

Rural Family Physician Use of Point-of-Care Ultrasonography: Experiences of Primary Care Providers



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*Submitted by the Centre for Rural Health
Research*

 **Rural IN PoCUS
Evaluation**

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Abstract Summary

Introduction

In British Columbia (BC), the distribution of radiology infrastructure is concentrated in large regional centers, which has created a problem of lack of proximal access to radiographic services in rural and remote areas. Although point-of-care ultrasound (PoCUS) is used in many rural Canadian emergency departments, a barrier to its greater use is lack of health system infrastructure to support implementation including limited training opportunities. Poor access to radiographic services in rural settings present a challenge to timely diagnosis and screening across many disease states and for healthy pregnancies. A solution to the lack of access to radiographic services in rural settings is broader application of PoCUS by local general practitioners (GPs), enabled by increased access to training, subsidized ultrasound probes and support provided by regional specialists.

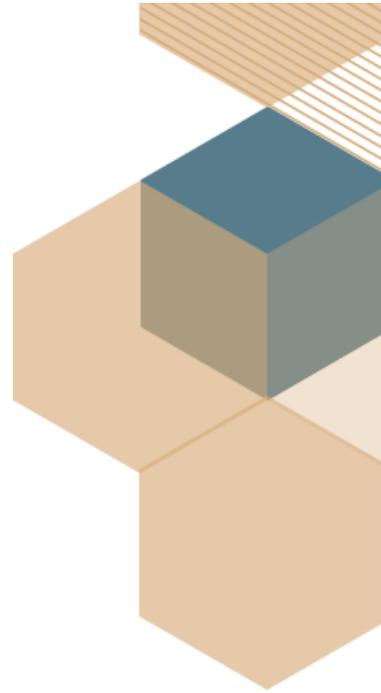
Methods

This qualitative study conducted in-depth virtual interviews with 21 GPs across rural BC on participants' motivation to participate in RCCbc program, the type of training they received, their current use of PoCUS, their experience with the technology and their experience interacting with specialists in regional centres. Thematic analysis of findings were undertaken.

Findings

Findings were described from the perspective of Rogers' five elements of diffusion of innovation and included:

1. The relative advantage of PoCUS (better decision-making, increased job satisfaction, facilitated procedural care and useful for determining acuity of COVID-19);
2. PoCUS' compatibility with existing values and experiences of adopters and seen as an extension of the physical exam, differentiated from formal imaging;
3. Perceptions of the complexity focused on complexity of the practice context as opposed to the technology itself;
4. Areas in which PoCUS could be trialed and modified included billing structures, a framework for education, subsidized probes for rural providers and feedback on scans from specialists;
5. Areas of outputs of PoCUS available to others were understood through patient and provider satisfaction and PoCUS peer support networks.



Recommendations

1. That PoCUS use be supported for rural health care providers through subsidized access to technology and education;
2. That a Quality Assurance Framework be integrated into peer support programs for real-time case review;
3. That a Mechanism for Rapid Diffusion of PoCUS be developed to ensure maximal benefit to Rural Patients and Care Providers;
4. Support be available for Skills Development and Skill Maintenance;
5. Support be available for dedicated PoCUS Mentors;
6. Provide Infrastructure for a PoCUS Community of Practice
7. Develop and Support a Framework for ongoing evaluation and Continuous Quality Improvement

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Executive Summary

Introduction

In British Columbia (BC), the distribution of radiology infrastructure is concentrated in large regional centers, which has created a problem of lack of proximal access to radiographic services in rural and remote areas. Although point-of-care ultrasound (PoCUS) is used in many rural Canadian emergency departments, a barrier to its greater use is lack of health system infrastructure to support implementation including limited training opportunities. Poor access to radiographic services in rural settings present a challenge to timely diagnosis and screening across many disease states and for healthy pregnancies. A solution to the lack of access to radiographic services in rural settings is broader application of PoCUS by local general practitioners (GPs), enabled by increased access to training, subsidized ultrasound probes, and support provided by regional specialists.

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Findings

Findings were described from the perspective of Rogers' five elements of diffusion of innovation and included:

1. The relative advantage of PoCUS:
 - Participants reported PoCUS use led to better decision-making including a reduction in patient transfers to a higher level of care;
 - PoCUS led to increased job satisfaction for many;
 - PoCUS was valued as a visual guide for procedures;
 - Some found PoCUS Lung scan helpful determining the acuity of COVID-19
2. PoCUS' compatibility with existing values and experiences of adopters:

- PoCUS was seen by most as compatible with generalist practice and as an extension of the physical exam;
 - It was differentiated from formal specialist imaging;
 - There was a resounding awareness of the need to stay within a generalist scope of practice with scans to avoid adverse consequences.
3. Perceptions on the complexity of PoCUS:
- Overall, the technology itself was not seen to be complex;
 - Challenges were expressed in connecting and uploading images to the IN PoCUS databank;
 - There was a sense of social and professional complexity to the practice context;
 - This complexity extended to knowing the limits of generalist PoCUS practice and when a scan may not be useful.
4. Areas in which PoCUS could be trialed and modified:
- Modifications were suggested to billing structures with the potential for PoCUS billing codes;
 - Participants suggested an iterative process to develop and framework for PoCUS education;
 - Trialability was suggested for further funding to support subsidized probes, and
 - A modified process was suggested for feedback on scans from specialists and opinion leaders.
5. The degree to which the outputs of PoCUS are available to others:
- Increased patient and provider satisfaction were identified as outputs of rural PoCUS;
 - Mechanisms of further observable outputs included informal peer-support PoCUS-user networks and review of scans by referral specialists.

Emerging Recommendations

The findings from this study, understood within the context of international literature attesting to the value and safety of PoCUS use by Family Physicians in rural settings and in anticipation of similar data that will be gathered in BC (forthcoming spring 2022), underscore the following systems level and program recommendations:

Recommendation #1: That PoCUS use be supported for rural health care providers through subsidized access to technology and education.

The provider cost to access PoCUS technology and education is significant: although the technology leads to better patient care and the potential for increased health system efficiency by mitigating the draw on specialist imaging services, there is currently no mechanism to recoup initial costs through direct billing. Expansion of subsidized access to PoCUS probes and educational programming is warranted.

Recommendation #2: That a Quality Assurance Framework be integrated into peer support programs for real-time case review.

Quality Assurance mechanisms for PoCUS scans should include real-time case review by the community of rural PoCUS users to ensure the maintenance of safety and quality. The results of this process should be made transparent and available to the wider community through aggregate reporting that respects the privacy of individual providers and the confidentiality of patients.

Recommendation #3: That a Mechanism for rapid diffusion of PoCUS be developed to ensure maximal benefit to rural patients and care providers.

Emerging evidence in British Columbia is aligned with international evidence in suggesting that the use of PoCUS in low-resourced rural and remote practice settings increases provider satisfaction and leads to better patient care. Given the relative cost-benefit of the technology and the need to support rural providers to achieve the goal of reducing health disparities and

promoting equity for rural communities, rapid diffusion of the technology across rural BC is warranted.



