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A Low-Cost Training Phantom for Lung Ultrasonography

VIDEO

To the Editor:

Lung ultrasonography (LUS) is a concept introduced recently to confirm problems associated with the lungs and the pleura. Since many international authors and organizations recommend LUS examination in clinical settings,[1] there is a necessity to train clinicians in the identification of normal and pathologic findings associated with LUS.[2] The purpose of this study was to create a low-cost ultrasonographic phantom to simulate normal and pathologic ultrasonographic findings of LUS. All aspects of this project were approved by the Institutional Review Board at the Dongguk University Ilsan Hospital (No. 2015-89).

To make the thoracic model with optimal elasticity and solidity for ultrasonographic examination, we created a gelatin model with various mixtures and concentrations. The concentration of gelatin was optimal when 20 g of gelatin was mixed with 60 mL of water; 1g of agar was appropriate as an additive. Tree branches and polyurethane dressing foam (Medifoam, Mundipharma, South Korea) were used to represent ribs and pleura (Fig 1). The gelatin and the agar used in this study were commercial products obtained from the local grocery store, and the phantom maintained its durability more than 1 month when refrigerated. Approximate cost for creating the phantom was $5.

Normal lung tissue, as well as lungs with pneumothorax, pulmonary edema, pleural effusion, and pneumonia, were simulated. To demonstrate the movement of pleura, dressing foam in contact with the phantom was moved repeatedly in a horizontal plane. In the case of the lung point of pneumothorax, dressing foam movement was limited to the middle half of the phantom. Dressing foam was soaked in water and moved repeatedly in a horizontal plane to make B lines. To demonstrate pleural effusion, a balloon

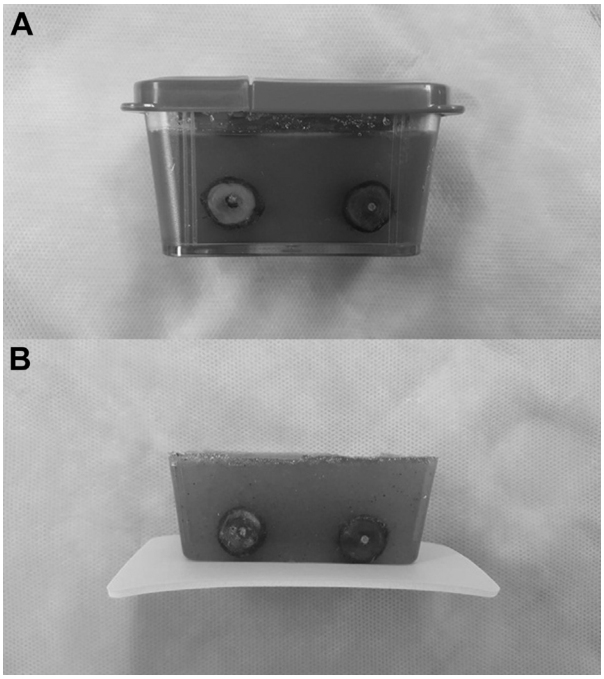

Figure 1 – *Lung ultrasonographic phantom. A, Phantom in container. B, Phantom with polyurethane dressing foam positioned at the bottom.*

