Assessment of Lung Ultrasound Artifacts (B-Lines)

Incremental Contribution to Echocardiography in Heart Failure?

We read with a great interest the paper by Miglioranza et al. (1), which sought to define the performance of lung ultrasound (LUS) compared with a clinical congestion score, natriuretic peptides, and echocardiography, to evaluate decompensation in patients with systolic heart failure (HF) in an outpatient clinic. This paper is a valuable effort to bridge the gap between echocardiography and thoracic ultrasound, and their separate skills and application—a topic that is still quite controversial (2).

Nonetheless, we remain skeptical about the value of this test. Four methodological observations seem relevant. First, the specificity of LUS B-lines is suboptimal: in addition to pulmonary congestion, these are visible in chronic obstructive pulmonary disease (3), pulmonary fibrosis (4), and lymphangitis (2,4). Second, the evaluation process is at best semiquantitative, because the method is more of a subjective overview than an actual "measurement." Third, most reference studies have used linear or convex probes rather than phased array transducers; the use of phased-array transducers provides a greater risk of artifacts, depending on machine settings and particularly at lower frequencies. Finally, the actual interobserver and intraobserver measurement range is not reported (1).

There are also some practical issues that warrant further attention. First, although the authors state that "this technique is faster to perform, is less expensive, and has lower technical requirements compared with a full echocardiography examination," such a comparison of cost and return needs formal study. Second, the statement "LUS could be used as an extension of the physical examination and to differentiate hemodynamic from pulmonary congestion" warrants examination in a mixed patient group with pulmonary disease, to truly evaluate the ability to perform this differentiation. Third, in our opinion, the implication of the article that pharmacological therapy could be tailored as soon as the patient, although asymptomatic, shows a significant increase in the number of B-lines is speculative and not yet supported by solid evidence.

In conclusion, we think that a critical reappraisal of this and other similar papers published on B-lines is mandatory. The evaluation of these artifacts using subjective scores is contrary to efforts to improve the reliability and objectivity of imaging (3–5).

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http://dx.doi.org/10.1016/j.jcmg.2013.11.013

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B-Lines: To Count or Not to Count?

We found the paper by Miglioranza et al. (1) interesting and useful for routine clinical practice because their purpose is that of simplifying and obtaining from an ultrasound B-line count a measure of lung water, a "measure" of disease, that would be approachable by all, with a short period of training. Some points, though, need to be clarified because, unfortunately, the concept of B-line is not just that.

The investigators define B-lines according to a consensus statement in which only a "qualitative" description is provided without any explanation of their origin (2), which is still debated in the literature (3). We know from past studies that these artifacts are an expression of an error of the ultrasound machine in interpreting acoustic interactions, so we do not agree that a simple "count" of B-lines could be an "unambiguous" measure of extravascular lung water (EVLW), because an increase in EVLW is not the sole origin of these artifacts.

In the study (1), to rule out false positives, only patients with a prior diagnosis of pulmonary fibrosis were excluded. But B-lines are found in many other pulmonary conditions, such as pneumonia, atelectasis, acute lung injury/acute respiratory distress syndrome, pleural disease, and actually any ground-glass opacity seen in CT scans. They are a very sensitive but, unfortunately, a very nonspecific sign. Is it, with this optic, possible to "count" an ambiguous phenomena, with debated and artifactual origin, to define a "cutoff" parameter related to EVLW in decompensated congestive heart failure? Other authors are pushing in this direction, and recently, Brattain et al. (4) have tested portable sonography with an algorithm to count and formulate a score of EVLW. Although promising, we would like to advise practitioners to be on guard on this subject because the risk of underestimating a problem by simplifying it is, yes, attractive, but could have serious clinical implications (i.e., when mechanically ventilating a patient in the intensive care unit: the origin of disease cannot be overseen).

