BLUE-Protocol and FALLS-Protocol
Two Applications of Lung Ultrasound in the Critically Ill

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This review article describes two protocols adapted from lung ultrasound: the bedside lung ultrasound in emergency (BLUE)-protocol for the immediate diagnosis of acute respiratory failure and the fluid administration limited by lung sonography (FALLS)-protocol for the management of acute circulatory failure. These applications require the mastery of 10 signs indicating normal lung surface (bat sign, lung sliding, A-lines), pleural effusions (quad and sinusoid sign), lung consolidations (fractal and tissue-like sign), interstitial syndrome (lung rockets), and pneumothorax (stratosphere sign and the lung point). These signs have been assessed in adults, with diagnostic accuracies ranging from 90% to 100%, allowing consideration of ultrasound as a reasonable bedside gold standard. In the BLUE-protocol, profiles have been designed for the main diseases (pneumonia, congestive heart failure, COPD, asthma, pulmonary embolism, pneumothorax), with an accuracy >90%. In the FALLS-protocol, the change from A-lines to lung rockets appears at a threshold of 18 mm Hg of pulmonary artery occlusion pressure, providing a direct biomarker of clinical volemia. The FALLS-protocol sequentially rules out obstructive, then cardiogenic, then hypovolemic shock for expediting the diagnosis of distributive (usually septic) shock. These applications can be done using simple grayscale machines and one microconvex probe suitable for the whole body. Lung ultrasound is a multifaceted tool also useful for decreasing radiation doses (of interest in neonates where the lung signatures are similar to those in adults), from ARDS to trauma management, and from ICUs to points of care. If done in suitable centers, training is the least of the limitations for making use of this kind of visual medicine.

ABBREVIATIONS: BLUE = bedside lung ultrasound in emergency; FALLS = fluid administration limited by lung sonography; LUCI = lung ultrasound in the critically ill; LUCIFLR = Lung Ultrasound in the Critically Ill Favoring Limitation of Radiation; PLAPS = posterolateral alveolar and/or pleural syndrome

Daily concerns of the intensivist are acute respiratory and circulatory failure. The need for fast and accurate management calls for a visual approach, which is what ultrasound provides. Portable machines suitable for use at the bedside have been available since 1982. This article, therefore, could have been written 33 years ago. Echocardiography has been used for a long time in the ICU and now is currently used inside the thorax through the transesophageal route.\(^1,2\) Echocardiography is an elegant way to solve
these respiratory and circulatory concerns. This article describes a complementary tool: lung ultrasound.

History
Lung ultrasound originally was not meant to be used in emergent care. Except for echocardiography used in cardiology and sonography used in obstetrics, ultrasound in general was a tool for radiologists, and the lung in particular was not considered suitable for this imaging technology. Since 1989, François Jardin’s ICU explored, applied, and made lung ultrasound with a portable unit a standard of care in critically ill patients. Based on our 25 years of experience using lung ultrasound in the critically ill (LUCI), the American College of Chest Physicians and La Société de Réanimation de Langue Française jointly proposed LUCI as a standard of care. Since 1991, intensivists have been using whole-body ultrasound, including vascular access, search for free blood, and so forth, and lung ultrasound. Gradually, the ICU community understood the relevance of lung ultrasound in critical care. Publications began to emerge and are now quite prevalent in the literature; thus, only a few regarding the lung are quoted in the present article.

Tools Used for the BLUE-Protocol
One application of lung ultrasound is the onsite exploration of acute respiratory failure: the bedside lung ultrasound in emergency (BLUE)-protocol. Although the new generation of intensivists benefits from a variety of excellent machines, we keep using our 1992 technology (last updated in 2008) for several reasons: We like its resolution; 32-cm width in settings where each lateral centimeter counts; 7-s start-up time; flat, easy-to-clean, fluid-proof design; 5-MHz microconvex probe allowing whole-body analysis from 0.6 to 17 cm; simple technology based on three clearly identified buttons, instant response, respect of artifacts, and ease of maintenance; intelligent narrow cart (preventing any drop); and low cost. These reasons make up the first of seven principles: The simplest equipment is suitable for lung imaging. Any modern machine can be used, however. We believe that redesigns of the same machine for use in modern facilities (using wireless transmission, Doppler and transesophageal echocardiography, etc) are appropriate as long as these do not interfere with the critical properties of small size, cost-effectiveness, and immediate start-up time. The alternative, which we have been using for 25 years, is to have one simple, cost-effective unit and one comprehensive echocardiographic unit on hand.

