


# Creating an Ultrasound Scholarly Concentration Program for Medical Students

Daniel R Bacon <sup>1</sup>

Keri Cowles<sup>1</sup>

Diwash Thapa<sup>1</sup>

Alexander White <sup>1</sup>

Austin J Allen <sup>1</sup>

John Doughton<sup>2</sup>

Gary Beck Dallaghan<sup>3</sup>

Sheryl G Jordan<sup>4</sup>

<sup>1</sup>University of North Carolina School of Medicine, Chapel Hill, NC, USA;

<sup>2</sup>Department of Family Medicine, University of North Carolina School of Medicine, Chapel Hill, NC, USA; <sup>3</sup>Office of Medical Education, University of North Carolina School of Medicine, Chapel Hill, NC, USA; <sup>4</sup>Department of Radiology, University of North Carolina School of Medicine, Chapel Hill, NC, USA

**Introduction:** Point of care ultrasound (POCUS) is increasingly prevalent and standardized in undergraduate medical education (UME); however, roughly 25% of United States medical schools lack an ultrasound curriculum. One of the commonly cited barriers to ultrasound training in UME is faculty time resources. Here, we describe an ultrasound scholarly concentration program (SCP) designed to provide medical students with ultrasound opportunities in clinical and scholarly domains, while reducing the need for extensive faculty resources.

**Methods:** SCPs at the University of North Carolina School of Medicine have 3 requirements: an elective course, a longitudinal portfolio, and a final scholarly project. Thus, the ultrasound SCP was designed to comprise an introductory clinical elective to ultrasound, development of a longitudinal scan portfolio, and a final scholarly project in ultrasound related research or educational innovation. A review of the literature and search of the top 50 US medical schools by US News & World Report was performed to assess the novelty of the ultrasound SCP.

**Results:** To the best of our knowledge, the ultrasound SCP is the first scholarly concentration, track or pathway offered to medical students in the United States. It is the first description of a student designed and student led curriculum focused on providing meaningful ultrasound opportunities to students without necessitating unavailable faculty resources and educational infrastructure.

**Conclusion:** A novel ultrasound SCP is described which has clinical aims to expose students to clinical ultrasound as well as scholarly aims to facilitate ultrasound related research and educational innovation. It is designed to enable students to make ultrasound a defining characteristic of their medical school experience. The SCP relies on motivated student involvement and near-peer teaching in a way that is self-sustaining and self-improving.

**Keywords:** ultrasound, ultrasound curriculum, undergraduate medical education, scholarly concentration

## Introduction

Point of care ultrasound (POCUS) training in undergraduate medical education (UME) is becoming increasingly more prevalent and standardized, yet the most recent analysis found that greater than 25% of US medical schools lack an ultrasound curriculum.<sup>1</sup> The need for ultrasound education in UME is increasingly recognized by published consensus statements,<sup>2,3</sup> and recently the Canadian Ultrasound Consensus for Undergraduate Medical Education outlined 85 ultrasound curricular elements recommended for inclusion in UME.<sup>4</sup> Despite need, integrating longitudinal ultrasound curriculum as accomplished at institutions like the University of South Carolina<sup>5-7</sup> is costly and challenging. In particular, protected faculty time is cited as a major barrier.<sup>1</sup>

Correspondence: Sheryl G Jordan  
University of North Carolina School of Medicine, 321 South Columbia Street,  
Chapel Hill, NC, 27514, USA  
Email sheryl\_jordan@med.unc.edu



In 2017, undergraduate ultrasound education at the University of North Carolina School of Medicine (UNC) was limited to a single introductory elective in which student interest greatly overwhelmed its 40-student capacity. Moreover, opportunities for students to further develop skills and pursue scholarly endeavors related to ultrasound were unstructured with limited visibility.

We describe a student-led initiative to design and implement an ultrasound scholarly concentration program (SCP) which has both clinical and scholarly aims. Its clinical aims are to expose students to ultrasound and its scholarly aims are to facilitate student involvement in ultrasound related research and educational innovation. The SCP allows students to make ultrasound a defining characteristic of their medical school experience in way that is self-sustaining, relying on motivated student leadership with minimal faculty resources.