In the study, in all but 2 patients, lung ultrasound was performed in the anterolateral surface of each hemithorax, following international recommendations (2), whereas the chest x-ray was always carried out in orthostatism. We know how water distribution in pulmonary congestion tends to accumulate in the posteroinferior, antigravitational regions: why not use the same position? Was there a difference between the 2 approaches?

Moreover, the investigators use a cardiac probe (2.5 to 3.5 MHz), although it is to date common knowledge in the field that the number and features of B-lines change when examined with different probes and at different angles of assessment (5). What would be the best probe setting to carry out a repeatable count with the least interoperator variability?

In conclusion, the description of extension (focal/bilateral), localization, involvement (homogeneous/dishomogeneous), and

gradient of distribution (gravitational/irregular) of vertical artifacts, as well as features of the pleural line (rough/smooth/thickened), with a standardized probe setting are pivotal in better defining B-lines, so we believe that a new approach, and not just a simple count, should be identified in order to guide clinicians to correct diagnosis and treatment.

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http://dx.doi.org/10.1016/j.jcmg.2013.12.018

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REPLY: B-Lines: a Nonspecific but Highly Informative Sign of Pulmonary Congestion

Dr. Zanforlin, Dr. Trovato, and colleagues have raised some issues about our study (1) that we are glad to address.

As mentioned in the paper, the lack of specificity of B-lines is well recognized (2). Our study group was selected so that no patient had a clinical condition apart from pulmonary congestion that was likely to cause the detection of B-lines. Many signs that we routinely use in clinical practice are not specific; as physicians, we should always contextualize B-lines, as well as other biomarkers, in the overall clinical picture. Of course, if we consider patients with other pulmonary diseases that involve the lung interstitial space, the usefulness of B-lines as a sign of extravascular lung water (EVLW) decreases. We would not advise the use of B-lines to help in differentiating hemodynamic from pulmonary congestion in these subsets of patients.

We agree that evaluation of B-lines can include much more than a simple semiquantitative estimation and we believe that the assessment of the pleura and subpleural features may offer important information (2). In our study group of outpatients with heart failure and no significant pulmonary comorbidity, we considered this limited analysis to provide an acceptable level of information. Counting B-lines is an attempt to enrich a finding that, in our view, is not just dichotomous. Although it is a rough semiquantification, rather than an accurate quantification, it nonetheless correlates with clinical, radiological, and invasive signs of EVLW, including gravimetric estimation (3). Moreover, B-lines have clear prognostic implications (4), even in this specific group (5). We will be glad to utilize a more accurate way to quantify B-lines, as soon as it becomes available.

We scanned most patients supine, limiting our evaluation to the anterolateral chest, as in most B-line studies. Because of the short time the patients were lying down, we believe this did not significantly change EVLW distribution from the orthostatic position. We agree, nevertheless, that in outpatients, it is reasonable to scan the posterior basal regions (dependent zones).

One of the advantages of evaluating B-lines is that their assessment is not strictly dependent on 1 specific probe. The convex or microconvex probes seem to be the most appropriate. However, we do not believe that we should give up the meaningful information we get in our everyday practice from lung ultrasound, just because we do not have the perfect probe at hand. The Bland-Altman plots showed a very low bias between probes, as well as for interobserver and intraobserver agreement (6).

We accept the criticism that there are no data on titrating treatments according to B-lines (2), nor studies on cost effectiveness. In our paper, we only briefly speculate about the potential tailoring of pharmacological therapy according to B-lines, as a possible clinical implication. A prospective, randomized trial on dialysis patients with heart failure, comparing a standard approach with that of B-line-driven therapy, is in progress (2).

We fully share the concern of improving the reliability and objectivity of imaging, as well as the scientific pathway to promote them. This is why we are trying to deepen our knowledge on this relatively new ultrasound application that, according to many authors, is very promising.

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http://dx.doi.org/10.1016/j.jcmg.2014.02.004

Please note: Dr. Miglioranza has received a post-graduate grant from CAPES, a Brazilian governmental agency for post-grad support.

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