4-28-2023

Brining Point-of-Care Ultrasound to a Rural Primary Care Clinic

Caleb E. Migda

Journal of the American Association of Nurse Practitioners

https://journals.lww.com/jaanp/Pages/informationforauthors.aspx

Title: Brining Point-of-Care Ultrasound to a Rural Primary Care Clinic

Author: Caleb Migda, BSN, RN

Co-Authors: Donna Rinker, DNP, MSN, RN, FNP-BC, PMHNP; Anne McKay, DNP, ANP-BC

Author Affiliations: Kirkhof College of Nursing, Grand Valley State University, Grand Rapids, Michigan

Corresponding Author:

Caleb Migda, BSN, RN

Email: migdac@mail.gvsu.edu

Submission Type: Program Development

Conflict of Interest: None

Acknowledgements: This project was supported by the Advanced Nursing Education Workforce (ANEW) Grant provided by the Health Resources and Services Administration (HRSA) of the United States (U.S.) Department of Health and Human Services (HHS). The contents are those of the author(s) and do not necessarily represent the official views of, nor an endorsement, by HRSA, HHS, or the U.S. Government. For more information, please visit HRSA.gov.

Abstract

Background and Objectives: In the rural primary care setting, the process for outpatient ultrasound testing has multiple steps, all of which provide opportunities for delay in testing and diagnosis. Point-of-care ultrasound (POCUS) is a solution that allows the physician to perform same-day ultrasound in the primary care clinic**.** The objective of this program development project was to implement POCUS in a rural primary care clinic to reduce time to testing and diagnosis for those patients requiring ultrasound testing.

Methods: A 3-month chart audit was conducted to examine the average length of time required to complete ultrasound testing in the outpatient radiology department. Audit results were compared to POCUS testing. A 6-question Likert scale was developed to assess patient satisfaction with the POCUS process. The Donabedian Model and Promoting Action on Research Implementation in Health Services framework were used to examine and implement POCUS.

Results: Chart audits revealed 34 ultrasounds that were ordered. The mean number of days from the time the ultrasound was ordered to the time it was uploaded into the electronic medical record was 27. One POCUS was performed during the implementation period. It was done same-day and its results eliminated unnecessary specialty referral.

Conclusion: POCUS is a valid and reliable tool that can be used by the primary care provider to assist in diagnosis and may significantly reduce time to testing and time to diagnosis. It may also have a unique role in rural settings where resources may be limited.

Keywords: Point-of-Care Ultrasound, Primary Care, Rural, Outcomes

Introduction

Point-of-care ultrasound (POCUS), defined as the use of a portable ultrasonic device for diagnosis or evaluation of a patient at the bedside, is becoming increasingly useful in the primary care setting (American College of Emergency Physicians, 2009; Maxwell, 2020). POCUS is commonly used in emergency medicine but has made its way into the primary care setting due to its broad utility across numerous patient populations (Sorensen & Hunskaar, 2019). When coupled with evidence from the physical examination, its utilization can greatly reduce the list of differential diagnoses and can support a formal diagnosis (Bhagra et al., 2016). As a result, more than 60% of medical schools offer some form of ultrasound training (Gilbertson et al., 2020). While POCUS is a versatile tool, it should be determined to what degree, if any, its use impacts the outcomes of patients within the primary care setting.

Currently, at the program development site, the process required for a patient to undergo ultrasound testing is cumbersome, with multiple steps that allow for delay in testing and subsequent delay in diagnosis, resulting in the potential for poor outcomes. These steps include the Medical Assistant (MA) contacting the patient to schedule a time for testing to be completed in the outpatient radiology department. Scheduling requires accessibility on behalf of the patient as well as availability within the outpatient radiology department, the latter being impacted by staff availability and prioritization of other diagnostic exams. Testing requires the patient to return to the facility on a separate date, and factors that may negatively impact the patient's ability to return include distance, weather, the necessity to take time away from work, or the obligation to obtain childcare, among others. Once the testing is complete, the ultrasound is read by a radiologist and uploaded into the electronic medical record. Often, the length of time from when ultrasound is ordered to when it is uploaded in the EMR can take weeks.

A solution to reducing multiple barriers is the implementation of POCUS. This would allow the provider to perform an ultrasound in the primary care clinic the same day an ultrasound is needed for further evaluation of a patient condition. Successful implementation offers the potential to significantly reduce time to testing and time to diagnosis, leading to improved time to treatment and improved patient outcomes. Such a process may also positively impact patient satisfaction, as patients would have test results sooner, reducing anxiety; nor would the patient be required to return to the facility on a separate date to have testing completed. Finally, the implementation of POCUS presents the opportunity for additional revenue generation within the primary care clinic. The purpose of this article will focus on the importance and the implementation process of POCUS in the primary care setting.

