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Artifacts, Noise and Interference: Much Ado about Ultrasound

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We appreciate the insight provided by Soldati et al. [1], who addressed the origin of artifacts in thoracic ultrasound (US), stating that they do not correspond to anatomical structures, visible or otherwise [1]. Indeed, like noise and interference, artifacts 'detected' by biomedical signaling tools, being equipment- or technique-related errors in the perception or representation of visual or auditory data [2], can be minimized and removed by clinical recording. In medical imaging they are essentially misrepresentations of tissue structures caused by phenomena such as the underlying physics of energy-tissue interaction (i.e., US-air), data acquisition errors (such as patient motion, variations in equipment settings and gain, and different transducer incidence angles), or the inability of a reconstruction algorithm to faithfully represent the anatomy.

Care must be taken to avoid mistaking artifacts for concrete imaging data – and, consequently, real pathology – so that physicians will recognize them and be fully aware of their 'artifactual' origin. Among the medical imaging techniques, US is susceptible to both sonic (accidental or unwanted sonic material) and visual artifacts (unwanted equipment-generated visual alterations), as well as to data compression distortion.

Artifacts are also related to the speed of propagation of ultrasound. The ultrasound systems are calibrated such that the crossing speed of the ultrasound beam through different tissues is, on average, 1,500 m/s (1,450–1,580). However, in the lung, the US speed drops to about 400 m/s, thereby giving rise to artifacts. As a consequence, no US device is currently able to reach the inner parts of the lung, unless a nonaerated lesion bridge (pleural effusion, cancer or pneumonia consolidation, or atelectasis, all adherent to the pleura) is present. The number and intensity of the visible B-lines depend on the type and frequency of the probe used, as well as on the degree of total gain compensation. The erroneous use of a medium-to-low frequency or excessive total gain and the lack of tissue harmonic imaging can generate a large number of such artifacts. An increase in the number of ring-downs and B-lines per intercostal space is generated every time the US beam is intercepted by an excessive quantity of air and liquid film or exudate in mantle-peripheral, strictly subpleural lung areas, by the presence of subpleural fibrosis or in subpleural lymphangitis. This condition is a feature of several diffuse lung and interstitial diseases of different nature, not pathognomonic of any particular disease state (such as acute pulmonary edema).

Aside from the validity of the above-stated comments by Soldati et al. [1], we would respectfully like to ask the authors for some clarification to reinforce their message:

(1) By 'generation of sonographic interstitial syndrome is not completely clear and the visual representation of lung artifacts (B-lines and white lung) by the machine is too simplistic' [1], do the authors mean that where we see B-lines that are only a 'sonographically' defined interstitial syndrome, the cause may be any, and even no, disease?
(2) Can the 'peripheral airspace geometry' [1] relationship forecast the detection of subsets specific to or suggestive of some lung disease within bulky artifacts, i.e., the white lung? No, reasonably.
(3) Does the information provided by the excised lung reflect the actual morphodynamic features of the human lung in health and disease and its behavior when challenged, or trespassed upon, by US? How comparable is their model, i.e., excised lungs from dead small adult animals, with living human beings, in whom the chest wall and respiratory movements cause sonographic effects? In our laboratories, as usual, fixed alveoli of human lungs do not collapse (surgical procedures).

We believe that by providing answers to these questions, Soldati et al. [1] will lend considerable weight to their highly appropriate statements regarding the futility of 'counting' B-lines [2, 3] and the risks of relying on such erratic artifacts [4, 5]. A strong fellow voice [1] opposing what we perceive as an unnecessary drain on resources – investigating B-line counts for associations with different diseases, and even grading them – would be very welcome indeed.

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