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## Critically Appraised Articles

### It is possible to replace chest X-rays with pulmonary ultrasound in the diagnose of pneumonia in children?

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**English key words:** pneumonia, ultrasonography, thoracic radiography.

**Palabras clave en español:** neumonía, ultrasonografía, radiografía torácica.

**Reception date:** June 7, 2017 • **Acceptance date:** June 9, 2017

**Publication date:** June 14, 2017

Evid Pediatr. 2017;13:26.

#### HOW TO CITE THIS ARTICLE

Albi Rodríguez MS, Martínez Rubio MV. ¿Puede la ecografía pulmonar sustituir a la radiografía para diagnosticar la neumonía en niños? Evid Pediatr. 2017;13:26.

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This article is available at <http://www.evidenciasenpediatria.es/EnlaceArticulo?ref=2017;13:26>

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# It is possible to replace chest X-rays with pulmonary ultrasound in the diagnose of pneumonia in children?

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**Original article:** Boursiani C, Tsoia M, Koumanidou C, Malagari A, Vakaki M, Karapostolakis G, et al. Lung ultrasound as first-line examination for the diagnosis of community-acquired pneumonia in children. *Pediatr Emerg Care*. 2017;33:62-6.

## Abstract

**Authors' conclusions:** lung ultrasound plays a significant role in the detection of community-acquired pneumonia, not inferior to chest x-ray and without radiation exposure.

**Reviewers' commentary:** in children with a high degree of clinical suspicion of pneumonia, pulmonary ultrasonography, performed by expert personnel, is of comparable utility to radiography. However, before proceeding to its generalized use, should be assessed its role, when it is performed by less experienced staff.

**Key words:** pneumonia, ultrasonography, thoracic radiography.

**¿Puede la ecografía pulmonar sustituir a la radiografía, para diagnosticar la neumonía en niños?**

## Resumen

**Conclusiones de los autores del estudio:** la ecografía pulmonar en el diagnóstico de neumonía en niños tiene un valor similar al de la radiografía, sin la radiación que esta conlleva.

**Comentario de los revisores:** en niños con alta sospecha clínica de neumonía, la ecografía pulmonar realizada por personal experto es de utilidad comparable a la radiografía. No obstante, antes de generalizar su uso se debería valorar su papel en manos de personal con menor experiencia.

**Palabras clave:** neumonía, ultrasonografía, radiografía torácica.

## STRUCTURED ABSTRACT

**Objective:** to evaluate the efficacy of lung ultrasound (LUS) compared to chest X-ray (CXR) in the diagnosis of community-acquired pneumonia (CAP) in children.

**Design:** diagnostic test evaluation.

**Setting:** children's hospital in Athens, from February 2014 to March 2015.

**Study sample:** 69 children aged 6 months to 12 years that visited the emergency department with symptoms compatible with pneumonia and underwent a CXR based on emergency department criteria, followed by a LUS scan performed by an expert paediatric ultrasonography expert that was one of the researchers involved in the study.

**Assessed diagnostic test:** a CXR was performed in all patients and an initial interpretation made by the radiologist on duty. Immediately after the CXR and with no knowledge of its results, the paediatric ultrasonographer performed a LUS. The following day, an expert paediatric radiologist made a second interpretation of the CXR. The definitive diagnosis of pneumonia was made *a posteriori* by an independent expert paediatrician based on the clinical manifestations, laboratory findings (CRP and leukocytosis), radiological findings and patient outcomes.

**Outcome measures:** Children aged less than 24 months underwent CXR in the supine position, whereas older children underwent posterior-anterior CXR in the standing position. Lateral radiographs were not obtained. The ultrasound technique consisted of longitudinal scans along the anatomical lines of the thorax and axial scans along the intercostal

spaces. The findings of both tests (CXR and LUS) were classified as follows: normal, interstitial pattern, consolidation, atelectasis, pleural effusion, or combinations of the above. Pneumonia was defined as presence of an interstitial pattern or alveolar consolidation.

