INNOVATIONS IN MEDICAL EDUCATION

A Mixed-Methods Evaluation of Medical Residents' Attitudes Towards Interprofessional Learning and Stereotypes Following Sonography Student-Led Point-of-Care Ultrasound Training

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BACKGROUND: Point-of-care ultrasound (POCUS) training is growing across internal medicine graduate medical education, but lack of trained faculty is a barrier to many programs. Interprofessional education (IPE) may offer a solution but must overcome potential biases of trainees.
AIM: To evaluate the impact of an interprofessional POCUS training on residents' attitudes towards interprofessional learning and stereotypes.
SETTING: Midwestern health sciences university.
PARTICIPANTS: Diagnostic medical sonography (DMS) students (n = 13) served as teachers for first-year internal medicine residents (IMR) (n = 49).
PROGRAM DESCRIPTION: DMS students participated in a train-the-trainer session to learn teaching strategies via case-based simulation, then coached IMR to acquire images of the kidneys, bladder, and aorta on live models.
PROGRAM EVALUATION: Mixed-methods evaluation, including pre-/post-surveys and focus group interviews. The survey response rate was 100% (49/49 IMR). Composite survey scores evaluating residents' attitudes towards IPE and stereotyping of sonographers improved significantly following the intervention. Qualitative analysis of focus group interviews yielded four themes: enhanced respect for other disciplines, implications for future practice, increased confidence of DMS students, and interest in future IPE opportunities.
DISCUSSION: Interprofessional POCUS education can improve residents' perceptions towards IPE, increase their level of respect for sonographers, and motivate interest in future interprofessional collaboration.

KEY WORDS: point-of-care ultrasound; interprofessional education; medical education.

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INTRODUCTION

Point-of-care ultrasound (POCUS) is the use of portable ultrasound technology by clinicians to enhance patient care. POCUS has many applications, with test characteristics that outperform traditional physical exam findings [1] and improved diagnostic accuracy over standard clinical evaluation.[2,3] Many internal medicine (IM) professional societies support the use of POCUS by trained providers,[4,5] and the Alliance for Academic Internal Medicine recently released a position statement advocating for the implementation of POCUS into IM residency training.[6] National surveys of IM educational leaders from the USA[7] and Canada[8] have found that 25–50% of programs have formal POCUS curricula but that lack of trained faculty is the most significant barrier to curriculum implementation.

One strategy to expand the pool of available teachers is through interprofessional education (IPE). IPE is defined as education that "occurs when students from two or more professions learn about, from, and with each other to enable effective collaboration and improve health outcomes."[9] Literature reviews have found that IPE interventions tend to improve learners' attitudes, knowledge, and skills,[10–12] but significant challenges exist. Negative professional stereotypes and perceived hierarchies are common among health professional trainees, and IPE interventions may not alter these

perceptions.[12] Some allied health professions, such as medical imaging technologists, are perceived as having relatively poor interpersonal skills, leadership abilities, and confidence.[13] Furthermore, medical trainees may have more negative perceptions of interprofessional education and collaboration than other health professionals.[14,15]

Studies investigating the role of IPE in ultrasound education have mostly involved obstetric sonography[16,17] and teaching of musculoskeletal anatomy.[18] There is limited research investigating the role of IPE for POCUS in medical education. Smith and colleagues described a pilot intervention in which diagnostic medical sonography (DMS) students taught internal medicine residents (IMR) to perform abdominal POCUS, resulting in a strong performance on a standardized examination of image acquisition skills.[19] To our knowledge, there has not been a research investigating the impact of POCUS training on participants' attitudes towards interprofessional learning. With this in mind, the purposes of this study were to (1) determine if interprofessional POCUS training changed residents' attitudes towards IPE and stereotypes of sonographers via survey instrument and (2) explore the experiences of IMR and DMS students participating in the intervention via focus group interviews.

SETTING AND PARTICIPANTS

The study took place at a Midwestern health professions university from 2018–2019 with two separate cohorts of participants. DMS students (n = 13) served as the teachers for first-year IMR (n = 49) learning abdominal POCUS. The DMS program is part of the College of Allied Health Professions. Students were in the last quarter of a 12-month program, which included > 1000 h of clinical instruction. IMR had prior training in cardiac, pulmonary, and procedural ultrasound, but no dedicated training covering the topics of the IPE workshop.

PROGRAM DESCRIPTION

A 2-h train-the-trainer workshop was developed to prepare DMS students for their role as teachers. Students participated in 4 scripted simulation-based teaching scenarios. Each case had learning objectives, highlighting common mistakes of novice POCUS learners (Appendix 1). DMS students worked in pairs alongside a simulated patient and an educational expert acting as a simulated learner.

