Ultrassonografia Pulmonar e Radiografia de Tórax: Existe uma Razão para um Líder entre os Dois?

Lung Ultrasound and Chest X-Rays: Is there a Reason for a Leader Between the Two?

Ortensi B[1], Caroselli C[2]

Resumo:

A radiografia de tórax (RX) é atualmente a primeira imagem diagnóstica tradicional usada em pacientes com sintomas respiratórios agudos, mas nos últimos anos a ultrassonografia pulmonar clínica (LUS) ganhou importância crescente.

O LUS clínico é definido como um ultrassom realizado no ponto de atendimento pelo médico integrado ao exame físico do paciente.

O uso de um LUS integrado no ponto de atendimento é seguro, barato, rápido e pode reduzir o tempo até o diagnóstico, melhorando o diagnóstico diferencial. Reduz o tempo até o tratamento, diminuindo o tempo de permanência na UTI em comparação com as abordagens convencionais e minimizando o número de exames radiológicos evitando a exposição à radiação ionizante; também reduzir os exames laboratoriais, otimizando o uso de recursos financeiros.

Palavras-chave: Dispneia/diagnóstico por imagem; Radiografia Torácica; Sistemas Point-of-Care; Ultrassonografia.

Abstract:

Chest X-rays (CXR) is currently the first traditional diagnostic imaging used in patients with acute respiratory symptoms, but clinical lung ultrasound (LUS) bedside has gained increasing importance in the last years.

Clinical LUS is defined like an ultrasonography performed at the point-of care from the physician integrated with the patient's physical examination.

The use of an integrated LUS at the point of care is safety, not expensive, fast and can shorten the time needed to formulate a diagnosis improving differential diagnosis reduces the time to treatment, decreasing length of stay in ICU compared to conventional approaches and minimizing the number of radiological exams avoiding the exposure to ionizing radiations; moreover, reduce the laboratory tests optimizing the use of financial resources.

Keywords: *Dyspnea/diagnostic imaging; Point-of-Care Systems; Radiography, Thoracic; Ultrasonography.*

Acute dyspnea is a common symptom in emergency departments (ED), intensive care units (ICU) and internal medicine departments. Usually, the approach to the patient with dyspnea, in addition to the history and physical examination, is based on blood gases, laboratory tests and chest radiography.

The literature shows that approximately 20% of patients presenting in ED with dyspnea are misdiagnosed or receive a wrong diagnosis and inappropriate therapy with negative prognostic consequences: the 30-day mortality rate of these patients is 8%–13%.[1,2]

Chest X-rays (CXR) is currently the first diagnostic imaging used in patients with acute respiratory symptoms but in this contest, clinical lung ultrasound (LUS) bedside has gained increasing importance.[3]

Clinical LUS is defined like an ultrasonography performed at the point-of care from the physician integrated with the patient's physical examination.

It is well demonstrated that this approach, in dyspnoic patients, could rapidly differentiate between “cardiac” and “respiratory” etiologies reducing the need of further diagnostic tests.[4]

While the use of clinical LUS at the point-of-care in the last 20 years has attracted the attention thanks to the use of portable machines and pocked sized devices[5] up to date its use still does not seem to be defined in a sufficiently systematic way, underestimating its real potential. It still remains underused and this tendency could be explained by the lack of standardized training facilities and the lack of high-quality evidence-based guidelines on this technique.[6,7]

Clinical LUS has several advantages compared to chest radiography such as efficiency, speed, safety, repeatability, low costs, it is independent of patient's breath-hold limitations, free from ionizing radiation, can be performed in real-time at the bedside, can be used safely in pregnant women, has immediate availability of results.[8]

[1]Specialization School in Geriatrics, University Politecnica delle Marche, Ancona, Italy
[2]Acute Geriatric Unit, Geriatric Emergency Room and Aging Research Centre IRCCS INRCA, Ancona, Italy

https://doi.org/10.24950/rspmi.2177

Ultrasound is limited in extremely obese patients, in case of subcutaneous emphysema or skin disorders are present. Another limitation of LUS is the observer- dependent nature.