Available Knowledge

A literature review was conducted using the PubMed database and was limited to randomized controlled trials and systematic reviews, written in English from 2017 to the present, and pertaining to adults aged 19 or older. Keywords included “Point-of-Care Ultrasound”, “Primary Care”, “General Practice”, and “Outcomes”. Due to the heterogenous nature of patient populations within Emergency Departments (EDs), studies conducted in EDs were considered. The usefulness of POCUS in the ED setting can be compared to the diverse patient population seen in general practice. Thus, inclusion criteria were met for those studies that were conducted in the ED or outpatient setting, such as a primary care office, urgent care center, or long-term care facility.

The original search yielded 240 articles, and four duplicates were removed. Each article was screened using inclusion and exclusion criteria according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria (Moher et al., 2009). Review of

titles and abstracts resulted in the removal of 212 articles that did not meet the criteria, and after in-depth examination of the remaining 23 articles, 18 were removed for not meeting inclusion criteria. As a result, the remaining 5 articles were included in this review, and results were grouped into three themes: POCUS in primary care, utility, and reliability.

POCUS in Primary Care

A systematic review by Andersen et al. (2019) examined training requirements and use of POCUS by providers working in general practice. The findings revealed that POCUS was utilized for numerous purposes, most commonly to assist in diagnosis, but also for minor procedures and general screenings. Use of POCUS to investigate abdominal, obstetric, and cardiac conditions were the most common. An additional finding of significance showed the training for use of POCUS is highly variable, with training for specific body systems ranging from as little as four hours to as many as 320 hours. A theme not included in the objectives of the analysis was patient perspective, which revealed positive attitudes in the decision of the general practitioner to utilize POCUS to support a diagnosis.

The systematic review by Sorensen and Hunskaar (2019) examined POCUS among general and ED practitioners from developed countries outside of the United States (U.S.) and found that use of POCUS among general practitioners varied greatly, and its use was less than that of ED practitioners. In Norway, nearly 25% of ED and general practitioners had access to POCUS, yet only one in 15 general practitioners reported ever using the tool. In contrast, in rural Canada, 95% of practitioners reported having common access to and use of POCUS, and 33% of those respondents reported using POCUS during every shift. While the findings by Sorensen and Hunskaar (2019) shows that use of POCUS varies among developed countries and within health

systems similar to the U.S., there was limited information about the utilization of POCUS in the primary care setting in the U.S.

Utility

In a systematic review by Sorensen and Hunskaar (2019), the utility of POCUS was examined. This review found the utilization of ultrasound by general practitioners had a wide range of indications and organ systems, which included the abdomen, heart, lungs, blood vessels, the eye, soft tissues, the musculoskeletal system, and obstetrics. The authors concluded that POCUS can be a very safe and useful tool for the general practitioner to aid in the evaluation and diagnosis of numerous conditions.

Three of the studies from the systematic review revealed that general practitioners can accurately assess left ventricular function to a degree that is impactful for management of the patient. One study revealed that general practitioners can accurately assess left ventricular hypertrophy in hypertensive patients. Pertaining to blood vessels, two studies discovered 100% accuracy in diagnosing abdominal aortic aneurysm at 3 centimeters and 5 centimeters in size. Additionally, five studies showed high accuracy in diagnosing deep vein thrombosis among general practitioners (Sorensen & Hunskaar, 2019).

Abdominal complaints are common in the primary care setting. Two studies revealed high accuracy in the diagnosis of cholelithiasis, and another study revealed 100% accuracy in finding ascites (Sorensen & Hunskaar, 2019).

Due to the heterogeneous nature of the patient population, usefulness of POCUS in the ED can be used to compare usefulness in the primary care setting. The findings of Sorensen and Hunskaar (2019) confirmed the use of POCUS in the ED can aid in estimation of left ventricular ejection fraction, detection of wall motion abnormalities, detection of pericardial fluid, and can

assist in the diagnosis of pneumonia, pneumothorax, hydronephrosis, cholecystitis, appendicitis, intussusception, small bowel obstruction, abscess, joint effusion, ligamentous injury, and joint dislocation.

Reliability

The use of POCUS is reliable when used to aid in the diagnosis of various conditions. Barbic et al. (2017) and Gottlieb et al. (2020) performed systematic reviews to determine the accuracy of POCUS when differentiating soft tissue infections from abscess. For the primary outcome measure, Barbic et al. (2017) found the use of POCUS for diagnosis of abscess had a 92.6% sensitivity and 82.9% specificity. Gottlieb et al. (2020) revealed similar results, as POCUS demonstrated a 94.6% sensitivity and 85.4% specificity for differentiating soft tissue infection from abscess. Not only did the use of ultrasound lead to a proper diagnosis but has a greater affinity in the decision making of the correct treatment for these two different infections and treatment plans.

In a systematic review and meta-analysis, Gentilotti et al. (2022) examined the diagnostic accuracy of point-of-care testing in 4,901 individuals with community acquired lower respiratory tract infections in both outpatient and ED settings. Results revealed a 90% sensitivity and 90% specificity when diagnosing bacterial pneumonia using POCUS and showed higher diagnostic accuracy than chest x-ray. Additionally, diagnostic accuracy did not vary based upon operator experience. Finally, the reliability of POCUS was supported by Sorensen and Hunskaar 2019) for diagnosing numerous conditions (see Table 2).