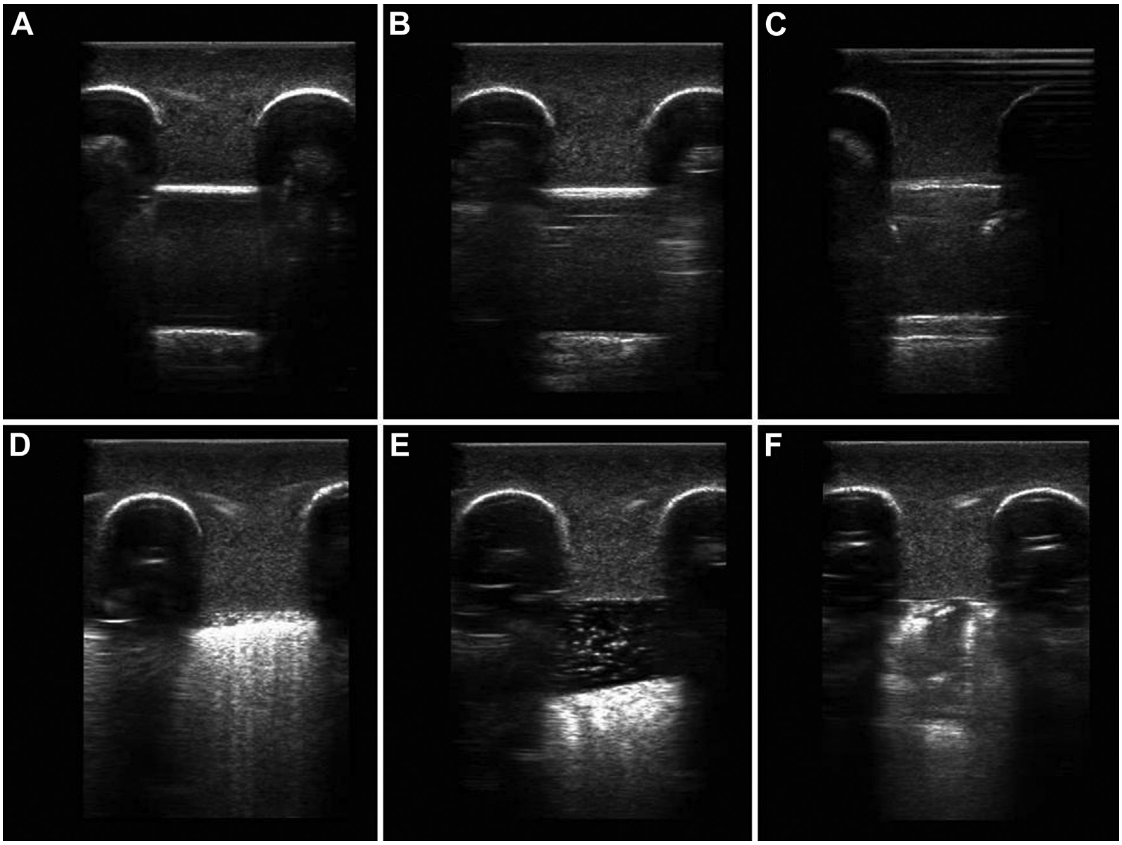

Figure 2 – *Six-item questionnaire using video clips obtained from the phantom administered to the raters for accuracy assessment. A, Normal lung sliding with A line. B, Limited lung sliding with lung pulse. C, Lung point of pneumothorax. D, Pulmonary edema with B lines. E, Pneumonia. F, Pleural effusion.*

filled with water was made to contact the bottom of the phantom.

A six-item questionnaire was administered to LUS imaging experts (three emergency medicine specialists and three intensivists) regarding normal lung findings and five pathologic findings—atelectasis, pneumothorax, pulmonary edema, pneumonia, and pleural effusion—made by using the phantom. For each question, six videos of the simulated findings were displayed on the screen, and the rater was asked to select the answer for the specific situations (Fig 2; Video 1). Rater agreement on the phantom for LUS was 100% for 36 questions. Every rater answered all six questions correctly. Table 1 shows the questions, answers, and agreement rates. Individual scores for normal and pathologic conditions

TABLE 1] Test Questions Administered to the Raters

Question (Correct: 1; Incorrect: 0)	Rater 1	Rater 2	Rater 3	Rater 4	Rater 5	Rater 6	Interrater Agreement, No. (%)
Please choose the video indicating pulmonary edema	1	1	1	1	1	1	6 of 6 (100)
Please choose the video indicating normal lung	1	1	1	1	1	1	6 of 6 (100)
Please choose the video indicating pneumothorax	1	1	1	1	1	1	6 of 6 (100)
Please choose the video indicating pneumonia	1	1	1	1	1	1	6 of 6 (100)
Please choose the video indicating pleural effusion	1	1	1	1	1	1	6 of 6 (100)
Please choose the video indicating atelectasis	1	1	1	1	1	1	6 of 6 (100)
Individual score, %	100	100	100	100	100	100	

in LUS were excellent, and interrater agreement was also excellent.

