Impact of a lung ultrasound course for rheumatology specialists (IMPACT-2)

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Abstract

Objective

Lung ultrasound (LUS) plays an increasing role in diagnosis and monitoring of interstitial lung disease (ILD). Connective tissue disorders (CTD) frequently cause ILD, and often presents symptomatically after irreversible fibrosis has ensued. As point-of-care musculoskeletal ultrasound (US) is commonly utilised by rheumatologists, translating this US expertise towards LUS places the rheumatologist in a position to screen for ILD. However, a standardised curriculum for the rheumatology community is lacking. The aim of this study is to determine the effectiveness of a formalised lung US training course for rheumatologists.

Methods

Four rheumatology fellows and four board-certified rheumatologists participated in a 4-hour training session. Pre-course, post-course and 6-month follow-up surveys evaluated perceptions towards previous US experience, training, clinical utility and attitudes toward lung US. Didactics explained the protocols utilised in ILD evaluation. Evaluation of knowledge in US physiology, lung anatomy, artifact and pathology recognition were done through written exams before, after training, and at 6 months and through a practical exam using live models and simulation.

Results

Temporally there was overall improvement in written test scores. Improvement was noted in overall practical skill score following training course (17.4% vs. 92.9%, $p<0.001$), in written test scores 49.3% vs. 72.5% $p<0.001$), and pathology identification (26.5% vs. 79.6%, $p<0.001$). Six-month follow assessments were similar to post-test results revealing similar written scores (70.6%) and practical scores (89.7%).

Conclusion

This formalised lung ultrasound training course was effective in improving skills and knowledge of rheumatology specialists.

Key words

ultrasound, interstitial lung disease, medical education, scleroderma, fibrosis

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Introduction

Interstitial lung disease related to connective tissue disorders (CTD-ILD) is an increasingly recognised group of diseases, notorious for their unpredictable natural history and complicated by a varied clinical, radiographic and pathologic presentation. Traditionally, high resolution computed tomography (HRCT) and diffusion capacity of carbon monoxide (DLCO) measurements have been the customary tools used for diagnosing and monitoring progression of pulmonary involvement. However, given the large reserve in the pulmonary system, most patients will not present with symptoms of dyspnea until a significant amount of lung damage has occurred often prompting the initial workup (3, 4). As the diagnosis are often elusive and involve multiple organ systems, multidisciplinary boards including radiologist, rheumatologist, pulmonologist and pathologist have been created to evaluate such cases (1). Evidence shows that such cooperation improves diagnostic accuracy and may lead to reduced delays in appropriate therapy (2). Despite cooperation amongst multiple specialties, there still remains a lack of consensus on a screening approach for early detection of lung disease. Frequent repeat testing with DLCO or HRCT is reasonable once the diagnosis is confirmed however this approach may lead to over utilisation of medical resources.

The use of point of care ultrasonography has exploded over the last decade influencing the pulmonary critical care and rheumatology fields alike. With the correlation of comet artifacts and the "alveolar-interstitial" pattern on chest CT by Lichtenstein, an interest in the use of bedside lung ultrasound (LUS) to diagnose and monitor ILD has emerged (5-9). Over the last 10 years a growing body of evidence has suggested that dedicated lung ultrasound may be useful in both screening and surveillance of patients with CTD-ILD, by demonstrating a correlation between LUS, HRCT and DLCO evaluations (10-13). The majority of these studies used highly trained specialists, often with greater than 4 years of clinical lung ultrasound experience (9, 13). Although such reliance on highly trained ultrasonographers is necessary when conducting research, evidence from other clinical applications demonstrates targeted training of novice users can result in a reasonable diagnostic reliability comparable to experts (14-16). The American College of Rheumatology created a certification course for Musculoskeletal Ultrasound. This course is available to physicians, assistants, and nurse practitioners with the aim of increasing utilisation and broader adoption of ultrasound within the clinical practice.