Project Aims

The aims of the program development project were twofold. The first was to investigate how the implementation of POCUS at a rural primary care clinic would impact diagnostic and

patient outcomes through a reduction in time to testing, and subsequently, time to diagnosis. The second was to obtain patient feedback through use of anonymous surveys with the intent to utilize that feedback for the improvement of the newly implemented process.

Model to Examine Point-of-Care Ultrasound

Due to its effectiveness in evaluating workflows, the Donabedian model was used to examine the current process for outpatient ultrasound testing at the project site and to assess how implementing POCUS may affect that process. The Donabedian (1988) model consists of three overarching categories: organizational structure, process, and outcomes (see Figure 1). The organizational structure includes the physical environment, technology used by the organization, availability of equipment, and the staffing models involved in providing care. The process includes how care is delivered, such as how a diagnosis is made, the treatment that may follow, and patient education that may be involved. Outcomes refers to quality improvement, health care costs, patient satisfaction, and patient quality of life (Donabedian, 1988).

Within the concept of organizational structure in the Donabedian model, the necessity for wireless connectivity and availability of Information Technology staff support, were already in place to support the implementation of POCUS. The current process for ultrasound testing is lengthy and cumbersome, allowing for delays in patient care along each step of the process. Utilizing a structured workflow process for POCUS would eliminate many of those steps. Implementation of POCUS requires testing to be done by the ordering physician on the same day the test is ordered, which does involve extra time. However, the average POCUS scan takes 5 minutes. Such interruptions in the daily workflow within the primary care environment are not uncommon. Finally, there is potential for improved patient outcomes due to reduced time to testing and reduced time to diagnosis.

Organizational Assessment

The organization was assessed using the McKinsey 7S framework, which considers an organization's structure, systems, strategy, style, skills, staff, and shared values; the framework considers those tangible qualities that are embedded within an organization as well as the intangible qualities that are brought to the organization through the skills of its employees (McKinsey & Company, 2008). Use of the framework supports the diagnosis of organizational shortcomings and provides a formula for organizational and performance improvement (Waterman et al., 1980).

A strengths, weaknesses, opportunities, and threats (SWOT) analysis, and components of the McKinsey 7S framework such as structure, strategy, skills, and shared values were integrated to inform the SWOT analysis. After thorough analysis and consideration of the project site's desire to provide high level, evidence-based care, it was determined that the implementation of point-of-care ultrasound has the potential to improve the delivery of care, reduce time to testing as it pertains to ultrasound, and can generate additional revenue for the health clinic.

Methods

Participants

The target population of this program implementation were those patients who presented to the outpatient clinic, were 18 years or older, and needed a diagnostic ultrasound as determined by the physician. POCUS scans are "limited", so those patients needing a "complete" ultrasound were not considered.

Implementation

Ultrasound Device

The chosen ultrasound device was the Butterfly iQ point-of-care ultrasound. Ultrasound images were cast onto an iPad 5. The butterfly IQ ultrasound device is available with an optional annual subscription which supports storage of POCUS scans in the secure Butterfly Cloud, and the clinic opted to purchase the annual subscription. The ultrasound device, IPad, and first year of the annual Butterfly subscription were supported through HRSA ANEW grant funding.

Information Technology

It was necessary to collaborate with the Information Technology department for initial setup of the butterfly application and iPad. Due to the necessity for patient confidentiality, it was imperative the iPad be connected to the organization's secure wireless network.

Billing and Coding

Proper reimbursement for services provided is necessary for the sustainability of any new program. As such, collaboration with the organization's billing department was sought to develop a POCUS billing and coding worksheet (see Appendix A). The worksheet contained all billable CPT codes for POCUS services, and for ease of use, the codes were grouped by body system, body region, and common soft tissue examinations.

POCUS Workflow

When a provider determines a patient requires ultrasound testing, the provider would assess the appropriateness of performing the ultrasound at the point of care. Verbal consent would then be obtained from the patient. After completion of the ultrasound, the images would include the patient's demographic information and date of service and then stored in the secure Butterfly Cloud. For reimbursement purposes, the physician performing the scan is responsible for documenting an indication for the test as well as an interpretation of the ultrasound within the

electronic medical record, and the Billing I-AIM framework was utilized to ensure that all necessary documentation was completed (Hughes et al., 2020).

Framework for Implementation

The Promoting Action on Research Implementation and Health Services (PARIHS) model was chosen as the implementation framework (See Figure 2). When translating research into practice, PARHIS suggests there is a relationship between the key elements of evidence, context, and facilitation; context and facilitation are equally as important as the evidence that is being put into practice (Rycroft-Malone, 2004). When defining the elements of the framework, evidence pertains to research, practitioner experience and expertise, and the population that is targeted for the intervention. Facilitation refers to the purpose of the intervention and the skills necessary to make it successful. Finally, context involves the culture of the organization where implementation occurs, the type of leadership involved, and the relevance of the proposed implementation to the organization. The model defines successful implementation as a function of evidence, context, and facilitation (Rycroft-Malone, 2004).

