

Ultrasound-Based Interprofessional Education: Priming Students for Interprofessional Collaboration

Charlene M. Gaw, MD, MPH¹, Christopher M. Gibbs, MD²; Jennifer A. Knight, MD³; Nathan J. Hellyer, PT, PhD⁴; Natalie R. Langley, PhD⁵; Sonya E. Van Nuland, PhD⁶

Abstract

Introduction: Health sciences education programs must prepare students to work in interprofessional teams in accordance with the interprofessional core competencies delineated by the Interprofessional Education (IPE) Collaborative. Using ultrasound to teach gross anatomy provides an opportunity to introduce IPE experiences and facilitate interprofessional interactions. This pilot study uses a validated survey to assess interprofessional attitudes before and after an ultrasound-based IPE intervention.

Methods: Medical and physical therapy students (n = 65) were randomly assigned to uniprofessional or interprofessional groups of 3 or 4 students to scan the shoulder and review the relevant anatomy for 30-minutes. Participants completed the University of the West of England Interprofessional Questionnaire (UWE-IPQ) before and after the IPE intervention to assess interprofessional attitudes and readiness.

Results: Student attitudes and perceptions about interprofessional collaboration did not change significantly following the ultrasound-based IPE intervention. The early timing of the IPE intervention in the curriculum and the brief and singular nature of the interaction may explain the results.

Conclusion: Using ultrasound to teach clinically relevant anatomy remains a useful way to facilitate IPE interactions. However, we recommend sustained, repeated efforts that are introduced early in curricula to improve interprofessional competencies like establishing relationships, communication, interprofessional learning and relationships, interprofessional experiences.

Keywords: interprofessional education; medical education; anatomy; ultrasound; physical therapy

Introduction

Interprofessional health care teams must collaborate effectively to address the complex healthcare needs of diverse patient populations and provide comprehensive patient care (Meleis, 2016). Interprofessional education (IPE) engages students from different professional backgrounds to improve communication and develop an appreciation for “the skills, strengths, and vocabularies of other professions” (Zheng et al., 2019). The World Health Organization’s Framework defines IPE as a situation where “students from two or more professions learn about, from and with each other to enable effective collaboration and improve health outcomes” (WHO, 2010). A number of medical schools in the United States integrate IPE into the undergraduate medical education curriculum (West et al., 2016). Several short-term studies assessed interprofessional curricular activities and reported greater appreciation and improved understanding of other professions, which may reduce medical errors and improve patient care (Hamilton et al., 2008; Reeves, et al., 2009, WHO, 2010; Oka et al., 2017; Vuuberg et al., 2019).

Anatomy courses are ideal for introducing IPE experiences due to the universal relevance of anatomy content in healthcare education (Zheng et al., 2019; Hamilton et al., 2008; Sysma et al., 2015; Fernandes et al., 2015). Anatomy laboratories provide a venue for interprofessional interactions that can foster teamwork, communication skills, and professionalism; however, not all students have access to human dissection opportunities (Thomas et al., 2011; Fernandes et al., 2015). Ultrasound represents an alternative means to introduce IPE experiences in anatomy courses, as it reinforces anatomical knowledge and develops clinical skills (Kondrashov et al., 2015).

¹ Department of Emergency Medicine, University of California Los Angeles, Los Angeles, CA

² Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, PA

³ Department of Radiology, University of Washington, Seattle, WA

⁴ Department of Physical Medicine and Rehabilitation, Mayo Clinic, Rochester, MN

⁵ Department of Laboratory Medicine and Science, Division of Anatomic Pathology, Mayo Clinic Arizona, Scottsdale, AZ

⁶ Department of Cell Biology and Anatomy, Louisiana State University Health Sciences Center, New Orleans, LA

Studies have investigated the impact of ultrasound as a basis for IPE experiences, but a validated IPE survey instrument has not been used to assess student attitudes and perceptions about interprofessional collaboration before and after a IPE learning activity (Luetmer et al., 2018; Struk et al., 2019). This pilot study aims to address this gap by determining if an ultrasound IPE session between medical and physical therapy students influences attitudes and skills required for interprofessional collaboration. We hypothesize that students working in interprofessional groups will experience greater improvement in interprofessional attitudes and skills than those working in uniprofessional groups, as measured by the University of the West of England Interprofessional Questionnaire (UWE-IPQ).

