

Explaining Snowstorms **Norbert Foudraine**

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Editorial

For centuries, doctors have tried to gain a clear insight into the anatomy of the various chest structures and the pathophysiological mechanisms of diseases of the organs lying within the chest. In ancient times, only direct inspection and auscultation by applying the ear onto the chest of the patient were used for the diagnosis. However, the latter technique of auscultation has improved revolutionary after the invention of the stethoscope by Laënnec [1]. However, despite being of tremendous value over decades, auscultation is only moderately reliable in the diagnosis and medical decision making even when used by experienced physicians [2]. Nevertheless, despite its limitations students are taught auscultation as the primary method for diagnosing chest diseases, owing largely to the low low costs and immediate available results associated with this method, which have contributed to preserving auscultation as a primary method of chest diagnostics, both in pulmonology and cardiology cases.

An unprecedented step forward in diagnostics was made with the invention of the chest X-ray in 1896. However, its use in daily practice was not validated and widespread until years after its introduction owing to a lack of appropriate techniques and unfamiliarity with the radiological manifestations of the different chest diseases [3]. This explains why the introduction of this new technology was primarily used in obvious abnormalities such as for 'diagnosing' fractures and looking for foreign bodies. Nevertheless, despite the initial reluctance, the ignorance and inexperience with the chest X-ray for expanded use were eventually overcome, and this method was gradually being explored for diagnostic purposes in the decades after its introduction. Nowadays, it might be difficult to understand the struggle of acceptance, as chest X-rays have been considered for years, by most physicians, a standard investigation for numerous chest diseases. However, as the static pictures of the chest became widespread and readily available the need was concomitantly growing for better understanding the movements and dynamics of both the heart and the lungs. Investigating movement of chest organs was already possible by direct fluoroscopy, but was complicated by the extremely high X-ray doses due to the prolonged exposure times needed, and it was the subsequent progress made in cardiac imaging that would pave the way for dynamic lung imaging.

After the first description of using cardiac ultrasonography (M-mode) in 1953 by Edler and Hertz [4] an enormous amount

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of research and technological developments were launched, consequently changing the paradigm from always first using the stethoscope and a chest X-rays always being used first, to echocardiography being considered a first-line diagnostic tool in cases of suspected heart disease. In fact, nowadays, it is standard to use echocardiography as the first line diagnostic approach to assess heart failure, contractility and valve diseases. Echocardiographic imaging not only reveals useful static images, but also show the movements of all parts of the heart, including the heart wall and endocardium, as a result of the use of extremely advanced velocity measurements (tissue Doppler and colour kinetic imaging).

These developments are in sharp contrast to the implementation of ultrasonography in pulmonology. The use of ultrasonography as a first line in diagnostic measure of pulmonary diseases has only just started becoming more widespread. Even in the 2011 edition Harrison's major textbook for internal medicine, lung ultrasonography is described as not being useful for the evaluation of the pulmonary parenchyma and that it cannot be used if there is any aerated lung between the US (ultrasonography) probe and the abnormality of interest (18th edition, p: 2098). In accordance with such widespread reluctance the intensivist and "father of lung ultrasonography" Daniel Lichtenstein, struggled to get his first articles published for almost 11 years. Even at this moment, physicians trained as pulmonologists are frequently not sufficiently trained in lung ultrasonography [5].

It is not quite clear why the history of a reluctant introduction of the chest X-ray is now repeating itself with the introduction of lung ultrasonography in daily practice, despite the numerous

advantages of this widely available technique. This maybe partly explained by the opinion leaders who previously reported chest X-rays could only confirm what a thorough physical examination had already revealed, or the fact that, nowadays, as mentioned above textbooks still proclaim the uselessness of lung ultrasonography. in combination with the fact that lung ultrasonography is not a standard investigation for radiologists.

Despite this, lung ultrasonography is fast, easy to perform and cheap. In many situations it has a reliability comparable with that of a CT-scan of the lung, and better compared to that of the chest X-ray, as well as a better performance than standard auscultation [6, 7]. Further, it also reduced interobserver variability for the interpretation of lung sounds [2].

Fortunately, diagnoses by lung ultrasonography are increasing considerably. The citations in PubMed with "lung ultrasound" in their title have increased from 28 to 83 to 471 for the periods of 1990-1995, 2000-2005, and 2010-2015, respectively, countless additional papers are being published on the application of lung ultrasonography.

A major advantage of lung ultrasonography is that some lung abnormalities can be easily detected, sometimes within seconds, at the patient's bedside. For example, pneumothorax can reliably be assessed with ultrasonography, as can many other causes of acute dyspnoea such as heart failure, pleural effusions, atelectasis, and pulmonary consolidations due to pneumonia [7-13]. Although, a chest-CT scan is generally considered the gold standard in these cases, it is logistically cumbersome and much more expensive; moreover, ultrasonography performs better compared with plain chest X-rays. Another major advantage is the possibility of frequent repetitions of the ultrasonography investigations within a short timeframe. Importantly, despite these uses, it should be noted that lung ultrasonography is not reliable for diagnosing lung cancer.

What once was considered as uninterpretable "snowstorms" can now be differentiated by accurate imaging of pulmonary oedema

(called "comets" or "B-lines"), as normal aeration of the lung (the "A profile") or as consolidation due to pneumonia. Moreover, comparable to echocardiography, both static and dynamic investigations (diaphragm mobility and movements) can easily be performed with lung ultrasonography.

It would be advisable that both cardiologists and pulmonologists have a thorough command of each other's basic ultrasonography principles [14]. In this perspective, it may be necessary to revitalise the old dogma in diagnosing chest diseases that "you cannot understand the heart without literally looking at the lung, and vice versa". As heart and lung diseases are frequently mutually influencing each other, there is a powerful opportunity to combine lung and heart diagnostic ultrasonography by one person. This is often the case in today's intensive care practice. Accordingly, the intensivist has to be trained in performing ultrasonography of both the lung and the heart [15-19]. For example, in weaning mechanically ventilated patients crossroads of cardiac and pulmonary (dys)function merge [20]. In ICU patients, the lungs can be investigated in a standardised manner according to the so called "blue protocol" [21]. However, as this protocol does not include investigations of the heart, a modification of this protocol, now including basic echocardiography, the so-called "the extended blue protocol", which also takes the clinical and laboratory data into account, has been developed [22].

Obviously, in most ICU patients, the heart and lung functions are more severely impeded compared to most other hospitalized patients and outpatients; however, the application of the "simple" blue protocol is sufficient to perform a quick and reliable diagnosis of many lung diseases, without the need for ordering a chest X-ray and waiting for the radiologist's report. Hence, not only in the ICU but also in emergency departments and for outpatients, lung ultrasonography is being increasingly applied [23, 24].

In summary, now when you now look through the "ultrasonogram" you can see now comets everywhere, even during heavy snowstorms.

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