

Standardized simulation-based obstetrics ultrasound curriculum increases medical students' knowledge and bridges the gap from classroom to clinical ultrasound

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PURPOSE / OBJECTIVES

- Ultrasound is increasingly used in medicine and is widely integrated into training. One of the challenges in ultrasound teaching is the ability to translate curriculum to clinical practice.
- Obstetrical ultrasound is highly standardized, and patients are familiar and receptive to ultrasound, which provides an excellent training opportunity for medical students. However, integrating medical student ultrasound training with simulation in the field of obstetrics is not well-studied.
- Our objective was to evaluate whether a highly standardized simulation-based curriculum could bridge the gap from classroom knowledge to clinical practice for medical students.

MATERIAL & METHODS

- This is a prospective study of Yale School of Medicine medical students from March 2022 to March 2023 during their Obstetrics and Gynecology clerkship rotation who underwent a highly standardized simulation-based obstetrical ultrasound curriculum.
- **Curriculum design:** based on national and international consensus guidelines of ultrasound physicians, basic knobology, transducer introduction, scan plane terminology, and ALARA principles. Simulation based training took up at least 75% of didactics time (See Figure 1).
- **The primary outcome** was an assessment on basic and advanced (anatomy-based) fetal ultrasound knowledge (Figure 2). Pre- and post- test knowledge scores were compared via Wilcoxon signed ranks test. To detect a 50% increase in the post-test ($\beta = 0.10$; $\alpha = 0.05$), at least 42 students were required. **Secondary outcomes** were the medical students' 1) ability to perform fetal biometry during simulation and 2) ability to perform basic or advanced obstetrical ultrasound during their clinical rotation under supervision (Figure 3) and 3) student and faculty feedback about the curriculum. Secondary outcomes were described using descriptive statistics. Medical student feedback was collected with qualitative analysis.

RESULTS

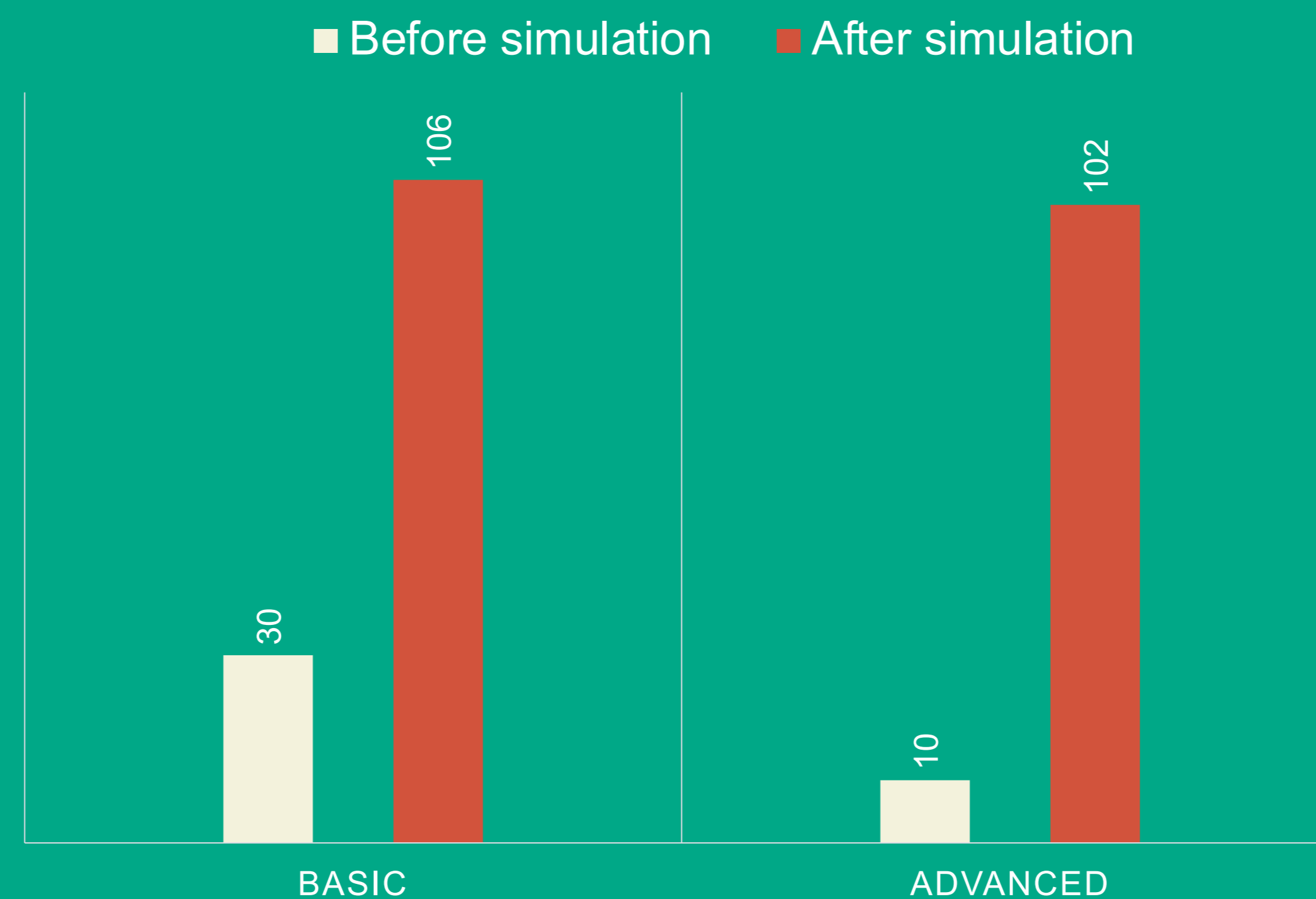
- **Primary outcome:** A total of 111 medical students were included. Overall obstetrical ultrasound scores were significantly higher after the session ($Mdn=90.0$) than before the session ($Mdn=47.5$). This difference was statistically significant, $Z=-9.10$, $p<0.001$, $r=0.86$. Basic obstetrical ultrasound scores tested students' knowledge of fetal position, placental location, and amniotic fluid assessment. These scores were also significantly higher after the session ($Mdn=83.3$) than before the session ($Mdn=50.0$). This difference was statistically significant, $Z=-8.88$, $p<0.001$, $r=0.84$. Lastly, advanced obstetrical ultrasound scores tested students' knowledge of fetal anatomical landmarks for biometry. Scores were significantly higher after the session ($Mdn=100.0$) than before the session ($Mdn=56.3$) and the difference was statistically significant, $Z=-8.76$, $p<0.001$, $r=0.83$.
- **Secondary outcomes:** All 111 students participated in and were able to perform fetal biometry during the simulation. A total of 40 students participated in clinical ultrasound skills assessment under direct supervision. 35 (87.5%) had an OBGYN resident, fellow, midwife, or faculty attending observe a complete basic ultrasound by student. In addition, 11 (27.5%) were able to complete an entire fetal biometry under supervision during their six-week clerkship rotation. **Student and faculty feedback** is shown as qualitative data is shown (Table 1, Figure 3) with overall very positive results. The numerical rating of the session mean and standard deviation was 4.79 ± 0.4 , compared to the average institution's lecture score as 4.5 ± 0.8 out of 5.0.