Recommendation #4: That support be available for skills development and skill maintenance

1. Support hands-on PoCUS training sessions where possible;
2. Organizing hands-on practice sessions among PoCUS peer support groups;
3. Provide refresher course close to home for PoCUS users in an environment that is conducive to learning (provide access to probes, a variety of patient models, and adequate time to scan patients), and
4. Support peer-to-peer teaching by developing a structure and opportunity for 'superusers' to coach novice or intermediate PoCUS users.

Recommendation #5: That support be available for PoCUS mentors

Having a full-time dedicated PoCUS mentor or consultant who can:

- a. Providing consultations on image generation and image interpretation;
- b. Provide one-to-one coaching and skill development; and
- c. Who can design and coordinate CME/peer support programs to further develop and maintain the skills of PoCUS users

Recommendation #6: Provide Infrastructure for a PoCUS Community of Practice

Foster a PoCUS community by creating a PoCUS virtual forum to:

- a. Share information and ideas;
- b. Foster skill development and maintenance and
- c. Share tips on integrating PoCUS into clinical practice, uploading scans into the database, accessing resources such as RUDI/ROSi.

Recommendation #7: Develop and support a framework for ongoing evaluation and CQI

1. Establishing peer-to-peer mentorship with superusers to review scans;
2. Establish a PoCUS book club to review the scans that were uploaded to further develop skills in a specific area/interest and review emerging evidence from other jurisdictions.

An Evaluation to Assess the Efficacy of the Use of PoCUS in Rural Settings in British Columbia: Findings from Phase I

Introduction

Increasingly, ultrasonography is used part of clinical examinations among many clinical specialities, including general medicine.¹ As a portable handheld device, Point-of-Care Ultrasonography (PoCUS) provides real-time feedback. Its high resolution allows clinicians to use PoCUS as a bedside test to provide timely and accurate diagnoses.^{2,3} Instead of using PoCUS as a diagnostic tool, PoCUS is commonly used as an ancillary strategy as part of a comprehensive clinical assessment to facilitate the most appropriate course of care by answering simple clinical questions.^{4,5} For example, physicians can rule in or out an abdominal aortic aneurism or determine if the fetal head position is facing up or down.

Rural communities across Canada face health service delivery challenges. There are gaps in local health care infrastructure, including access to diagnostic imaging services. To diagnose and treat patients, rural physicians often have to transfer or refer patients out of their community, particular after-hours, to receive access to appropriate diagnosis services at major hospitals.⁶ Consequently, rural patients often experience delays in receiving timely diagnosis and treatment.⁶ Studies have noted the efficacy of PoCUS in rural general medicine in improving clinical decisions and patient management in primary, in-patient, emergency, and obstetric care.⁷⁻¹⁰

Moreover, the affordability and portability of PoCUS probes make access to ultrasonography accessible to rural physicians. The built-in WiFi, artificial intelligence-assisted diagnosis, and connectivity to smartphones and tablets render PoCUS a valuable tool for facilitating timely diagnoses and informing clinical decision-making with consultation from a specialist or peer.¹¹ The utility and efficacy of PoCUS has been

demonstrated in Canada as well as in other countries, including Australia, New Zealand, Denmark, and the United States.¹²⁻¹⁶

Despite the many benefits of PoCUS, numerous studies continue to note limited uptake in PoCUS use. 72% of rural GPs in Whitehorse, Yukon Territory, stated that incorporating PoCUS in their practice would positively affect patient care and improve clinical decision-making. However, the lack of training opportunities, available probes, and personal confidence in the skill prevented GPs from fully incorporating PoCUS in their clinical practice.¹² Overall, PoCUS use in general practice remains limited despite a wealth of training experience and interest among rural Family Physicians and supporting specialists. There is a need to address and remove barriers to facilitating the integration and uptake of PoCUS among rural Family Physicians and healthcare decision-makers in Canada.

To increase ultrasound capacity and use in rural BC communities, the Joint Standing Committee on Rural Issues has provided funding through the Rural Coordination Centre of BC (RCCBC) to support rural Family Physicians' who want to include PoCUS in their clinical practice. With this funding, 50 rural GPs across BC have been issued ultrasound probes and training on the use of the probes. As part of this "Intelligent Network for PoCUS" (IN PoCUS) program, recipients of the probes were asked to upload their ultrasound images onto an online platform to build a provincial reference database. Phase I of this evaluation study aims to explore how PoCUS is being used in rural BC communities. Specifically, this study aims to:

1. Understand the experiences of participants in the IN PoCUS program (rural GPs using ultrasound probes and regional referral specialists providing ultrasound consultation);
2. Identify the scope of PoCUS practice and training for rural GP participants in the IN PoCUS program; and

3. Understand the perspectives of key provincial and national stakeholders on rural PoCUS training and use.

Methods

This qualitative study sought to understand the importance of and process through which PoCUS has been integrated into rural general practice in BC among a cohort of rural physicians who received subsidized Clarius probes from the Rural Coordination of BC. In-depth interviews were conducted with GPs who are participants of the IN PoCUS program. A thematic approach to coding the data was used. Ethics approval was granted by the University of British Columbia's Behavioural Research Ethics Board.

Participant selection: A letter of invitation was sent out to all 50 participants who were enrolled in the IN POCUS program. Rural GPs who were interested in participating in a research interview reached out to the research team. Out of 50 participants, 21 participated in the study.

Data Gathering:

To minimize the exposure to and transmission of covid-19, interviews took place over Zoom. An interview guide was developed based on knowledge gained from a scoping literature review on the experiences of PoCUS in rural settings. A study advisory committee consisting of rural GPs and PoCUS users provided additional comments on the interview guide. The interview guide covered topics on participants' motivation to participate in RCCbc program, the type of training they received, their current use of PoCUS, their experience with the technology and their experience interacting with specialists in regional centres. See Appendix 1 for the complete interview guide. The semi-structured interviews lasted between 22 to 67 minutes. All interviews were audio recorded and transcribed with the participants' permission.

Analysis:



A thematic analysis framework outlined by Braun and Clarke (2006) was used to analyze the data.¹⁷ One Research Assistant and two students analyzed the data independently using an inductive approach to develop salient themes and sub-themes from the interview and compared findings to determine the degree of congruency. As there was a high level of agreement on the salient themes with only minor variations in semantics, a code book was developed based on the themes articulated to guide the rest of the coding. This process led to a high degree of validity.

Findings

Theoretical Framework



We considered users' experiences of PoCUS from the perspective of the *diffusion of innovation* and used the characteristics described to Rogers (1962) in his influential work expressed through the Diffusion of Innovation (DOI) theory.¹⁸ DOI theory provides an explanatory framework to understand how an idea, product or process spreads through a population or social system over time, with the end result being the adoption of a new practice. Rogers defined diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system," with successful diffusion contingent on the individual's perception of the innovation.^{19(p5), 20(p 17-18)} He noted the importance of exposure to the innovation across time as a key influence in adoption.

Rogers developed a model that articulated a social process that includes different stages of adoption, each phase led by groups with distinct characteristics. There are five adopter categories: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards.

'Innovators' are those who want to be the first to try the innovation (willing to take risks and in need of little encouragement). 'Early Adopters' are often opinion leaders who are comfortable adopting new ideas and only need implementation guidance ('how-to' guides). This group does not need to be coerced or convinced to adopt the innovation.