The second principle is to use gravity rules (gas toward the sky, fluids toward the earth) to locate disorders. The third principle is to define standardized thoracic points, called BLUE-points, to allow for reproducible analyses (Fig 1), and the fourth is to precisely define the pleural line, the first of 10 basic signatures. The fifth principle in lung ultrasound focuses specifically on artifacts. The A-line is a repetition of the pleural line, indicating gas (Fig 2). The sixth principle analyzes lung sliding, which is a twinkling visible at the pleural line that spreads homogeneously below it (generating the seashore sign in M-mode). Lung sliding and A-lines define a normal
The lung surface\textsuperscript{66} (Figs 2, 3). The seventh principle is based on the fact that all acute, life-threatening disorders are superficial. This allows to standardize the field (Table 1).

Diagnosis of pleural effusion is an old application of lung ultrasound\textsuperscript{51,52} and basically yields two standard signs: the quad sign and the sinusoid sign (Figs 4, 5).\textsuperscript{47} Alveolar syndrome (lung consolidation) is also an old diagnostic application of lung ultrasound.\textsuperscript{53} This fluid disorder usually is superficial\textsuperscript{48} and, thus, accessible to ultrasound, particularly in the diagnosis of nontranslobar consolidations, which yield the fractal (or shred) sign (Fig 5), and translobar forms, which yield the tissue-like sign (Fig 6).\textsuperscript{48} Interstitial syndrome generates lung rockets on lung ultrasound (Fig 7).\textsuperscript{49} This application is a main point of discussion in this article.

Pneumothorax was first approached in lung ultrasoundography using the sole abolition of lung sliding.\textsuperscript{54,56} This sign had a poor specificity until it was associated with the A-line sign (Fig 8).\textsuperscript{46,57} Abolished lung sliding generates the stratosphere sign in M-mode. Lung sliding (or its equivalent, the lung pulse)\textsuperscript{58} or B-lines rule out pneumothorax. The lung point (Fig 9) is a pathognomonic sign.\textsuperscript{59} Pneumothorax occurring in patients with severe dyspnea or adherences is beyond the scope of this article.

Patients, Diseases, and Profiles in the BLUE-Protocol

The BLUE-protocol was developed based on the study of 300 consecutive adults with acute respiratory failure who were admitted to our ICU and given a diagnosis. The most frequent cause of respiratory failure was pneumonia (32%) followed by acute hemodynamic pulmonary edema (24%); exacerbated COPD (18%); severe asthma (13%); pulmonary embolism (8%); pneumothorax (4%); and countless rare causes, including easy-to-diagnose ones, such as massive pleural effusion (3%). We excluded rare, unknown, and multiple diagnoses because they generate methodologic issues. The

| TABLE 1 | Published Performances of Lung Ultrasound in Critically Ill Patients Compared With CT Scanning |
|------------------------|------------------------|------------------------|
| Ultrasound             | Sensitivity, %          | Specificity, %          |
| Pleural effusion\textsuperscript{57} | 94                     | 97                     |
| Alveolar consolidation\textsuperscript{58} | 90                     | 98                     |
| Interstitial syndrome\textsuperscript{59} | 100                    | 100                    |
| Complete pneumothorax\textsuperscript{56} | 100                    | 96                     |
| Occult pneumothorax\textsuperscript{50} | 79                     | 100                    |
BLUE-protocol is integrated within the control of acute respiratory failure, which requires an understanding of anatomy, physiology, pathophysiology, clinical signs, traditional imaging, and the biology of dyspnea. The BLUE-protocol is fully based on pathophysiology.

One feature of the BLUE-protocol is the established profiles, that is, signs associated with locations. These profiles are labeled simply to indicate abridged concepts. The A-profile is shorthand for “anterior lung sliding with A-lines profile.” The remaining eight profiles follow the same labeling convention: B-profile (hemodynamic pulmonary edema), B9-profile, A/B-profile, C-profile, A-profile without DVT but with posterolateral alveolar and/or pleural syndrome (A-no-V-PLAPS-profile) (pneumonia), A-profile plus DVT (pulmonary embolism), A'-profile (pneumothorax), and nude profile (COPD/asthma).