Translation of this expertise towards pulmonary pathology places the rheumatologist in a unique position to screen for lung involvement among patients with CTD prior to symptom onset, ideally improving patient care and decreasing morbidity. Our objective is to show that a formalised lung ultrasound training course can be implemented within a rheumatology fellowship programme and improve the skill and knowledge of rheumatology specialists in lung ultrasonography.

Materials and methods

This is a prospective single-centre observational cohort study performed at tertiary, academic medical centre between November 1, 2016 and June 1, 2017. Participants included 4 current fellows enrolled in an Accreditation Council for Graduate Medical Education (ACGME)-approved rheumatology fellowship programme and 4 board certified rheumatologists, three of whom were certified in Rheumatology Musculoskeletal Ultrasound (RhMSUS) by the American College of Rheumatology (ACR), and one currently enrolled in the Train-the-Trainer programme of the Ultrasound School of North American rheumatologists (USSONAR). Written consent was obtained from each participant. Participation in the study was not a requirement for attending course or fellowship completion. Exclusion criteria included participants previously certified in use of ultrasound for lung evaluation or have received formal lung ultrasound training within the 12 months prior to study enrolment.

Course curriculum

The 4-hour course was conducted by one board certified pulmonary critical care physician as well as 2 ACGME fellows in a pulmonary critical care fellowship. The didactic session included topics of general ultrasound physics, specific techniques for LUS including: location of probe placement, anatomic recognition of important structures and landmarks, artifact recognition and clinical pathologic correlation (45 min). Participants were also given a 30 minute lecture on previous experiments in lung ultrasonography specific to its use in screening and quantifying CTD-ILD. Following the didactic session participants were then given hands on training on live healthy models for approximately 45 minutes followed by 30 minutes of pathologic image recognition through a simulation model ultrasound system (SonoSim®).

Knowledge assessment

In order to assess LUS knowledge, each participant completed a 22 question written test pre, post and 6 months following the initial course. Questions were created based on previous LUS courses and tailored specifically for rheumatology participants. Questions explored basic operation of ultrasound equipment, knowledge of basic ultrasound physics, artifact recognition via pathologic and non-pathologic images as well as published guidelines on terminology and diagnosis.

Image acquisition on healthy volunteers and simulation

Participants were asked to perform a complete lung ultrasound examination on a live healthy model. The exam consisted of machine setup, appropriate depth and preset function, appropriate probe direction, anatomical site evaluation including images from at least 8 chest zones, pleural line recognition, lung sliding, cardiac pulse, rib shadowing, A-lines, diaphragm, liver, spleen and kidney identification. Participants were then asked to complete 4 simulation scenarios requiring recognition of abnormal pathology including pleural effusion, pneumothorax and B-line quantification of severity. Simulation scenarios were completed both pre and post course however only image acquisition of a healthy volunteer could be arranged at all three pre, post and at 6 month intervals due to time and logistic responsibilities.

Evaluation

Evaluations were judged by two pulmonary fellows trained in point-of care lung ultrasound. A 30-item checklist was used to standardise assessments of technical performance on each set of exams including assessment of ultrasound machine setup usage, model subject positioning, anatomic site location, artifact and pathology identification via simulation and video images. Subjects were again reexamined at 6 months using a repeat written test and practical exam. Participants were allowed one 15 min session with a member of training team in the 6-month follow up period to clarify technical aspects of lung ultrasonography.

Data collection

All participants were given a subject code number for identification for data analysis. Data collected from written test and practical evaluations were stored offline.

Statistics

Student *t*-test or Anova test with repeated measures was used to determine significant changes in test scores and practical skills between 3 different evaluation points. All statistical calculations were conducted on Prism7 (GraphPad Software, California).

Table I. Summary of test scores amongst participants.