The current group of IN PoCUS participants in British Columbia rests within these two groups. The 'Early Majority' do not adopt new ideas before the average person and generally need to see evidence that the innovation works prior to adoption. The 'late majority' are more skeptical of change and will only adopt an innovation after it has been tried by the majority whereas 'Laggards' are those who are skeptical of and resistant to change and require pressure from others in the adopter groups to embrace the innovation.

The perception that the new practice is beneficial or improves existing practices is key to the adoption of innovation and, as Rogers noted, it does not happen in a uniform way but instead permeates through a population in discrete steps as just described. Rogers (1962) also described, however, five elements of an innovation or new technology that will determine the speed of its movement through the adoption phases.¹⁸ They include:

1. *Relative advantage* (the "degree to which an innovation is perceived as better than the idea it supersedes.")
2. *Compatibility* (the "degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters."^{18 (p15)})
3. *Complexity* (the "degree to which an innovation is perceived as difficult to understand and use."^{18 (p16)})
4. *Trialability* (the "degree to which an innovation may be experimented with on a limited basis,"^{18 (p16)} and
5. *Observability* (the "degree to which the results of an innovation are visible to others."^{18 (p16)})

Findings from interviews with PoCUS users in BC who received a Clarius probe from RCCbc will be presented through their reflections on these five characteristics. In this way, we can consider how social forces driving innovation (to optimize diagnosis and

treatment in rural and remote communities) lead to both clinical practice experiences and insights into the characteristics of those who are ‘early adopters’.

Relative advantage

Key Points:

- *Participants reported PoCUS use led to better decision-making including a reduction in patient transfers to a higher level of care;*
- *PoCUS led to increased job satisfaction for many;*
- *PoCUS was valued as a visual guide for procedures;*
- *Some found PoCUS Lung scan helpful determining the acuity of COVID-19*

Participants reported that the use of PoCUS provided a ‘relative advantage’ in their clinical practice. They identified improved clinical decision making and job satisfaction as two major relative advantages and noted that PoCUS provided the advantage of having additional information that can inform clinical decision making. Several participants emphasized the convergence of information gained from the scans with the patient’s history and physical exam, as well as other diagnostics, lead to better decision making and transfer avoidance. Some saw the use of PoCUS as “an extension of the physical exam” while others noted the value of PoCUS as a visual guide for procedures, for example inserting a central line or IUD. Many participants referenced the advantage of PoCUS to improve system functioning, specifically by reducing the draw on formal imaging services. One participant noted the value of this specifically for maternity care:

I wasn't sure [if] one of my... patients was breech. I didn't have to send her to the hospital, right? I could just do a quick office ultrasound... or if they couldn't feel, you know, find a fetal heart at 13 weeks when they should've been able to, they would send their patients to me instead of bothering the hospital. So, for obstetrical reasons, [I could] take the load off of the hospital.

Others expressed the value of using PoCUS in other clinical areas such as diagnosing fractures (“I’ve had a few fractures that were only diagnosable with ultrasound”) and heart failure (“I did a chest X-ray and the mediastinum in his heart looked a bit enlarged. So then, I put the ultrasound on and he had a massive pericardial effusions...”).

The overarching value of PoCUS to rural practice was consistently expressed by almost all participants with observations like, “it is game changer for small communities”, “I suppose I could practice without it, but it would not be the same”, “very rarely a day goes by that [PoCUS] isn’t helping with care in a substantial way” and “I could never go back to not using ultrasound... I think if I worked in a place that didn't have ultrasound, I would be quite anxious”. Summatively, one participant noted, “[I]t’s an incredibly important tool that I don’t think I can practice in rural Canada without any longer”.

Beyond the practice advantage, almost all participants in this study noted the role of PoCUS in improving job satisfaction. The importance of care providers’ job satisfaction in health care sustainability has been well-recognized and documented and is now included in Institute for Healthcare Improvement’s (IHI) Quadruple Aim (along with better health outcomes, better satisfaction and lower costs).^{21,22} Overall, participants in this study observed the simplification of their job due to PoCUS (‘It makes our job way easier’) and the concomitant improvement in patient care. As one participant noted,

But there are certain instances where you can get a positive [result], interpret it, make a clinical decision that changes the outcome and helps the patient a lot. So that’s where it really makes a difference for me. I don’t have those experiences all the time [but] whenever that happens, it really makes it all worthwhile.

This was perhaps noted most consistently when applied to maternity care. The immediate feedback it allowed providers to communicate to patients, particularly in communities without access to formal ultrasound services.

A key attribute of increased satisfaction for many was increased confidence ('I find [I have] more confidence...especially during the times of COVID, it's been amazing'). This was linked by others to a sense of empowerment:

[PoCUS] became a way to really validate your physical exam skills or validate your physical exam findings. It allowed you to be able to do... these things with ultrasound guidance ... it was very empowering.

Summatively, increased job satisfaction was directly linked to participants' increased capacity to provide improved patient care. As one participant noted, '[I]t brings you back to the bedside. And so, it brings back the humanity of medicine for me in many ways.'

Others noted the advantage the availability of PoCUS had in recruitment to low volume sites, with any interested candidates reassured by the availability and uptake of PoCUS in early-adopter communities.

Finally, several participants noted the advantage of PoCUS in the context of COVID-19 ('doing lung PoCUS on somebody would be something that would be beneficial no matter what kind of access to specialist care or advanced imaging you had'). Others noted that although a COVID-19 diagnosis (and level of acuity) is based on the presentation of clinical symptoms, ultrasound was seen as helpful by providing additional clinical information. As one participant noted,

[It] might not change anything you're going to necessarily do. However it might change the conversation that you have with the patient. You can say, 'from what I'm seeing, I now more strongly believe that you have a viral pneumonia such as COVID.'

A few participants cited COVID-19 as a barrier to the use of PoCUS due to concerns around transmission.

Compatibility

Key Points:

- *PoCUS was seen by most as compatible with generalist practice and as an extension of the physical exam;*
- *It was differentiated from formal specialist imaging;*
- *There was a resounding awareness of the need to stay within a generalist scope of practice with scans to avoid adverse consequences*

Almost all participants in this study noted that the use of PoCUS was an extension of their generalist medical training and experience. Participants frequently articulate their use of PoCUS as an extension of the physical exam or ‘extending the senses of a practitioner.’ This sense of compatibility was seen as foundational to widespread adoption due to low barriers to usage (‘I don’t want to lose the quality of the ultrasound being an extension of the physical exam because that, to me, lowers the barrier to people using it’). Others expressed more directly their view of PoCUS as an extension of known skills. As one participant said:

I was teaching med students percussion... And I was like, this is just ultrasound, but old school... you’re basically using sound waves to try and detect fluid under a structure... And now, we have an ultrasound machine that can help us visualize what we were listening to before. [T]o me, that’s so powerful... We do need to make sure there’s safety that it’s being used in a safe way.