When evaluating the implementation of POCUS within the context of the PARIHS framework, there is supporting evidence in the literature to suggest its efficacy. One provider within the practice has received formal training for the use of POCUS, providing the knowledge and skill necessary to use the device safely and effectively. There is significant cost involved in the training process which may act as a barrier to training other providers in the future. Regarding context, the site of implementation had managerial support and approval.

Data Collection and Analysis

Chart Audit

A manual chart audit was conducted through the organizations electronic medical record examining de-identified patients seen in the clinic by the solo physician trained in using POCUS from October 2, 2022, to January 2, 2023. The purpose of the audit was to investigate the number of ultrasounds ordered in the primary care setting and completed in the outpatient radiology department during that time frame. Further data was collected including the date the ultrasound was ordered, the date the MA contacted the patient to schedule the ultrasound, the date the ultrasound was completed, and the date the ultrasound results were uploaded into the EMR.

POCUS Testing

Point-of-care ultrasound testing was to be performed as the physician determined its necessity and appropriateness. Most POCUS scans take 5 minutes, thus performing the test can be easily incorporated into the daily workflow. Nonetheless, scenarios exist that do not provide time for the physician to perform in-office testing. Once POCUS testing was completed, information about the type of ultrasound, time to testing, and time to diagnosis were to be collected. Most POCUS testing can be done same-day; however, there are some insurance providers that require prior authorization. In such cases, once prior authorization was attained, a separate appointment would be made for testing to be done in the office.

Patient Surveys

A six-question Likert scale survey was developed and intended to be delivered to those patients who underwent POCUS testing at the project site. The survey addressed the patient experience when having same-day ultrasound testing in the primary care clinic and the intention was for patient responses to inform changes and improvements to the POCUS process.

Ethical Considerations

Approval from the organization's Institutional Review Board (IRB) was obtained and was determined the project did not fall under the category of human subject's research. All protected health information that was gathered for the project was stored in the Research Electronic Data Capture (REDCap) password protected secure platform that is approved by the organization for data storage.

Results

The chart audits revealed 51 ultrasounds that were ordered between October 2, 2022, and January 2, 2023. Seventeen of those ultrasounds (6 complete echocardiograms, 7 transvaginal ultrasounds, and 4 complete breast ultrasounds that were ordered to be done in conjunction with diagnostic mammography) were removed from data collection, as these types of ultrasounds cannot be performed at the point of care. As a result, 34 ultrasounds from the chart audit were analyzed.

Because the current outpatient ultrasound process contains multiple steps, each step of the process that could result in a delay in patient care was analyzed. These included the number of days from when the provider ordered the ultrasound to when the Medical Assistant documented that she had contacted the patient to schedule the test; the amount of time from when the MA scheduled the test to when the test was completed; and the amount of time from when the test was completed to when it was uploaded into the electronic medical record. Additionally, the number of days from when the physician ordered the test to when the test was completed was recorded as well as the time from when the physician ordered the test to when the results were uploaded into the electronic medical record.

During the implementation period, 1 POCUS scan was performed. The patient presented with posterior knee swelling and there was concern for deep vein thrombosis (DVT). POCUS

was performed, it was determined no DVT was present, and the patient was referred to orthopedics due to the presence of a Baker cyst. In this case, the inability to perform POCUS at the visit would result in a referral to a vascular surgeon for a venous duplex. As a result, unnecessary referral and testing were avoided, and treatment was expedited through prompt referral to an orthopedic specialist.

Discussion

At the implementation site, the current outpatient ultrasound process requires multiple steps, all of which allow opportunity for delays in care. The greatest delay occurs between the time the MA collaborates with the patient to schedule the test and when the test is completed, and the mean time from when the ultrasound is ordered to when it is uploaded into the EMR is nearly 4 weeks. Receiving results from testing that occurs at a different facility may take even longer, and this delay typically occurs due to the increased time it takes to receive the ultrasound results and upload them into the EMR.

There are numerous factors that may contribute to delays, including scheduling conflicts or staffing concerns within the outpatient radiology depart. From the standpoint of the patient, employment or childcare conflicts may negatively impact the ability for timely scheduling. Testing may be scheduled, cancelled, then rescheduled, causing even greater delay. Because the clinic is in a rural area, returning to the facility for testing on a separate day may be influenced by long distance travel. Additionally, in the winter months, weather may be a significant factor. The implementation of POCUS has potential to eliminate or significantly reduce time to testing, and subsequently, time to diagnosis. Finally, it may reduce the need for unnecessary testing and referral to other specialties.

