DEDICATED EMERGENCY DEPARTMENT ULTRASOUND ROTATION IMPROVES RESIDENTS’ ULTRASOUND KNOWLEDGE AND INTERPRETATION SKILLS

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Abstract—Background: Graduates of Emergency Medicine (EM) residency training programs are expected to be proficient in ultrasound. However, best practices for teaching residents ultrasonography has yet to be determined. Study Objectives: To determine if a dedicated Emergency Department (ED) ultrasound rotation objectively improves residents’ EM ultrasound knowledge, interpretation accuracy, and clinical decision-making based on ultrasound findings. Methods: EM residents completing a required ED-based ultrasound rotation were prospectively studied. Before the start of the rotation, each resident completed a 20-question pre-test. At the end of the rotation, residents completed a 20-question post-test. Both tests covered physics, trauma (focused assessment with sonography for trauma), first-trimester pregnancy, aorta, biliary, echocardiography, and vascular sonography, using a multiple-choice format. In both tests, ultrasound images were included in 11 of the 20 questions. The questions were divided into three categories: knowledge-based (8 questions), interpretation (9 questions), and clinical decision-making (3 questions), for both tests. Scores on pre-tests and post-tests were compared using a Wilcoxon signed-rank test. Results: During the 2-year study period, 21 residents completed the rotation. The median pre-test score was 16 (interquartile range [IQR] 14.5–17), compared to a median post-test score of 19 (IQR 18–20), \( p < 0.001 \). Conclusions: A dedicated ED ultrasound rotation improves residents' EM ultrasound knowledge and interpretation accuracy based on ultrasound findings, as measured by improvement on ultrasound test scores. © 2012 Elsevier Inc.

Keywords—ultrasound; resident education; emergency medicine

INTRODUCTION

Over the past 15 years, ultrasound has been increasingly incorporated into the clinical practice and training of Emergency Medicine (EM) (1). The Model of Clinical Practice of Emergency Medicine considers bedside sonography to be an essential skill (2). Therefore, current graduates from EM residency training programs are now expected to be proficient in bedside sonography. Although most EM residency training programs are teaching bedside ultrasound, there is a wide variation in the curricula being used (3). This has created concerns that some EM residency graduates may lack adequate ultrasound training (4–6).

To address this concern, the 2008 Council of Residency Directors (CORD) Annual Academic Assembly provided guidelines to residency programs regarding an Emergency Department (ED) ultrasound curriculum, including “minimum education standards” (4). This included the recommendation that an ED-based ultrasound rotation be used for EM resident ultrasound education. However, this recommendation was based on consensus, and to date, there have been few research studies in EM...
resident ultrasound education. In addition, many of the existing studies have investigated the educational value of ultrasound workshops, rather than a dedicated ultrasound rotation (7,8). At the writing of this manuscript, the educational impact of a dedicated EM ultrasound rotation is unknown. The objective of this study is to determine if a dedicated ED ultrasound rotation objectively improves residents’ EM ultrasound knowledge, interpretation accuracy, and clinical decision-making based on ultrasound findings.

MATERIALS AND METHODS

EM residents completing a mandatory ED-based ultrasound rotation at Louisiana State University Health Sciences Center Shreveport (LSUHSC-S) from July 2008 through May 2010, were prospectively studied. LSUHSC-S is a tertiary care facility, Level I trauma center, and academic center home to a 3-year EM residency program training 7 residents per year.

The ED ultrasound rotation is a 1-month rotation covering ultrasound physics, knobology, the focused assessment with sonography for trauma (FAST) examination, first-trimester pregnancy, aorta, biliary ultrasound, echocardiography, deep vein thrombosis, and vascular access. Each week of the rotation, the residents receive 1–2 h of didactic presentations followed by approximately 2 h of hands-on instruction in the ED. The residents are also assigned weekly readings from an EM ultrasound text (9). In addition, the residents have required ‘‘scanning shifts’’ in the ED 5 days a week, lasting approximately 3–4 h. During the rotation, residents are expected to complete a minimum of 50 FASTs, 50 aortas, 50 gall bladders, 20 limited echocardiograms, and 10 lower-extremity vascular ultrasounds. In addition, residents are expected to perform 5–10 ultrasound-guided vascular access procedures. Residents are asked to log their ultrasounds on New Innovations Residency Management Suite (New Innovations Inc., Uniontown, OH) and save images electronically onto a flash card for review. This rotation became mandatory in 2007 as a second year rotation, but in 2008 it was moved to the first year. Therefore, the July 2008–June 2009 ultrasound rotations included second- and first-year EM residents. After July 2009, the rotation included only first-year residents.