On the other hand, the learning curve is fast.[9,10]

It represents a valid support to physical examination as shown by D. Lichtenstein *et al*: chest auscultation performed alone was detected successfully 61% of pleural effusions, 36% of consolidations, and 55% of alveolar-interstitial syndromes.[11]

LUS seems to be at least as accurate as CXR, with a higher sensitivity for pulmonary edema, pneumothorax, pneumonia, and free pleural effusion.[12-14]

In a systematic review and meta-analysis, Staub *et al*[15] evaluated 11 017 titles and abstracts screened, involving 25 studies. Fourteen studies assessed pneumonia (n = 1867 patients), 14 assessed acute heart failure (n = 2778 patients), and four studies assessed exacerbation of COPD or asthma (n = 527 patients): in patients suspected for pneumonia, LUS showed high sensitivity and specificity in detecting consolidations. In acutely dyspnoic patients LUS showed sensitivity of 0.90 (95%) and specificity of 0.93 (95%) for acute heart failure, whereas B-profile had sensitivity of 0.93 (95%) and specificity of 0.92 (95%) in detecting modified diffuse interstitial syndrome. The sensitivity of US using B-lines to diagnosis acute cardiogenic pulmonary edema (ACPE) was 94.1% (95%) and the specificity is 92.4% (95%) in patients with a moderate to high pretest probability for ACPE.[16]

There is a linear correlation between the number of B-lines and the degree of extravascular lung water. Decompensated congestive heart failure can be difficult to differentiate from ACPE and POCUS can play an important role.

Marini *et al*, to underline the value of LUS, have shown the higher LUS sensitivity and specificity compared to CXR in 4 frequently encountered pathological conditions like: pleural effusion (LUS sensitivity 92% and specificity 93% *vs* CXR sensitivity 39% and specificity 85%), pneumonia (LUS sensitivity 95% and specificity 90% *vs* CXR sensitivity 77% and specificity 91%), pneumothorax (LUS sensitivity 87% and specificity 99% *vs* CXR sensitivity 46% and specificity 100%), pulmonary edema (LUS sensitivity 88% and specificity 90% *vs* CXR sensitivity 73% and specificity 90%).[17]

Another study concerning atelectasis, showed a high sensitivity and specificity of lung pulse, respectively 93% and 100%. About pleural effusion, the sensitivity was 94% and specificity 98% compared to CXR (sensitivity 51%, specificity 91%) as previously demonstrated in their meta-analysis.[18] In relation to pneumothorax, LUS showed a sensitivity of 78.6% (95%) and a specificity of 98.4% (95%). The absence of lung sliding at a point, followed by the demonstration of the lung point had a sensitivity of 95.3% and a specificity of 91.1% to detect pneumothorax.[19]

Several ultrasound signs are connected to a high specificity for pulmonary embolism (PE).[20] Considering that the proportion of confirmed PE can be expected to be 10% in a low-probability population and 65% in a high-probability population, a hypoechoic pleural-based lesion confirmed from LUS would yield a positive predictive value for the diagnosis of PE of 41.7% and 92.3% respectively.

Moreover, it was demonstrated that LUS is superior to CXR for diagnosing pneumonia in the ICU settings: sonographic consolidation was highly specific but moderately sensitive for pneumonia[21]; during SARS-CoV-2 pandemic use of LUS underlined its pivotal role.[22-24]

However, the use of LUS had a limited influence on 30-day and in-hospital mortality and had no relevant effects on the 30-day re-admission rate.[25,26]

Furthermore, a recent study has emphasized how there are many lung alterations related to heart failure and lung ultrasound is an increasingly widespread tool since it is sensitive, repeatable and safe both for the diagnosis and management of heart failure.[27]

Another study showed that in clinical scenarios of decompensated heart failure, LUS and CXR are the most used diagnostic tools and, although LUS does not fully replace CXR, it may be of great help in the emergency setting when a prompt diagnostic evaluation of dyspneic patients is requested and for monitoring clinical evolution too.[28]

In conclusion the use of an integrated LUS at the point-of-care can shorten the time needed to formulate a diagnosis improving differential diagnosis,[29,30] reduces the time to treatment with an higher rate of receiving appropriate management in the first hours after arrival at the ED, decreasing length of stay in ICU compared to conventional approaches,[31] minimizing the number of radiological and laboratory tests and optimizing the use of financial resources, even more so in countries with reduced economic resources.[32]

This approach should be considered a standard and not only as a supplementary tool when standard diagnostic measures fail.[33] It represents a valid extension of the physical examination[26] in all patients suffering from acute onset dyspnea. LUS at the point of care[34] may represent the first accurate diagnostic approach to the patient with dyspnea in emergency departments, helping stratifying patients who should undergo a second-level diagnostic test. ■

Acknowledgements

The authors wish to thank Dr. Eliana Viola for the careful English revision of the manuscript.