**Main results:** out of the 69 patients, only 3 did not receive a pneumonia diagnosis. In all children with a clinical diagnosis of pneumonia, either the CXR or the LUS confirmed the diagnosis. In 3 cases in which the findings of CXR were not positive for pneumonia, LUS did detect an interstitial pattern or consolidation. The findings of LUS were not compatible with pneumonia in 4 cases in which CXR found an interstitial pattern with central distribution. The authors performed ROC analysis for the two diagnostic tests, both of which had a specificity (Spe) and positive predictive value of 100%, while the sensitivity (Sen) was 95.5% for CXR and 92.42% for LUS, and the negative predictive value was 50% for CXR and 37% for LUS.

**Conclusion:** lung ultrasonography plays an important role in the diagnosis of pneumonia in children that is similar to CXR, without the exposure to radiation involved in the latter.

**Conflicts of interest:** the authors declared not having any.

**Funding source:** not noted.

## COMMENTARY

**Justification:** although current guidelines increasingly recommend the diagnosis of CAP based on clinical manifestations,<sup>1</sup> radiologic tests can be useful in its diagnosis and management. Recent studies<sup>2</sup> have assessed the use of LUS as an alternative to CXR to avoid exposure to radiation. This study contributes additional data on the use of LUS in children managed in emergency settings.

**Scientific rigour and validity:** the population and setting were well defined. Patients were selected based on the clinical suspicion of pneumonia, although the authors did not clearly specify the clinical criteria for suspicion, which may affect the generalisation of the results, given the high incidence of pneumonia observed in this sample. Since the study only included patients in whom there was a high suspicion of CAP (pre-test probability of 95.6%), it may have overestimated the Sen and Spe of LUS. In the study, the gold standard for the diagnosis of CAP was the judgment of an expert paediatrician based on CXR and clinical, laboratory and outcome variables that were poorly defined. It seems that the reviewer that made the initial interpretation of LUS examinations was blinded to the results of the CXR, but it is not clear whether the expert that made the definitive diagnosis of CAP was also blinded.

The diagnostic test procedures were well defined. All children underwent both imaging tests, which were interpreted independently. Lung ultrasonography was performed by an expert, so the results may not be generalisable to different circumstances.

Although this was not the case in the study, the authors warned of the possibility of failing to detect CAP with LUS in cases in which consolidation does not reach the pleural region; furthermore, the sample was small, and the authors did not calculate the minimum sample size needed to detect this effect.

**Clinical relevance:** lung ultrasonography performed similarly to CXR, with a Sen of 92.42% (95% confidence interval [95 CI], 88.2% to 99.7), a Spe of 100% (95 CI, 100 to 100) and good accuracy (area under the curve, 0.962). To correctly diagnose 100 children with CAP, it would be necessary to perform 106 ultrasound examinations (number needed to diagnose [NND], 1.06\*), compared to 105 CXRs (NND, 1.05\*).

Both tests have a high sensitivity and specificity. There was a strong agreement between the two tests, although the confidence interval was wide (kappa coefficient, 0.92; 95 IC, 0.75 to 1.08).

The findings of this study were similar to those of other studies conducted recently in different settings, in which LUS was performed by staff with different levels of expertise and the diagnosis of CAP was based in clinical and/or radiologic criteria in children<sup>3</sup> as well as adults.<sup>4</sup> The study under review found a higher specificity, since it only included patients in whom there was a high clinical suspicion, and one of the tests that was being evaluated (CXR) was used in making the definitive diagnosis.

**Applicability to clinical practice:** although the sample was small, the study suggests that in children assessed in emergency settings in whom there is a high suspicion of pneumonia, LUS performed by experienced providers performs comparably to CXR with the advantage of not exposing patients to radiation. Some aspects to consider are the availability of LUS, the time needed to perform it, and the variability of its findings when performed by less-experienced staff.

**Conflicts of interest:** the authors of the commentary have no conflicts of interest to declare.

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\* Calculated by reviewers from data provided in the original article.