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# Enhancing Musculoskeletal Care in Rural Clinics: Barriers and Best Practices for PoCUS Training

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## Abstract

**Introduction**: Point of care ultrasound (PoCUS) is a portable diagnostic technology with broad applicability, no radiation, and is less expensive than alternative imaging methods. PoCUS is emerging as high utility technology to expand bedside physical exams for primary care clinicians. This technology is even being incorporated into medical school clerkships, such as Family Medicine. Access to medical care in rural areas is an ongoing issue, especially for specialty care. By using PoCUS, rural providers may be able to screen for conditions more completely and determine if patients need to seek specialty care, such as orthopedic intervention, and would be equipped to enhance the medical student's learning experience.

**Objectives**: This study aims to identify barriers to learning and using PoCUS for musculoskeletal evaluations among rural primary care clinicians. A secondary objective is to evaluate best practices for expanding PoCUS training in these settings.

**Methods**: The team identified six rural primary care clinicians at outpatient clinics around Indiana. Grant funding was used to equip these clinics with portable ultrasound probes with PoCUS-software-equipped iPads. Training consisted of approximately one hour of independent didactic material and two hours of in-person hands-on training with our investigators and students. Initial surveys were collected before and after the in-person training session. The third survey was collected approximately six months after the initial training session. Teleguided follow-up sessions were offered to the clinicians, as well.

**Results**: The initial survey before the in-person training session from the six clinicians found that the previous PoCUS experience of these clinicians varied greatly. This survey also showed unanimously that these clinicians make orthopedic diagnoses in their practice but do not feel comfortable using ultrasound in supporting these diagnoses, demonstrating the potential for PoCUS in their clinical practice. The second survey results showed that even after just two hours of training, 100% of participants reported increased comfort in using PoCUS for orthopedic diagnoses, with 80% feeling confident enough to teach the material to others. The third survey focused on barriers to incorporating PoCUS into the participant's clinic. Various barriers were reported, such as limited opportunity, insufficient time and training, and low comfortability. Reoccurring themes from qualitative comments included a busy practice and personal schedule and software issues ranging from equipment connectivity and login problems.

**Conclusions**: Implementing PoCUS in rural clinics to evaluate orthopedic diagnoses was met with enthusiasm and has shown potential for streamlining evaluation at specialty clinics. Significant barriers to adopting this technology include finding adequate time for busy clinicians to learn and practice using the equipment and scheduling live, ongoing training.

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## INTRODUCTION

Point-of-care ultrasound (PoCUS) emerges as an economical and highly portable diagnostic technology, exhibiting broad applicability with no reported contraindications for evaluating relatively superficial orthopedic pathology.[1] Notably, the financial burden on patients is diminished compared to alternative imaging modalities like MRI.[2] Knowing the potential of PoCUS, many medical schools have been proactive with incorporating PoCUS skills into curriculums. Originally included in OB/Gyn and emergency medicine clerkships, PoCUS has now expanded into family medicine and critical care medicine, equipping students to use these skills in all settings.

PoCUS proves to be a cost-effective and somewhat effective alternative for diagnosing superficial anatomical pathologies such as rotator cuff tears or ruptures[3,4,5,6], carpal tunnel syndrome[7,8], knee and other joint effusions[9,10,11], and distinguishing cellulitis from abscess formation.[12,13] For orthopedic injuries characterized by pain or impairment and a discernible clinical history, imaging is often relied upon to confirm suspected diagnoses. Studies assessing ultrasound's clinical effectiveness in orthopedic pathology suggest that specificity is consistently higher than sensitivity. Although with limited power, some studies report approximately 60% sensitivity but 100% specificity and positive predictive value for ultrasound in diagnosing supraspinatus tears.[6] Additionally, studies indicate that the accuracy of ultrasound in diagnosing rotator cuff tears is statistically comparable to MRI when reviewed by a clinician proficient in image interpretation for both techniques.[14] Notably, errors in ultrasound evaluation appear unrelated to inherent technique integrity.[15,16]