A prior study by Rippey and Gawthrope[3] attempted to create an LUS phantom. In that study, the authors used pork rib, chicken breast, and sponges to reproduce normal and pathologic lung conditions. Because animal products are used, the materials may produce unwanted odors and require infection control precautions. Furthermore, the model is highly perishable because of the use of animal products, and although it is less expensive than commercial models, cost is still a limiting factor.

In this study, a phantom was created that would be able to simulate the human lungs to be used in LUS training. The phantom in this study will help trainees become comfortable with LUS equipment and techniques, as well as make it possible to determine the pathologic findings in practical situations. In further investigations, improvements to the phantom, such as reinforcing the details and simulating other pathologic conditions, will be explored.

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Acknowledgments

Additional information: The Video can be found in the Supplemental Materials section of the online article.

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Pleural Infections in Intensive Care

To the Editor:

Few studies of pleural infection in ICUs exist, yet they suggest variable etiology and substantial associated mortality.[1-5] None of these studies have examined long-term outcomes, and most were published more than a decade ago. The current incidence, microbiology, and long-term outcomes for these patients remain unclear, hindering treatment advances.

We screened our statewide microbiology database for all culture-positive pleural fluid specimens from all three tertiary ICUs in Western Australia between January 1, 2006 and December 31, 2011. Clinical data were retrospectively obtained from patients' records to determine the (1) incidence, (2) microbiology, and (3) clinical outcomes 5 years after culture-positive pleural infection was confirmed. Cases were included if there was documented clinical suspicion of pleural infections and the patients were treated with intravenous antibiotics and pleural fluid drainage. The Sir Charles Gairdner Group Research Ethics Committee approved the study (reference 2012-038).

A total of 22,274 patients were admitted to three ICUs over 6 years. Sixty of 69 patients (0.3%) with positive pleural fluid results had confirmed culture-positive pleural infection while in the ICU; a total of 83 isolates were cultured (Fig 1). Staphylococci were the commonest isolates (38 of 83; 46%), and 19 of the 60 patients (31.7%)

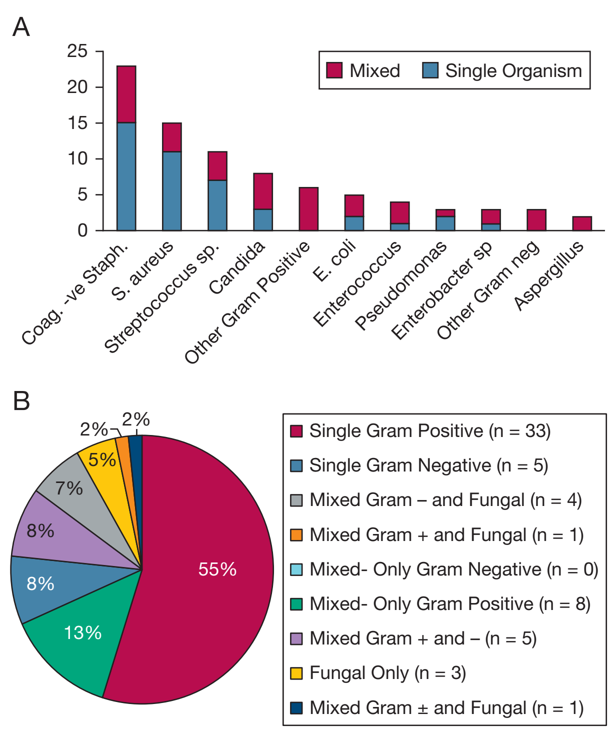

Figure 1 – *A, Numbers of different microbial isolates showing mixed or single pathogens. B, Pie chart depicting the proportion infections caused according to type of isolate and single or mixed infection. Coag -ve Staph = coagulase-negative staphylococci; E. coli =* Escherichia coli*; neg = negative; S. aureus =* Staphylococcus aureus.