## Methods

### Scholarly Concentration Programs

This description of the SCP was considered exempt by the University of North Carolina Institutional Review Board considering its descriptive nature. SCPs at the UNC School of Medicine are extra-curricular enrichment pathways for students to learn more extensively about a discipline than would otherwise be encountered through universal graduation requirements. Additionally, they facilitate mentorship and scholarly contributions within a given field.<sup>8</sup> As of July 2021, there were 8 SCP options at UNC SOM: global health, medical education, clinician leadership in quality and safety, care of the older patient, humanities and social sciences, medical education supporting sexuality and gender expressions, nutrition and most recently, ultrasound.<sup>9</sup> Currently, there are 12 students enrolled in the ultrasound SCP from the class of 2023 and 10 students from the class of

2024. A total of 13 students applied from the class of 2023, and a total of 25 students applied from the class of 2024. [Table 1](#) depicts the ultrasound SCP requirements in chronological fashion over the course of medical school. Students final scholarly project involving topic-related research or educational innovation; for the Ultrasound SCP, each are discussed in detail below.

### Elective Course: Radiology 121, Ultrasound Fundamentals

Originally designed as a summer in-person didactic session experience followed by hands on practice, this curriculum was adapted to meet physical distancing requirements imposed by the COVID-19 pandemic. A completely virtual and asynchronous pre-clinical curriculum was designed for rising 2nd year medical students to complete during the summer after their first year of medical school. [Table 2](#) lists the topics and course requirements which include online didactics (EMSono, LLC, Canton, OH), quiz assessments and scan assignments utilizing handheld butterfly ultrasound probes (Butterfly Network, Inc. Guilford, CT) which students were provided continuous access to for the duration of the course. The course aim is to introduce students to normal sonoanatomy, and to provide hands on experience with ultrasound technique prior to clinical rotations. Student-selected scans are evaluated according to a standardized grading scheme which assessed orientation, gain, depth, centering, complete visualization of correct anatomy and quality of measurements.

This 3-credit hour pre-clinical course is now officially registered in the UNC School of Medicine course catalogue. Our preliminary results showed increased student confidence levels and demonstrated that remote, asynchronous ultrasound education is feasible, and greatly reduces faculty time requirements. Final evaluation results are

**Table 1** Academic Calendar for the Ultrasound Scholarly Concentration Program

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MS1							Begin medical school			Application to US SCP		
MS1/MS2							Fundamentals of ultrasound elective (Radiology 121)					
MS3	Monthly ultrasound case conference, scholarly project round table conference, Radiology 121 teaching opportunities, development of scan portfolio and scholarly project											
MS4	Continue scan portfolio and final project, present work at academic conferences and/or publish findings in academic journals, participate as in near-peer teaching and mentorship.											

**Abbreviations:** MSX, medical student year X (1,2,3,4); US, ultrasound; SCP, scholarly concentration program.

**Table 2** Summary of Topics, Quiz and Scan Requirements for Fundamentals of Ultrasound Elective (RADY 121)

Topic	Subtopics/Modules (Minutes)	Number of Quizzes	Scans (1–2 of Each)
Practical Scanning	Total time: 55 min 1.Sound wave essentials (4) 2.Ultrasound transmission in human tissue (10) 3.Instrumentation (6) 4.Knobology (15) 5.Greyscale optimization (6) 6.Artifacts (11) 7.Scanning principles (3)	4	None
FAST Abdomen and Pericardium	Total time: 116 min 1.Hemoperitoneum (8) 2.Perihepatic window (31) 3.Perisplenic window (34) 4.Pelvic window (14) 5.Hemopericardium (5) 6.Subcostal window (9) 7.PSLA window (13) 8.Interpreting PSLA window (10) 9.Optional: Clinical Applications	5	1–2 FAST exams (Subxiphoid, RUQ, LUQ, suprapubic windows)
Gallbladder and Renal	Total time: 78 min 1.Gallbladder introduction (5) 2.Sagittal exam (9) 3.Transverse exam (7) 4.Gallbladder shape (4) 5.Gallbladder size (4) 6.Gallbladder lumen (13) 7.Gallbladder wall/pericholecystic fluid (8) 8.Common bile duct (4) 9.Introduction to renal (4) 10.Right renal (6) 11.Left renal (6) 12.Urinary bladder (8) 13.Optional: Assessing for hydronephrosis, clinical applications	3	1–2 scans of each of the following: <ul style="list-style-type: none"> <li>• Gallbladder with measurements of wall thickness, sagittal diameter, transverse diameter, and common bile duct</li> <li>• Renal (longitudinal/transverse) and bladder</li> </ul>
Cardiac and Pulmonary	Total time: 55 min 1.Transthoracic windows (10) 2.Visual estimation of LV function (13) 3.IVC (9) 4.Search for pneumothorax (4) 5.Focused thoracic exam (19) 6.Optional: effusion and tamponade physiology, acute right heart strain, the crashing patient,	3	1–2 scans of each of the following: <ul style="list-style-type: none"> <li>• PSLA, PSSA, apical 4 chamber</li> <li>• IVC with respiration</li> <li>• Lung sliding</li> </ul>
Vascular	Total time: 108 min 1.Vascular access essentials (31) 2.Long axis approach (4) 3.Short axis approach (11) 4.oblique axis approach (3) 5.Introduction to Aorta (3) 6.Sagittal aorta (15) 7.Transverse aorta (12) 8.Interpreting the aorta exam (22) 9.Abdominal aortic exam (7) 10.Optional: central line placement, peripheral line placement, aorta clinical applications	4	1–2 scans of each of the following: <ul style="list-style-type: none"> <li>• Aorta (longitudinal and transverse with measurements at the levels of the celiac access, SMA, and proximate to the iliac bifurcation)</li> </ul>