The literature presents a gap in comparable data for ultrasound evaluation of carpal tunnel syndrome and knee injuries. However, studies support the use of ultrasound for detection of knee effusions and improves the success rate of arthrocentesis procedures.[11,17,18] It is noteworthy that ultrasound can confidently differentiate between abscess formation and cellulitis.[12,13]

Orthopedic applications of Point-of-Care Ultrasound (PoCUS) gain significance in underserved and rural communities facing barriers to comparable access to MRI or CT evaluations. Compared to more well-established vascular and obstetric applications, orthopedic PoCUS techniques remain less familiar, a gap evident in the current literature. The extent to which orthopedic ultrasound techniques are actively employed in clinical practice for evaluating suspected orthopedic injuries remains to be determined due to a lack of literature on the subject. Therefore, the primary objective of this study is to assess the effectiveness of training clinicians to apply ultrasound to various common pathological states, specifically targeting the discussed orthopedic pathologies.

The novelty of employing PoCUS for orthopedic applications, particularly in rural settings, is reflected in the limited available studies. Given the probable lack of experience among rural clinicians in orthopedic PoCUS, this project serves a dual purpose: advocating for its integration into rural clinics and developing effective teaching methods to facilitate its utilization. This initiative aims to address the unique challenges faced by rural healthcare providers, promoting accessibility to advanced diagnostic tools and contributing valuable insights to the broader medical community.

## METHODS

**Study Design and Setting**:

A study was conducted on clinicians practicing at rural clinics in Indiana. Eligible participants were included if they were practicing in a rural-defined county in Indiana. Clinicians were recruited through an association with the Indiana University School of Medicine (IUSM) Rural Track Program in Terre Haute and volunteered after being informed via email that the project was ongoing. Physcians participants were third year Family Medicine Clerkship preceptors. Training events were scheduled in advance at the convenience of the location. In-person training events began with reviewing and acknowledging the informed consent statement. Online didactic material before the training session included hand-picked text and videos from the IUSM PoCUS database and other online platforms like YouTube. The in-person training session focused on hands-on practice and answering questions specific to the participant.

This study was approved by the Indiana University IRB, protocol number 17769.

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**Materials and Data Collection:**
Grant funding was used to equip these clinics with portable ultrasound probes with PoCUS-software-equipped iPads connected to the Indiana University network with Cerner connectivity. Clinicians were subsequently trained with approximately one hour of independently reviewed didactic material and two hours of in-person training. The one hour of didactic material included a file with links to videos from Indiana University School of Medicine's PoCUS YouTube channel, FOAMed online videos, and Ultrasound for Primary Care textbook chapter links. *** The topics included basic ultrasonography and a focus on orthopedic applications, including shoulder rotator cuff, carpal tunnel, knee effusion, and soft tissue abscess evaluation. Aortic, deep venous thrombosis, cardiac, and pulmonary topics, were included in the file, as well. Physicians were encouraged to spend at least 1 hour going through the material that fit their learning style the best, prioritizing basic ultrasonography and orthopedic applications before other topics.

The two hours of in-person training was done at the participants' clinics with both primary investigators and at least one student investigator serving as the instructors. If there was more than one clinician at an office, the training session was done together. For most of the training sessions, there were three instructors to one clinician. The session started off with a quick orientation of the equipment before reviewing the orthopedic applications they had learned about during their didactic session. A side show was used to structure each topic, showing how to obtain an image and what the image should look like. Pathologic images were also included in the slide show to help identify abnormalities they might encounter. The students and primary investigators served as models for the clinicians to practice with. If time allowed or the clinicians specifically requested, other topics were taught and practiced, as well.

A pre-session survey was collected prior to the in-person training session. This was completed in-person, on a paper survey immediately before the session began. The first post-session survey was collected immediately following the training session as well. Online resources were provided for clinicians to refer to as they incorporated the PoCUS technology into their clinics. They were encouraged to expand their skill set for new pathology as they felt comfortable. In order to follow up face-to-face, virtual tele-guidance training sessions were offered after the initial encounter. The second post-session survey was emailed approximately six months after the initial encounter and was collected through a Google Survey link. Surveys were not anonymous to help correlate with each participant's particular training experiences.