Implications for Practice

Point-of-care ultrasound is a valid and reliable tool within the primary care setting (Anderson et al., 2019; Sorensen & Hunskaar, 2019), and it has tremendous potential to be a unique diagnostic aid in rural clinics. It can reduce time to testing and time to diagnosis. Additionally, it has the potential to improve patient satisfaction. Patients often experience anxiety related to diagnostic testing, so a reduction in time to testing can lead to reduced patient anxiety. Moreover, satisfaction can be bolstered because POCUS can eliminate the need for a return trip to the healthcare facility, as most POCUS testing can be done same-day.

Implementation of POCUS provides opportunity for additional revenue, as the average reimbursement is $88.18; all ultrasound guided procedures, such as intraarticular injection, abscess drainage, or small foreign body removal are reimbursed $61.20 (POCUS 101, n.d.). An additional Evaluation and Management (E/M) billing code is also included and reimbursed for ultrasounds performed in the office.

Advance Practice Providers (APP) are reimbursed at the same rate as physicians. If the practitioner performed one POCUS per week, additional annual revenue may amount to nearly $4,600. Compounded by multiple physicians or APP within a practice, the additional revenue becomes significant.

There is also potential that addition of POCUS can create a competitive advantage for the practice. The ability to provide same-day diagnostic testing offers tremendous convenience to the patient in the rural setting. It has the potential to strengthen patient confidence in the healthcare provider and provide satisfaction with the quality of care. Moreover, long-term strategic planning is imperative, especially considering the current difficulties facing healthcare systems, so the additional revenue may add to a long-term sustainability advantage for the practice.

Recommendations

Provider confidence can be a tremendous barrier to performing POCUS, as providers who are less confident may be less likely to perform the testing as indicated. To combat a lack of confidence, it is recommended that the provider focus on mastering the 3 most common types of ultrasounds that are ordered within the practice. During this program development, the 3 most common included liver, gallbladder, and breast ultrasounds. Achieving mastery of the common ultrasounds affords the potential to perform other types in the primary care setting. This approach allows the practitioner to improve confidence and skill in addition to being able to provide improved care while capturing the revenue potential that POCUS can offer.

Formal POCUS training counts toward Continuing Medical Education, and many organizations reimburse their providers for continuing education. As such, reimbursement should lessen the financial barrier for practitioners seeking POCUS certification. It is recommended that organizations support and encourage their providers to complete formal POCUS training, as it can improve patient outcomes and provide additional revenue to the practice.

Finally, the only cost for maintaining POCUS within a practice is an annual subscription through the company that provided the ultrasound tool. In this case, Butterfly Network offers annual subscriptions ranging from $199 to $420. If the most expensive subscription package is chosen, 5 POCUS scans per year can cover the subscription costs.

Limitations

Limitations to the development and implementation of the program include a shortened period for POCUS data collection, which was impacted by delays in IRB approval for the project, staffing concerns within the office, physician availability, and lack of patients requiring ultrasound during that timeframe.

Of significance to POCUS, some insurance providers require prior authorization for certain POCUS scans. In that event, testing would require the patient to return to the primary care clinic at another scheduled appointment after prior authorization is obtained. Having a separate appointment for POCUS testing may be inconvenient for the patient; however, it is likely that time to testing and time to diagnosis can still be significantly reduced when compared to ultrasound testing completed in the outpatient radiology department.

Conclusion

Point-of-care ultrasound is a valid and reliable tool that can be used to evaluate numerous patient conditions and can be particularly useful in the rural, primary care setting where resources may be limited. It has potential to reduce time to testing, time to diagnosis, improve patient satisfaction, and reduce patient anxiety related to diagnostic testing. Sustainability is supported by provider confidence in performing POCUS scans, and annual costs are minimal. There is potential, especially in larger practices for significant revenue generation.

Tables

Table 1

Outpatient Ultrasound Testing Results

Outpatient Ultrasound Testing Results (days)		
	Median	**Mean**
Order placed by provider – Ultrasound scheduled by medical assistant.	*1*	*2*
Ultrasound scheduled by medical assistant – Ultrasound completed in outpatient radiology department.	*24*	*22*
Ultrasound completed in outpatient radiology department – Results uploaded into EMR.	*0*	*3*
Order Placed by provider – Ultrasound completed in outpatient radiology department.	*25*	*23*
Order placed by provider – Results uploaded into EMR.	*26*	*27*

Note: Chart audit of all ultrasounds that were ordered between October 2, 2022 and January 2, 2023 and were to be completed in the outpatient radiology department.