	Pre course test %	Post course test %	Difference from pre-test % (*p*-value)	6 Month Follow-up (%)	Difference from pre-test % (*p*-value)
Practical test scores					
Overall	17.4	92.9	75.0 (0.0001)	89.7	72.3 (0.0001)
Attending (n=4)	23.9	91.3	67.4 (0.0002)	89.1	65.2 (0.0003)
Fellow (n=4)	10.9	94.6	83.7 (0.0001)	90.2	79.3 (0.0001)
Written test scores					
Overall	49.4	72.5	23.1 (0.0029)	70.6	21.2 (0.0004)
Attending (n=4)	52.5	76.3	22.5 (0.04)	71.3	18.8 (0.004)
Fellow (n=4)	46.3	68.8	22.8 (0.009)	70.0	23.8 (0.036)
Pathologic imaging					
Overall	26.6	79.6	53.1 (0.0002)		
Attending (n=4)	34.4	75.0	40.6 (0.064)		
Fellow (n=4)	12.5	83.3	68.8 (0.001)		

Summary of test scores grouped by evaluation type comparing scores between pre-test, post-test and 6-month follow-up. Pathologic images were tested using SonoSim.

Results

Written test scores: The average written test score improved from pre-test 49.3% to 72.5% on post-test and 70.6% at 6-month follow-up assessments. Comparison of post-course and 6-month scores showed a statistically non-significant decline of 2% (*p*-value 0.69). Subgroup comparison of attendings and fellows showed similar results: attendings scores improving by 22.5% and 18.8% and fellows improving by 22.8% and 23.8% on post course and 6-month assessments, respectively. (Table I)

Image acquisition on healthy volunteers: The average practical exam scores improved at both time points when compared to pre-course exam scores of 17.4% post-course and 6-month follow-up scores were 92.9% and 89.7%, respectively. Again when comparing post course and 6 month follow up scores there was a minimal change of -3.3% which was statistically insignificant. Subgroup comparison of attendings and fellows showed similar results with attending's improving by 67.4% and 65.2% on post course and 6 month follow up assessments while fellows improved by 83.7% and 79.3%. (Table I)

Practical exam pathology recognition: The average pathology exam score improved from a pre-course value of 26.5% to 79.6% in the post-course as-

sessment. Subgroup comparison of attendings and fellows showed similar results with attending's score improving from 34.4% to 75.5% on post-test exam. The results for fellow's pre- and post-course also showed improvement from 12.5% and 83.3% (Table I).

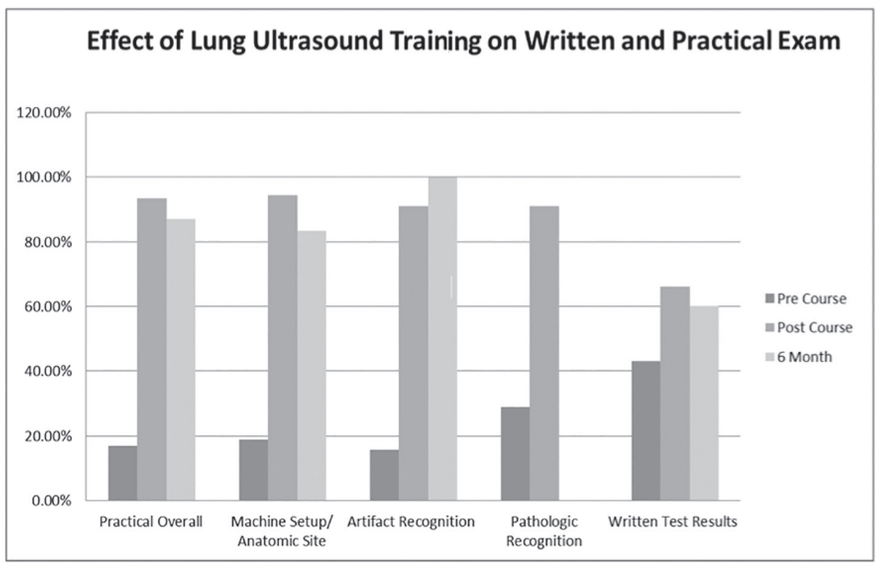

Fig. 1. Graphic representation comparing baseline and follow-up evaluations for lung ultrasound training course.