Before the start of the rotation, each resident completed a 20-question pre-test. At the end of the rotation, residents completed a 20-question written post-test. Both tests covered physics, the FAST examination, first-trimester pregnancy, aorta, biliary, echocardiography, and vascular sonography, using a multiple-choice format. In both tests, ultrasound images were included in 11 of the 20 questions. The questions were divided into three categories: knowledge-based (8 questions), interpretation (9 questions), and clinical decision-making (3 questions) for both tests. The pre-test and post-tests included the same questions presented in a different order. However, after the pre-test, the tests were collected and the answers were not discussed with the resident, to avoid question recall. In addition to the written examination, at the end of the rotation, residents undergo a proctored practical test in which they are graded on their ability to perform ultrasound examinations on volunteering ED patients. Residents are required to obtain a pass on the practical and 75% correct on the written examination to pass the rotation (Figure 1).

Scores on pre-tests and post-tests were compared using a Wilcoxon signed-rank test to assess individual differences (paired analysis). Wilcoxon rank-sum tests were used to assess differences between first- and second-year residents. Statistical analysis was performed with SPSS 11.0 (SPSS Inc., Chicago, IL) for Windows.

RESULTS

During the 2-year study period, from July 2008 through May 2010, 21 residents were studied. All 21 residents successfully completed the ED ultrasound rotation by scoring 75% or greater on the written examination and passing the practical test. The study group consisted of 14 men (67%), 7 women (33%), 14 first-year residents (67%), and 7 second-year residents (33%).

The median pre-test score was 16 (interquartile range [IQR] 14.5–17), compared to a median post-test score of 19 (IQR 18–20), \( p < 0.001 \). First-year residents had a median pre-test score of 16.5 (IQR 14.5–17) and a median post-test score of 19 (IQR 18–20), \( p = 0.001 \). Second-year residents had a median pre-test score of 16 (IQR 14–18) and a median post-test score of 19 (IQR 18–20), \( p = 0.017 \). There was no significant difference between first-year resident and second-year resident pre-test and post-test scores (\( p = 0.80 \) and \( p = 0.91 \), respectively) (Table 1).

Figure 1. An example of a multiple choice test question.
There was a significant increase in ultrasound knowledge and ultrasound interpretation questions from the pre-test to post-test. However, there was no significant change in the clinical decision-making test questions. The three clinical decision-making questions were answered correctly on all but 2 pre-tests and post-tests. Results of the different types of questions are summarized in Table 2.

**DISCUSSION**

The results of this study demonstrate a statistically significant improvement in test scores after the completion of a 1-month dedicated ED-based ultrasound rotation. This improvement occurred in test questions assessing ultrasound knowledge and interpretation accuracy. In addition, the educational benefits occurred in both first- and second-year residents independently.

The results of our study agree with a prior study looking at the predictors of success in EM ultrasound education. This study tested several different residency programs and determined that higher test scores were associated with residency programs with ultrasound rotations (odds ratio 1.82; 95% confidence interval 1.29–2.55) (10). To our knowledge, no other studies have prospectively evaluated the educational impact of a dedicated ED-based ultrasound rotation.

Other studies of didactic and hands-on ultrasound sessions have demonstrated educational benefits to EM residents. However, these studies focused on short intensive workshop sessions rather than dedicated EM ultrasound rotations. Lanoix et al. demonstrated that after a 4-h ultrasound course, EM residents were able to interpret ultrasounds with high sensitivity compared to a reference standard (7). Mandavia et al. demonstrated improvement in ultrasound test scores and high diagnostic accuracy among health care professionals after a 2-day “condensed 16 hour emergency ultrasound curriculum (8).” In a more recent study, Noble et al. examined EM residents given a 2-day ultrasound course consisting of 8 h of didactics with or without additional hands-on training. Six months after the didactic course, there was improvement in ultrasound test scores among all residents, with the greatest improvement seen in the group of residents receiving additional hands-on training (11).

The results of our study provide some evidence that support the recommendations from the 2008 CORD Academic Assembly regarding dedicated ED-based ultrasound rotations (4). Recommendations from CORD depart from prior consensus documents. In 1994, The Society for Academic Emergency Medicine endorsed an ultrasound curriculum consisting of 40 didactic hours and 150 proctored ultrasounds (12). In 2001, the American College of Emergency Physicians provided guidelines that included 16 h of didactic content and at least 150 proctored ultrasounds (13). However, all of these guidelines, including the CORD guidelines, have been largely based on expert opinion, as there are very few research studies on EM resident ultrasound curricula. Our study provides some evidence supporting the recommendation of a dedicated EM ultrasound rotation. However, this study was not designed to test the superiority of a dedicated ED ultrasound rotation over other curricula.