Table 2

Reliability of POCUS

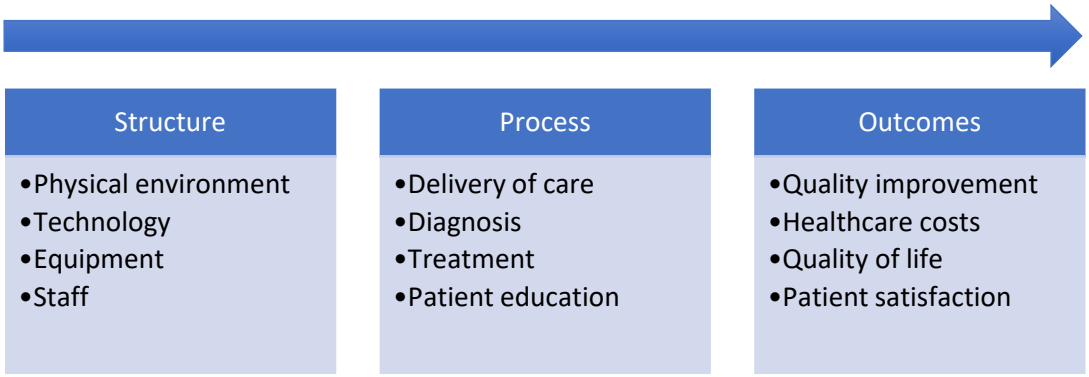
Disease/Condition	Subjects (*n*)	Sensitivity (%)	Specificity (%)
Aortic insufficiency	*n* = 393	86.1	97.5
Mitral insufficiency	*n* = 393	89.1	87.2
Pneumonia	*n* = 5850	92 – 95	90 – 93
Pneumothorax	*n* = 4181	81 – 88	98 – 99
Abdominal aortic aneurysm screening (>3 cm)	*n* = 200	100	100
Evaluation of deep vein thrombosis	*n* = 6177	77.8 – 100	91.4 – 98
Hydronephrosis	*n* = 1823	70.2 – 100	72 – 75.4
Cholecystitis	*n* = 699	37.8 – 92	78 – 100
Appendicitis	*n* = 1832	63 – 80	90.6 – 99

Note: Sensitivity and Specificity of POCUS testing for various conditions based upon the research of Sorensen and Hunskaar (2019).

Figures

Figure 1

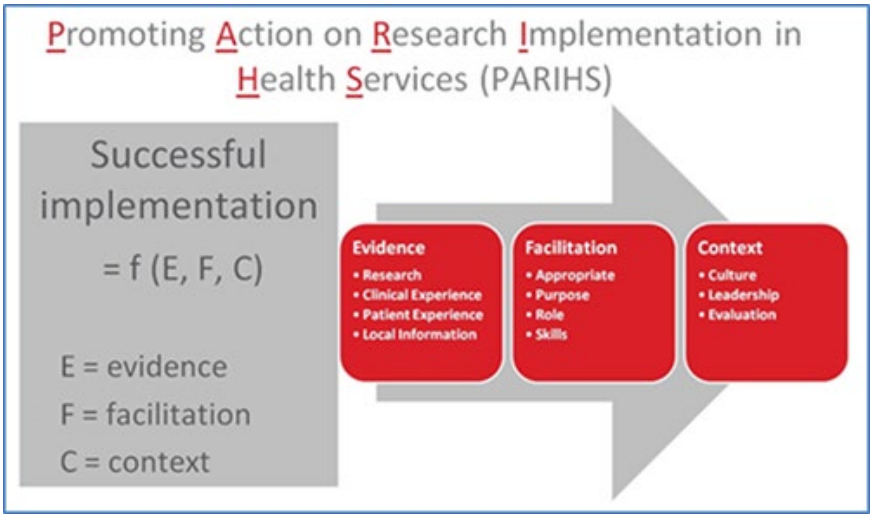
The Donabedian Model for Quality of Care



Note: The Donabedian Model can be used to assess quality of care delivery and evaluation of improvements (Donabedian, 1988).

Figure 2

Promoting Action on Research Implementation in Health Services model



Note: The PARIHS model was use as a framework for implementation of POCUS (Rycroft-Malone, 2004; Kitson et al., 2008)

Appendix A

CPT Coding Worksheet

Visit Date Appt Time Patient MSR

Apt Reason: Collection Code
Name: DOB: Age Sex:

Guarantor #:

Head & Neck

___ 76512	Ocular
___ 76536	Head/Neck, soft tissue

Thorax/Back

___ 76604	Thoracic/Pulmonary
___ 76604	Pneumothorax
___ 76641	Breast, unilateral, complete
___ 76642	Breast, unilateral, limited
___ 76882	MSK/Soft Tissue
___ 76882	Joint, non-vascular
___ 93308	Cardiac, limited

Abdomen/Retroperitoneum

___ 76705	Gallbladder
___ 76775	Kidney/Renal
___ 76775	Aorta (AAA)
___ 76857	Bladder
___ 76882	MSK/Soft Tissue

OB/GYN/MUTA

___ 76815	Pregnant transabdominal
___ 76817	Pregnant transvaginal
___ 76830	Non-pregnant transvaginal
___ 76857	Pelvis
___ 76870	Scrotum

