessible, non-invasive, and low cost. The new, shortened lung POCUS protocol reduces neonatal manipulation and is described in detail, so it is reproducible. On the other hand, the study has limitations, such as the small sample size, the lack of clinical data, and the fact that interobserver and intraobserver agreement was not assessed.

CONCLUSION

In this study, a new shortened lung POCUS protocol showed better diagnostic performance than chest X-ray for the diagnosis of NRDs in a NICU. However, diagnostic performance was lower than the conventional lung POCUS protocol in the assessment of neonates with an NRD. Studies with larger populations using the shortened lung POCUS protocol in the NICU are needed to determine its potential role as a diagnostic tool in diagnosing NRDs.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that the procedures followed complied with the ethical standards of the responsible human experimentation committee and adhered to the World Medical Association and the Declaration of Helsinki. The procedures were approved by the institutional Ethics Committee.

Confidentiality, informed consent, and ethical approval. The authors have followed their institution’s confidentiality protocols, obtained informed consent, and received approval from the Ethics Committee. The SAGER guidelines were followed according to the nature of the study.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

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