

UTILITY OF CHEST ULTRASONOGRAPHY IN QUANTIFYING CLOTAND PLEURAL EFFUSION VOLUME IN PRECLINICAL MODELS OF PLEURAL DISEASE

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ABSTRACT

Early detection and monitoring of pleural disease is critical in guiding appropriate treatment decisions. In the United States, chest radiography and computed tomography (CT) are the most employed imaging techniques to assess pleural disease for diagnosis and management. However, repeated imaging using these modalities exposes patients to cumulative ionizing radiation. In contrast, chest ultrasonography offers a safer, cost-effective, and portable alternative that could be of advantage to pediatric, rural, or resource-limited hospital settings. In addition, ultrasonography brings great utility to preclinical research where advanced imaging is limited. In this study, we developed and validated an ultrasound-based tool that enabled pleural effusion and clot volume quantification in our preclinical models of disease (early-stage empyema, advanced-stage empyema, and retained hemothorax). Four methods were tested for estimating pleural effusion and of the two of these most accurate methods were used to quantify clot volume. Across three animal models of pleural disease, both the Predicted Pleural Effusion and Clot Volume (mL) were closest to the actual volume (gold standard, mL) when area volumetry (pleural effusion or clot) was conducted in the coronal view of the pleural space of the subjects. Lastly, ultrasonographic imaging was able to distinguish the difference in clot dissolution (Predicted Clot Volume, mL) between subjects treated with vehicle control or fibrinolytic therapy, providing evidence of its utility in our preclinical model. These findings support the potential applications of these volumetric tools for preclinical and potential clinical use.

Keywords: pleural disease, ultrasonography, pleural effusion, empyema, retained hemothorax, rabbit model.

INTRODUCTION

The pleura is a thin serous membrane that covers the lungs and lines the inner surface of the chest wall. Pleural diseases are often characterized by the accumulation of fluid or air within this potential space, often in association with parenchymal lung diseases including pneumonia [1]. Pleural effusion is defined as the abnormal accumulation of fluid in the pleural cavity, which may include serous fluid (hydrothorax), blood (hemothorax), or pus (empyema) [2]. This accumulation can lead to restricted lung expansion and result in dyspnea (shortness of breath) [3]. Diagnoses of pleural effusion can be achieved through a variety of imaging modalities including chest radiography (X-ray), computed tomography (CT), and/or chest ultrasonography [4]. Chest radiography and CT are commonly used to