Discussion

Our study was an evaluation of the impact of a dedicated lung ultrasound training course for rheumatology fellows and attendings at a university medical centre. Using a comprehensive, four hour, multi-session course including didactic sessions, practical hands-on session with live volunteers and ultrasound simulation, we were able to show lasting measurable improvements in participants written knowledge, their ability to acquire adequate images, and recognition of normal and pathologic findings on lung ultrasonography. Written test scores as well as practical skills improved significantly when comparing pre-course scores to post-course or 6-month follow up assessments. Similar results were seen both in aggregate and in each phase of practical exam evaluations including machine setup, anatomic, artifact and pathologic recognition. (Fig. 1) Although there was a small decrease in test scores when comparing the post-test to 6 month scores, the differences were statistically insignificant and represent similar findings to previously published studies (17). When looking at sub groups, attendings tended to have better average pre test scores than the fellow group. Although not significant, this suggests a better foundation of knowledge and overall comfort and skill level prior to the course. By the 6-month follow-up time point there was no difference between the two groups (Table I).

Although results from our study correspond with previous studies examining point of care ultrasound training, to our knowledge, this is the only study to evaluate rheumatology specialist specifically, with respect to lung ultrasonography (10, 14, 17). A previous study in critical care ultrasound demonstrated knowledge and skills retention of 94% and 100%. Similarly, our study demonstrated a retention of 97% and 96% for written and practical examination scores at a 6 month follow up, demonstrating the overall effectiveness of the training session. (Table I) In addition to the unique focus on ILD amongst rheumatology specialist, it is important to highlight the resource and time efficiency of this training programme and assessment. Approximately five hours of time were needed to complete a didactic session accompanied by hands on training, testing and follow up surveillance. This minimal investment of time needed for excellent knowledge and skill retention makes such a programme practical for training and non-training programmes alike especially when similar courses require 12 hours to 2 full days (15-17).

We believe our study represents an important first step in incorporating lung ultrasonography within the Rheumatology clinical practice and fellowship training. One proposed application would be to perform and document LUS findings yearly and at the time of initial diagnosis in a select group of patients with a high prevalence of CTD-ILD like scleroderma. Tracking changes routinely over time may alert physicians to the early occurrence of disease, and may also add to the understanding of overall disease progression. Similarly, repeated assessments of patients prescribed potentially pulmonary toxic medications may inform physicians to seek alternative therapies prior to the occurrence of significant functional impairment. Having an accessible, inexpensive and robust technology available to trained practitioners is an empowering way to improve efficiency within an ever more complex health system.

Our study has several limitations, most notably the small sample size conducted at a single institution limited to our available faculty and fellows. Despite the small group of participants, statistically significant improvements were demonstrated at two time points separated by 6 months and such results are encouraging for further follow up studies to demonstrate a broader reliability. Although our study utilised simulation models, which is novel within this space, the use of live abnormal volunteers would have improved our ability to assess participant accuracy and reliability. Unfortunately, such arrangements are often time intensive and fraught with logistical hurdles that may be discouraging especially in an academic setting where time and resources are often limited. Finally, when comparing to a similar study conducted with critical care fellows we did not evaluate participant utilisation nor its effect on clinical decision making through surveys, however we felt the use of subjective reports in a small personal group may introduce bias (17).

Although there have been extensive,

well designed, studies validating the use of lung ultrasonography as a screening modality for ILD, there remains a lack of consensus on exactly how this tool should be integrated into clinical use. As previously noted there has been wide variability in number of sites examined, number of B lines that constitute a significant pathologic finding and the need for pleural examination. In addition, the prolonged and variable natural history of the disease offers unique challenges to developing screening criterion. Paradoxically these limitations highlight the need for a rational, consensus driven approach to ultrasound education so that wider adoption can be leveraged to fully recognise its potential within the field. It is our hope that increasing the comfort and skill of rheumatology specialists will open up further research potential and encourage a legacy of cost effective innovation and education.

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