**Abbreviations:** FAST, focused assessment with sonography for trauma; PSLA, parasternal long axis; PSSA, parasternal short axis; LV, left ventricle; RUQ, right upper quadrant; LUQ, left upper quadrant; IVC, inferior vena cava; SMA, superior mesenteric artery.

being reported elsewhere by Bacon et al, and these results are in accord with another recently reported example of virtual ultrasound education for medical students.<sup>10</sup>

## Longitudinal Portfolio, Case Conferences and Website

Student scans are archived in the Butterfly cloud database (Butterfly Network, Inc. Guilford, CT), which allows for efficient faculty evaluation and feedback in the form of a comment attached to the student's scan. Additionally, optional office hours and in-person scan opportunities are offered to students desiring to discuss questions related to particular scans or questions related to technique. At present, there is no set number of scans that are required for the portfolio; rather by design, this is an opportunity for students to pursue self-directed learning with the opportunity to track progress over time and incorporate faculty feedback. Students seeking advanced ultrasound proficiency may benefit from individualized learning plans over the course of medical school; aspirational examples include previously described and standardized ultrasound milestones.<sup>11</sup>

Students also participate in a monthly case conference and are required to attend five per year and present at one session during their 3rd or 4th year of medical school. Case presentations are 30 minutes and center around a clinical vignette in which the student used POCUS during their rotations. Students present the history, indication for ultrasound, an example of the scan they performed, diagnosis and management of the condition, and present a pertinent review of the literature related to a specific clinical question. For example, utilizing skills from Radiology 121, a student recently performed echocardiography to identify a pericardial effusion (Figure 1). The student logged this scan into a portfolio and prepared a case presentation for monthly conference centered around the clinical question: Can POCUS decrease the time to diagnosis for acute pericarditis? The full presentation can be viewed on our website.<sup>12,13</sup>