**Outcomes and Data Analysis:**
The primary outcome of this study was to evaluate the effectiveness of training rural clinicians to apply point-of-care ultrasound technology for expanded examination, specifically for orthopedic care. The secondary objective of this study was to assess the logistics and mechanisms of how a study of this nature can best be performed. The data was analyzed using Microsoft Excel.

## RESULTS

A total of six clinicians were trained and surveyed. No encounters were excluded.
In the pre-session survey, we found that these clinicians' previous PoCUS experience varied greatly, from never using ultrasound to only obstetric applications to prior dedicated training. However, nearly all these clinicians have not used ultrasound in their clinic within the last year and are uncomfortable with the Butterfly IQ type PoCUS technology. Figure 1 shows the distribution of concerns that were indicated by clinicians about incorporating PoCUS into their practice.

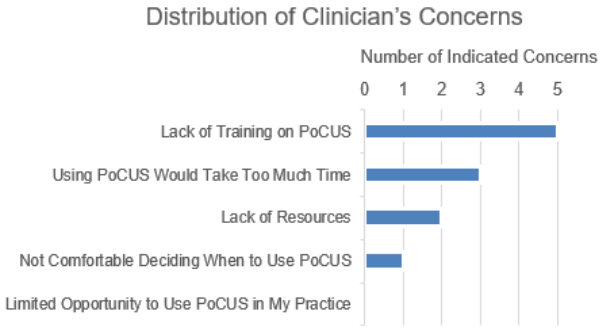


*Figure 1: The distribution of clinicians' specific concerns about incorporating PoCUS into their practice as reported in the pre-session survey.*

The most frequently reported concern was lack of training. Other reported concerns include a lack of

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time, resources, and knowledge on when to use this technology. The concern about the lack of opportunity to use PoCUS in their clinics was not indicated by any of the clinicians. The pre-session survey also showed that all of these clinicians make orthopedic diagnoses in their practice, specifically carpal tunnel syndrome, rotator cuff pathology, knee joint effusions and bursitis, and differentiating and confirming abscess from cellulitis. However, none felt comfortable using ultrasound to support these diagnoses.

As shown in Figure 2, the first follow-up survey revealed an improvement from the pre-session survey: All clinicians were at least "somewhat comfortable" using PoCUS to make orthopedic diagnoses after two hours of training. This improved to the point that the majority are also "somewhat comfortable" teaching this material to others.

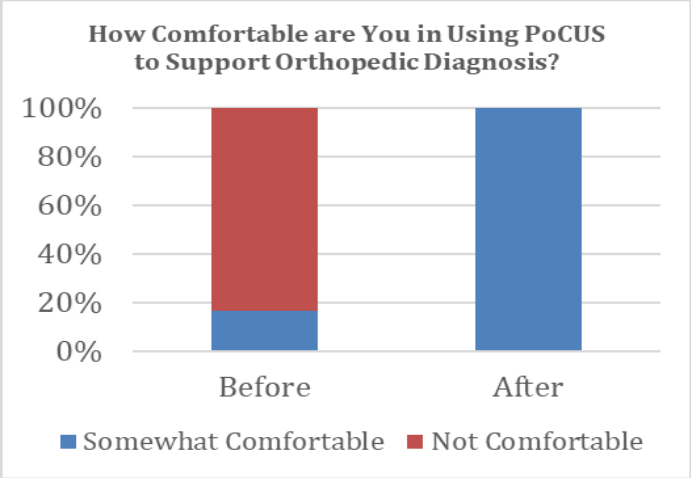


*Figure 3: Comfortability in using PoCUS before and after the in-person training session.*

The second post-session survey collected approximately six months after the training, showed equal reports of the barriers to using PoCUS, as seen in Figure 3. Reoccurring qualitative themes that appeared in the comments included the clinicians' busy practices, software issues, and personal lives. Time constraints due to patient volume and appointment length limited the participants from incorporating PoCUS into their practice. The software issues were described as "One probe won't plug into my phone and the app is logged out and I can't find the correct email." It was also stated multiple times that clinicians' personal lives made it challenging to utilize PoCUS in their clinics.