For some, a sense of compatibility was reflected through the awareness of what their role vis-à-vis PoCUS was *not*: an equivalent or replacement of specialist diagnostic imaging (‘...a diagnostic scan is a very different kettle of fish with some very, very strict and clear parameters and is an incredibly useful tool. It’s just a different tool than point-of-care ultrasound’). Participants recognize specialized diagnostic imaging to be outside of their scope of practice, training, and comfort. This distinction between specialists imaging and PoCUS reinforced the compatibility of PoCUS use with generalism. This

grounding of the use of PoCUS for Family Physicians created a container for practice that was aligned with participants' education and training and allowed them to set clear boundaries regarding things they were *not* comfortable doing. As one participant observed:

I don't have a problem saying 'no, I'm not doing that. It's not safe'... I can't have that become the precedent or the kind of standard, because it's not the standard of care... [L]ike the DVT is a classic example: we're trying to do the patient a favour, we're trying to save them from having to travel, but if you miss an actual DVT and they have a PE and die, you haven't done the patient a favour.

This sense of limiting PoCUS to situations within generalist scope and training noted by almost all participants in this study, underscored by a strong sense of caution to not exceed their expertise due to the potential for significant clinical consequences. Another participant noted:

I am officially certified to do kind of like the-the first trimester scans to confirm an intrauterine pregnancy, but I think it is such a high-risk scan for a false positive... if you miscall that, the downside is infinite. So... I struggle with that one.

Moreover, participants extended their awareness of their generalist skillset to the application and interpretation of PoCUS:

So, there could be things that I'm missing, but I think I'm careful enough with my clinical judgment that I would never send somebody... out of the department where I'm clinically concerned and my scan is negative and then I just say, 'oh well, my scan was negative so we're good'... I don't fully rely on my scanning to make decisions like that.

There was an overall appreciation of PoCUS as a clinical tool, rather than a diagnostic test for most participants in this study, best applied to answer specific 'yes-or-no' questions. Several participants cautioned against 'fishing expeditions' due to the danger of 'finding something you are going to misinterpret'. When an unanticipated finding did arise, participants noted the importance of a radiological consult. This was congruent with others who noted that a key attribute to rural PoCUS use was 'being honest about your limitations'.

Complexity

Key Points:

- Overall, the technology itself was not seen to be complex;
- Challenges were expressed in connecting and uploading images to the IN PoCUS databank;
- There was a sense of social and professional complexity to the practice context;
- This complexity extended to knowing the limits of generalist PoCUS practice and when a scan may not be useful.

Participants in this study identified two levels of complexity in the using PoCUS: technological complexity and a sense of social complexity arising out of the practice setting. The former was seen to be easily addressed with additional exposure to the technology while solutions to the latter were less determined.

Technological complexity was articulated by participants in terms of learning how to use and interact with the new technology. There were expected challenges of getting to know a new system ('It takes a little bit of a while to load up, it's not as fast as something that's plugged into the machine [that] can start up right away'). Many participants noted challenges with connectivity ('It's always a little bit cumbersome'),

including choice of connecting modality (Wifi, LAN, data).

Others noted the propensity to forget to charge the battery (of both the probe and the enabling cell phone through which it works) and that the Clarius probe itself 'can be finicky.' Other entry-level challenges included determining how to best physically incorporate the probe into the practice setting ('...do people carry it, do you put it in your pocket? How do you bring it to the bedside?'). In the context of COVID-19, others noted difficulty negotiating the use of the probe in a bag to ensure a sterile environment. Regardless of the simplicity of addressing

the perceived technological challenges, most participants noted that when confronted with any technological perturbations, they were less inclined to use the technology.

Although most participants in this study reported that the technology of PoCUS was straightforward to adopt and use with minimal instruction, they expressed practice setting complexities of ensuring accurate clinical diagnosis. Many participants mentioned that they had to constantly navigate the boundaries of their training and experience and the subsequent need to maintain “that index of clinical suspicion” in instances of scans that appear to be normal. As captured above, most participants had a high degree of caution around using findings from a scan alone in making clinical assessments, particularly when the consequences of a false negative could be significant. Relatedly was the challenge of recognizing when a scan would not be helpful, or ‘knowing when to give up.’ Many participants referred to the value of ‘healthy fear’ or, as one participant noted, the importance of ‘a respect for ultrasound before you start using it in your practice.’ These social determinates of practice were imbued with more complexity than the technology itself and involved, for some, an awareness of the propensity of rural health care providers to ‘go above and beyond.’ Participants noted the tendency when working in low-resourced environments to ‘get pressed into spreading ourselves thinner and thinner, working miracles with nothing’ or ‘being a hero rural doctor,’ while realizing as well that adverse events ‘end up on our shoulders.’ Negotiating this tension came through as a complexity of professional practice with regards to PoCUS.

The final layer of social complexity expressed by the participants was negotiating the traditionally specialist domain from a generalist perspective. This was reflected in the normative practice of formal scans done upon the patients’ arrival to a larger centre, regardless of the conclusively of the scans done locally. This was done to not only confirm the diagnosis and assess for progression, but also to ensure there was a record of the image and that it had been read by a radiologist. In some instances, formal imaging was deemed unnecessary based on the availability of the bedside scan, but usually in

instances underscored by existing, trusting relationships: 'I sent a referral to the surgeon and said you know I've arranged formal imaging, but she, the surgeon, also knew that I had also done the fellowship and so she kind of took my word for it.' Although most agreed they would not make a specialist referral without an official scan, several mentioned they would include the results of a PoCUS to the radiologist as a rationale for an urgent scan. One participant summarized the value of official scans for referred patients:

Those machines and the diagnostic imaging units are much more powerful machines, so it's a completely different study that we're doing, and we need to remember that. What we're using is meant as a, it's meant as a kind of an accessory to our clinical decision making.

Relatedly, most respondents expressed, at the minimum, a lack of 'pushback' from specialists and usually helpful support for PoCUS in rural settings. As one noted, 'I'd say that the vast majority of specialists that have been consulted where ultrasound is part of the clinical picture have been excited that we're doing bedside ultrasounds'. Others noted specialists' understanding of rural, low-resource practice settings and an appreciation that local providers do 'whatever [they] can.' Some noted that a key attribute underscoring the support was 'being honest about your abilities' and not being over-confident. Although the majority of respondents had positive consultation experiences, many also noted hearing otherwise from colleagues: 'I'm also aware of situations where it hasn't been as positive.' The minority of respondents who experienced a lack of support from regional specialists noted that the lack of support seemed to be due to the protocol of only reading images generated by Ultrasound Technicians. This created a sense of resignation for these providers.

Trialability

Key Points:

- *Modifications were suggested to billing structures with the potential for PoCUS billing codes;*
- *Participants suggested an iterative process to develop and framework for PoCUS education;*
- *Trialability was suggested for further funding to support subsidized probes, and*
- *A modified process was suggested for feedback on scans from specialists and opinion leaders.*

In the context of PoCUS, 'trialability' addresses the introduction into rural practice and the organic emergency of practice patterns, protocols and the capacity to 'course correct' based on observable process outcomes. As PoCUS is a relatively new protocol for generalist care providers, there was appreciation amongst study participants of the importance of the emergent practice patterns and for conventions to be developed in an iterative way that responds to the emergent realities of practice. Participants noted the need to seek clarity and/or solution on the following areas: integrating PoCUS into regular workflow patterns, financial considerations for using PoCUS (billing codes for generalist PoCUS use and subsidizing providers for technology and education), and creating clarity around the legal implications of PoCUS scans including regulatory guidance and accreditation.

