Outcomes and lessons learned while upscaling a successful trauma ultrasound curriculum quality improvement project

Timothy S. Wulfestieg, DO |CPT, MC, USA|¹
Yang-En Kao, MD |COL, MC, USA|²
Elianna Peak, MD³
Cole Burr, DO |CPT, MC, USA|¹
David Hostler, MD |LTC, MC, USA|⁴

Dept. of Radiology: PGY-4 ¹ PGY-3³, Program Director²
Previous Chief of Pulmonology⁴

Tripler Army Medical Center
Oahu, HI

The views expressed in this abstract/manuscript are those of the author(s) and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the US Government.
Trauma US: The eFAST\(^1\) exam (extended focused assessment with sonography for trauma) is a well utilized modality for rapidly assessing and determining management of emergent patients.

**Background:** Despite the modality’s ubiquity, as of 2016 only 28% of medical schools in the United States had a formal US curriculum.\(^2\)

**Local problem:** New interns described limited experience and confidence with US prior their ER and Trauma rotations.

**Intended improvement:** Implement a novel eFAST US curriculum.

**Study questions:**
- To what degree could resident competence and confidence be improved by a novel curriculum?
- How could a successful curriculum be upscaled without losing efficacy?

Methods

• 97 resident learners included, representing a diversity of medical schools including USU, domestic MD/DO programs and international schools.

• Varying specialties were represented:

<table>
<thead>
<tr>
<th>Transition year (TY) Interns</th>
<th>Family Medicine</th>
<th>Pediatrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Medicine (IM)</td>
<td>General Surgery</td>
<td>Dermatology</td>
</tr>
<tr>
<td>OBGYN</td>
<td>Radiology</td>
<td>ENT</td>
</tr>
<tr>
<td>OMFS</td>
<td>Orthopedics</td>
<td>Urology</td>
</tr>
<tr>
<td>Psychiatry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Setting:

Tripler Army Medical Center, a military tertiary care hospital serving 260,000 soldiers, family members and retirees.

1. Create a quality improvement (QI) project of resident curriculum covering US basics and trauma topics.

2. Utilize pre and post-tests to assess learning and confidence.

3. Implement Plan/Do/Study/Act. Three implementations were completed involving larger groups: 1st with transition year interns, 2nd with a medicine cohort, and 3rd with all new hospital interns from the following year at once.
Curriculum Sequence

1. Pre-test
2. Lecture
3. eFAST Demonstration
4. Hands-on tutorials
5. Post-test

Length: 2 hours

Educational content

US physics, probes, knobology, US imaging planes and anatomic orientation, imaging anatomy, normal versus abnormal findings, and trauma concepts.
Methods: Study Design

Testing


- **Factual questions**: 14 multiple choice, regarding probe characteristics, US generation, eFAST, management of eFAST findings, Glasgow Coma Score, and others.

- **Imaging**: 18 questions. Anatomic identification, Normal vs Abnormal exams.

- **Confidence**: 10 questions based on a 5-point Likert-style scale.

- Post-tests utilized 87.5% new factual and imaging questions, with all new images provided.

- The remaining repeated questions stressed core competencies.

- Confidence questions remained unchanged pre and post to allow direct comparisons.
### Methods: Assessment

<table>
<thead>
<tr>
<th><strong>Tests</strong></th>
<th>Each learner received a packet consisting of both pre and post-tests. Each packet represented one data point.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anonymity</strong></td>
<td>Learners identified their packets by drawing a small unique sketch in the upper corner.</td>
</tr>
<tr>
<td><strong>Data input</strong></td>
<td>Each packet was given an identification number, and the entries uploaded to an online web form. The data was then compiled as a report for analysis.</td>
</tr>
<tr>
<td><strong>Statistical analysis</strong></td>
<td>Analysis was completed with SAS software and included descriptive tallies, Wilcoxon and paired t-tests.</td>
</tr>
</tbody>
</table>
Results: 1st Iteration with Transition Year Interns

**Details**
- Single instructor
- 15 learners

**Lessons Learned†**
15 learners is the maximum per demonstration station to ensure decreased wait time.

†These were conclusions based on experience, and were not studied in isolation nor specifically measured for significance.