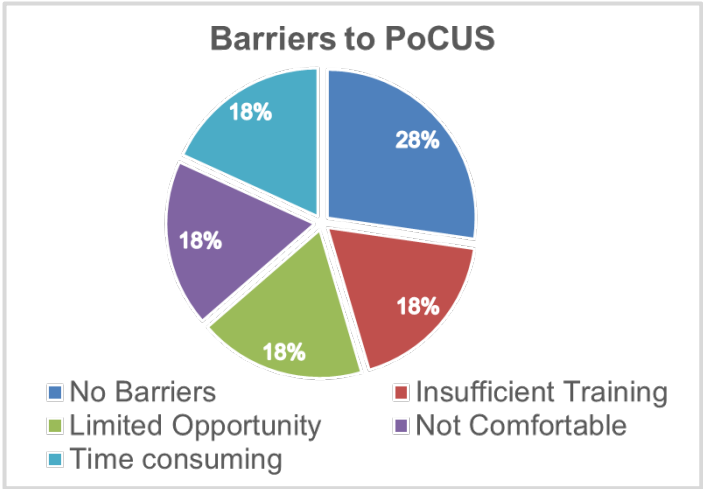


*Figure 2: Barriers to PoCUS for rural clinicians.*

One participant stated, "(I have) little time in my life to devote to learning new things," while another noted going on maternity leave altered her schedule.

## DISCUSSION

Orthopedic applications of PoCUS have significant potential in rural communities facing barriers to alternative imaging modalities and specialty care. Current literature shows a gap in knowledge of orthopedic PoCUS training techniques for rural clinicians. It was predicted that rural clinicians would not utilize these techniques well, but they would offer them practical tools for their practice. It was found that this method of integrating orthopedic PoCUS into rural clinics was feasible, easy to implement, and viewed beneficial by the clinicians. However, none felt comfortable using ultrasound to support these diagnoses after the sessions. More training would be required than what was utilized in this project to increase clinicians' comfort with POCUS to a level that could achieve change in clinical practice.

Though the PoCUS experience of the clinicians varied greatly, we found that all of these rural clinicians make orthopedic diagnoses in their practice. Despite this, they did not feel comfortable using ultrasound to support these diagnoses. This showed the potential for PoCUS in their clinical practice and the need for further training in this area, especially for rural clinicians who may not have imaging resources in their clinic already.

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After reviewing the online material and participating in the training sessions, clinicians felt more comfortable with PoCUS, specifically orthopedic PoCUS. This is important because it has been documented that rural residence is a risk factor for a larger size of non-traumatic rotator cuff tears.[19] While other programs have utilized PoCUS training for rural clinicians, our study focuses on orthopedic applications, as this is poorly adapted in other research studies. For example, a previous study implementing a longitudinal PoCUS curriculum in rural Mexico showed that only 5-10% of scans were musculoskeletal in nature.[20] Additionally, it has been found that acquiring faculty in remote areas to teach ultrasound has been difficult, especially for Family Medicine Clerkships.[21] This is due to the lack of confidence among Family Medicine preceptors without exposure to POCUS, making it challenging for them to assist or teach students in their clinics. Considering this, our work fills a gap in research on barriers and best practices to utilizing orthopedic PoCUS, particularly in rural settings and with Family Medicine trained physicians.

The barriers to incorporating PoCUS into the participants' clinics were limited opportunities, insufficient time and training, and poor comfort. Many of the clinicians had a heavy patient load with a limited allotted appointment time, making it challenging to incorporate PoCUS as a new skill. Personal schedules and life changes also made it challenging to make learning PoCUS outside of the clinic and pursuing follow-up training a priority. Lack of clear PoCUS images, along with equipment connectivity and login issues made it difficult for the participants to use this technology with ease. Part of this issue relates to the clinicians not being familiar with the IUSM electronic system since other organizations employ them. However, positive comments conveyed that the participants enjoyed having PoCUS as a teaching tool for both rotating medical students and patients alike. One participant even stated their patients benefited from "easier access to care, more direct transfers/referrals, (and) more appropriate care options." These benefits are the ultimate hope for rural communities.