Participants diverged on the ease with which they incorporated PoCUS into the context of their clinical practice based on whether they practiced in a fee-for-service or alternative payment setting. Consistently, those in an Alternative Payment Program (APP) setting reported ease of integration of PoCUS due to the lack of volume pressures. Many of those in a fee-for-service setting, however, found the additional time required for a PoCUS scan was incompatible with the efficiency of their practice ('Adding in a PoCUS scan usually puts me over a normal visit kind of time'). Additionally, a participant noted:

[T]here's definitely people that I'm seeing in a family practice context where I'm not telling them I have an ultrasound... because it's going to double the length of the appointment, and I can't do that when I have a full waiting room. ... It just makes my life so much more stressful when I have a whole bunch of people that now you're getting further and further behind, and it's so uncomfortable to be working on that situation.

Several participants in a fee-for-service environment noted a perceived advantage of creating billing codes for PoCUS scans to incentivize practice (such as in Ontario and Quebec): 'if you want something to get done, put a billing code on it, it'll start getting done.' Others in fee-for-service settings disagreed with this, suggesting instead that once proficient, it does not take long to complete a scan or emphasized the long-term efficiency of the upfront investment of time ('[W]hen you're still learning, it can slow you down. When you're really adept then it's like you're pulling it out on every patient because it's what you're using instead of a stethoscope, basically'). As one participant noted,

[at] the end of the day, you end up being a more efficient clinician and you do better patient care, which is the idea... it's great that you get paid to work for what you do, but you actually want to ... do better for your patient. So for me, incorporating PoCUS into my assessment only takes a few extra minutes and it provides an immense amount of extra information that'll make the patients care better.

Currently, specialists are only paid to review formal ultrasound scans undertaken by Ultrasound Technicians. A few participants in this study noted the importance of payment for specialist consults on generalist PoCUS scans ('I think that would be even more important than paying the ultra-stenographer to get the scan').

In addition to billing codes for generalist PoCUS, participants noted the value of funding for the technology itself, such as subsidized access to the Clarius probes supported by the Rural Coordination Centre of BC and training. Most participants are wary of the financial barriers involved in keeping current with PoCUS. Many participants noted that they would not have a probe if the subsidy was not available, some noting the

amount of personal expenditure that would be incurred to improve efficiency and patient care: '[Y]ou provide better patient care but you won't get any more remuneration, you'll actually take a bit of a pay [cut] to pay it off and then the training and stuff to do with it...'

Others noted the technological imperative towards improvement and obsolescence, which can be challenging due to financial barriers of keeping up-to-date with the technology. Relatedly, some participants noted the value of subsidized funding for training, such as through the Hands On Ultrasound Education (HOUSE) course, appealing to the benefits of comprehensive training programs. Participants saw value to training programs, beyond scanning and reading images to including 'the ability to not be overconfident' and, relatedly, 'They don't know what they don't know.'

Several study participants queried their legal liability for scans that lead to a course of care, particularly when the objective of the scan may be to seek information to reduce unnecessary transfers out of the community. One participant asked specifically '[D]oes this suffice in place of a formal ultrasound? Am I putting myself at legal liability by doing a AAA screen and saying, "Well, they're negative?'

Participants also noted a lack of guidance from professional bodies and the perception of the aversion to address the issue:

And that needs to change. The college has no policy on ultrasound. And they need one, they need to decide what's you know, what's in line, what's the scope of practice and what isn't. And they may be forced to do that very shortly here.

Another participant noted 'the college is going to have to issue a statement on their thoughts on point-of-care ultrasound replacing other modalities.'

Relatedly, several participants raised the issue of accreditation within the emerging practice environment, with most respondents expressing a lack of support for additional credentials ('It should be part of and embedded into the training of anybody who's doing bedside care'). Further concern was expressed about accreditation creating additional barriers to PoCUS practice:

Well, I actually hope it doesn't get more regulated, to tell you the truth. I hope it doesn't become, like, I mean, I think... it is accessible to everyone. You know, you were trained to kind of use it and know what we're doing. And if we don't know what we're doing, we ask for help.

Others pointed out that most skills gained in medicine are not accredited ('You don't have a certificate that says you can examine somebody's belly or listen to their heart...You just get taught these skills and then you do them and then you feel confident that you can do them...'). There was additional concern that some people would develop a false sense of security because of a certificate. Still, others pointed out the relative value of in-person mentorship:

the thing that really made me feel confident in my skills was the one-on-one teaching and having somebody look over my shoulder and you know I didn't even get a certificate for the fellowship... I mean, it's just like I did this for nine months and now I feel much more confident...

Further arguments were made against accreditation due to the value of real-time and real-world PoCUS training over courses 'using standardized patients with no pathology. Underlying most arguments against accreditation was the sentiment that most physicians know their limitations and know when they need help and relying on this knowledge keeps the onus of responsibility on the individuals as opposed to with the system. A final argument against accreditation of PoCUS was a pragmatic one regarding standardized Continuing Medical Education and the difficulty that may pose for many rural providers if

it occurred outside of the community and required time away from practice. Not all participants argued against accreditation, with some seeing the value to standardized Continuous Quality Improvement and the potential advantage of increased acceptance by specialists.

Some of the study participants referenced the inclusion of PoCUS use in Emergency Departments in BC's Provincial Privileging

Dictionary (PPD) and the capacity it has to generate administrative awareness about its importance. One participant went on to note they would like to see PoCUS as a standard of Emergency care in the PPD, but also recognized the dangers of barriers to rural ED practice and the potential disincentive to current providers ('[Y]ou don't want to be in a situation where half your rural doctors can't work in the emergency room [because] they don't know how to use PoCUS, right?').

Observability

Key Points:

- *Increased patient and provider satisfaction were identified as outputs of rural PoCUS;*
- *Mechanisms of further observable outputs included informal peer-support PoCUS-user networks*

The capacity for rural use of PoCUS to generate favorable results observable by patients, rural physicians or specialists was noted by most respondents. Participants conveyed are two observational benefits of using PoCUS. First is through participants' experiences and case studies on the significant improvement to clinical care to rural patients. Secondly, participants engaged in informal Quality Improvement (QI) initiatives with their peers to further develop their PoCUS skills. This QI process enabled participants and their peers to observe their use of PoCUS to develop over time.

Most interview participants shared anecdotes of positive responses from patients due to the immediate information provided on their clinical condition. This was particularly observed with maternity patients who could be easily reassured about the viability of a pregnancy or the in-utero position of a baby at term. The position of the fetus at term is a significant piece of information for those in rural communities that may not have the capacity to support breech deliveries. In all instances, the capacity of a simple scan to avoid referral out of the community for formal imaging was appreciated.

Observable results of rural PoCUS to clinical practice were noted by everyone who participated in the study, which is not surprising due to the voluntary nature of both receiving the subsidized probes and participating in the research interviews. That is, those who (as one participant described) had ‘drunk the Kool-Aide’ were naturally predisposed to being rural PoCUS champions and shared common descriptors such as ‘game changer’, ‘essential to rural practice’, ‘I could never go back’, ‘amazing potential’ and ‘better decision-making.’ The two quotes below capture the transformative impact PoCUS has on rural health care:

[I]t's hard to know where to start. [T]here's very rarely a day goes by that it isn't helping with care in a substantial way.