**Limitations**

This study is limited by a small sample size. In addition, this study was conducted at a single institution.

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**Table 1. Pre-test and Post-test Scores by Question Type**

<table>
<thead>
<tr>
<th>Residents</th>
<th>Pre-test Score Median (IQR)</th>
<th>Post-test Score Median (IQR)</th>
<th>p Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (21)</td>
<td>16 (14.5–17)</td>
<td>19 (18–20)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>First-year (14)</td>
<td>16.5 (14.5–17)</td>
<td>19 (18–20)</td>
<td>0.001</td>
</tr>
<tr>
<td>Second-year (7)</td>
<td>16 (14–18)</td>
<td>19 (18–20)</td>
<td>0.017</td>
</tr>
</tbody>
</table>

IQR = interquartile range.  
*p < 0.05 is considered significant.  
*p Value from paired analysis (calculated with Wilcoxon signed-rank test).

**Table 2. Pre-test and Post-test Scores by Question Type**

<table>
<thead>
<tr>
<th>Question Type</th>
<th>Pre-test Score Median (IQR)</th>
<th>Post-test Score Median (IQR)</th>
<th>p Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpretation (8 questions)</td>
<td>6 (4–6)</td>
<td>7 (7–8)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Knowledge (9 questions)</td>
<td>8 (7–8)</td>
<td>9 (8–9)</td>
<td>0.001</td>
</tr>
<tr>
<td>Clinical decision-making (3 questions)</td>
<td>3 (3)</td>
<td>3 (3)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

IQR = interquartile range.  
*p < 0.05 is considered significant.  
*p Value from paired analysis (calculated with Wilcoxon signed-rank test).
LSUHSC-S is a tertiary care center, Level I trauma center, and academic institution training 7 EM residents per year. The results from this study may not be generalizable to other residency programs. This study was also limited by high pre-test scores, indicating that many of our residents have a working knowledge of ultrasound before formal ultrasound teaching. This study also included both second- and first-year residents. Although it might be expected that second-year residents would perform better on tests, there were no statistically significant differences in pre-test or post-test scores. Also, the pre-test and post-test had only three clinical decision-making questions, which was insufficient to assess differences in the residents’ clinical decision-making based on ultrasound findings. Using the same questions on the pre-test and post-test may have resulted in bias due to question recall. However, this study attempted to limit this bias by changing the order of the questions and not discussing the pre-test with the residents. In addition, because a post-test score of 75% or more was required to pass the rotation, improvement in the post-test score may have been related to the pressure of passing the rotation. Although the effect of this “pressure” is unknown, the results of this study may be less generalizable to ED-based ultrasound rotations without a final examination.

Finally, it is still unknown if utilizing an ED-based ultrasound rotation is superior to other methods of ultrasound teaching. Future studies should compare different curricula and be adequately powered to detect differences. Due to the small number of residents per training program, this would likely require a multi-center study. Unfortunately, obstacles to a large multi-center study, such as a lack of funding for educational research, may prevent the creation of a truly evidenced-based ultrasound curriculum.

CONCLUSIONS

High pre-test scores suggest that today’s EM residents often have a working knowledge of ultrasound before formal ultrasound teaching. However, a dedicated ED-based ultrasound rotation improves residents’ ultrasound test scores. The ED rotation resulted in significant improvement in ultrasound knowledge and ultrasound interpretation. In addition, test scores were significantly improved in both first- and second-year residents completing the rotation. The results of this study provide some evidence supporting the recommendations from the 2008 CORD Academic Assembly.

REFERENCES

ARTICLE SUMMARY

1. Why is this topic important?
   At the writing of this manuscript, the educational impact of a dedicated Emergency Medicine (EM) ultrasound rotation is unknown.

2. What does this study attempt to show?
   The objective of this study is to determine if a dedicated Emergency Department (ED) ultrasound rotation improves residents’ EM ultrasound knowledge, interpretation accuracy, and clinical decision-making based on ultrasound findings.

3. What are the key findings?
   An ED-based ultrasound rotation resulted in significant improvement in ultrasound knowledge and interpretation.

4. How is resident education impacted?
   The results of this study provide some evidence supporting the recommendations from the 2008 Council of Residency Directors Academic Assembly.