At the anterior chest wall, lung sliding with predominant A-lines define the A-profile. Lung sliding is explained by the respiratory movements of the visceral pleura against the parietal pleura. The A-line is displayed when normal subpleural interlobular septa are too thin for disturbing the reverberation of the pleural line. The A-profile indicates a normal anterior lung surface. Associated with a DVT, it is connected with pulmonary embolism. The venous step is the longest part of the BLUE-protocol. The anterior lung analysis takes 0.5 min, negative venous scanning 2 min, and posterior lung step 0.5 min by an experienced operator using the standardized BLUE-points.

Lung sliding with lung rockets define the B-profile and usually indicate hemodynamic pulmonary edema. When interlobular septa are enlarged by edema, the ultrasound flow penetrates the lung, but the major impedance gradient between gas and fluids traps the ultrasound flow, hence showing a persistent to-and-fro dynamic, generating the B-line. Three B-lines between two ribs, a pattern called lung rockets, correspond to the anatomic number of subpleural interlobular septa. Hemodynamic pulmonary edema creates a transudative, pressurized pulmonary edema, therefore associating lung sliding with a culminant (anterior) location of lung rockets. Anterior lung rockets associated with abolished lung sliding define the B’-profile. In inflammatory interstitial syndrome (ie, pneumonia), each subpleural interlobular septum should exude fibrin, behaving like glue, resulting in abolishing lung sliding. Unilateral lung
rockets define the A/B-profile. This asymmetry of interstitial signs is also linked to pneumonia.

Anterior lung consolidation, regardless of number and size (up to simply a thick, irregular pleural line), defines the C-profile. In the BLUE-protocol, the C-profile is associated with pneumonia. Following the second principle of lung ultrasound, consolidations seen in hemodynamic pulmonary edema or pulmonary embolism are posterior.60

Anterior A-lines associated with abolished lung sliding define the A'-profile. The A'-profile suggests pneumothorax—the lung point is mandatory. In pneumothorax, the abolished lung sliding is explained by the absence of visceral pleura and the A-line by the absence of any fluid structure abutting the parietal pleura. The lung point is explained by the slight inspiratory increase of volume of the collapsed lung and, therefore, an increased parietal contact making an abrupt ultrasound change.

At the posterior chest wall, lung consolidations and pleural effusions are assessed together for simplicity because both disorders usually come together, hence the practical term “PLAPS” (Fig 5). The A-no-V-PLAPS-profile is connected with pneumonia. The A-profile with no DVT and no PLAPS (ie, nude profile) is linked with asthma and COPD (two bronchial diseases with similar therapy combined for simplification).

In developing the BLUE-protocol, all study patients, including the excluded ones, benefited from receiving a profile. The A-profile was seen in 53.8%, the B-profile in 27.3%, the A'-profile in 3.4%, the B'-profile in 3.4%, the C-profile in 7.6%, and the A/B-profile in 4.6%.

The BLUE-Protocol: When and How Is it Used, What Occurs Practically, With How Much Accuracy?

The BLUE-protocol is done each time the physician has clinical doubts after the physical examination. The machine is brought to the bedside, the probe applied at
Figure 8 – Pneumothorax and A′-profile. The diagnosis of pneumothorax requires a two-step approach. The first step is to detect the A′-profile, associating the A-line sign with the abolition of lung sliding. The left image shows the A-line sign. The Merlin space always displays A-lines (arrowheads), meaning gas below the pleural line (arrows). The A-line shown here is ill defined, again more like an O-line, but there is definitely no B-line. The dots delineate the M-mode shooting line. The right image shows the stratosphere sign. This homogeneous, stratified pattern demonstrates what is seen on real-time imaging (ie, the constant and complete abolition of lung sliding). The arrows indicate the pleural line. The A′-profile is very sensitive but not specific to pneumothorax. Note that the two images are not only side by side but also exactly side by side (take a ruler at the pleural line) without any lag that may generate, in acute conditions, one element of confusion. This case is of a eupneic pneumothorax and represents a first step for learning (the signs of dyspneic pneumothorax are standardized too but add one more degree of complexity because they obey the rules of shooting at a mobile target).

Figure 9 – Pneumothorax and lung point. The lung point: Each time an A′-profile is detected (at the anterior wall, by definition), the search for the lung point is the second mandatory step, time permitting. At a certain location of the thorax (lateral, posterior), probe standstill, lung patterns such as lung sliding and lung rockets replace the A′-profile. The change in rhythm with respiration is abrupt (arrow in right image). The lung point is pathognomonic for pneumothorax, indicating its volume. (In this patient, the lung point was roughly located at the PLAPS point, corresponding to a radiovisible pneumothorax.) It indicates that the equipment is suitable (real-time instant-response acquisition, suitable resolution, mastery of filters). Arrows in the left image indicate the pleural line. See Figure 1 legend for expansion of abbreviation.

