New education method or tool

A pilot project to introduce ultrasound skills to medical students to facilitate peer-led delivery of an ultrasound-assisted physiology session

Thomas Simpson[2], Daniel Curley[3], Asya Veloso Costa[3], Liju Ahmed[3]

Corresponding author: Dr Thomas Simpson thomas.simpson@kcl.ac.uk
Institution: 2. Kings College London, 3. King's College London
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Abstract

The delivery of physiology and anatomy teaching using live subjects is limited by challenges relating to safety, and also the identification and interpretation of meaningful clinical signs. Use of ultrasound can overcome these challenges by providing a safe method of visualising and interpreting live physiology and anatomy. At the same time, the development of ultrasonographic competence is increasingly desired by healthcare professionals in multiple disciplines and specialties. Time and resources are required to achieve competence in post-graduate training outside of radiology. Incorporating ultrasonography into the undergraduate medical curriculum may improve the delivery of physiology and anatomy teaching, as well as providing a grounding a basic skills enabling the next generation of doctors to use ultrasonography in their daily practice.

We present here the results of a pilot project, designed and developed using near-peer student faculty to deliver sessions on cardiac anatomy and physiology using ultrasonography. The project was extremely well received by both student faculty and student learners, with positive self-reported learning.

We propose this model as a solution to the incorporation of ultrasonography into a medical school curriculum without incurring high costs of trained professional faculty.

Keywords: Ultrasound; Peer-led teaching; Integrated medical curriculum; Cardiac physiology

Introduction

The teaching of life sciences has increasingly moved away from the bedside of patients towards classroom-based or
technology enhanced learning modalities. Whilst these bring significant benefits to bear, not least in terms of patient safety and experience, we lose the unique affordances of seeing physiology ‘in the wild’. Learning basic physiology and anatomy on human subjects can be challenging due to the need to have an objective way of demonstrating and appreciating the signs suitable for novice learners, as well as the need to avoid harm to the subjects.

As an example, learning cardiac physiology from real patients using traditional teaching techniques and adjuncts can be challenging, not least because recognising the signs is a significant challenge in itself, alongside developing the associated skills required to use a stethoscope correctly. The interpretation of those signs is also challenging, requiring the application of physiological concepts, often taught using visual and textual modalities, to sounds and other physical examination signs to appreciate the physiology in action.

Using ultrasonography as a teaching support in demonstrating cardiac physiology on live patients can provide a way to visualise the cardiac cycle in real time, whilst also bringing students into contact with a ‘patient’. It is extremely safe if effectively supervised, and the screen display of ultrasonographic findings can be used to ensure correct anatomical and physiological features are being identified. Using a combination of physical examination, auscultation and ultrasonography can help students to make sense of the concepts they are learning in a real-life demonstration of physiology.

However, the faculty and equipment required for this type of approach has been prohibitively expensive until recently. The cost, size, portability and usability of ultrasonography machines has made significant strides in recent times towards enabling the kind of ubiquity seen with other bedside measuring devices in clinical settings. At the same time, ultrasonographic skills are increasingly used in daily practice amongst clinicians outside the radiology department. The use of ultrasonography amongst acute physicians, respiratory physicians, emergency medics and so on has led to an increasing expectation that many procedures, routine or otherwise, should be ideally ultrasound-guided. In the case of intercostal chest drain insertion for fluid removal, the use of ultrasonography is now effectively mandatory. However, historically, due to the cost of machines and the limited availability of opportunities to learn skills to certifiable level, ultrasonographic skill has remained within relatively few hands. Thus where training is available, it is usually for learning specific skills such as pleural ultrasound, FAST scanning and screening echocardiography. These courses are often over-subscribed and we are failing to train our wider workforce in basic skills which could assist in their daily practice, such as venepuncture and cannulation.

As the cost, size and availability of ultrasonography machines falls rapidly, and more and more professionals from across different professions are seeking to train in ultrasonography to make their assessments more objective and their procedures safer, we need to identify the best approach to ensuring that our workforce are appropriately competent and confident in ultrasonography to be able to use it in daily practice for routine procedures, whilst also capable of learning higher level skills appropriate to their specialty.