Though recruiting physician participants was relatively easy, one of the biggest obstacles this study faced was scheduling the initial in-person and subsequent follow-up training sessions. The difficulty lies in lining up physician schedules with our investigators and traveling to these rural areas in a timely manner. Another obstacle this study has overcome is getting the correct equipment. In addition to the iPads and Butterfly Probes, we have also had to order supplement equipment that was not considered initially, like a carrying case, wipes, and gel.

As a pilot study, a future investigation should consider using personal iPads or phones to run the PoCUS software to create more familiarity. Scheduling follow-up sessions and the second post-session surveys at the initial training session would also be beneficial, as calendar reminders and office staff could help initiate these events more easily. Future plans include extending this study for additional follow-up. The participants have been allowed to keep the equipment and software to continue using in their clinics. An additional follow-up would allow us to determine what other applications are most valuable for these clinics and the role of tele-guidance in further training.

## LIMITATIONS

The major limitation of this study is the sample size. Additionally, though different rural communities were represented, bias may be present due to the sample being located in a similar southern region of the state. Expansion of the sample size across the state would allow for more representative data. Bias may exist in the pre-session and first post-session surveys as they were completed while investigators and students were physically present for the in-person training session. Additional bias may be present because the surveys were not anonymous.

## CONCLUSIONS

Musculoskeletal PoCUS was well received by rural clinicians, and the teaching session was feasible and easy to implement. Given none of the clinicians felt comfortable using PoCUS to support these diagnoses, more training would be required than what was utilized in this project to increase clinicians' comfort with POCUS to a level to achieve change in primary care clinical practice.

## ACKNOWLEDGMENT

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**SUPPLEMENTAL MATERIAL**

**Survey 1 (Pre-training survey) Questions**

1. How many times did you practice using ultrasound during your undergraduate or graduate medical education?
    a. Never
    b. Obstetric applications only
    c. Used regularly in rotations
    d. Had a special elective or other dedicated training for 2 weeks or more

2. When was the last time you used ultrasound on a patient?
    a. During medical school
    b. During residency
    c. At a previous practice
    d. At current practice
    e. I have never used it

3. Do other practitioners at your clinic use point-of-care ultrasound?
    a. Yes
    b. No
    c. In the past, but not currently
    d. Unknown

4. How frequently have you used non-obstetric ultrasound in your practice in the last year?
a. None
b. 1 to 10
c. 11 to 50
d. 51 or more

5. How comfortable are you with the Butterfly IQ type of point-of-care ultrasound technology?
a. Not comfortable at all
b. Somewhat comfortable
c. Very comfortable

6. What doubts, if any, do you have regarding the use of ultrasound in your practice? (Please select all that apply)
a. Lack of training on operating ultrasound
b. Limited opportunity to use ultrasound in my practice
c. Not comfortable deciding when to use ultrasound
d. Using ultrasound would take too much time
e. Lack of resources (no ultrasound machine, low support)
f. No doubts

7. How comfortable are you in using ultrasound for obstetric purposes?
a. Not comfortable at all
b. Somewhat comfortable

c. Very comfortable

8. As part of your practice, do you make orthopedic diagnoses? (Please select all that apply)
a. No
b. Yes, for carpal tunnel syndrome
c. Yes, for rotator cuff
d. Yes, for knee joint effusion/bursitis
e. Yes, to differentiate or confirm abscess from cellulitis

9. If you answered “Yes” above, are these patients typically referred to specialist or for further scans for confirmation?
a. Yes
b. No
c. Unsure

10. Have you ever used ultrasound to support orthopedic diagnosis? Please mark all that apply)
a. No
b. Yes, for carpal tunnel syndrome
c. Yes, for rotator cuff
d. Yes, for knee joint effusion/bursitis
e. Yes, to differentiate or confirm abscess from cellulitis

11. How comfortable are you using ultrasound to support orthopedic diagnosis?
a. Not comfortable at all
b. Somewhat comfortable
c. Very comfortable

12. Have you ever used ultrasound to evaluate vascular conditions? (Please mark all that apply)
a. No
b. Yes, for aortic aneurism
c. Yes, for deep vein thrombosis
d. Yes, other _____