I just want to leave you guys with the impression that point-of-care ultrasound is a game changer for these small communities...

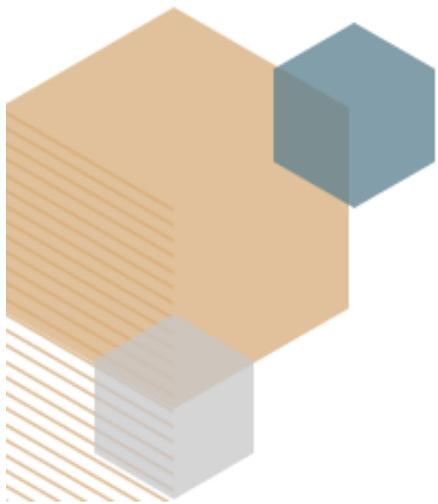
The final layer of ‘observability’ for participants in this study was gained through mentorship and Quality Improvement (QI) initiatives, with the caveat that all participants noted the lack of such formal programs. This the *lack* of observability in their rural PoCUS practice was noted, namely the idea of ‘you don’t know what you don’t know because you are always working solo.’ Almost all participants voiced the value of mentorship and formal review of scans, suggesting that isolated work made improvement difficult. To this end, participants developed informal networks and peer support to assess the quality of their work and created processes such as parallel studies (for example, ‘I’m the only one in most the places where I work who’s comfortable making a diagnosis or ruling out a diagnosis using lung ultrasound. So, what I do is I often order a chest x-ray in parallel’). Others relied on ‘scanning and scanning again’ while most took advantage of peer review by other physicians in their community. As one participant noted, ‘... we're always helping each other out. Someone can call me from the clinic and say, "Hey, could you help me with the scan?" or "What do you think of this?"' Some participants noted the strategy for reaching a ‘critical mass’ of PoCUS users in their community to be a stable resource for others who want to develop or maintain their skills. Other participants described a

slightly more formal approach of accessing funding for local training and dedicated teaching time.

A smaller group of respondents recalled accessing provincial resources for support, including the Rural Urgent Doctors In-aide (RUDI), a virtual practice support line staffed by physicians who offered guidance with PoCUS. Others noted that there were opportunities through UBC's Coaching and Mentoring Program (CAMP) for one-on-one support. Others access supportive provincial experts for feedback on scans, although in an ad-hoc way. These additional resources allow rural physicians to further develop their skills and further demonstrate the value and utility of PoCUS in their clinical practice.

Limitations

Rural Family Physicians who received subsidized Clarius probes from RCCbc were highly motivated to take up PoCUS and went through a low-barrier screening process to receive the probe that assessed enthusiasm and commitment more than experience and training. From this group of highly motivated providers, approximately half volunteered to participate in the interview. Although this study cohort may not represent the entire population of rural PoCUS users, the consistency of experience and value attribution of PoCUS by participants suggests a common experience that is likely extrapolatable to the larger population.



Emerging Recommendations

Results from the qualitative inquiry with rural Family Physicians who received Clarius probes through the RCCbc subsidized program revealed the value and efficacy of PoCUS from the perspective of rural health care providers. Qualitative evidence attested to increased job satisfaction and improved clinical decision-making. The optimization of patient care is highly valuable, especially when rural services are further away from specialist imaging centres. While PoCUS

enable rural FPs to make better clinical decisions and thereby improve patient management, it is crucial to recognize that the use of PoCUS is not surrogate for specialist imaging services. PoCUS functions as an additional resource for rural FPs in low-resource settings. The findings from this study, understood within the context of international literature attesting to the value and safety of PoCUS use by Family Physicians in rural settings and in anticipation of similar data that will be gathered in BC (forthcoming spring 2022), underscores the recommendations, stemming from the following values proposition.

1. Rural health service delivery contexts are marked by significant differences when compared to urban settings. This includes but is not limited to lower procedural volume reflecting lower population densities and the consequent reduced availability of local specialists and specialized imaging services. Any additional resources to support local decision making and the reduction of unnecessary transfers to high levels of care is an essential component of stabilizing rural health services and supporting rural health care providers;
2. As per IHI's Quadruple Aim, health care improvement must be focused on optimizing patient care by increasing safety, improving outcomes and increasing satisfaction while containing costs. Part of this optimization in rural settings includes reducing unnecessary transfers of care out of the local community for patients who can safely be cared for within the community. PoCUS enhances the transfer decision making process;
3. In order to optimize health care efficiency, improve outcomes and retain care providers, providers need to work in practice settings that facilitates care within their full scope of practice. PoCUS encourages clinical care to full scope of practice.

The following recommendations are presented discretely as *system* and *program* level recommendations.

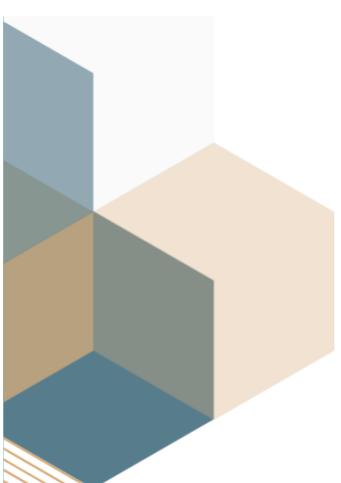
System-Level Recommendations

Recommendation #1: That PoCUS use be supported for rural health care providers through subsidized access to technology and education.

The provider cost to access PoCUS technology and education is significant. Although PoCUS leads to better patient care and the potential for increased health system efficiency by mitigating the draw on specialist imaging services, there is currently no mechanism to recoup initial costs through direct billing. Expansion of subsidized access to PoCUS probes and educational programming is warranted.

Recommendation #2: That a Quality Assurance Framework be integrated into peer support programs for real-time case review.

Quality Assurance mechanisms for PoCUS scans should include real-time case review by the community of rural PoCUS users to ensure the maintenance of safety and quality. The results of this process should be made transparent and available to the wider community through aggregate reporting that respects the privacy of individual providers and the confidentiality of patients.



Recommendation #3: That a Mechanism for Rapid Diffusion of PoCUS be developed to ensure maximal benefit to Rural Patients and Care Providers.

Emerging evidence in British Columbia is aligned with international evidence in suggesting that the use of PoCUS in low-resourced rural and remote practice settings increases provider satisfaction and leads to better patient care.²³ Given the relative cost-benefit of the technology and the need to support rural providers to achieve the goal of reducing health disparities and promoting equity for rural communities, rapid diffusion of the technology across rural BC is warranted.

Program-Level Recommendations

The following recommendations reflect the needs of study participants and are congruent with international evidence.

Recommendation #1: Support for Skills Development and Skill Maintenance

Many participants commented that information sessions, refresher sessions, and personal consultations as part of the IN PoCUS program was beneficial. They noted the limitations of online learning and "not being able to practice in person." Despite the lack of hands-on training, many also appreciate the additional support through the IN PoCUS program.