Methods

Participants and Recruitment

First year undergraduate medical students (MD) and physical therapy (DPT) students enrolled in the gross anatomy courses during the Fall of 2016 at the Mayo Clinic School of Medicine and Mayo Clinic School of Health Sciences, respectively, were eligible to participate in the study. All participants had previous exposure to shoulder anatomy in their respective gross anatomy lectures (1-hour) and laboratory dissection sessions (2.5-hours). Furthermore, both MD and DPT students had been introduced to ultrasound in a uniprofessional setting prior to the study via a 25-minute didactic lecture followed by a 20-minute hands-on-training session.

Students were recruited through an in-class announcement and emails from authors CM and JK. A total of 65 students consented to participate. This study was deemed exempt from full review by the Mayo Clinic Institutional Review Board (protocol number: 16-008541).

Interprofessional Experience Measures

Participants completed a demographic survey and the University of the West of England Interprofessional Questionnaire (UWE-IPQ). The demographic questionnaire gathered information about program, age, gender, highest degree attained, and relevant prior interprofessional healthcare experiences. The UWE-IPQ measures attitudes and perceptions about interprofessional collaboration and has been validated on a range of healthcare students, it has acceptable internal validity, and it is reportedly sensitive to change (Pollard et al., 2004; 2005). Questionnaires such as the Readiness for Interprofessional Learning Scale (RIPLS) and the Interdisciplinary Education Perception Scale (IEPS) had poor internal consistency, while the Interprofessional Socialization and Valuing Scale (ISVS) focuses on the transfer of interprofessional learning to the practice setting and is therefore beyond the scope of a first-year student population study (Pollard et al., 2004).

The UWE-IPQ consists of 35 items divided into four scales: Communication and Teamwork Scale, Interprofessional Learning Scale, Interprofessional Interaction Scale, and Interprofessional Relationships Scale (Pollard et al., 2004; 2005; 2006; Pollard and Miers, 2008). Each scale is comprised of 8 to 9 statements scored using a 4- or 5-point Likert scale. Since all respondents had at least informal experience in communication and teamwork, the Communication and Teamwork scale uses a 4-point Likert scale that omits the 'neutral' option. The remaining scales use a standard 5-point Likert scale. Each statement is scored from 1 to 5, with 1 equaling "strongly agree" and 4 or 5 equaling "strongly disagree". Thus, lower scores represent more positive attitudes (Table 1).

Table 1. UWE-IPQ Subscales and Scores.

Scale	Range	Positive	Neutral	Negative
Communication and Teamwork	9 - 36	9 - 20	21 - 25	26 - 36
Interprofessional Learning	9 - 45	9 - 22	23 - 31	32 - 45
Interprofessional Interactions	9 - 45	9 - 22	23 - 31	32 - 45
Interprofessional Relationships	8 - 40	8 - 20	21 - 27	28 - 40

*as reported by Pollard et al., 2004; 2005; 2006.

IPE Learning Experience Design

After completing the UWE-IPQ, participants were assigned to groups of 3-4 students randomly to practice the ultrasound exam and review shoulder anatomy. Groups consisted of uniprofessional groups (DPT-only (n=14 students) or MD-only (n=31 students), and interprofessional groups (DPT's and MDs; n=20 students).

Students observed two teaching assistants (third year medical students) demonstrate how to perform an ultrasound exam of the shoulder. Participants were then allotted 30 minutes to practice in their groups. Participants completed a second UWE-IPQ after the learning experience.