Declaração de Contribuição

BO – Redação do manuscrito.

CC – Redação e revisão do artigo.

Todos os autores aprovaram a versão final a ser publicada.

Contributorship Statement

BO - Writing the manuscript.

CC - Drafting and revising the article.
All authors approved the final draft.

Responsabilidades Éticas

Conflitos de Interesse: Os autores declaram a inexistência de conflitos de interesse na realização do presente trabalho.
Fontes de Financiamento: Não existiram fontes externas de financiamento para a realização deste artigo.
Confidencialidade dos Dados: Os autores declaram ter seguido os protocolos da sua instituição acerca da publicação dos dados de doentes.
Proveniência e Revisão por Pares: Não comissionado; revisão externa por pares.

Ethical Disclosures

Conflicts of interest: The authors have no conflicts of interest to declare.
Financing Support: This work has not received any contribution, grant or scholarship.
Confidentiality of Data: The authors declare that they have followed the protocols of their work center on the publication of data from patients.
Provenance and Peer Review: Not commissioned; externally peer reviewed.

Correspondence / Correspondência:

Costantino Caroselli - costantinocost@yahoo.it
U.O.C. Geriatria, Accettazione Geriatrica e Centro di Ricerca per l'invecchiamento,
IRCCS INRCA, Ancona
Via della Montagnola, 81, 60127 Ancona, Italy.

Recebido / Received: 2023/07/10
Aceite / Accepted: 2023/09/27
Publicado / Published: 2023/12/15