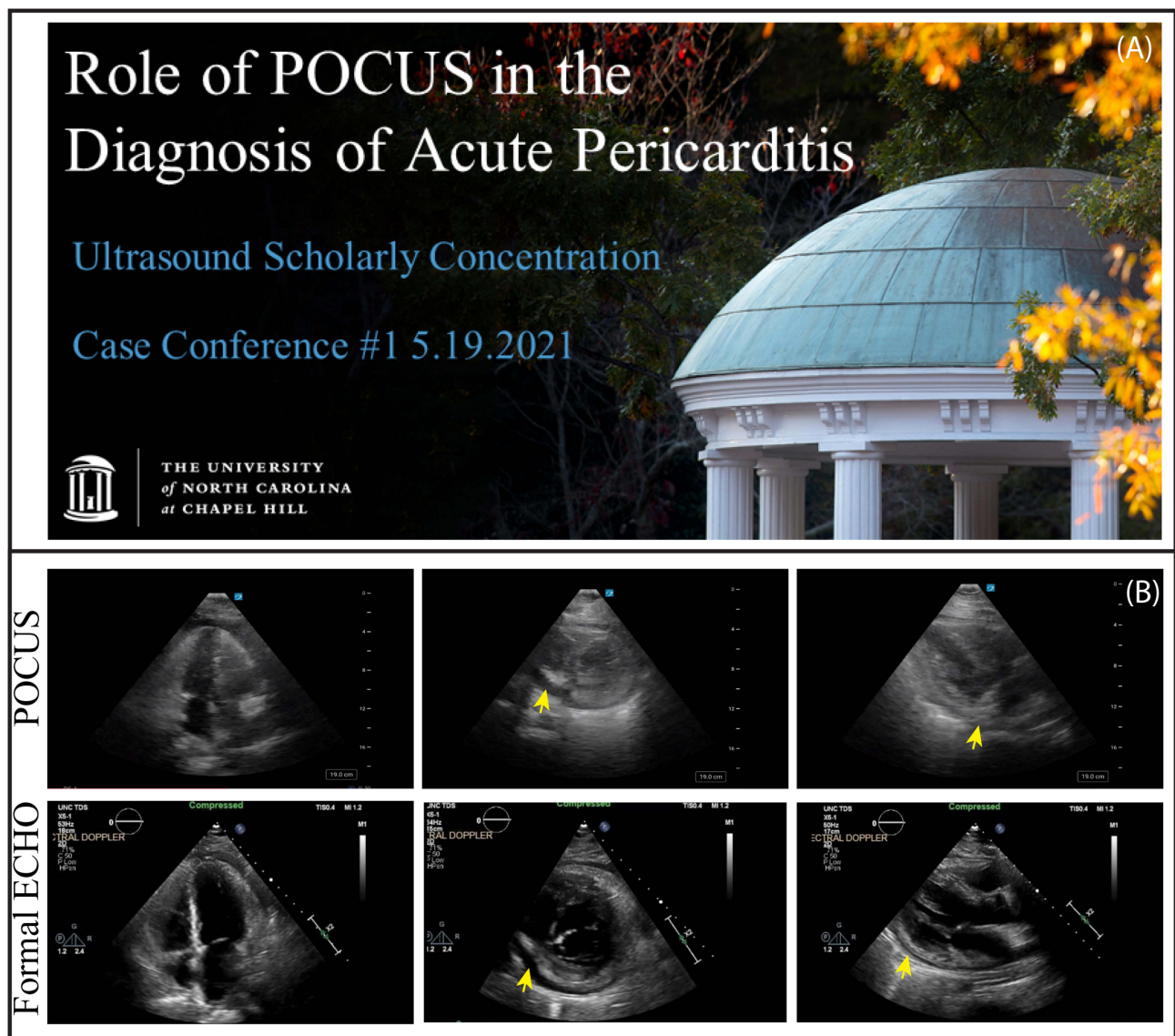
Students are encouraged to submit these presentations to be considered for peer-reviewed publication on the ultrasound SCP website, which was originally created as an open-access educational radiology website for medical students.<sup>14</sup> This website has been used successfully in a variety of other educational capacities including student-led virtual journal club presentations<sup>15,16</sup> and student-authored teaching files.<sup>17–19</sup> At present, the ultrasound

SCP peer review team is comprised of 3 resident physicians who are blinded to the case conference presentation. One reviewer is assigned at random to the case and asked to make recommendations for acceptance or revisions for resubmission. Final publication decisions are made by the SCP faculty advisor (SGJ).

## Scholarly Projects

Over the course of the SCP, students are required to participate in a scholarly project which could involve participation in an ultrasound related research project or educational innovation. Research requirements are flexible, but could include basic science, clinical research, or quality improvement aims. Alternatively, students could propose an educational innovation such as developing modules, simulators, enhancements of the evaluation process, or reflective teaching experiences. Examples of current project proposals are described in Table 3.

Students are encouraged to present project proposals to peer student leaders (DRB, KC) in the form of a PowerPoint presentation with the elements discussed above. This format reinforces well-reported advantages of near-peer teaching and mentoring.<sup>20–23</sup> Student leaders help refine research design ideas and assist with practical guidance such as with applications for Institutional Review Board approval. Students then make project proposals to faculty advisors (SGJ), and ideally present at one of the monthly conferences discussed above for further feedback. In addition to formal presentations, students have informal opportunities during “round table” discussions which occur every 3–4 months in place of the case conference discussed above. Students are encouraged to present ideas at all stages of development, whether at initial hypothesis or presentation of completed research. One or two students make formal research proposals at these meetings which include background literature review, study design, methods, and anticipated barriers. Students and faculty participate by offering feedback and suggestions. Anecdotally, we have found that these meetings are effective at refining student research plans and are idea-generating for students at all levels in the SCP. This format has also helped to facilitate connections between students and faculty mentors; for example, one student interested in 3D printing and biomedical engineering of high-fidelity ultrasound simulators was connected with faculty members in these respective departments. Students are encouraged to present their project findings



**Figure 1** Student presentation example for monthly case conference. top panel: Title slide. Bottom panel: Comparing POCUS identified pericardial effusion to formal echocardiography.

at regional, national, and international academic conferences and to publish their work in academic journals.