Statistical Analyses

A two-sample t-test was used to assess differences in the demographic parameters between groups. The four subscales of the UWE-IPQ (Communication and Teamwork, Interprofessional Learning, Interprofessional Interaction, and Interprofessional Relationships) were analyzed using two-way mixed model ANOVAs with groups (DPT, MD, DPT-MD) as the between-subjects variable and time (pre- and post-questionnaires) as the within-subjects variable. Two-way interactions and main effects were assessed. Effect size calculations (partial η^2) were interpreted with Cohen's recommendations (Cohen, 1988). Statistical analyses were done with SPSS v.22 statistical software package (IBM Corp, Armonk NY).

Results

Demographics

Of the 65 students who participated in the study, 40 individuals were enrolled in the Doctor of Medicine (MD) program, and 25 were enrolled in Doctor of Physical Therapy (DPT) program (males to females = 22:43, mean age = 24.0 ± 3.3 years old). Irrespective of program enrollment, most students had a bachelor's degree (88.9%), no previous ultrasound training (92%) and no exposure to IPE (76.9%). Independent t-tests revealed two significant differences between MD and DPT students: 1. More DPT students (100%) reported having previous anatomy experience compared to MD students (47.5%; $t(63) = -4.70, p < 0.001$), and 2. MD students reported more comfort with ultrasound technology than DPT students ($t(57) = 2.69, p = 0.009$).

University of the West of England Interprofessional Questionnaire (UWE-IPQ) Outcomes

A one-way ANOVA showed that initial attitudes and perceptions about interprofessional collaboration were similar between groups. Figure 1 shows the mean differences in student perceptions on each UWE-IPQ subscale after completing the IPE activity (mean difference = post-scores minus pre-scores). No significant interactions between inter- and uniprofessional groups and subscale scores over time were detected. However, a significant main effect of time revealed improvement in perceptions toward Communication and Teamwork ($F(1, 62) = 4.709, p = .034, \text{partial } \eta^2 = .017$), Interprofessional Interactions ($F(1, 62) = 8.176, p = .006, \text{partial } \eta^2 = .117$) and Interprofessional Relationships ($F(1, 62) = 14.86, p < .005, \text{partial } \eta^2 = .193$) after the IPE experience, regardless of whether students were in interprofessional or uniprofessional groups. However, no significant change Interprofessional Learning was detected.

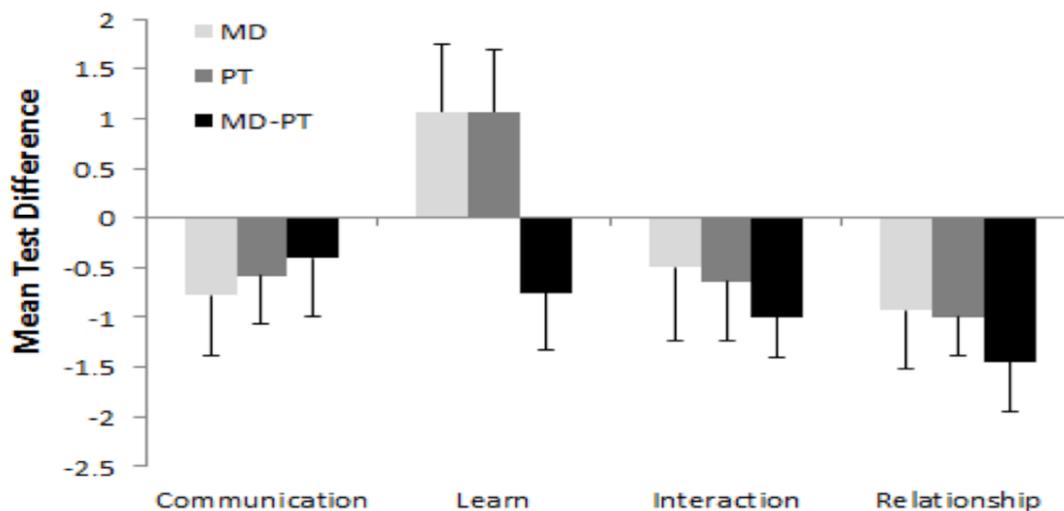


Figure 1. Mean UWE-IPQ subscale score differences between MD-only groups, DPT-only groups, and interprofessional groups. Negative differences represent an improvement in attitudes and perceptions about interprofessional collaboration.