Participants who enrolled in the IN PoCUS program have varied skill levels with PoCUS. Novice PoCUS users struggled with learning how to use the probe during the pandemic when hands-on teaching was unavailable. Many participants stressed the importance of hands-on training as PoCUS relies on kinaesthetic learning to generate a good image.

For intermediate PoCUS users who are more proficient, there is a general concern that low patient volume or use of PoCUS can impede skill maintenance and skill progression. Several participants noted that the low volume of cases is a challenge to maintaining their skills and can cause their skills to atrophy ("it's hard because coming out of the fellowship, you get a broad training. But you go through a period where you're not utilizing everything. So, there is another gap [in knowledge] due to lack of practice").

To maintain competence, participants noted several strategies, including attending refresher courses and engaging in peer support networks.

Recommendations:

1. Support hands-on PoCUS training sessions where possible;
2. Organizing hands-on practice sessions among PoCUS peer support groups;
3. Provide refresher course close to home for PoCUS users in an environment that is conducive to learning (ensuring refresher courses are affordable and accessible.

Ensuring that the course provide access to probes, a variety of patient models, and adequate time to scan patients), and

4. Support peer-to-peer teaching by developing a structure and opportunity for 'superusers' to coach novice or intermediate PoCUS users.

Recommendation #2: Support Dedicated PoCUS Mentors

Study participants emphasized the value of having a dedicated PoCUS mentor who can be reached at any time to provide immediate consultation on scans and facilitate further skill development. Several participants highlighted the need for "follow-up or post-course mentorship." Participants pointed out patient models used in training sessions where generally healthy patients who are not reflective of the clinical acuity seen in practice. Many participants recognized and appreciated the mentorship and consultation provided through the IN PoCUS program. However, several participants commented that they felt guilty for constantly researching out to the program lead, recognizing they were also a busy rural provider. One participant commented having a dedicated mentor "takes away that sort of stress of bothering people if you know that they are dedicated to doing that specific task."

Recommendations:

1. Having a full-time dedicated PoCUS mentor or consultant who can:
 - a. Providing consultations on image generation and image interpretation;
 - b. Provide one-to-one coaching and skill development; and
 - c. Who can design and coordinate CME/peer support programs to further develop and maintain the skills of PoCUS users

Recommendation #3: Provide Infrastructure for a PoCUS Community of Practice

Many participants commented on the benefit of having a PoCUS community (CoP) of practice to facilitate learning and knowledge exchange. As IN PoCUS participants are dispersed across BC, many commented that they felt isolated working on their own, which impeded their ability to develop their skills. Many participants shared enthusiasm for being part of a CoP to support the learning and knowledge exchange. One intermediate PoCUS user pointed out, "I'm not a superuser like some of them, but I could probably support people who are starting out. Just building those kinds of inter-collegial support networks is would be helpful."

In addition to knowledge exchange of technical skills, several participants pointed out the benefit of a PoCUS community to further support the use and integration of PoCUS into their clinical practice. Several participants expressed technical and workflow challenges that could be addressed by more experienced users.

Recommendations:

1. Fostering a PoCUS community by creating a PoCUS virtual forum to:
 - a. share information and ideas;
 - b. Foster skill development and maintenance and
 - c. Share tips on integrating PoCUS into clinical practice, uploading scans into the database, accessing resources such as RUDI/ROSi.

Recommendation #4: Developing and Supporting a Framework for ongoing evaluation and Continuous Quality Improvement

Study participants have several suggestions for a formalized CQI process, including a framework for engaging with their peers and specialist colleagues to review their scans and improve image generation. One participant pointed the potential for peer-to-peer support in CQI: "I want to go and work with a superuser who is going to critique my skills and help me be better and then give me the confidence to say 'yeah you meet the standard'." Another suggested developing regular scanning reviews with a PoCUS

mentor. This requires an organizational infrastructure and sessional funding for mentor time.

Participants further commented on the potential of the IN PoCUS database as part of the CQI process: "I can imagine having an easily accessible database where you can scroll through pictures of all kinds of pathology". However, many participants commented on the lack of feedback and engagement on the scans uploaded onto the database. One participant suggested having "a monthly book club" where PoCUS users can review ultrasound images on a particular organ that were uploaded on the database.

Recommendations:

1. Establishing peer-to-peer mentorship with superusers to review scans;
2. Establish a PoCUS book club to review the scans that were uploaded to further develop skills in a specific area/interest and review emerging evidence from other jurisdictions.



References

1. Moore CLCJ. Point-of-care ultrasonography. *N Engl J Med*. 2011 Feb 24; 364(8):749–57.
2. Laursen CB, Sloth E, Lassen AT, Rd C, Lambrechtsen J, Madsen PH, et al. Point-of-care ultrasonography in patients admitted with respiratory symptoms: a single-blind, randomised controlled trial. *Lancet Resp Med*. 2014 Aug;2(8):638–46.
3. Smallwood N, Dachsel M. Point-of-care ultrasound (POCUS): unnecessary gadgetry or evidence-based medicine. *Clin Med (Lond)*. 2018;18(3):219–24.
4. Weile J, Brix J, Moellekaer AB. Is point-of-care ultrasound disruptive innovation? Formulating why POCUS is different from conventional comprehensive ultrasound. *Crit Ultrasound J*. 2018 Oct 1;10(1):3.
5. Competency Training Requirements for the Area of Focused Competence in Acute Care Point-of-Care Ultrasonography. 2019 Dec [cited 2021Mar]. Available from: <https://www.royalcollege.ca/rcsite/documents/ibd/acute-care-pocus-ctr-e.pdf>
6. Sounness B, Hughes C, Winzenberg T. Rural GPs' satisfaction with radiology services to their communities: a qualitative study. *Rural and Remote Health*. 2008 Apr; 8(2): 902. [DOI link](#), [PMid:18452368](#)
7. Nicola R, Dogra V. Ultrasound: the triage tool in the emergency department: using ultrasound first. *Br J Radiol*. 2016;89(1061):20150790. doi: 10.1259/bjr.20150790. Epub 2015 Dec 15. PMID: 26568440; PMCID: PMC4985450.
8. Nixon G, Blattner K, Koroheke-Rogers M, Muirhead J, Finnie WL, Lawrenson R, Kerse N. Point-of-care ultrasound in rural New Zealand: Safety, quality and impact on patient management. *Aust J Rural Health*. 2018 Oct;26(5):342-349. doi: 10.1111/ajr.12472. PMID: 30303278.
9. Léger P, Fleet R, Maltais-Giguère J, Plant J, Piette É, Légaré F, Poitras J. A majority of rural emergency departments in the province of Quebec use point-of-care ultrasound: a cross-sectional survey. *BMC Emerg Med*. 2015 Dec 11;15:36. doi: 10.1186/s12873-015-0063-0. PMID: 26655376; PMCID: PMC4676152.
10. Becker DM, Tafoya CA, Becker SL, Kruger GH, Tafoya MJ, Becker TK. The use of portable ultrasound devices in low- and middle-income countries: a systematic review of the literature. *Trop Med Int Health*. 2016 Mar;21(3):294-311. doi: 10.1111/tmi.12657. Epub 2016 Jan 10. PMID: 26683523.
11. Britton N, Miller MA, Safadi S, Siegel A, Levine AR, McCurdy MT. Tele-Ultrasound in Resource-Limited Settings: A Systematic Review. *Front Public Health*. 2019 Sep 4;7:244. doi: 10.3389/fpubh.2019.00244. PMID: 31552212; PMCID: PMC6738135.
12. Siu T, Chau H, Myhre D. Bedside ultrasonography performed by family physicians in outpatient medical offices in Whitehorse, Yukon. *Can J Rural Med*. 2013 Spring;18(2):43-6. PMID: 23566861.
13. Arnold AC, Fleet R, Lim D. A case for mandatory ultrasound training for rural general practitioners: a commentary. *Rural Remote Health*. 2021 Jul;21(3):6328. doi: 10.22605/RRH6328. Epub 2021 Jul 9. PMID: 34237995.
14. Andersen CA, Davidsen AS, Brodersen J, Graumann O, Jensen MB. Danish general practitioners have found their own way of using point-of-care ultrasonography in primary