In our medical school our approach to these two opportunities, made possible by the affordability and ubiquity of the current generation of ultrasonography machines has sought to introduce ultrasonography based teaching to the medical curriculum, as a part of the cardiac physiology component of the first phase of our undergraduate medical degree. We believe this is an ideal time to introduce ultrasonography and the intention is to continue to embed it within the curriculum where possible as a teaching adjunct, such that our medical school graduates in future years will leave medical school with competence in basic skills. However, this approach requires a large trained faculty, which was not readily available for this pilot. Our solution was to recruit and train older medical students within the medical school in the basic skills of ultrasonography, targeted cardiac scanning and some essential teaching skills. We present here the results of our pilot.
Methods

The project proceeded in 2 stages, student faculty recruitment and training and then teaching (see Figure 1). In the first stage the course leads recruited a group of students between 2nd and 4th year of a 5-year MBBS course. Two project introduction sessions were run with the purpose of outlining the plan and discussing any questions surrounding the project, and ultimately, 23 students agreed to participate and become student faculty.

6 sessions were delivered over a period of 6 weeks by core faculty made up of two qualified physicians with significant experience in both ultrasonography and medical education. These sessions covered the physics of ultrasonography, basic practical ultrasonography, basic cardiac ultrasonography and assessment of the inferior vena cava. During these sessions, student faculty could practice using the ultrasonography machines with the aid of live models, and were given the opportunity to ask questions. Student faculty were also encouraged to sign up to the Society of Ultrasound in Medical Education (SUSME) website. This provides an easily accessible learning platform for basic ultrasonography skills which could be accessed in their spare time. To ensure all student faculty had received the same level of training, revision sessions were also offered to those who had missed sessions or for those wanting to refresh their knowledge.

Following the faculty training programme, sessions were delivered to 450 1st year MBBS students. Each session consisted of a 15-minute introductory lecture delivered by core faculty covering the physics of ultrasonography and basic practical ultrasonography, with a focus on cardiac anatomy and physiology, followed by a 45-minute interactive session with live models. Student faculty facilitated and ran the sessions with experienced core faculty overseeing these. Student faculty focused primarily on cardiac views such as parasternal long and short axes, highlighting key structures relating to cardiac anatomy and describing basic cardiac physiology. These were materials 1st year students were covering in their course at the time.

Over the course of these sessions, all 1st year students were given the chance to find the correct cardiac views by placing transducers on the chest, incorporating basic surface anatomy knowledge. Students were also able to listen to heart sounds with stethoscopes whilst visualising the valves opening and closing in real time. If time allowed, and students were happy with cardiac views, student faculty were able to move on to other interesting structures in the body such as peripheral arteries and veins and the inferior vena cava, highlighting additional ways in which ultrasonography is useful in a clinical setting.

Evaluation was carried out using a mix of Likert scale and free-text responses collected immediately after the session. A follow-up evaluation of the learners was performed one year later by issuing and collecting further Likert scale-based and free-text responses during a compulsory lecture series. Student faculty were also surveyed on their experience 3 months after all sessions had been delivered. Thematic analysis was conducted free-text responses by three authors independently (TS, DC, ACV), to identify positive and negative key themes regarding their experience.
Results

Students

During the pilot year, 1\textsuperscript{st} year students (n=450) participated in a one-hour student faculty-delivered teaching session. All students had hands-on experience of using the transducer to find the two cardiac views. 60\% of students (n=272) completed the evaluation form. Positive key themes are shown in Fig 2.
97% of students rated their experience of the session as positive or very positive, 95% of students said they wanted more of this type of teaching and 94% of students felt that integrating US in their teaching will help their learning. Table 1 shows average student responses.

| Question                                                                 | Response  \\
|--------------------------------------------------------------------------|-----------|
| I find this class helpful to the way that I learn                        | 4.62 (0.61) |
| I feel this session was engaging                                         | 4.70 (0.56) |
| I feel sessions like this will help me understand anatomy and physiology better | 4.44 (0.73) |
| I find that this class stimulates my interest in reading about this subject outside of class | 4.15 (0.94) |
| I feel real time anatomy will make my understanding easier              | 4.61 (0.66) |
| I would like more of this teaching                                      | 4.71 (0.61) |
| I feel integrating ultrasonography where possible in scenario teaching will help my learning | 4.66 (0.63) |

Table 1: Average post-session first year student responses on a scale of 1-5, given after their practical session. Standard deviation reported in brackets. Five point Likert scale: 1 = strongly disagree; 2 = disagree; 3 = neither agree or disagree; 4 = agree; 5 = strongly agree.