Frequently asked questions are answered in Lichtenstein. For example, a frequent question is, “Why is the heart not included?” Looking at the heart to solve a pulmonary failure is a legitimate, yet indirect approach. The suffering organ is the lung, so lung ultrasound provides a direct approach. Echocardiography is associated but not included (searching for left-sided heart anomalies in the absence of lung rockets makes less sense because pulmonary edema has been ruled out as a cause of respiratory failure). Small anterior lung consolidations (C-lines) suggest pneumonia 18 times more frequently than pulmonary embolism. Of importance, the BLUE-protocol is only designed to be piloted by the physician’s common sense and integrated with other basic data. A nude profile will sometimes require confident elimination of pulmonary embolism (CT scan, scintigraphy); an anterior small consolidation will, rarely, be one sign of pulmonary embolism. Used this way, the BLUE-protocol shows maximal efficiency.

A Development of the BLUE-Protocol: Lung Ultrasound for Diagnosing Acute Circulatory Failure—the FALLS-Protocol

For this major concern, successive tools have been used, with echocardiography currently being one of the most popular. Many others are competing,
providing an impressive list of parameters when combined, suggesting that no gold standard is currently available. The fluid administration limited by lung sonography (FALLS)-protocol is not yet supported by clinical studies but should be considered as a potential source of help in difficult situations. It is based on sequential concepts: Pulmonary edema generates a thickening of the interlobular septa of which their subpleural end is accessible using lung ultrasound\(^63,64\); A-lines transform into B-lines at a pulmonary artery occlusion pressure threshold of 18 mm Hg at the anterior chest wall in critically ill patients\(^65\); and no artifact has ever been described between A-lines and B-lines, indicating that B-lines appear (and vanish) all of a sudden, making septal thickening an on-off parameter. The use of lung artifacts allows for a direct assessment of lung water, more specifically interstitial lung water (what no bedside tool can do). The FALLS-protocol assumes that pulmonary edema is the most harmful consequence of fluid overload in an extreme emergency (see limitations presented later in this section).

The FALLS-protocol follows the Weil classification of shock.\(^66\) The best of simple cardiac sonography and some BLUE-protocol are used. With the same unit and the same probe, we first search for a substantial pericardial

![Figure 10](Image)

**Figure 10** – BLUE-protocol decision tree showing the practical steps of the BLUE-protocol. See Figure 1 legend for expansion of abbreviations. (Adapted from Lichtenstein and Mezière.\(^61\))

### TABLE 2 Accuracy of the BLUE-Protocol

<table>
<thead>
<tr>
<th>Mechanism of Dyspnea</th>
<th>Profiles of BLUE-Protocol</th>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
<th>PPV, %</th>
<th>NPV, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute hemodynamic pulmonary edema</td>
<td>B-profile</td>
<td>97</td>
<td>95</td>
<td>87</td>
<td>99</td>
</tr>
<tr>
<td>Exacerbated COPD or severe acute asthma</td>
<td>Nude profile (A-profile with no DVT and no PLAPS)</td>
<td>89</td>
<td>97</td>
<td>93</td>
<td>95</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>A-profile with DVT</td>
<td>81</td>
<td>99</td>
<td>94</td>
<td>98</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>A’-profile (with lung point)</td>
<td>88</td>
<td>100</td>
<td>100</td>
<td>99</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>The four profiles</td>
<td>89</td>
<td>94</td>
<td>88</td>
<td>95</td>
</tr>
<tr>
<td>A’-profile</td>
<td></td>
<td>11</td>
<td>100</td>
<td>100</td>
<td>70</td>
</tr>
<tr>
<td>A/B profile</td>
<td></td>
<td>14.5</td>
<td>100</td>
<td>100</td>
<td>71.5</td>
</tr>
<tr>
<td>C-profile</td>
<td></td>
<td>21.5</td>
<td>99</td>
<td>90</td>
<td>73</td>
</tr>
<tr>
<td>A-no-V-PLAPS-profile</td>
<td></td>
<td>42</td>
<td>96</td>
<td>83</td>
<td>78</td>
</tr>
</tbody>
</table>

BLUE = bedside lung ultrasound in emergency; NPV = negative predictive value; PLAPS = posterolateral alveolar and/or pleural syndrome; PPV = positive predictive value. (Adapted from Lichtenstein and Mezière.\(^61\))
effusion (assimilated to tamponade), then an enlarged right ventricle (assimilated to pulmonary embolism) (if poor cardiac windows, the BLUE-protocol can be used instead), and then an A’-profile (suggesting a tension pneumothorax). At this step, obstructive shock can reasonably be ruled out.

