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Mathijs Kreeft
AIOS SEH OLVG
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Question

Is lung ultrasound an accurate diagnostic tool for pneumonia in adult patients in the Emergency Department?

PICO

Patient: Adult patients with suspected pneumonia

Intervention: Lung Ultrasound

Comparison: Chest X-ray

Outcome: Accuracy for diagnosing pneumonia

Background

Dyspnea is a common presentation in the Emergency Department where Emergency Physicians often need to make rapid diagnosis with limited information. Chest ultrasonography is emerging as an increasingly helpful tool for the diagnosis of various thoracic conditions, such as pneumothorax, pericardial effusion, pulmonary edema and pulmonary embolism. Ultrasonography in pneumothorax and pericardial effusion has been widely studied and the application has spread to daily practice. To use chest ultrasonography as a diagnostic tool in the undifferentiated patient, the accuracy of detecting pneumonia must be reviewed as well.

Pneumonia is a major health problem with a high mortality and morbidity. Currently there is strong consensus that chest radiography is performed as a routine investigation in patients with suspected pneumonia. However, chest radiography has several limitations in the ED due to patient characteristics and interobserver variability. The availability of the current gold standard, thoracic CT, is limited and has high costs and radiation dose.

Search strategy

	Results	Useful
Pubmed:	73	5
Mesh terms: "pneumonia/ultrasonography"[Mesh]	719	5
Text terms: "pneumonia" AND (ultrasound OR ultrasonograph* OR sonograph* OR echo OR echograph*)		
Limits: Humans, Languages (Dutch, English, German)		
Embase:	103	2
Emtree search: [pneumonia] AND [echography]		
Limits: 2002-current		
Cochrane:	2	0
Text terms: "pneumonia" AND "ultrasound"		
Mesh terms: "pneumonia" subheading [ultrasound]	1	0
Trip database:	593	3
Text terms: "pneumonia" AND "ultrasound"		
PICO search: (lung ultrasound)(chest radiography)(pneumonia)	5	3
	Total	5

Study	Study type	Patients	Intervention	Comparison	Outcome	Result	Discussion	L
Cortellaro 2012 Italy	Prospective cohort study	Adults (>18 yrs) with suspected pneumonia*	Lung ultrasound (US)	Chest X-ray (CXR) (all patients, 120) or Thoracic CT (26/120) (if clinically indicated, blinded from US-results) Final diagnosis at discharge (based on radiographs, laboratory tests, microbiology and clinical evolution)	Sensitivity and specificity lung US en CXR in comparison to: -final diagnosis at discharge (pneumonia+ in 81/120 pt) -thoracic CT (pneumonia+ in 26/30 CT's)	Lung US reliable tool for diagnosing pneumonia in ED. Lung US vs final diagnosis: sens 98% / spec 95% CXR vs final diagnosis: sens 67% / spec 85% US vs. Thoracic CT: sens 96% (25/26) CXR vs. Thoracic CT: sens 69% (16/26)	Use of the gold standard CT based on clinical suspicion, limited numbers. Final diagnosis as primary outcome is not gold standard. Performed by only 1 ultrasound operator.	2B
Reissig 2012 Europe	Prospective multicenter cohort study	Adults (>18 yrs) with suspected pneumonia*	Lung ultrasound	Chest X-ray (all patients, 362) or Thoracic CT (63/362), if: -inconclusive CXR findings or -lung US positive with CXR negative result	Accuracy of lung US compared with reference test (CXR or CT, combined with follow up of pneumonia).	Lung US has a high-accuracy diagnosis of CAP. Negative findings does not exclude CAP. Lung US: -sensitivity 92.1% -specificity 95.5% -positive LR 40.5 -negative LR 0.07	Imperfect reference test (CXR) in 83% of patients, low numbers of gold standard CT. Therefore probably overestimated accuracy of US. Exclusively CAP.	2B
Parlamento 2009 Italy	Prospective cohort study	Adults (>16 yrs) with suspected pneumonia* ^	Lung ultrasound	Chest X-ray (all patients, 32) or Thoracic CT (8/32) (if lung US positive with CXR negative result)	Accuracy of lung US compared with final diagnosis at discharge. Accuracy compared with CXR. Diagnostic improvement by lung US compared with CXR using thoracic CT.	Lung US reliable tool for diagnosing pneumonia in ED. 31/32 pt US + (97%) 24/32 pt CXR+ (75%) 8/8 pt US+ CXR- had thoracic CT which showed pneumonia	No sensitivity or specificity because gold standard CT is performed on limited numbers. Lung US compared to CXR overestimate accuracy. Performed by only 1 ultrasound operator	2B
Sperandeo 2011 Italy	Prospective study	Patients admitted with clinical signs of and CXR-proven pneumonia	Lung ultrasound	Chest X-ray proven pneumonia (n=342)	Detection of pneumonia with lung US of proven pneumonia	Lung US is a useful complementary diagnostic tool for diagnosis of pneumonia. Lung US detected consolidation in 92% of the cases.	Not diagnostically prospective; reference standard was a proven pneumonia on CXR. No reliable sensitivity and specificity. Exclusively CAP en inpatients. Study is mainly about follow-up using US.	4