REFERENCES

1. Sørensen SF, Ovesen SH, Lisby M, Mandau MH, Thomsen IK, Kirkegaard H. Predicting mortality and readmission based on chief complaint in emergency department patients: a cohort study. Trauma Surg Acute Care Open. 2021;6:e000604. doi: 10.1136/tsaco-2020-000604.
2. Lindskou TA, Pilgaard L, Søvsø MB, Kløjgård TA, Larsen TM, Jensen FB, et al. Symptom, diagnosis and mortality among respiratory emergency medical service patients. PLoS One. 2019;14:e0213145. doi: 10.1371/journal.pone.0213145.
3. Cid-Serra X, Royse A, Canty D, Johnson DF, Maier AB, Fazio T, et al. Effect of a Multiorgan Focused Clinical Ultrasonography on Length of Stay in Patients Admitted With a Cardiopulmonary Diagnosis: A Randomized Clinical Trial. JAMA Netw Open. 2021;4:e2138228. doi: 10.1001/jamanetworkopen.2021.38228. Erratum in: JAMA Netw Open. 2022;5:e2211248.
4. Perrone T, Maggi A, Sgarlata C, Palumbo I, Mossolani E, Ferrari S, et al. Lung ultrasound in internal medicine: A bedside help to increase accuracy in the diagnosis of dyspnea. Eur J Intern Med. 2017;46:61-5. doi: 10.1016/j.ejim.2017.07.034.
5. Narula J, Chandrashekhar Y, Braunwald E. Time to add a fifth pillar to bedside physical examination: inspection, palpation, percussion, auscultation, and insonation. JAMA Cardiol. 2018;3:346-350. doi:10.1001/jamacardio.2018.0001
6. Ultrasound Guidelines: Emergency, Point-of-Care and Clinical Ultrasound Guidelines in Medicine. Ann Emerg Med. 2017;69:e27-e54. doi: 10.1016/j.annemergmed.2016.08.457.
7. Smallwood N, Dachsel M. Point-of-care ultrasound (POCUS): unnecessary gadgetry or evidence-based medicine? Clin Med. 2018;18:219-24. doi: 10.7861/clinmedicine.18-3-219.
8. Raheja R, Brahmavar M, Joshi D, Raman D. Application of Lung Ultrasound in Critical Care Setting: A Review. Cureus. 2019 Jul 25;11(7):e5233. doi: 10.7759/cureus.5233.
9. Volpicelli G, Elbarbary M, Blaivas M, Lichtenstein DA, Mathis G, Kirkpatrick AW, et al. International Liaison Committee on Lung Ultrasound (ILC-LUS) for International Consensus Conference on Lung Ultrasound (ICC-LUS). International evidence-based recommendations for point-of-care lung ultrasound. Intensive Care Med. 2012; 38:577-91. doi: 10.1007/s00134-012-2513-4.
10. Gullett J, Donnelly JP, Sinert R, Hosek B, Fuller D, Hill H, et al. Interobserver agreement in the evaluation of B-lines using bedside ultrasound. J Crit Care. 2015;30:1395-9. doi: 10.1016/j.jcrc.2015.08.021.
11. Lichtenstein DA, Mezière GA. Relevance of lung ultrasound in the diagnosis of acute respiratory failure: the BLUE protocol. Chest. 2008;134:117-25. doi: 10.1378/chest.07-2800. Erratum in: Chest. 2013;144:721.
12. Maw AM, Hassanin A, Ho PM, McInnes MD, Moss A, Juarez-Colunga E, et al. Diagnostic Accuracy of Point-of-Care Lung Ultrasonography and Chest Radiography in Adults With Symptoms Suggestive of Acute Decompensated Heart Failure: A Systematic Review and Meta-analysis. JAMA Netw Open. 2019;2:e190703. doi: 10.1001/jamanetworkopen.2019.0703.
13. Llamas-Álvarez AM, Tenza-Lozano EM, Latour-Pérez J. Accuracy of Lung Ultrasonography in the Diagnosis of Pneumonia in Adults: Systematic Review and Meta-Analysis. Chest. 2017;151:374-82. doi: 10.1016/j.chest.2016.10.039.
14. Falster C, Jacobsen N, Coman KE, Højlund M, Gaist TA, Posth S, et al. Diagnostic accuracy of focused deep venous, lung, cardiac and multiorgan ultrasound in suspected pulmonary embolism: a systematic review and meta-analysis. Thorax. 2022;77:679-89. doi: 10.1136/thoraxjnl-2021-216838.
15. Staub LJ, Mazzali Biscaro RR, Kaszubowski E, Maurici R. Lung Ultrasound for the Emergency Diagnosis of Pneumonia, Acute Heart Failure, and Exacerbations of Chronic Obstructive Pulmonary Disease/Asthma in Adults: A Systematic Review and Meta-analysis. J Emerg Med. 2019;56:53-69. doi: 10.1016/j.jemermed.2018.09.009.
16. Al Deeb M, Barbic S, Featherstone R, Dankoff J, Barbic D. Point-of-care ultrasonography for the diagnosis of acute cardiogenic pulmonary edema in patients presenting with acute dyspnea: a systematic review and meta-analysis. Acad Emerg Med. 2014;21:843-52. doi: 10.1111/acem.12435.
17. Marini TJ, Rubens DJ, Zhao YT, Weis J, O'Connor TP, Novak WH, et al. Lung Ultrasound: The Essentials. Radiol Cardiothorac Imaging. 2021;3:e200564. doi: 10.1148/ryct.2021200564. P
18. Yousefifard M, Baikpour M, Ghelichkhani P, Asady H, Shahsavari Nia K, Moghadas Jafari A, et al. Screening Performance Characteristic of Ultrasonography and Radiography in Detection of Pleural Effusion; a Meta-Analysis. Emerg. 2016;4:1-10.
19. Ding W, Shen Y, Yang J, He X, Zhang M. Diagnosis of pneumothorax by radiography and ultrasonography: a meta-analysis. Chest. 2011;140:859-66. doi: 10.1378/chest.10-2946.
20. Falster C, Jacobsen N, Coman KE, Højlund M, Gaist TA, Posth S, et al. Diagnostic accuracy of focused deep venous, lung, cardiac and multiorgan ultrasound in suspected pulmonary embolism: a systematic