The B-profile is sought next. In its absence, a cardiogenic shock from left origin (ie, the far majority) can be ruled out by definition.

The next step is performed in patients with neither the A’-profile nor the B-profile. The A-profile or equivalent (A/B-profile mainly) usually is seen, indicating that the patient is a FALLS-responder. Only hypovolemic and distributive shock are remaining causes, and the therapeutic part begins, which is fluid resuscitation. The A-profile shows that fluids can be administrated, a notion of interest for intensivists who use volume resuscitation in distributive shock. Intensivists who would rather use vasopressors may appreciate that the FALLS-protocol allows them to avoid giving these drugs in underestimated hypovolemia (ie, a safety factor useful at the initial step). The improvement of clinical/biologic signs of circulatory failure with an unchanged A-profile under fluid therapy reasonably defines hypovolemic shock. The FALLS-protocol as a new tool for diagnosing hypovolemia should be appreciated in these complex settings (prolonged surgery, prolonged intensive care) occurring in complex, challenging, and bariatric patients.

If no clinical improvement occurs, fluid therapy continues. The apparition of anterior B-lines (one can search more laterally) means that an iatrogenic interstitial syndrome likely has been generated by the fluid administration. Interstitial edema is an early step, preceding alveolar edema. This step is clinically and biologically silent and is the FALLS-end point (ie, the time to discontinue fluid therapy). Schematically, the FALLS-protocol rules out obstructive, then cardiogenic, then hypovolemic shock to expedite the diagnosis of the last remaining cause, distributive shock (ie, usually septic shock) (Fig 11).

At this step, one must acknowledge that the fluid therapy has positioned the (left-side) heart at the inflection point of the Frank-Starling curve. Blood tests are performed, including blood cultures (fully indicated here), as well as other maneuvers to withdraw this slight fluid excess (reversal of initial passive leg raising [a variant labeled FALLS-PLR-protocol], diuretics, or other options).

Previous guidelines recommended early and massive fluid therapy in sepsis. The FALLS-protocol allows an earlier fluid therapy (on admission) hours before the sepsis is confirmed and provides the fluid volume just necessary to generate an infraclinical, infrabiologic step of interstitial edema (ie, likely an appropriate volume). Fluid administration is discontinued once the last tolerable drop has been given. The FALLS-protocol aims at decreasing high mortality from septic shock.

The main limitation of the FALLS-protocol is the presence of diffuse lung rockets (B-profile, B’-profile) on admission because no transformation from A-lines to B-lines can occur. To simplify this preliminary approach, conventional tools are used. Similarly, each time isolated, fully asymmetric right-sided heart failure is suspected, one is free to associate right ventricle and caval veins assessment. Bear in mind that pulmonary embolism has been discounted at this step. It should also be understood that the FALLS-protocol is not...
devoted to defining the need for fluid in a given critically ill patient but to expediting a diagnosis.

The FALLS-protocol does not appear to have any drawbacks relative to other hemodynamic tools, but any criticism is welcome. Based on pathophysiology, and above all pragmatism, the FALLS-protocol can be used when the usual tools fail (eg, limited cardiac windows). Furthermore, the FALLS-protocol cannot be compared directly with these tools because it does not monitor cardiac output changes, yet both approaches have a common bond: providing therapeutic orientations. Like traditional tools, the FALLS-protocol suggests who should receive fluids and when to discontinue fluids based on pathophysiology. Many questions are answered in Lichtenstein.  

The FALLS-protocol requires a simple unit without Doppler and has a steep learning curve. It can be of interest to not only those who have not yet mastered expert echocardiography but also those who do not yet (or will never) have echocardiographic units.

**How Can These Protocols Affect the Routine of Several Disciplines?**

Lung ultrasound in critical care is a holistic tool. A concept is holistic when the understanding of each of its multiple components is necessary to fully understand the whole. The result generates a whole-body approach in addition to the main vital organ. This allows for simplification of expert domains such as echocardiography, if associated with lung ultrasound. In the case of suboptimal cardiac windows, the B-profile suggests pulmonary edema and the A-profile hypovolemia, schematically. Using simple equipment and appropriate training, lung ultrasound is an accessible discipline for physicians.

