Comparative effectiveness of a mnemonic-use approach vs. self-study to interpret a lateral chest X-ray

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The chest radiograph (CXR) is the most frequently performed diagnostic image in medicine (6). A complete CXR consists of both a frontal and a lateral projection (29). A frontal and lateral view allows the clinician to examine the patient’s chest in three dimensions to better localize infiltrates and lesions (25). However, clinicians most commonly use only the frontal view (25). The lateral CXR film contains valuable information on the thoracic cage, pleura, lungs, pericardium, heart, mediastinum, upper abdomen, trachea, and inferior vena cava (6, 12). The lateral view allows detection of lesions behind the heart, near the mediastinum, or near the diaphragm (9, 19), and visualization of the tracheal air column, inferior vena cava, retrosternal space, posterior margin of the heart, and diaphragmatic contour (25). Although some studies show little value to the lateral radiograph in specific circumstances (1, 5, 7), most studies and expert opinions continue to show its importance (15, 22). By developing lateral CXR diagnostic skills and learning techniques, clinicians can avoid more expensive imaging tests and unnecessary radiation exposure, which are often done because of inability to interpret the lateral CXR (8).

Today, medical educators find it challenging not only to teach how to read CXR, but also to evaluate proficiency, accuracy, and repeatability in reading CXRs (11, 18, 23). Even among seasoned clinicians, there is significant variability in interrater reliability, proficiency, and accuracy (4, 10, 26). Although several medical education curricula and training programs address how to interpret CXR, they often ignore the lateral view. While many clinicians admit characteristic knowledge is obtainable from the frontal view (3, 27), there is little available educational material on how to reliably read a lateral CXR. Thus the need for a more effective method of training and interpreting the lateral view of the CXR is apparent.

Mnemonics are a commonly used teaching technique in various medical, psychiatric, and surgical fields (21). Furthermore, mnemonics have demonstrably improved quality of care in residency programs through implementation in patient handoffs (17). However, there is a lack of user-friendly methods to develop proficient lateral CXR interpretation techniques (2). In the present study, we hypothesize that a specific mnemonic for learning the lateral CXR will result in improved learning and interpretation of CXR compared with a conventional, self-taught method.

METHODS

Participants. After obtaining Institutional Review Board approval, we recruited $n = 29$ second-year osteopathic medical students in Yakima, Washington, from 5/5/2011 to 6/27/2013, who completed courses in cardiovascular and pulmonary pathology. None of the students had received training in the mnemonic approach before our study, but all had some exposure to lateral CXR interpretation.

Study design. This prospective, randomized control pilot study assigned participants to either the mnemonic-use method group (MUM) or the self-taught, multimodal educational group (STMM). Students were randomly assigned to each group and completed a preassessment to gauge their prior knowledge of lateral CXR interpretation. A board-certified radiologist (BCR) taught the MUM group the following mnemonic using the first eight letters of the alphabet (Fig. 1). The alphabetical mnemonic is organized so that A, B, and C correspond to opaque structures; D, E, F, and G refer to darker structures; and H refers to the heart (cardiac silhouette). The BCR instructed the MUM group how to assess each structure and region based on each letter in the mnemonic. Pathological conditions for each letter of the mnemonic were also reviewed. The radiologist instructed the MUM group by going through the mnemonic letter by letter, and showing them examples of what each structure looked like in the...
normal patient, along with several examples of abnormalities. The students were free to ask questions throughout.

In the other classroom, a supervising medical student informed the STMM group of the approved websites and teaching files recommended by the same BCR who taught the MUM group. The role of this student only concerned website access and was not to conduct an instruction of the content. This student was not trained in the mnemonic method or had any different educational exposure to instruct the STMM group. The STMM group reviewed the websites (Table 1) and were instructed to read articles on interpreting the lateral chest X-ray. The STMM group was allowed to self-study these resources for a few hours.

For both groups, the instrument utilized to assess performance was radiographic scout views obtained from prior thorax computed tomography (CT) scans at the local hospital. Before patients received a chest (thorax) CT scan, digital images of their chest were obtained by the CT scanner. These are slightly lower resolution images than a standard upright chest radiograph. These chest “scout” images are utilized to properly position the rotating CT gantry to image the correct region of the body (thorax region from low neck through diaphragms).

