LUNG ULTRASOUND FOR THE DIAGNOSIS OF PNEUMONIA IN CHILDREN: A META ANALYSIS

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1.INTRODUCTION:

- **Pneumonia is the leading cause of illness & death of children (# a global annual incidence of 150 - 156 million cases in children <5 years of age, ~11 - 20 million of cases need hospitalization & 1.1 million die of this condition).**

Pneumonia accounts for 18% of the total number of deaths in children <5 years worldwide, more than tuberculosis, AIDS, malaria combined.

- **Diagnostic tools include chest radiography CRs, still remains a challenge in resource-limited settings.**
- **The AAP recommends the use of CRs *cautiously*:**
  - potential late adverse effects of ionizing radiation
  - the lack of findings on CR does not rule out the diagnosis.
  - a chest CT scan almost never used for the diagnosis of pneumonia because of higher ionizing radiation exposure, difficulty in patient cooperation, cost.
  Other disadvantages: availability & portability, a considerable time delay & a final reading.

- **Advances in ultrasound technology have made lung ultrasound (LUS) an attractive option for the diagnosis of pneumonia. Moreover, ultrasound is safe, portable, inexpensive, and relatively easy to teach.**

- **We conducted a meta-analysis to summarize evidence on the diagnostic accuracy of LUS for childhood pneumonia.**

2.METHODS:

➢2.1. Search methods:

A systematic literature search was applied to:

- **PubMed (1946 → present)**
- **Embase (1974 → now)**
- **The Cochrane Library (1898 → now)**
- **Scopus (1966 → now)**
- **Global Health (1973 → now)**
- **Wolrd Health Organization Global Health Regional libraries (1980 → now)**
- **Latin American and Caribbean Health Sciences Literature (1980 → now)**

Key words: <18 years, pneumonia, ultrasound

❖2.2. Study Eligibility:

Children with clinical suspicion (signs and symptoms) of pneumonia and/or confirmation with CR or chest CT scan.

-The evaluation of pneumonia was based on a combination of clinical data, laboratory results, and chest imaging by CR or chest CT scan

❖2.2.Data Extraction:

-Sample size,

-gender proportion,

-mean age,

-LUS technique,

-areas of the chest that were evaluated,

-time lapse between CR and LUS, average time to perform LUS,

-operator expertise,

-blinding,

-LUS pattern definitions,

-and number of true-positives, true-negatives, false-positives, and false-negatives.

2.3.Methodologic Quality Assessment and Biostatistical Methods:

- **Methodologic quality was assessed by using the QUADAS -2 critetion**
- **Biostatistical methods: The primary objective = estimate pooled measurements of diagnostic accuracy**
  - **Pooled sensitivity and specificity: Mantel-Haenszel method**
  - **Pooled positive and negative likelihood ratios (LRs): DerSimonian-Laird method**
  - **Heterogeneity: the Cochran Q-statistic and the inconsistency (I2) test**
  - **Statistical analyses: Meta-DiSc 1.4 and R**

3.RESULTS:

-In 1475 studies, we selected 8 studies for analysis (6 conducted in the general pediatric population & 2 conducted in neonates).

-5 studies conducted in Italy, 1 in USA, 1 in China & 1 in Egypt

-3 studies were conducted in emergency departments, 2 in hospital wards, 1 in the pediatric ICU, and 2 in the neonatal ICU.
-Overall, there were 765 children. The mean age: 5 years (range: 0–17 years) and 52% were boys.

-5 studies (63%): a highly skilled physician performed LUS,

3.1.Methodologic Heterogeneity:

The quality of most of the studies: high. 7 studies (88%) enrolled patients who would have had a CR as part of usual clinical practice. Only 1 (12%) study included controls who did not have CRs.

All studies conducted LUS immediately after chest imaging was obtained.

1 (12%) study used the same radiologist to read both the CR and LUS.
7 (88%) studies assessed LUS results independently and were blinded to CR results.

3.1.Methodologic Heterogeneity:

LUS sonographers were not blinded to clinical data.
Furthermore, 5 (63%) studies used clinical criteria and CR as a diagnosis standard and 3 included laboratory results as additional diagnostic tools.
3 studies (38%) used chest CT scan for clinical purposes.

All of the studies used a linear probe , with frequencies ranging from 6 to 12 MHz. In addition, a convex probe with frequencies ranging from 2 to 6.6 MHz was used in conjunction with the linear probe in 3 of the 8 studies.

3.2.Overall Meta-analysis:

-LUS had a sensitivity of 96% (95% confidence interval [CI]: 94%–97%) and specificity of 93% (95% CI: 90%–96%), and

-positive and negative likelihood ratios were 15.3 (95% CI: 6.6–35.3) and 0.06 (95% CI: 0.03–0.11), respectively.

-The area under the receiver operating characteristic curve was 0.98.

3.3.Subgroup Analyses:

- In the 6 studies (75%) (excluding neonates), LUS had a sensitivity of 96% (93%–98%) - a specificity of 92% (88%–95%); and in the 2 studies (only neonates), LUS had a sensitivity of 96% (90%–98.5%) - a specificity of 100% (92%–100%).
- 3 studies were conducted in emergency departments: sensitivity of 94% (88%–98%) and specificity of 90% (85%–94%). Studies conducted in hospital settings other than in an emergency department had a combined sensitivity of 96% (94%–98%) and a specificity of 97% (93%–99%)
- 4 studies that used emergency department physicians, general practitioners, residents, or health care professionals otherwise not specified, LUS had a pooled sensitivity of 95% (95% CI: 91%–97%) and aspecificity of 91% (87%–95%).

4.Limitations:

- **The total number of studies was small, a low number of patients, there was significant heterogeneity between studies.**
- **Second, not all studies compared LUS results with a clinical diagnosis and, in some studies, the final diagnosis was based solely on CR findings without the influence of clinical data.**

5.CONCLUSION:

- **Current evidence supports LUS as an imaging alternative for the diagnosis of childhood pneumonia.**
  Recommendations to train pediatricians on LUS for diagnosis of pneumonia may have important implications in different clinical settings.