Upper Extremity

___ 76882	MSK/Soft Tissue
___ 76882	Joint, non-vascular
___ 93970	DVT, bilateral
___ 93971	DVT, unilateral

Lower Extremity

___ 76882	MSK/Soft Tissue
___ 76882	Joint, non-vascular
___ 93970	DVT, bilateral
___ 93971	DVT, unilateral

Miscellaneous

___ 76999	Unlisted US procedure

Soft Tissue

___ 76512	Ocular
___ 76536	Head/Neck
___ 76604	Chest wall
___ 76604	Upper back
___ 76641	Breast, unilateral, complete
___ 76642	Breast, unilateral, limited
___ 76705	Lower back
___ 76705	Abdominal wall
___ 76857	Pelvic wall
___ 76882	Axilla
___ 76882	Extremity

Ultrasound-guided Procedure

___ 76942	US-guided abscess drainage
___ 20604	US-guided joint aspiration: small joint (finger, toe)
___ 20606	US-guided joint aspiration: intermediate joint (elbow, wrist)
___ 20611	US-guided joint aspiration: large joint (shoulder, hip, knee)

CPT modifier

___ 26	Professional component of global fee
___ 52	Partially reduced service provided
___ 59	Distinct procedural service (report procedures that are distinct but have the same CPT code)

References

American College of Emergency Physicians. (2009). Emergency ultrasound guidelines. *Annals of Emergency Medicine, 53*(4), 550-570. doi: 10.1016/j.annemergmed.2008.12.013

Andersen, C. A., Holden, S., Vela, J., Skovdal, R., & Jensen, M. B. (2019). Point-of care-ultrasound in general practice: A systematic review. *The Annals of Family Medicine, 17*(1), 61-69. https://doi.org/10.1370/afm.2330

Barbic, D., Chenkin, J., Cho, D. D., Jelic, T., & Scheuemeyer, F. X. (2017). In patience presenting to the emergency department with skin and soft tissue infections what is the diagnostic accuracy of point-of-care ultrasonography for the diagnosis of abscess compared to the current standard of care? A systematic review and meta-analysis. *British Medical Journal Open, 7*(e13688). doi:10.1136/bjmopen-2016-013688

Bhagra, A., Tierney, D. M., Sekiguchi, H., & Soni, N. J. (2016). Point-of-care ultrasonography for primary care physicians and general internists. *Mayo Clinic Proceedings, 91*(12), 1811-1827. http://dx.doi.org/10.1016/j.mayocp.2016.08.023

Donabedian, A. (1988). The quality of care: How can it be assessed? *Journal of American Medical Association, 260* (12). 1743–1748.

Gentilotti, E., Nardo, P., Cremonini, E., Gorska, A., Mazzaferri, F., Canziani, L. M., Hellou, M. M., Olchowski, Y., Poran, I., Leeflang, M., Villacian, J., Goossens, H., Paul, M., & Tacconelli, E. (2022). Diagnostic accuracy of point-of-care tests in acute community-acquired lower respiratory tract infections. A systematic review and meta-analysis. *Clinical Microbiology and Infection, 28*, 13-22.

Gilbertson, E. A., Hatton, N. D., & Ryan, J. J. (2020). Point of care ultrasound: The next evolution of medical education. *Annals of Translational Medicine, 8*(14). doi:10.21037/atm.2020.04.41

Gottlieb, M., Avila, J., Chottiner, M., & Peksa, G. D. (2020). Point-of-care ultrasonography for the diagnosis of skin and soft tissue abscesses: A systematic review and meta-analysis. *Annals of Emergency Medicine, 76*(1), 67-77. https://doi.org/10.1016/j.annemergmed.2020.01.004

Hughes, D., Corrado, M. M., Mynatt, I., Prats, M., Royall, N. A., Boulder, C., & Bahner, D. P. (2020). Billing I-AIM: A novel framework for ultrasound billing. *The Ultrasound Journal, 12*(8), 1-10. https://doi.org/10.1186/s13089-020-0157-0

Kang, A. (2022). *How much does an ultrasound cost without insurance?*. https://houseofdebt.org/how-much-does-an-ultrasound-cost-without-an-insurance/

Kitson, A. L., Rycroft-Malone, J., Harvey, G., McCormack, B., Seers, K., & Titchen, A. (2008). Evaluating the successful implementation of evidence into practice using the PARiHS framework: Theoretical and practical challenges. *Implementation Science, 3*(1), 1-12. doi:10.1186/1748-5908-3-1

Maxwell, Y. L. (2020). *Ultrasound proliferates at the point of care*. https://acpinternist.org/archives/2020/01/ultrasound-proliferates-at-the-point-of-care.htm

McKinsey & Company. (2008). Enduring ideas: The 7-S framework. *McKinsey Quarterly*. https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/enduring-ideas-the-7-s-framework

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine, 6*(7), e1000097. doi:10.1371/journal.pmed.1000097

POCUS 101. (n.d.) *Complete ultrasound CPT codes list and reimbursement rates.* https://www.pocus101.com/complete-ultrasound-cpt-code-list-and-reimbursement-rates/

Rycroft-Malone, J. (2004). The PARIHS Framework—A framework for guiding the implementation of evidence-based practice. *Journal of Nursing Care Quality, 19*(4), 297-304.

