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Lung Ultrasound in Hemodynamic Assessment

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The newborns with compromised hemodynamics and respiratory failure are on higher risks for multiple adverse outcomes. Care of these patients is a challenging issue. Traditional bedside physical examination can be misleading. The chest X-ray and/or chest computerized tomography are the main imaging tools in the diagnosis of lung diseases. In neonatal respiratory and hemodynamic compromise, a combined heart and lung evaluation may help to assess the organ functions. Recently, targeted neonatal echocardiography (TNE) and point-of-care ultrasound (POC-LUS) have been integrated into clinical care in NICUs.

POC-LUS is a easy-to-learn, radiation-free, bedside, quick and repeatable diagnostic method that can be performed in the NICU at the bedside. LUS can reliably and accurately diagnose many neonatal pulmonary diseases such as respiratory distress syndrome (RDS), transient tachypnea of the newborn (TTN), meconium aspiration syndrome (MAS), pneumonia, and pneumothorax.

Normal neonatal lung ultrasound manifestations

The neonatal normal lung field appears hypoechoic on a B-mode ultrasound. Pleural lines and A-lines are smooth, regular and straight. A-lines are hyperechoic, arranged in parallel and equidistant from one each other, which together form a kind of bamboo like appearence known as the bamboo sign. There may not be any B-lines or just a few B-lines (within three to seven days after birth) in the lung fields. However, there is no alveolar interstitial syndrome (AIS), pleural effusion or lung consolidation. Lung sliding is detectable by real-time ultrasound, whereas in M-mode imaging, a linear pattern appears in tissues superficial to the pleural line, and a grainy or sandy pattern appears below the pleural line, creating the seashore sign.

Lung ultrasound findings for lung diseases of the newborns

Respiratory distress syndrome (RDS):

Lung consolidations accompanied by air-bronchograms

The pleural line is abnormal, and the A-lines disappear

The nonconsolidated zones may appear as AIS

The patients may have different degrees of unilateral or bilateral pleural effusion

Transient tachypnea of the newborn (TTN):

Mild TTN mainly manifests as AIS and a double lung point

Severe TTN in the acute period mainly manifests as a compact B-line, white lung, or severe AIS, while a double lung point may appear with disease recovery

Mild or severe TTN is characterized by pleural line abnormalities, A-line disappearance, and different degrees of pleural effusion in one or the bilateral side of the chest

No consolidation is observed in the lung fields

Pneumonia of the newborn:

Lung consolidations accompanied by air-bronchograms or fluid-bronchograms

The pleural line is abnormal and A-lines disappear

B-lines or AIS are visible in the nonconsolidated areas

Different degrees of unilateral or bilateral pleural effusion may be visible

Pneumothorax:

Disappearance of lung sliding is the most important sign in the ultrasound diagnosis of pneumothorax; if lung sliding is present, pneumothorax can essentially be excluded

There are no B-line or comet tail signs; if present pneumothorax can also be excluded
The clear presence of the lung point is a specific sign for ultrasound diagnosis of mild-to-moderate pneumothorax
The pleural line and A-lines are present
Pulmonary atelectasis of the newborn:
Lung consolidation accompanied by air bronchograms, or even dynamic bronchograms or paralel air bronchograms are visible in severe cases
The edges of the consolidation area are relatively clear and regular in severe large-area pulmonary atelectasis; if the atelectasis is limited to a small region, the edges of the consolidation area may not be obvious
The pleural line in the consolidation area is abnormal and A-lines disappear
In the early stages of severe or large-area atelectasis, the lung pulse may be visible while lung sliding often disappears under real-time ultrasound
The pulmonary blood flow may be visible in the consolidated areas by color or power Doppler ultrasound; if atelectasis persists (the final stages of atelectasis), both the dynamic bronchograms and the blood flow will disappear
As conclusion, LUS has the advantages of no radiation, noninvasiveness, and simplicity aside from dynamic observation. To detect the basic signs and then use them for infinite applications, the principles of LUS should be followed. Ultrasound provides a different way of management, opening up a whole new world of visual medicine. Therefore, the use of POC-LUS in the NICU should be encouraged.

References:

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