SUMMARY / CONCLUSION

We present a highly standardized simulation-based obstetrical ultrasound curriculum that significantly increased student knowledge and bridged the gap between classroom to clerkship. Obstetrics has the potential to lead in ultrasound education for medical students given its unique characteristics.

Obstetrics provides a unique opportunity for medical student ultrasound education. Highly standardized simulation-based learning can *bridge the gap from classroom to the clerkship.*

NUMBER OF MEDICAL STUDENTS COMFORTABLE PERFORMING OBSTETRICAL ULTRASOUND DURING THEIR CLERKSHIP



RESULTS



Figure 1: The CIRS Fetal Biometry Model 065-20 was used for the hands-on simulation portion (left). Students were taught in small groups to maximize time to practice fetal biometry and learn practice ultrasound skills led by one of the Maternal-Fetal Medicine fellows (right).



Figure 2: Scan QR code for pre- and post-test material

Table 1: Student and faculty evaluations after the session

Strengths categories	Number of comments	Selected Examples
Pre- and post-test	3	"I appreciated the pre-test which helped me pay more attention during the lecture." "I liked the concise presentation sandwiched by pre- and post-tests." "I really enjoyed the session especially the pre-test and post-test."
Lecture	25	"Excellent content and lecture. Instructor's lecture was very clear." "Very well-organized lecture, I feel much more confident." "Great session! Very interactive and useful!"
Hands-on simulation	20	"Great hands-on practice." "Great. I liked the chance to practice ultrasound." "Found it very helpful and I enjoyed the hands-on component of it. I felt like I learned a lot from it"
Instructor	3	"Instructor taught us exactly what I needed to know during my time in obstetric triage." "This was a great lecture and workshop by a great teacher."
Learner confidence and utility on the wards	15	"I had no knowledge going into the session on how to read fetal ultrasound, but I came out more confident about recognizing the images much better." "Well run and proved useful immediately after." "Helpful primer, more comfortable with estimated fetal weight now." "I feel much more confident about identifying relevant structures on ultrasounds." "Excellent session, felt much more confident about fetal ultrasound following session."
Improvement categories	Number of comments	Selected Examples
Lecture and pre- and post-test	1	"There were a couple of things that I felt were taught differently from how I learned. Some of the pre- and post-test questions were ambiguous because the answers depended on how the probe was placed."
Hands-on simulation	9	"Lots of useful information! However, it would be great if this could be an hour and a half or two hours so we can have more practice!" "The only suggestion I could make is having multiple models/more realistic model to practice on (moves around, more realistic anatomy)" "Great session but would've really liked to have more time to work with the ultrasound after the lecture portion." "I wish we had more time in this session!"
Timing of course	2	"Great, useful, ultrasound training, could have been even more useful if we had this earlier in the block." "Great session! Very interactive and useful! Would be useful to have at the beginning of the clerkship instead of towards the end."
Feedback categories	Number of comments	Selected Examples
Attending provider feedback for learners	4	"Performed ultrasound without guidance." "Great hand-eye coordination with ultrasound." "Resident-level skills with ultrasound." "Student shockingly adept at performing ultrasound, better than most residents."

Note: Learner sections will not sum to 54 because students may have indicated multiple strengths and not all students indicated improvements. Categories were coded based on recurring themes in the free responses.



Figure 3: Word cloud of strengths from students

YALE SCHOOL OF MEDICINE OBSTETRICAL CLERKSHIP ULTRASOUND CURRICULUM

BASIC OB SCAN	Performed by learner and reviewed by resident, midwife, fellow, or attending (signature below)
<input type="checkbox"/> Fetal presentation	
<input type="checkbox"/> Amniotic fluid evaluation (DVP, MVP)	
<input type="checkbox"/> Placental location	
ADVANCED OB SCAN (optional)	Performed by learner and reviewed by resident, midwife, fellow, or attending (signature below)
<input type="checkbox"/> All components of basic OB scan	
<input type="checkbox"/> Biparietal diameter/head circumference	
<input type="checkbox"/> Abdominal circumference	
<input type="checkbox"/> Femur length	

Figure 4: Example of evaluation form for ultrasound during the clerkship