Discussion

Ultrasound is gaining momentum as a promising means of integrating clinical practice with foundational sciences content in health sciences education (Rempell et al., 2016; Stone-McLean et al., 2017; Wilson et al., 2017).

Studies that combine IPE and ultrasound education have shown that it fosters collaborative practices amongst learners and healthcare professionals (Arya et al., 2017; Struk et al., 2019). This pilot study used a validated survey instrument (the UWE-IPQ) to assess student attitudes and perceptions about interprofessional collaboration before and after an ultrasound-based IPE experience. Contrary to our hypothesis, a two-way mixed ANOVA demonstrated that group composition did not impact participants' perceptions. However, student perceptions toward interprofessional communication/teamwork, interactions, and relationships improved significantly regardless of the group to which they were assigned (inter- or uniprofessional).

The common variable between interprofessional and uniprofessional groups was ultrasound, indicating that improvement in attitudes may be due to students' attitudes toward ultrasound integration into the curriculum. Ultrasound is a clinically-relevant tool that provides the opportunity to learn from peers in an interactive exchange and may prime positive attitudes towards interprofessional collaboration. For example, this IPE ultrasound session had a moderate effect on student perceptions of interprofessional relationships, accounting for 19.3% of the variance between pre- and post-intervention scores on the UWE-IPQ Interprofessional Relationship scale. The use of ultrasound to facilitate IPE experiences is further supported by research that shows IPE is more effective when it is integrated longitudinally into health professions curricula rather than as a stand alone activity (Brashers et al., 2016; Zheng et al., 2019). Ultrasound presents a powerful opportunity for longitudinal integration because the content and skills are relevant to many courses in health sciences education.

Overall, our results support the existing body of IPE research that suggests interprofessional experiences should be sustained, repeated efforts that are introduced early in health professions education (Fernandes et al., 2015; Zheng et al., 2019). Brief, singular, and isolated IPE experiences are not sufficient for exposing students to interprofessional competencies like establishing relationships, communication, interprofessional learning and relationships. These competencies require longitudinal initiatives with elements designed to help students understand each other's professional roles (Fernandes et al., 2015; Zheng et al., 2019). Specifically, one longitudinal IPE study highlights that more emphasis on IPE may be required for early establishment and maintenance of positive attitudes and competencies in interprofessional practice (Zheng et al., 2019). Our study suggests that structuring IPE experiences around ultrasound may prime students for interprofessional interactions and provide a means to implement IPE throughout the curriculum.

Limitations

This study introduces a template for leveraging a clinical tool to engage health professions learners in interprofessional education. However, several limitations must be addressed. This short-term pilot study used a quasi-experimental design with no control group. The interprofessional experience was limited to a one-time interaction that did not contain a structured component to allow students to learn about each other's professions. The IPE experience was voluntary and conducted outside of formal curricular requirements.

Furthermore, only one survey was used to assess student perceptions. Given that no gold-standard exists to assess interprofessional attitudes, researchers are encouraged to use multiple surveys in an attempt to triangulate changes in interprofessional attitudes with improved reliability (Blue et al., 2015). Varying sensitivities of interprofessional attitude measurement instruments have been reported and even conflicting results when using several different instruments for the same study, including the UWE-IPQ (Aravamudhan et al., 2015).

Conclusion

This study confirms that a single brief, early IPE exercise may not be sufficient to influence students' attitudes, perceptions, and skills about interprofessional collaboration, as measured by the UWE-IPQ. However, ultrasound may be a powerful tool for priming positive attitudes towards interprofessional collaboration. Ultrasound also presents an opportunity to integrate IPE experiences longitudinally throughout health professions curricula. The content and skills are relevant to many courses in health sciences education. As ultrasound continues to expand as diagnostic imaging technique and therapeutic modality, its inclusion in educational programs is increasing in popularity and necessity. The next phase of our study will build on the lessons from this pilot study. Ultrasound IPE experiences will be integrated bi-weekly in the MD and DPT anatomy courses to create sustained and repeated interactions. Students will receive questions to prompt reflection on the exploration of the roles, responsibilities and skills of other professions. We hypothesize that these experiences will foster early establishment of positive attitudes and competencies in interprofessional practice.