Table 1. Resources for self-taught, multimodal educational group

<table>
<thead>
<tr>
<th>Title</th>
<th>Web Link</th>
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<tbody>
<tr>
<td>University of Virginia: Introduction to Chest Radiology</td>
<td><a href="https://www.med-ed.virginia.edu/courses/rad/cxr/">https://www.med-ed.virginia.edu/courses/rad/cxr/</a></td>
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<tr>
<td>Patient-Trusted Medical Information and Support, Chest X-ray—</td>
<td><a href="https://patient.info/doctor/chest-x-ray-systematic-approach">https://patient.info/doctor/chest-x-ray-systematic-approach</a></td>
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<tr>
<td>Uniformed Services University of of Health Sciences: USU</td>
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<td>Radiology Interest Group (RIG)</td>
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<td>Interpretation of the Chest X-ray: a system for looking at the film</td>
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<td>Emergency Medicine Residents’ Association: 10 Tips for</td>
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<tr>
<td>Evaluating a Lateral Chest Film</td>
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Fig. 1. Lateral chest X-ray mnemonic.
were a total of $n = 20$ patient cases to review. As each case had six different entities to check for, there were a total of 120 points possible for each student. Each patient case had a digital frontal and a lateral chest radiographic view obtained immediately before the CT scan. The multiplanar images from the CT scan were utilized to assess for the presence or absence of the findings noted on the lateral radiographic view. Each student was asked to document the presence or absence of the following findings on each lateral radiographic view: lung infiltrate, mediastinal mass, hiatal hernia, pneumothorax or pneumomediastinum, pleural or pericardial effusion, and bony or soft tissue abnormality. The CT images were utilized to determine the true presence or absence of each of these findings.

A two-way mixed ANOVA was performed to examine the main effects of condition (between subjects) and pre- vs. post-assessment performance (within subjects) as well as the interaction between condition and performance. Comparisons (dependent $t$-tests) within the two groups' performances on the pre- and postassessments were used to determine a potential significant interaction.

**RESULTS**

A total of $n = 29$ students completed the pre- and postassessment with $n = 14$ in the MUM group and $n = 15$ in the STMM group. There were no significant differences ($P = 0.251$) in the baseline assessment scores between MUM and STMM groups (Table 2). There was a significant difference between the groups (averaged across conditions) [$F(1,57) = 7.4$, $P < 0.05$]. Inspection of the means revealed the experimental group scored significantly higher than the control group (postassessment mean for the MUM group was 92.1, postassessment mean for the STMM group was 79.9). There was, however, a significant interaction between condition and subjects [$F(1,57) = 79.6$, $P < 0.001$]. Planned post hoc comparisons revealed that this effect was isolated to the experimental group [$t(13) = 10.87$; $P < 0.001$]. There was no significant difference in the pre- and postassessments for the control group.

**DISCUSSION**

Participants using the mnemonic scored significantly higher than the self-learning group. Our results indicate both groups of students showed some improvement in their understanding of lateral CXR interpretation; however, there was a significant difference in improvement between the MUM and STMM groups. As expected, both groups had similar preassessment scores; however, the MUM group showed a $\geq 16\%$ overall improvement in the postassessment compared with only a $1\%$ improvement in the SSTM group.

Several studies have shown mnemonics improve medical education and clinical application outcomes (13, 14). On the other hand, a web-based radiological education platform was also found to be a user-friendly e-learning platform that allows for customized exercises and interactive imaging similar to the STMM group (24, 28). Proto and Speckman (20) created a method of teaching lateral CXR via a monograph where they describe the meaning of each line and edge on the normal lateral radiograph. Their method may be more appropriate for radiology residents with a greater baseline of CXR knowledge and experience.

Even with positive results, our study has several limitations. The MUM group was instructed by the BCR the entire 3 h vs. the STMM group, which had a student liaison. Only the MUM group received any true didactic instruction by the BCR. The self-study group was given access to web-based learning resources and asked to read these and learn about lateral CXR interpretation. There was no formal instruction by the supervising student or BCR in the STMM group. In addition, student retention of this mnemonic was not measured, nor was follow up obtained to identify if it was used or useful in clinical rotations. Moreover, the usefulness of this method for teaching and learning lateral CXR interpretation may only be applicable to undergraduate medical education and may not be helpful in graduate medical education and beyond. On the other hand, the inexpensive and time-effective mnemonic does provide evidence to support future studies in graduate medical programs, fellowships, and refreshers for active attending physicians.

The lateral CXR is a valuable source of information that has become increasingly undervalued in the era of chest-CT. Our results verify that a learning mnemonic improves knowledge of lateral CXR in medical students and may potentially increase the use and application of the lateral CXR for diagnostic imaging.

**DISCLOSURES**

No conflicts of interest, financial or otherwise, are declared by the authors.

**AUTHOR CONTRIBUTIONS**


**REFERENCES**


