# Euro Pediatrics 2020: Lung Ultrasound Completely Replacing of Chest X-ray to Diagnose Neonatal Pulmonary Diseases: the Feasibility and Necessity- Jing Liu- Maternal and Child Health Care Hospital

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**Abstract**

We would like to explain whether or not lung ultrasound (LUS) can replace chest x-ray to diagnose neonatal lung diseases and should be routinely used in NICUs.

**Ultrasound can diagnose every kind of common neonatal lung diseases (NLDs):** A variety of NLDs that can be diagnosed by CXR can be clearly and differentially diagnosed by LUS now. NLDs, including RDS, MAS, pneumonia, pneumothorax, atelectasis, lung bleeding and pleural effusion, all have their own characteristic ultrasound imaging features.

**Lung ultrasound is more sensitive, accurate, and reliable for diagnosing pneumothorax than chest X-ray:** 1)LUS has higher sensitivity for the diagnosis of atelectasis and can reveal "occult atelectasis" : According to our study, the LUS can find 100% atelectasis,whereas CXR could detect only approximately 75% of atelectasis.

2)Ultrasound can accurately diagnose and identify pseudo atelectasis: In clinical practices, there were some patients diagnosed as atelectasis by CXR on admission, but in fact they were not, so for these so called "atelectasis", we named them as term pseudoatelectasis.3)The sensitivity and accuracy of ultrasound diagnosis of pneumothorax are superior to those of CXR: The ultrasound diagnosis of pneumothorax is very sensitive and specific, both a meta-analysis and a prospective controlled study had showed that the LUS was more accurate than chest radiography for detection of pneumothorax.4)The sensitivity and accuracy of ultrasound diagnosis of pneumonia are superior to CXR: A systematic review and meta-analysis about LUS in diagnosing adult pneumonia revealed that both the sensitivity and specificity for the diagnosis of pneumonia using LUS were 94% and 96%, respectively. Our long-term clinical practice and experience also confirmed that LUS might replace CXRs for diseasing pneumonia.5)Ultrasound is accurate and reliable for the diagnosis and identification of RDS and TTN: In clinical practice, TTN is often treated as RDS with a misdiagnosis rate as high as 62% -77%, which may lead to a series of serious adverse consequences. However, LUS can clearly differentiate RDS from TTN, thus avoiding misdiagnosis and mistreatment.

**Lung ultrasound can accurately reveal the etiology of long-term oxygen dependence in premature infants:** Long-term oxygen dependence is a common problem in preterm infants, especially in those with GA <32 weeks. LUS not only helps to clarify and identify the causes of oxygen dependence but also helps guide treatment, improve the prognosis of patients and avoid misdiagnosis of BPD.

**Application in our clinical practice:** From March 2017, LUS has been routinely performed in our hospital to replace CRX for the diagnosis and differential diagnosis of NLDs; thus, hospitalized pediatric patients can avoid undergoing CRX for NLDs.

**Protocol:** This work was approved by the research ethics committee of Beijing Chaoyang District Committee of Science & Technology and the ethics committee of Beijing Chaoyang District Maternal and child Healthcare Hospital, and that the protocol follows the guidelines of the hospital's human research ethics committee.

**1. Ultrasound exam preparation**

**1. 1. Probe selection**

1. Select a high-frequency linear probe (≥9.0 MHz) for POC-LUS to ensure high resolution. NOTE: A higher frequency linear probe is used to assure higher resolution. For infants with a lower gestational age or lower birth weight, a higher frequency probe is required. When the penetration is not enough, decrease the frequency or change to a lower frequency liner probe. If no suitable linear probe is available, consider using a high-frequency (≥8.0 MHz) convex array probe.

**1.2. Probe disinfection**

1. Disinfect the probe before and after patient examination to avoid nosocomial infection and cross-contamination. NOTE: The easiest, most convenient and effective disinfecting method is the use of special disinfection wipes. Alternatively, powderless gloves or probe covers can also be considered.

**1.3. Preset selection**

1. Choose a LUS preset.

2. Optimize the image for lung scanning if there is no LUS preset.

1. Select one of Small Parts presets.

2. Modify the parameters to perform lung scanning. Adjust the Depth button to make it 4-5 cm.

3. Press the Focus Zone button to have 1-2 focuses and adjust the focus position near the level of pleural line. Turn on the SRI (Speckle Reduction Imaging) button and select level 2-3 to reduce the speckle noise.