13. How comfortable are you using with using ultrasound for evaluating vascular conditions?
a. Not comfortable at all
b. Somewhat comfortable
c. Very comfortable

14. Is there a particular point-of-care ultrasound application you believe you would use most frequently, other than obstetric?
(free response)

**Survey 2 (Immediate post-training survey)**

1. In what ways has your knowledge in using PoCUS for non-obstetric diagnostics improved following the training?

(free response)

2. Has your enthusiasm in using PoCUS increased after this training?

a. Yes, it has increased
b. Neutral, it's about the same
c. No, I am less enthusiastic

3. Would you be confident enough to teach others what you have learned from this training?

a. Not comfortable at all
b. Somewhat comfortable
c. Very comfortable

4. How comfortable are you using the Butterfly IQ type of point-of-care ultrasound equipment following training?

a. Not comfortable at all
b. Somewhat comfortable
c. Very comfortable

5. After this training, do you see yourself using PoCUS to screen for orthopedic conditions? (Please select all that apply)

a. No
b. Yes, for carpal tunnel syndrome
c. Yes, for rotator cuff
d. Yes, for knee joint effusion/bursitis
e. Yes, to differentiate or confirm abscess from cellulitis

6. After this training, how comfortable are you with using ultrasound to evaluate orthopedic conditions?

a. Not comfortable at all
b. Somewhat comfortable
c. Very comfortable

7. After this training, do you see yourself using PoCUS to evaluate vascular conditions? (Please select all that apply)

a. No
b. Yes, for aortic aneurysm
c. Yes, for deep vein thrombosis

8. After this training, how comfortable are you with using ultrasound for screening for vascular conditions?

a. Not comfortable at all
b. Somewhat comfortable
c. Very comfortable

9. Did didactic material supplement the PoCUS training?

a. Yes
b. Neutral
c. No

10. Was this training adequate to improve your confidence in your ability to implement some of the exams in your practice?

(free response)

**Survey 3 (Last follow-up survey)**

1. How many times per month have you used non-obstetric PoCUS since the training?

(free response)

2. How comfortable are you with the Butterfly IQ type of point-of-care ultrasound technology?

a. Not comfortable at all
b. Somewhat comfortable
c. Very comfortable

3. Have you used ultrasound to support orthopedic diagnosis? Please select all that apply:

a. No
b. Yes, for carpal tunnel syndrome
c. Yes, for rotator cuff
d. Yes, for knee joint effusion/bursitis
e. Yes, to differentiate or confirm abscess from cellulitis

4. Have you used ultrasound to support vascular diagnosis? Please select all that apply:

a. No
b. Yes, for aortic aneurysm
c. Yes, for deep vein thrombosis
d. Yes, other (free response)

How comfortable are you with using ultrasound to support orthopedic diagnosis?

a. Not comfortable at all
b. Somewhat comfortable
c. Very comfortable

5. How comfortable are you with using ultrasound for evaluating vascular conditions?

a. Not comfortable at all
b. Somewhat comfortable
c. Very comfortable

6. What barriers, if any, did you encounter regarding the use of ultrasound in your practice?

a. Insufficient training to reliably implement in practice
b. Limited opportunity to use ultrasound in my practice
c. Not comfortable deciding when to use ultrasound
d. Using ultrasound would take too much time
e. Lack of resources (no ultrasound machines, low support)
f. No barriers
g. I did not attempt to implement ultrasound in my practice
h. Other (free response)

7. Did you utilize any of the supports for point of care ultrasound? Please select all that apply:

a. No
b. Yes, I utilized the Butterfly IQ remote diagnostics

c. Yes, I attended one or more meetings of the PoCUS ECHO
d. Yes, I reached out to members of this project team with questions
e. Other (free response)

8. In what ways did ultrasound training change your practice? (If it did not, mark N/A)
(free response)

9. In what ways did your patients benefit from the use of ultrasound in your practice? (If no benefit, please mark N/A)
(free response)

10. Would you endorse the use of ultrasound to other physicians of similar practice to yours?
(free response)