Notes on Contributors

- CHARLENE M. GAW, M.D., M.P.H., is resident physician in the Department of Emergency Medicine at Los Angeles, CA. She is interested in point-of-care ultrasound and health policy.
- CHRISTOPHER M. GIBBS, M.D. is a resident physician in the Department of Orthopaedic Surgery at University of Pittsburgh in Pittsburgh, PA.
- JENNIFER A. KNIGHT, M.D. is a resident physician in the Department of Radiology at University of Washington in Seattle, WA.
- NATHAN J. HELLYER, P.T., Ph.D. is an assistant professor of physical therapy in the Department of Physical Medicine and Rehabilitation at Mayo Clinic in Rochester, MN.
- NATALIE R. LANGLEY, Ph.D. is an associate professor of anatomy in the Department of Laboratory Medicine and Science, Division of Anatomic Pathology, at Mayo Clinic Arizona in Scottsdale, AZ.
- SONYA E. VAN NULAND, Ph.D. is an assistant professor in the Department of Cell Biology and Anatomy at the Louisiana State University School of Medicine, Health Sciences Center in New Orleans, LA. She teaches gross anatomy and mammalian histology, and her research interest is in the anatomical e-learning tool effectiveness.

References

- Aravamudhan, R., Vitek, M., Casser, L. (2015). The Implementation and Assessment of an Interprofessional Education Initiative at Salus University. *Optometric Education*, 40(3),1-6.
- Arya, S., Mulla, Z. D., & Plavsic, S. K. (2017). Interprofessional education with ultrasound simulation: diabetes and pregnancy. *Journal of Interprofessional Education & Practice*, 9, 61-65.
- Brashers, V., Erickson, J. M., Blackhall, L., Owen, J. A., Thomas, S. M., & Conaway, M. R. (2016). Measuring the impact of clinically relevant interprofessional education on undergraduate medical and nursing student competencies: a longitudinal mixed methods approach. *Journal of interprofessional care*, 30(4), 448-457.
- Blue, A. V., Chesluk, B. J., Conforti, L. N., & Holmboe, E. S. (2015). Assessment and evaluation in interprofessional education: Exploring the field. *Journal of allied health*, 44(2), 73-82.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Academic press. 2nd Edition. Hillsdale, NJ: Lawrence Erlbaum Associates
- Fernandes, A. R., Palombella, A., Salfi, J., & Wainman, B. (2015). Dissecting through barriers: A mixed-methods study on the effect of interprofessional education in a dissection course with healthcare professional students. *Anatomical sciences education*, 8(4), 305-316.
- Hamilton, S. S., Yuan, B. J., Lachman, N., Hellyer, N. J., Krause, D. A., Hollman, J. H., ... & Pawlina, W. (2008). Interprofessional education in gross anatomy: Experience with first-year medical and physical therapy students at Mayo Clinic. *Anatomical Sciences Education*, 1(6), 258-263.
- Kondrashov, P., Johnson, J. C., Boehm, K., Rice, D., & Kondrashova, T. (2015). Impact of the clinical ultrasound elective course on retention of anatomical knowledge by second-year medical students in preparation for board exams. *Clinical anatomy*, 28(2), 156-163.
- Luetmer, M. T., Cloud, B. A., Youdas, J. W., Pawlina, W., & Lachman, N. (2018). Simulating the multi-disciplinary care team approach: Enhancing student understanding of anatomy through an ultrasound-anchored interprofessional session. *Anatomical sciences education*, 11(1), 94-99.
- Meleis, A. I. (2016). Interprofessional education: a summary of reports and barriers to recommendations. *Journal of Nursing Scholarship*, 48(1), 106-112.
- Oza, S. K., Wamsley, M., Boscardin, C. K., Batt, J., & Hauer, K. E. (2017). Medical students' engagement in interprofessional collaborative communication during an interprofessional observed structured clinical examination: A qualitative study. *Journal of Interprofessional Education & Practice*, 7, 21-27.
- Pollard, K. C., Miers, M. E., & Gilchrist, M. (2004). Collaborative learning for collaborative working? Initial findings from a longitudinal study of health and social care students. *Health & social care in the community*, 12(4), 346-358.
- Pollard, K., Miers, M. E., & Gilchrist, M. (2005). Second year scepticism: pre-qualifying health and social care students' midpoint self-assessment, attitudes and perceptions concerning interprofessional learning and working. *Journal of interprofessional care*, 19(3), 251-268.
- Pollard, K. C., Miers, M. E., Gilchrist, M., & Sayers, A. (2006). A comparison of interprofessional perceptions and working relationships among health and social care students: the results of a 3-year intervention. *Health & social care in the community*, 14(6), 541-552.