**Selected Pre and Post intervention Confidence Results of TY Learners**

<table>
<thead>
<tr>
<th>I can perform an eFAST exam:</th>
<th>4.5</th>
<th>3.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>I know the next step in management for a positive eFAST exam:</td>
<td>4.4</td>
<td>3.3</td>
</tr>
<tr>
<td>I can describe which critical injuries the eFAST exam is used to screen for:</td>
<td>4.5</td>
<td>3.7</td>
</tr>
<tr>
<td>I know what settings to set in order to improve the ultrasound image quality:</td>
<td>4.5</td>
<td>3.4</td>
</tr>
<tr>
<td>I can accurately explain how sound reflections (echos) are generated in the body:</td>
<td>4.1</td>
<td>2.5</td>
</tr>
</tbody>
</table>

All results are statistically significant with P-values <0.05.

**Percent Correct of Pre and Post-tests for TY Learners**

- Overall Score*
- Factual knowledge score
- Imaging knowledge score

<table>
<thead>
<tr>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>86</td>
</tr>
<tr>
<td>48</td>
<td>92</td>
</tr>
<tr>
<td>54</td>
<td>77</td>
</tr>
</tbody>
</table>

*Overall Score includes other tested subjects beyond factual and imaging knowledge scores.
**Results: 2\textsuperscript{nd} Iteration w/Internal Medicine Residents**

### Details
- 2 instructors
- 22 learners

### Lessons Learned\textsuperscript{†}
Learner engagement was increased by utilizing simple descriptions and stressing anatomic relationships.

\textsuperscript{†}These were conclusions based on experience, and were not studied in isolation nor specifically measured for significance.

### Percent Correct of Pre and Post-tests for IM Learners

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Score*</td>
<td>46</td>
<td>1.8</td>
</tr>
<tr>
<td>Factual knowledge score</td>
<td>37</td>
<td>2.9</td>
</tr>
<tr>
<td>Imaging knowledge score</td>
<td>54</td>
<td>4.3</td>
</tr>
</tbody>
</table>

\*Overall Score includes other tested subjects beyond factual and imaging knowledge scores.

### Selected Pre and Post intervention Confidence Results of IM Learners

- I can perform an eFAST exam: \(4.3\)
- I know the next step in management for a positive eFAST exam: \(4.2\)
- I can describe which critical injuries the eFAST exam is used to screen for: \(4.3\)
- I know what settings to set in order to improve the ultrasound image quality: \(3.9\)
- I can accurately explain how sound reflections (echos) are generated in the body: \(3.7\)

All results are statistically significant with P-values <0.05.
Results: 3rd Iteration w/All New Hospital Interns

**Details**
- 7 instructors
- 57 learners

**Lessons Learned†**
- Maintain pace of demonstration by assigning learners. Don’t wait for volunteers.
- Teach a method to localize anatomy by US. Decreases time spent surveying.
- Promote engagement by giving live challenges.

*These are conclusions based on experience and were not studied in isolation or specifically measured for significance.

---

**Selected Pre and Post intervention Confidence Results of All New Interns**

- I can perform an eFAST exam:
- I know the next step in management for a positive eFAST exam:
- I can describe which critical injuries the eFAST exam is used to screen for:
- I know what settings to set in order to improve the ultrasound image quality:
- I can accurately explain how sound reflections (echos) are generated in the body:

All results are statistically significant with P-values <0.05.
Summary Results

Results for all 97 learners*:
• Overall Scores: 48 → 78%.
• Confidence at performing eFAST: 2.5 → 4.2.

Run Chart of Curriculum Iterations with Class Size, Testing Scores, and Instruction Enhancements*

Conclusion

While not specifically measured for effect, the following principles were learned from implementation:

• Maintain pace by assigning an order of participation: 1 instructor could lead 15 learners in a 60-minute hands-on demonstration.

• Describing relational anatomy increased learner engagement: “Is there free fluid within Morrison’s pouch?” was not as effective as describing the anatomy, “We expect to see the liver and kidney nearly touching and separated by echogenic pararenal fat. If there’s a dark grey gap between the organs, we must consider hemorrhage.”

• A specific US technique decreased hesitation with the probe: Learners told to make large sweeps first, then once the anatomy looks familiar, stop probe motion and make tiny angulations.

• Spontaneous challenges encouraged problem solving: Challenges included: 1) Correcting abnormal imaging settings, 2) Probe orientation was flipped, 3) Learners encourage to scan others to observe anatomic variation.

Trauma US is an important modality in the emergent setting, and the results of this project demonstrate that a small group curriculum may be upscaled through iterative improvement, while maintaining efficacy.

*All results are statistically significant with P-values <0.05.