In this way, the ultrasound SCP has developed a culture of scholarly inquiry and collaboration which is self-sustaining in that student research ideas often further advance SCP goals (ie, a student project to improve our Radiology 121 elective). This underlines the advantage of motivated student leadership, as it is often cited that faculty resources are a rate-limiting step in ultrasound education.<sup>1,24</sup>

## Results

### Novelty

The concept of scholarly concentrations, tracks or pathways is well reported in the literature, and has gained

popularity in UME. In particular, SCPs at UNC were modeled after the SCPs at the Warren Alpert medical school of Brown University originally reported in 2007.<sup>25</sup> A simple screening of the top 50 US medical schools (separately by research and primary care) by US News and World report<sup>26</sup> revealed that at least 68% (n=34) of schools reported provision of longitudinal scholarly concentrations, tracks or pathways. These SCPs center around topics that are not traditionally covered in medical school beyond a superficial depth, including: global health, care of the older patient, nutrition, genetics in medicine, humanities and social sciences, to name a few. However, SCPs rarely, if ever, focus on a specific clinical skill. Thus, ultrasound appears to be a unique and novel scholarly

**Table 3** Examples of Current Student Scholarly Project Proposals Organized by Theme

<b>Access to Care</b>
Pilot study to increase access to POCUS in an underserved patient population in a student-led medical clinic. Implementing a telemedicine ultrasound clinic in a rural international setting Introducing POCUS to Emergency Medical Services (EMS) setting
<b>Educational Innovation</b>
Pilot study to remotely teach ultrasound to novice users in an acute setting Improving comprehension of ultrasound basic principles through the use of scanning inanimate objects Creating ultrasound simulators with 3D printing Standardizing competency assessment of ultrasound skills across specialties Creating a high-yield POCUS handbook for medical students Narrative reflections on ultrasound education in medical school
<b>Novel Applications of Clinical Ultrasound</b>
Using ultrasound in sports medicine to prognosticate recovery timelines Applying machine learning algorithms to emerging ultrasound modalities. Introducing POCUS for as a non-invasive tool in trauma sensitive care for domestic violence survivors.

concentration that fits the general paradigm of a topic that is of interest to students but is covered only at a superficial level at many institutions. To the best of our knowledge, there are no reports of ultrasound SCPs in the literature. Furthermore, prior to instituting our SCP, we screened school of medicine websites for the same top 50 US medical schools with the search terms, “ultrasound”, “concentration”, “pathway”, and “track”, which did not reveal any other scholarly concentration in ultrasound. Thus, the ultrasound SCP at UNC is a novel contribution to medical education literature and is likely the first of its kind.

## Discussion

### Reproducibility and Limitations

The success of the ultrasound SCP has relied upon motivated student involvement, simplicity and flexibility, supportive faculty mentors, and modest funding. As described above, faculty resource limitations are a commonly cited barrier to ultrasound education. Based on our experience, a prospective ultrasound SCP is likely to succeed if it is initiated and sustained by students. For this reason, starting with an interest group may be a reasonable place to identify driven student leaders who are prepared to advocate for the curriculum, fulfill a variety of administrative tasks, and be highly involved in near-peer teaching and mentorship.

The simplicity of the SCP is important. We focus our improvement efforts on only 3 discrete components: a pre-clinical elective, a longitudinal component (case

conference and scan portfolio), and a final scholarly project. Simplicity begets flexibility which is appreciated by medical students interested in gaining new skills efficiently without distracting from their primary medical education. Starting with the pre-clinical elective, a virtual and remote curriculum during the summer after the first year of medical school allows students to complete assignments at their convenience so that they can simultaneously engage in other opportunities. To promote flexibility during the longitudinal component, we intentionally limit obligatory meetings and rigid scan requirements, especially during clinical rotations. Scholarly projects are intrinsically flexible as they are open-ended opportunities that students can begin working on at any point during medical school.

Lastly, we are fortunate to have had funding for 10 handheld ultrasound probes (~\$2000/probe) which we use for Radiology 121 and loan out to students for scholarly projects and clinical rotations. Additionally, we have funding to purchase commercial didactic resources (~\$100/student for annual subscription). Although these resources certainly enhance our curriculum, we were prepared to implement the SCP with or without this funding utilizing standard ultrasound machines which are available ubiquitously at academic hospitals and schools of medicine.

Possible barriers to prospective SCPs include availability and usability of secure databases for archiving scans, the availability of motivated student leaders and a committed faculty mentor, as well the availability of

educational content. However, we note comprehensive open-source educational modules which are available through the University of South Carolina School of Medicine, and we suggest this as a starting point.<sup>27</sup>

## Conclusion

A novel student-led ultrasound SCP was designed and implemented at the UNC School of Medicine. This curriculum can serve as a model to other institutions who look to increase clinical and scholarly ultrasound opportunities for students. The strengths of this curriculum include its simplicity, flexibility, and reliance on motivated students in manner that facilitates leadership opportunities in and is self-sustaining and self-improving.

## Disclosure

The authors report no conflicts of interest.

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