- Pollard, K. C., & Miers, M. E. (2008). From students to professionals: Results of a longitudinal study of attitudes to pre-qualifying collaborative learning and working in health and social care in the United Kingdom. *Journal of interprofessional care*, 22(4), 399-416.
- Reeves, S., Perrier, L., Goldman, J., Freeth, D., & Zwarenstein, M. (2013). Interprofessional education: effects on professional practice and healthcare outcomes. *Cochrane Database of systematic reviews*, (3).
- Rempell, J. S., Saldana, F., DiSalvo, D., Kumar, N., Stone, M. B., Chan, W., ... & Kohler, M. J. (2016). Pilot point-of-care ultrasound curriculum at Harvard Medical School: early experience. *Western Journal of Emergency Medicine*, 17(6), 734.
- Stone-McLean, J., Metcalfe, B., Sheppard, G., Murphy, J., Black, H., McCarthy, H., & Dubrowski, A. (2017). Developing an undergraduate ultrasound curriculum: a needs assessment. *Cureus*, 9(9).
- Struk, I., Hellmann, R., Haeri, F., Calderon, R., Diaz, D., & Senft, G. (2019). Collaborative peer to peer learning for shoulder ultrasound and anatomy. *Journal of Interprofessional Education & Practice*, 14, 39-42.
- Sytsma, T. T., Haller, E. P., Youdas, J. W., Krause, D. A., Hellyer, N. J., Pawlina, W., & Lachman, N. (2015). Long-term effect of a short interprofessional education interaction between medical and physical therapy students. *Anatomical Sciences Education*, 8(4), 317-323.
- Thomas, K. Jackson, Bryan E. Denham, and John D. Dinolfo. "Perceptions among occupational and physical therapy students of a nontraditional methodology for teaching laboratory gross anatomy." *Anatomical sciences education* 4.2 (2011): 71-77.
- Vuurberg, G., Vos, J. A. M., Christoph, L. H., & de Vos, R. (2019). The effectiveness of interprofessional classroom-based education in medical curricula: A systematic review. *Journal of Interprofessional Education & Practice*, 15, 157-167.
- West, C., Graham, L., Palmer, R. T., Miller, M. F., Thayer, E. K., Stuber, M. L., ... & Joo, P. A. (2016). Implementation of interprofessional education (IPE) in 16 US medical schools: Common practices, barriers and facilitators. *Journal of Interprofessional Education & Practice*, 4, 41-49.
- Wilson, S. P., Mefford, J. M., Lahham, S., Lotfipour, S., Subeh, M., Maldonado, G., ... & Fox, J. C. (2017). Implementation of a 4-year point-of-care ultrasound curriculum in a Liaison Committee on Medical Education–accredited US medical school. *Journal of Ultrasound in Medicine*, 36(2), 321-325.
- World Health Organization. (2010). *Framework for action on interprofessional education and collaborative practice* (No. WHO/HRH/HPN/10.3). World Health Organization.
- Zheng, Y. H., Palombella, A., Salfi, J., & Wainman, B. (2019). Dissecting through barriers: A follow-up study on the long-term effects of interprofessional education in a dissection course with healthcare professional students. *Anatomical sciences education*, 12(1), 52-60.