During the role-play exercises, DMS students practiced an evidence-based strategy for teaching procedural skills. Peyton's four-step approach has proven superior to traditional teaching methods for an array of clinical procedures.[20–23] The four instructional steps[20] of this model are:

1 Demonstrate—the trainer demonstrates the procedure without comment.
2 Deconstruction—the trainer repeats the demonstration while describing each step.
3 Comprehension—the trainer performs the procedure as the student describes each step.
4 Performance—the student performs the procedure independently.

In the current study, we modified the Peyton model by eliminating step 1, thereby starting with the "deconstruction" step. This was done to maximize the time allotted for the other steps of the process, which are most important for skills development.[24]

IPE Workshop

The 3-h workshop covered POCUS exams of the kidney, bladder, and aorta. Appendix 2 provides a description of course content and objectives. The workshop design was informed by the contact hypothesis, which states that positive changes in attitudes can be developed when members of different social groups interact with one another under particular conditions.[25] A flipped classroom strategy was employed, with participants viewing pre-course videos from free online resources. After a short lecture and ice-breaker exercise, IMR rotated between 4 stations, each led by a different DMS student-teacher. The teacher to learner ratio was 1:2 or 1:3. Participants received an instructional checklist, outlining all of the expected behaviors for each POCUS exam, including image optimization, anatomy identification, labeling, and measuring. The faculty were available only for technical problems.

PROGRAM EVALUATION

We conducted an explanatory mixed-methods study in which qualitative data served to enrich and clarify quantitative data.[26] Researchers have advocated for mixed-methods research in medical education to better understand complex interventions.[26,27] Immediately before and after the intervention, IMR completed a 24-item online survey evaluating 2 constructs: attitudes towards IPE and stereotyping of sonographers.

The first survey section included 14 questions evaluating participants' perceptions towards interprofessional education.[28] The first 9 questions were adapted from the readiness of health care students for interprofessional learning survey (RIPLS), a widely used instrument in IPE research.[29] The remaining 5 questions assessed attitudes towards IPE in the academic setting, as originally described by Gardner.[30] Questions were modified to fit the context of the intervention and ensure consistent wording based on the measurement scale.[31]

The second survey section evaluated IMR stereotypes towards sonographers using the Student Stereotypes Rating Questionnaire (SSRQ).[13] The SSRQ is used to rate other

health professions on 9 characteristics: academic ability, professional competence, interpersonal skills, leadership, ability to work independently, ability to be a team player, decision-making, practical skills, and confidence. To this list, we added a tenth item—teaching skills.

Survey questions were scored on a 5-point Likert scale, with higher values indicating more positive attitudes. Individual survey items were summed to calculate aggregate scores for the IPE and stereotyping sections. Mean pre- and post-intervention aggregate scores were analyzed via Wilcoxon sign-rank test. A p value of 0.05 or less was considered statistically significant.

Immediately following the workshop, DMS students and IMR participated in semi-structured focus group interviews (Appendix 3). Interview questions explored concepts derived from the survey instrument, including heterosterotypes,[13] shared learning, and collaboration.[32,33] Each group had 6 participants. Interviews lasted 30 min and were conducted by consultants specializing in qualitative data collection. Interviews were recorded, transcribed verbatim, and uploaded into NVivo 12 (QSR International). Researchers used qualitative descriptive methodology to analyze data.[34] One coder conducted selective coding based on the interview topic categories to identify themes. A second coder reviewed the transcripts and verified the themes identified by the first coder. Resultant themes were sent to a sample of 12 participants for validation via member checking. This study was approved by the local institutional review board (#704–17-EX).

RESULTS

The combined survey response rate for IMR over the 2-year study period was 49/49 (100%). Forty-three percent were female (21/49) and 24% had POCUS training in medical school (12/49). The majority of IMR had personally performed 10 or fewer POCUS exams (44/49, 90%). Aggregate survey scores evaluating IMR's attitudes towards IPE (pre 60.3, SD 4.3 vs. post 65.0, SD 4.6, $p < 0.001$) and stereotyping of sonographers (pre 39.0, SD 3.9 vs. post 45.8, SD 4.6, $p < 0.001$) improved significantly following the interventions (Table 1). Cronbach's alpha for the pre- and post-intervention survey scales ranged from 0.88 to 0.97, indicating good to excellent internal consistency.