review and meta-analysis. Thorax. 2022;77:679-89. doi: 10.1136/thoraxjnl-2021-216838.
21. Alzahrani SA, Al-Salamah MA, Al-Madani WH, Elbarbary MA. Systematic review and meta-analysis for the use of ultrasound versus radiology in diagnosing of pneumonia. Crit Ultrasound J. 2017;9:6. doi: 10.1186/s13089-017-0059-y.
22. Caroselli C, Blaivas M, Marcosignori M, Chen YT, Falzetti S, Mariz J, et al. Early Lung Ultrasound Findingsin Patients With COVID-19 Pneumonia. A Retrospective Multicenter Study of 479 Patients. J Ultrasound Med. 2022; 41:2547–56.
23. Caroselli C, Blaivas M, Falzetti S. Diagnostic imaging in newborns, children and adolescents infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): is there a realistic alternative to lung high-resolution computed tomography (HRCT) and chest X-rays? a systematic review of the literature. Ultrasound Med Biol.2021; 47: 3034-40.
24. Volpicelli G, Cardinale L, Fraccalini T, Calandri M, Piatti C, Geninatti C, et al. Descriptive analysis of a comparison between lung ultrasound and chest radiography in patients suspected of COVID-19. Ultrasound J. 2021; 13:11. doi: 10.1186/s13089-021-00215-9
25. Shokoohi H, Liteplo AS, Ma IW. Point-of-Care Ultrasonography: Clearly More Than a Pretty Picture. JAMA Intern Med. 2022;182:567. doi: 10.1001/jamainternmed.2022.0067.
26. Gartlehner G, Wagner G, Affengruber L, Chapman A, Dobrescu A, Klerings I, et al. Point-of-Care Ultrasonography in Patients With Acute Dyspnea: An Evidence Report for a Clinical Practice Guideline by the American College of Physicians. Ann Intern Med. 2021;174:967-76. doi: 10.7326/M20-5504.. Erratum in: Ann Intern Med. 2022;175:458-9.
27. Siwik D, Apanasiewicz W, Zukowska M, Jaczewski G, Dabrowska M. Diagnosing Lung Abnormalities Related to Heart Failure in Chest Radiogram, Lung Ultrasound and Thoracic Computed Tomography. Adv Respir Med. 2023;91:103–22. doi: 10.3390/arm91020010
28. Cardinale L, Priola AM, Moretti F, Volpicelli G. Effectiveness of chest radiography, lung ultrasound and thoracic computed tomography in the diagnosis of congestive heart failure. World J Radiol. 2014; 6: 230-7.
29. Zanobetti M, Scorpiniti M, Gigli C, Nazerian P, Vanni S, Innocenti F, et al. Point-of-care ultrasonography for evaluation of acute dyspnea in the ED. Chest. 2017;151:1295-301. doi: 10.1016/j.chest.2017.02.003.
30. Laursen CB, Sloth E, Lassen AT, Christensen Rd, Lambrechtsen J, Madsen PH, et al. Point-of-care ultrasonography in patients admitted with respiratory symptoms: a single-blind, randomised controlled trial. Lancet Respir Med. 2014;2:638-46. doi: 10.1016/S2213-2600(14)70135-3.
31. Szabó GV, Szigetváry C, Szabó L, Dembrovszky F, Rottler M, Ocskay K, et al. Point-of-care ultrasound improves clinical outcomes in patients with acute onset dyspnea: a systematic review and meta-analysis. Intern Emerg Med. 2023;18:639-53. doi: 10.1007/s11739-022-03126-2.
32. Amatya Y, Rupp J, Russell FM, Saunders J, Bales B, House DR. Diagnostic use of lung ultrasound compared to chest radiograph for suspected pneumonia in a resource-limited setting. Int J Emerg Med. 2018;11:8. doi: 10.1186/s12245-018-0170-2.
33. Kok B, Wolthuis D, Bosch F, van der Hoeven H, Blans M. POCUS in dyspnea, nontraumatic hypotension, and shock; a systematic review of existing evidence. Eur J Intern Med. 2022;106:9-38. doi: 10.1016/j.ejim.2022.07.017.
34. García-Araquea HF, Aristizábal-Linaresb JP, Ruíz-Ávilac HA. Semiology of lung ultrasonography – Dynamic monitoring available at the patient's bedside. Rev Colomb Anestesiol. 2015;43:290–8.