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4. Turn on the CRI button (Crossbeam) and select level 2 to improve contrast resolution. Activate the Harmonics to improve the signal-noise ratio or use the fundamental frequency for sharper A-lines or B-lines.

**1.4. Ultrasound gel application**

1. Warm up the gel.

2. Apply a layer of gel on the transducer. Make sure to avoid air bubbles between the transducer and the skin surface.

**2. Infant positioning**

1. Keep the infant in a quiet state.

2. Swaddle the infant exposing only the area to be examined.

3. Place the infant in the supine, prone or side position before and during the process of examination. NOTE: In general, we do not recommend using sedatives while pacifier use is encouraged. Supine positioning is convenient for scanning of the anterior and lateral chest. Prone or side positioning is convenient for scanning of the back and lateral chest.

**3. Lung partitioning**

**1.1. Six-region method**

1. Divide each lung into three regions: anterior, lateral and posterior lung area. To do this, use the anterior axillary line and the posterior axillary line as boundaries. Divide both lungs into a total of six regions.

**1.2. Twelve-region method**

1. By using the line that connects the nipples, divide each lung into upper and lower lung fields, resulting in a total of 12 regions on both sides of the lungs. NOTE: Carefully scan the entire lung fields. Each of the 6 or 12 areas should be scanned separately to ensure comprehensive coverage and to minimize the possibility of missing existing lung lesions.

**4. Scan mode selection**

**4.1. B-mode ultrasound**

1. Press the 2D button on the user interface to start B-mode scanning. NOTE: B-mode scanning is the most important and the most commonly used mode in obtaining LUS images. The majority of lung diseases can be diagnosed with B-mode scanning.

**4.2. M-mode ultrasound**

1. Press the M button on the user interface to start M mode scanning if needed.

NOTE: M-mode ultrasound is helpful for further confirmation of the possibility of pneumothorax.

3. Color or power Doppler ultrasound

1. Press the C button or PD button on the user interface to start the color or power Doppler examination if needed.

NOTE: Doppler ultrasound is used occasionally to assess the blood flow in the large area of lung consolidations or to distinguish the bronchi from blood vessels.

**5. Scanning methods**

**5.1. Perpendicular scanning**

1. Place the transducer perpendicular to the ribs and slide it from the midline to the lateral side along the wide axis to perform the perpendicular scanning.

2. After initial area of the lung is scanned, move the transducer from up to down and scan the remaining areas until all the lung fields are examined.

NOTE: Perpendicular scanning is the most important scanning method. Keeping the transducer perpendicular to the ribs is the key to obtaining accurate and reliable results.

**5.2. Parallel scanning**

1. Rotate the transducer 90° after finishing the perpendicular scanning. Keep the transducer parallel to the ribs and slide it along the narrow axis to realize the parallel scanning.

2. After the initial area of the lung is scanned, move the transducer from up to down to scan the remaining areas until all the lung fields are examined.

**5.3. Transdiaphragmatic scanning**

1. Place the transducer below the xiphoid and angle the transducer from side to side to scan the diaphragm and the bottom of lungs via the liver as the acoustic window.

NOTE: Increase the depth and turn on virtual convex scanning to expand the far field area if needed.

**Why the traditional chest X-ray is not a good method for the diagnosis of NLDs:** First, the position of the infant and the direction of the radiation beam might hinder the detection of the focus of injury in some areas, such as deep areas in the lungs or the posterior lungs. As we all know, the adults or children are in the postero-anterior position while the newborn infants are in the antero-posterior position when taken CRX. Second, the radiation beam might not be sufficiently strong to detect tiny areas of the lung injury. Third, spontaneous breathing or mechanical ventilation might result in chest radiographic images obtained during expiration. While LUS can detect small areas of atelectasis in almost any part of the lungs, regardless of the patient's position.

**Conclusions:** Therefore, for clinicians with sufficient experience, experience, well understanding and mastery of LUS, use of ultrasound instead of CRX as the preferred method for NLDs is not only necessary but also feasible. This work was supported by the Social Development Projects, Beijing Chaoyang District Bureau of Science, Technology and Information (CYSF1922).

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