Forty-eight of 49 (98%) IMR and 12/13 (92%) DMS students participated in focus group interviews. The qualitative analysis yielded four themes (see Table 2 for representative quotes):

Enhanced Respect for Other Professions via Personal Interaction. Participants in both groups noted minimal interaction with the other profession prior to the workshop. By understanding one another's backgrounds and interacting in a safe learning environment, participants gained appreciation for each other's skills and contributions. IMR were especially impressed by the training, knowledge, and skills required of the DMS students. Both groups recognized the importance of respect and collegiality, given the increasingly collaborative nature of patient care.

Table 1 Mean Survey Scores Evaluating Internal Medicine Residents' Attitudes Towards Interprofessional Education and Stereotypes of Sonographers Before and After POCUS Training. Individual Survey Items Are Listed Under Aggregate Scores

	Pre (SD)	Post (SD)
Perceptions towards interprofessional education (IPE)		
IPE aggregate score*	60.6 (4.3)	65.0 (4.6)
I like courses that include students from other colleges or departments	3.9 (0.9)	4.5 (0.7)
Interprofessional learning better utilizes resources	4.2 (0.9)	4.7 (0.6)
I would welcome more small-group projects with other health professionals	4.1 (0.9)	4.6 (0.7)
It is important for my training program to provide interprofessional learning opportunities	4.2 (0.8)	4.6 (0.6)
Shared learning will help me think positively about other professionals	4.3 (0.9)	4.7 (0.6)
I like courses taught by faculty from other colleges or departments	4.0 (1.0)	4.5 (0.8)
Interprofessional learning should be a goal of my training program	4.1 (0.8)	4.5 (0.8)
Shared learning will help me to understand my own limitations	4.4 (0.8)	4.7 (0.6)
Learning with other health professionals is a worthwhile use of my time	4.4 (0.8)	4.7 (0.7)
Learning with other professionals will help me become a more effective member of a health care team	4.6 (0.7)	4.7 (0.7)
It is beneficial to learn clinical problem-solving skills from health professionals outside my own college or department	4.5 (0.7)	4.6 (0.6)
Shared learning with other health professionals will increase my ability to understand clinical problems.	4.4 (0.9)	4.6 (0.6)
Patients would ultimately benefit if health professionals worked together to solve patient problems.	4.8 (0.6)	4.9 (0.5)
Team-working skills are essential for all health professionals to learn.	4.7 (0.6)	4.7 (0.6)
Stereotypes of sonographers		
Stereotype aggregate score*	39.0 (3.9)	45.8 (4.6)
Teaching skills	3.6 (0.8)	4.5 (0.7)
Leadership abilities	3.4 (0.8)	4.3 (0.7)
Decision-making ability	3.5 (0.9)	4.4 (0.7)
Academic ability	3.7 (0.8)	4.5 (0.5)
Interpersonal skills	3.8 (0.9)	4.6 (0.5)
Team player	4.0 (0.7)	4.7 (0.7)
Ability to work independently	4.2 (0.7)	4.7 (0.5)
Practical skills	4.3 (0.8)	4.8 (0.4)
Confidence	4.1 (0.7)	4.6 (0.5)
Professional competence	4.3 (0.6)	4.7 (0.5)

Pre vs. post p value < 0.001

Table 2 Qualitative Themes from Focus Group Interviews with Representative Quotes. Symbols Annotate Relation to Survey Constructs

Theme	Representative quotes from residents	Representative quotes from sonographers
Enhanced respect for other professions via personal interaction*†	"It's kind of like you live in these different worlds, like a super Republican and a super Democrat coming together and be like 'hey we would never talk in a normal situation but let's talk'. Because I think we all struggle with knowing where our scopes of practice are." "You automatically grow an appreciation for the sonographers who are able to get images when you're sitting there, you have the probe on the same spot of the body that they do but in your image, you can't see anything. It's a white fuzzy mess and they're able to hone-in and get a great image."	"I even had a chance to ask some of them why have doctors ordered this, like what are you looking for in this or that weird order. . . . Hearing that explanation from them it's like 'okay, I get it.'" "You know, I got a bigger picture than what we're typically looking at. . .patient care is just obviously collaborative."
Implications for future practice*	"I think I'd be more likely to ask them a question of what they think is going on instead of waiting for the radiologist read. I'd just be more open to talking shop if you walk in while they're working at obtaining images." "There have been several times where I would go into a room and someone's doing an echo or an ultrasound and I just start talking to the patient not thinking that it has a bearing on the images they collect. But today some of the patients would say things while I was trying to get the image and it would throw off the entire image. So I think I'll be cognizant of interrupting the scans."	"Just the ability to . . . work alongside them and being able to communicate [effectively] with them will help regardless of where we're working at." "I think they understand how hard it is [to get a good image] because . . . we have to know anatomy, we have to know pathologies. I think it will be easier in the future [practice] with them realizing it's a lot harder than it looks."
Increased self- confidence of sonography students†	NA	"For me it was a big confidence boost. Like I do know what I'm doing so I think that'll carry over into my future job and talking with physicians. Just like 'yeah, this is what I think' or even asking them for help or being like 'hey, I found this'" "You have two residents that you have to teach and when they leave this room, whatever you taught them, that's what they're going to know. So as far as leadership goes, it really made me want to do my best teaching so that [knowledge] would be carried on."
Interest in additional IPE*	"Actually, like, physically what do the nurses do...or have them coach us a little bit…could be huge. And it would help us figure out how things work, like why things take a certain amount of time." "I think in nursing sometimes, like some of the practical stuff we don't have a full understanding of. When we put in orders and what that actually means to have it executed."	NA