Students were given a similar questionnaire one year later asking retrospectively about the session (n=86). Although many were lost to follow up, 93% of those students surveyed agreed (n=40) or strongly agreed (n=40) that their understanding of US imaging was significantly improved, 94% of students either agreed (n=38) or strongly agreed (n=43) that they enjoyed being taught by other medical students and 98% enjoyed the session in retrospect (in keeping with the 97% from the post-survey data). Many students felt that they would appreciate more US-based teaching in their curriculum (Fig. 3).
Students were asked if they felt their physiology and anatomy knowledge had improved as a direct result of the US-based session. Although many students had a neutral response, the majority of students felt their understanding of physiology (56%) and anatomy (56%) had improved (Fig. 4). However, only 21% of students agreed (16%) or strongly agreed (5%) that this session had helped them to get better exam results (Fig. 5).

**Figure 3**: number of students who would appreciate more US-based teaching in their medical curriculum, when surveyed retrospectively regarding the US practical session. Based on a five point Likert scale.
My understanding of cardiac physiology/anatomy was significantly improved

![Bar chart showing responses](chart.png)

**Figure 4:** A graph to show the number of students who thought their understanding of physiology and anatomy had improved as a result of the US based session, when surveyed retrospectively. Based on a five point Likert scale.
Student faculty

16 out of 23 student faculty (70%) completed the follow-up survey. Overall the experience was reported as being extremely positive. As well as improvements in their appreciation of the role, uses and performance of ultrasonography, their own understanding of cardiac anatomy and physiology was reported to have improved. There were also improvements in their perception of their medical student career.

**Figure 5:** A graph to show the number of students who the US based session helped them to get better exam results, when surveyed retrospectively. Based on a five point Likert scale.
All 16 felt that they would like to learn further ultrasonographic skills as part of their training, with 11 (69%) identifying a career incorporating ultrasonography as something they would like to consider. Free-text responses to the question: ‘Describe specific ways in which the programme has impacted on you in the 12 months since you completed it’ demonstrated that it had been a positive experience for them all, with particular themes of: peer-to-peer-teaching; learning ultrasonographic skills and the improvement in their own cardiac anatomical and physiological knowledge.

**Discussion**

This programme, incorporating basic cardiac anatomy and physiology, utilising peer-led ultrasonographic sessions on live volunteers, demonstrated extremely high engagement and satisfaction scores. Alongside these there were self-reported improvements in understanding cardiac anatomy and physiology. Given that each student attended only 1 hour-long session, it was very unlikely that we would impact on their self-reported exam performance, as is reflected in the neutral response to this questions. Thematic analysis from both students and faculty highlighted the value perceived in the delivery of these sessions by peers.

The benefits of this approach extend beyond the experience of the students and the student faculty. Incorporating ultrasonography into medical school curricula is likely to become an increasing priority in the next 10 years, as ultrasonographic competence is seen more as a core skill of a wider range of specialties. The two major challenges of training in ultrasonography are the time required and the cost of providing equipment and faculty for training.

Introducing ultrasonography as a significant component of the medical school curriculum, initially as a teaching adjunct with a greater emphasis on skill acquisition in later years could be a solution to these challenges.
Conclusion

Life sciences teaching, realistic clinical experience and the development of skills can be integrated using ultrasonographic techniques as an adjunct to teaching. We have demonstrated here a model for how to establish this in the absence of a large, trained, professional faculty. Through a peer-led teaching model we have delivered this session to 450 1st year medical students. The programme has subsequently been continued, and we are exploring ways in which we can incorporate ultrasonography into all appropriate elements of the medical school curriculum using the same model. This approach can support the delivery of physiology and anatomy teaching on live subject in a safe manner, alongside developing core ultrasonography skills in the medical students in preparation for a future in which competence in ultrasonography will form part of daily practice for many of them.

Take Home Messages

Ultrasonography can be used as an adjunct to the teaching of physiology and anatomy

Medical student faculty can be trained to deliver sessions to their peers to enable the creation of sufficient faculty for a comprehensive teaching programme using ultrasonography

This approach can support integrated physiology, anatomy and clinical skill teaching

The development of basic ultrasonographic skills at medical school is the most plausible approach to the increasing desire for healthcare professionals to use ultrasonography in daily practice

Notes On Contributors

Dr Thomas Simpson was involved in the design of this project. He was also core faculty throughout the pilot and has been involved at all stages of the writing process.

Daniel Curley was a student faculty member. He was involved in the delivery of the project and has been involved at all stages of the writing process.

Asya Veloso Costa was a student faculty member. She was involved in the delivery of the project and has been involved at all stages of the writing process.

Dr Liju Ahmed conceived the project. He was also core faculty throughout the project and has supervised the writing process.

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Appendices

Declarations

The author has declared that there are no conflicts of interest.

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