Reissig 2007 Germany	Prospective study	Patients admitted with clinical signs of and CXR-proven pneumonia	Lung ultrasound	Chest X-ray proven pneumonia (n=30)	Detection of pneumonia with lung US of proven pneumonia	Lung US is an additional imaging technique applicable for the confirmation of pneumonia Lung US detected consolidation in 90% of the cases	Not diagnostically prospective; reference standard was a proven pneumonia on CXR. No reliable sensitivity and specificity. Study is mainly about follow-up using US.	4
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*according to American Thoracic Society Guidelines: fever, cough, sputum-production, dyspnoea and pleuritic pain.

^in elderly (>75 yrs): altered mental status, failure to thrive and falls.

Conclusion

Lung ultrasound is a reliable and accurate tool for the diagnosis of pneumonia in the Emergency Department.

Discussion

Although these studies show that lung ultrasound has high accuracy, the studies all have limitations. Main drawback is the comparison investigation; gold standard CT is only used in a small sample of the study group and final diagnosis is not a perfect comparison. Further, the numbers of these studies are relatively low. Two studies (Reissig '07 and Sperandeo '11) didn't use lung ultrasound as a diagnostic tool, but were designed to show the possibilities of ultrasound in pneumonia.

Furthermore is the investigation operator-dependent which requires specific training for the operators. The ultrasonography in the discussed studies was performed by small amount of physicians.

Lastly, there is a possibility of selection bias as negative results tend to stay unpublished in this area of research.

It is recommended that more research should be done in blinded, large number studies to evaluate the usefulness and accuracy of lung ultrasound in pneumonia.

Level of recommendation

B

Literature

Cortellaro F, Colombo S, Coen D, Duca PG. Lung ultrasound is an accurate diagnostic tool for the diagnosis of pneumonia in the emergency department. Emerg Med J 2012; 29:19–23.

Reissig A, Copetti R et al. Lung Ultrasound in the Diagnosis and Follow-up of Community-Acquired Pneumonia. CHEST 2012; 142(4):965–972.

Parlamento S, Copetti R, Di Bartolomeo S. Evaluation of lung ultrasound for the diagnosis of pneumonia in the ED. Am J Emerg Med 2009;27:379e84.

Sperandeo M, Carnevale V et al. Clinical application of transthoracic ultrasonography in inpatients with pneumonia. Eur J Clin Invest 2011; 41 (1): 1–7.

Reissig A, Kroegel C. Sonographic Diagnosis and Follow-up of Pneumonia: A prospective Study. Respiration 2007;74:537–547.