**Interprofessional learning*
†Interprofessional stereotyping

Implications for Future Practice. Both IMR and DMS participants discussed ways the IPE training would impact their clinical practice. IMR participants felt newfound confidence in performing abdominal POCUS examinations. IMR and DMS students both reported more willingness to collaborate with one another and discuss ultrasound findings in the patient care setting.

Increased Confidence of DMS. Because of implicit professional hierarchy and limited prior interactions, DMS participants often felt intimidated by physicians and hesitant to share their insights. The opportunity to teach and be recognized for their expertise resulted in more confidence in their teaching and communication skills.

Interest from IMR in Additional IPE Opportunities. Residents recognized the transformative nature of IPE and expressed interest in other IPE activities. Nursing was the most frequently mentioned profession, with a particular interest in learning the practical aspects of clinical nursing.

DISCUSSION

Interprofessional POCUS education can improve residents' attitudes towards IPE and enhance their opinions of sonographers, as demonstrated by significant improvements in survey responses following the training. Qualitative interview data provided insight into how these attitudinal changes occurred. As suggested by the contact theory, bringing IMR and DMS students together within a supportive environment resulted in enhanced respect for one another and increased willingness to engage in future collaborative care. Furthermore, IMR reported interest in future IPE with other professions, suggesting the impact of this intervention on participants' attitudes may not be limited to sonographers. DMS students benefited from the experience with improved confidence in their teaching skills and willingness to engage with physicians. This educational intervention has the practical advantage of expanding the pool of available sonography teachers, as lack of POCUS-trained faculty is a common problem for internal medicine,[7] family medicine,[35] and pediatric[36] residency programs around the country.

In considering what elements of the intervention led to its success, it is useful to review existing evidence. A systematic review[12] identified predictive factors that contribute to the success of IPE interventions. First, there are contextual factors. POCUS is currently a "hot topic" in medical education and is generally popular among trainees. This enthusiasm likely motivates learner "buy-in" for the workshop. We also had the support of educational and administrative leadership. Participants were relieved of other duties to attend the workshops, and faculty time was supported to develop the intervention. We therefore had both "bottom-up" and "top-down" drivers, which tends to lead to the most impactful interventions.

Second, teacher characteristics impact IPE interventions. In a previous study, we found that the use of DMS student-teachers resulted in the creation of a safe learning environment, which is vital for successful facilitation.[19] Teaching instruction is also an important characteristic of successful IPE. Our "train-the-trainer" session ensured that DMS students had the necessary background to successfully translate their sonography skills to teach novice learners.

Third, learner characteristics can affect the success of IPE, especially perceptions of professional stereotypes and imbalanced professional hierarchy. We hypothesize that several aspects of the curriculum design helped equalize intergroup status. DMS students' took on the role as expert teachers for the relatively novice IMR learners, which likely helped negate any perceived gaps in status between the two groups. The "ice-breaker" activity may have also helped in this respect. Finally, the fact that both IMR and DMS student groups were still in their respective training programs may have helped equalize their perceived positions.

Our study had several limitations. It was conducted at a single institution and the sample size was limited. The workshop was a one-time intervention, so it is unclear if findings are sustainable, although prior studies have found that limited IPE interventions can have the same impact as prolonged interventions.[37] Finally, this study did not evaluate skills acquisition, although this has been demonstrated previously.[19] Future studies should investigate if changes in attitudes translate to changes in behaviors in clinical settings.

In conclusion, interprofessional POCUS training of internal medicine residents by sonography students can improve participants' attitudes towards other health professionals and interprofessional learning. POCUS curriculum developers should consider IPE, especially when faculty availability is limited.

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Compliance with ethical standards:

This study was approved by the local institutional review board (#704–17-EX).

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