These fast protocols can help in cases of cardiac arrest where each second is precious for sequentially pinpointing reversible causes, including pneumothorax, pulmonary embolism, bleeding, pericardial tamponade, and others. This application does not require urgent validation because it uses already-validated fields; simply, all elements optimizing the speed (narrow units, a 7-s starting time, the universal probe, etc) as well as a logical sequence (ie, first scanning the lungs, a 4-s step) are adopted in determining the diagnosis.

Apart from critical care, lung ultrasound will affect several disciplines. In the critically ill neonate, the 10 to 12 signs assessed in adults are found, with no difference. In anesthesiology and emergency medicine, where moderate dyspnea is managed, we see similar profiles for pneumonia, pulmonary edema, COPD, asthma, and pneumothorax. In the case of small pulmonary embolisms, infarctions may be more frequent. The respiratory physician can assess for pleural effusions, safe thoracentesis, an early diagnosis of chronic interstitial diseases, and lung consolidations in oncology. Expert approaches are available in Mathis and Reissig and Kroegel.  

Disciplines including pediatrics, cardiology, nephrology, neurology, and internal medicine, will find interest in lung ultrasound. The use of lung ultrasound by these disciplines is made without complex adaptation because of the simplicity of the equipment and the same signs used for diagnosis. To define a normal lung, only two signs are necessary, regardless of where the probe is applied, which is not the case in cardiac, fetal, and abdominal ultrasound. For this reason, lung ultrasound is probably far less operator dependent. This means that priorities can be reconsidered. One may, for instance, initiate a curriculum with the normal lung and become rapidly operational for basic applications (pneumothorax, pulmonary edema) and then learn expert echocardiography, taking as long a time as necessary. The feasibility of ultrasound of this superficial organ is > 98% even in bariatric patients the anterior approach provides basic data.

Medical irradiation (and costs) can be drastically reduced, which is of critical interest in neonates and young women. The Lung Ultrasound in the Critically Ill Favoring Limitation of Radiation (LUCIFLR) project aims to limit, not eradicate, one-third of urgent bedside radiographs and two-thirds of urgent CT scans in the next three decades, which can be considered a reasonable target. The LUCIFLR project does not require independent confirmatory studies. Bedside radiography has demonstrated an inaccurate sensitivity for most life-threatening disorders. With a roughly 60% to 70% sensitivity, it appears to be a suboptimal tool in critical care. Urgent CT imaging offers a strong overview yet at the cost of severe drawbacks (need for transportation, anaphylaxis, etc). Lung ultrasound has proven to be a quite similar diagnostic tool in most cases and sometimes superior, particularly with better detection of pleural septations, necrosis within consolidations, real-time assessment of lung sliding with no bedside equivalent, dynamic air bronchograms, and diaphragmatic analysis. Ultrasound provides quantitative data for all disorders (as shown in the figure legends in this article) and helps to quantify pleural effusions and monitor lung consolidation, which are of interest for intensivists who use positive end-expiratory pressure.
for lung recruitment.21 Pneumothorax volumes are indic-
ated by the lung point location.26,39,50 For these reasons, lung ultrasound should be considered a reasonable bed-
side gold standard. Each time that the clinical question is focused (ie, pneumothorax or not) and irradiating tests are avoided, not in theory but while practically using ultrasound, physicians take part, aware or not, in the LUCIFLR project.

Ultrasound, a multifaceted tool, can be used in sophisti-
cated ICUs, outpatient settings,84 and rural areas. We
remain discreet on a nonscientific, but significant ben-
et: the comfort of the physician when using this visual
approach to the patient.

Conclusions
The BLUE-protocol and the FALLS-protocol, two main
applications of LUCI, are simple to use at each step,
beginning with the choice of equipment (one simple
unit, one microconvex probe for the whole body). The
BLUE-protocol directly scans the lung to assess the
cause of a respiratory failure. The FALLS-protocol
considers a direct marker of fluid overload at the
lung surface in patients with septic shock. With these
applications, lung ultrasound appears once again as a
visual stethoscope (from “stethos,” meaning chest
wall), and should be tailored as a new kind of visual
medicine.85

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section BLUE-protocol.

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