- care: a qualitative study. *BMC Fam Pract*. 2019 Jun 28;20(1):89. doi: 10.1186/s12875-019-0984-x. PMID: 31253102; PMCID: PMC6599254.
15. Andersen CA, Holden S, Vela J, Rathleff MS, Jensen MB. Point-of-Care Ultrasound in General Practice: A Systematic Review. *Ann Fam Med*. 2019 Jan;17(1):61-69. doi: 10.1370/afm.2330. PMID: 30670398; PMCID: PMC6342599.
 16. Sorensen B, Hunskaar S. Point-of-care ultrasound in primary care: a systematic review of generalist performed point-of-care ultrasound in unselected populations. *Ultrasound J*. 2019 Nov 19;11(1):31. doi: 10.1186/s13089-019-0145-4. PMID: 31749019; PMCID: PMC6868077.
 17. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006Jul;3(2):77–101.
 18. Rogers EM. *Diffusion of innovations*. Glencoe, IL: Free Press; 1962
 19. Rogers EM. *Diffusion of innovations* Glencoe, IL: Free Press; 1983
 20. Rogers EM. *Diffusion of innovations*. New York: Free Press; 1995.
 21. Sibeoni J, Bellon-Champel L, Verneuil L, Siaugues C, Revah-Levy A, Farges O. Workplace environment around physicians' burnout: A qualitative study in French hospitals. *Scand J Work Environ Health*. 2021 Oct 1;47(7):521-530. doi: 10.5271/sjweh.3977. Epub 2021 Aug 7. PMID: 34363393.
 22. Feeley D. The triple aim or the quadruple aim? Four points to help set your strategy [Internet]. Institute for Healthcare Improvement. 2017 [cited 2021Aug26]. Available from: <http://www.ihl.org/communities/blogs/the-triple-aim-or-the-quadruple-aim-four-points-to-help-set-your-strategy>
 23. Henwood PC, Mackenzie DC, Rempell JS, Douglass E, Dukundane D, Liteplo AS, Leo MM, Murray AF, Vaillancourt S, Dean AJ, Lewiss RE, Rulisa S, Krebs E, Raja Rao AK, Rudakemwa E, Rusanganwa V, Kyanmanywa P, Noble VE. Intensive point-of-care ultrasound training with long-term follow-up in a cohort of Rwandan physicians. *Trop Med Int Health*. 2016 Dec;21(12):1531-1538. doi: 10.1111/tmi.12780. Epub 2016 Oct 19. PMID: 27758005.

Appendix I: Interview Question Guide

Incentive

1. What interested you in PoCUS?
2. What made you choose to integrate ultrasound into your day-to-day work as a GP?

Level of training/confidence

1. Could you describe any training that you have received in PoCUS?
 - a. What specific organizations have provided you with training?
 - b. Are there any informal learning opportunities that have been useful?
 - c. What types of training has been most useful? Least useful?
2. What would the ideal training scenario be for you?
 - a. Would you like to receive further or ongoing PoCUS training?
3. How confident are you in your abilities in PoCUS?
 - a. Which exams are you most comfortable performing?
 - b. Which exams are you least comfortable performing?
 - c. Are there any exams that you have difficulty performing?
 - d. Have there been instances when you have not been confident about an ultrasound finding? Can you provide an example? What do you do when you are uncertain about a finding?
4. Do you feel like you have any gaps in your training?
5. Are there any PoCUS quality assurance systems in place for you? Please describe these systems. Are they helpful?
6. Can you describe your communication to patients before, during, and after an ultrasound exam?
 - a. Do you ever worry about negative implications from PoCUS regarding patient's understanding of the technology's accuracy?

Current use of PoCUS

1. How long have you been using PoCUS?
2. Which patients/indications are you using PoCUS for?
 - a. Which PoCUS exams do you do most often?
 - b. How frequently do you use PoCUS?
3. Have you expanded your use of PoCUS since receiving your training?
 - a. What do you think could be potentially useful extensions of PoCUS?
4. Can you describe the last time that you used PoCUS? (should cover indication for use, ease of scanning, adequacy of image, interpretation, affect on care, etc.)
 - a. Does this example represent a typical instance of PoCUS use for you?
5. To what extent is PoCUS affecting your care and/or management of patients/conditions?
 - a. Which PoCUS exams do you find the most helpful clinically? Why?

- b. Why do you find the most helpful clinically/regional referral centers regarding use of PoCUS? Which PoCUS exams do you find the least helpful? Why?
- 6. Can you give us any (other) examples where PoCUS positively impacted patient care? How about (other) examples of no impact? Any examples of a negative impact?
- 7. Have you used PoCUS in the identification and/or management of patients with a potential COVID-19 diagnosis? Please describe.
- 8. Does doing PoCUS make time management more difficult? Easier? Provide examples.
 - a. Does using PoCUS take time away from other important clinical activities (e.g., focus less on consultation discussions)?
- 9. Overall, how has PoCUS affected the clinical care that you provide?
- 10. Has the ability to do PoCUS affected your job satisfaction?

Equipment and technology

- 1. Have you had any challenges with PoCUS equipment or technology?
 - a. Any issues with the use or maintenance of equipment?
 - b. Any issues with downloading or storing images?
 - c. Any issues with electronically sharing images?
- 2. Do you feel you have enough administrative and technical support to use PoCUS? Please explain.

Experience interfacing with specialists at regional referral centers regarding use of PoCUS

- 1. How much do you rely on regional referral specialists in your use of PoCUS?
- 2. Has your referral pattern shifted at all?
- 3. Do you feel regional specialists are supportive of rural FP PoCUS?

Rollout of PoCUS

- 1. Were you involved in the rural rollout of PoCUS at a community and/or provincial level?
- 2. What were the facilitators to implementation? What about the barriers or challenges to implementation?
- 3. What advice would you give to other communities or provinces newly implementing PoCUS?

Interviews with the specialist cohort will focus on their views regarding FPs performing PoCUS. Interview questions for specialists may include:

- 1. Do you see a need for FP PoCUS in rural settings?
- 2. Do you have any concerns with PoCUS in rural settings?
- 3. Are there certain conditions and/or patient populations where you believe FP PoCUS use is more/less beneficial?

4. What are your overall thoughts/perceptions/attitudes regarding the use of PoCUS by FP?