Sorensen, B. & Hunskaar, S. (2019). Point-of-care ultrasound in primary care: A systematic review of generalist performed point-of-care ultrasound in unselected populations. *The Ultrasound Journal, 11*(31), 1-29. https://doi.org/10.1186/s13089-019-0145-4

Waterman, R. H., Peters, T. J., & Phillips, J. R. (1980). Structure is not organization. *Business Horizons, 23*(3), 14-26. https://doi.org/10.1016/0007-6813(80)90027-0

Bringing Point-of-Care Ultrasound to a Rural Primary Care Clinic

Caleb E. Migda

DNP Project

April 26, 2023

Grand Valley State University
Kirkhof College of Nursing

Acknowledgements

- Advisor:
  - Dr. Donna Rinker, DNP, MSN, RN, FNP-BC, PMHNP
- Advisory Team:
  - Dr. Anne McKay, DNP, ANP-BC
  - Dr. Kelly Flynn, DO
- Funding:
  - Health Resources and Services Administration (HRSA) Advanced Nursing Education Workforce (ANEW) grant

Objectives for Presentation

1. Introduce project background and site
2. Discuss organizational assessment and SWOT analysis
3. Review synthesis of literature
4. Discuss the implementation of point-of-care ultrasound
5. Review data from implementation
6. Propose sustainability plan

Background

- Ultrasound (US) technology has been used since the early 1940s.
- Handheld US prototype developed in 1998.
- Point-of-Care ultrasound (POCUS) is frequently used in emergency medicine.
  - Has become common in general medicine.
- POCUS greatly narrows differential list and supports formal diagnosis.
- Many patients requiring ultrasound experience a delay in completing the test due to necessity for scheduling or referral to different specialty.

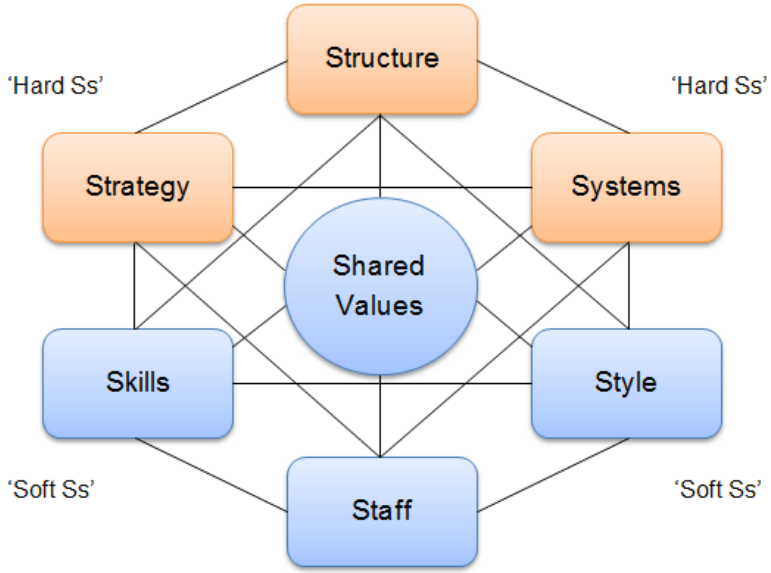
(The British Medical Ultrasound Society, n.d.; McGahan et al., 2015; Sorensen & Hunskaar, 2019; Bhagra et al., 2016)

Organizational Setting

- Primary care practice in rural Midwest.
- Affiliated with a larger health system.
- 2 physicians.
- Offers a range of services for patients of all ages across the lifespan.
  - Emphasis placed on preventative care.
- Ultrasound commonly ordered for accurate diagnoses.
  - Requires outpatient appointment or referral to specialty clinic.
  - Creates delay in diagnosis and/or delay in treatment plan.

Organizational Assessment

- McKinsey 7S Framework
  - Strategy
  - Structure
  - Systems
  - Skills
  - Style
  - Staff
  - Shared Values



(McKinsey & Company, 2008; Jurevicius, 2021)

SWOT Analysis

Strengths

- Part of a larger, statewide not-for-profit healthcare system
- Clear mission and vision
- **Experienced physicians**
- **Dedicated and cohesive team of staff in practice**
- Smaller practice allows for more personalized care
- Patient surveys: "The staff work well together. It is easy to communicate with the office"
- Strong interprofessional dynamics

Opportunities

- Office was designed to facilitate an additional provider
- **Recent physician residency program may aid in recruiting quality physicians/APP to the practice**
- **Recent purchase of a local primary care office by another organization may lead to addition of new patients into the practice due to the other organization's refusal to accept various forms of health insurance.**
- **1 NP joining practice in June**
- Many individuals moving to the area seeking new employment

Weaknesses

- **Physician-to-MA ratio of 1:1**
- Difficulty hiring and keeping MAs
- Fewer human capital resources may result in inability to maximize care
- **Difficulty convincing Executive Team of the necessity for additional MA**
- Lack of emphasis of importance of non-physician/APP support staff
- Recent scheduling difficulties due to clinic receptionist turnover

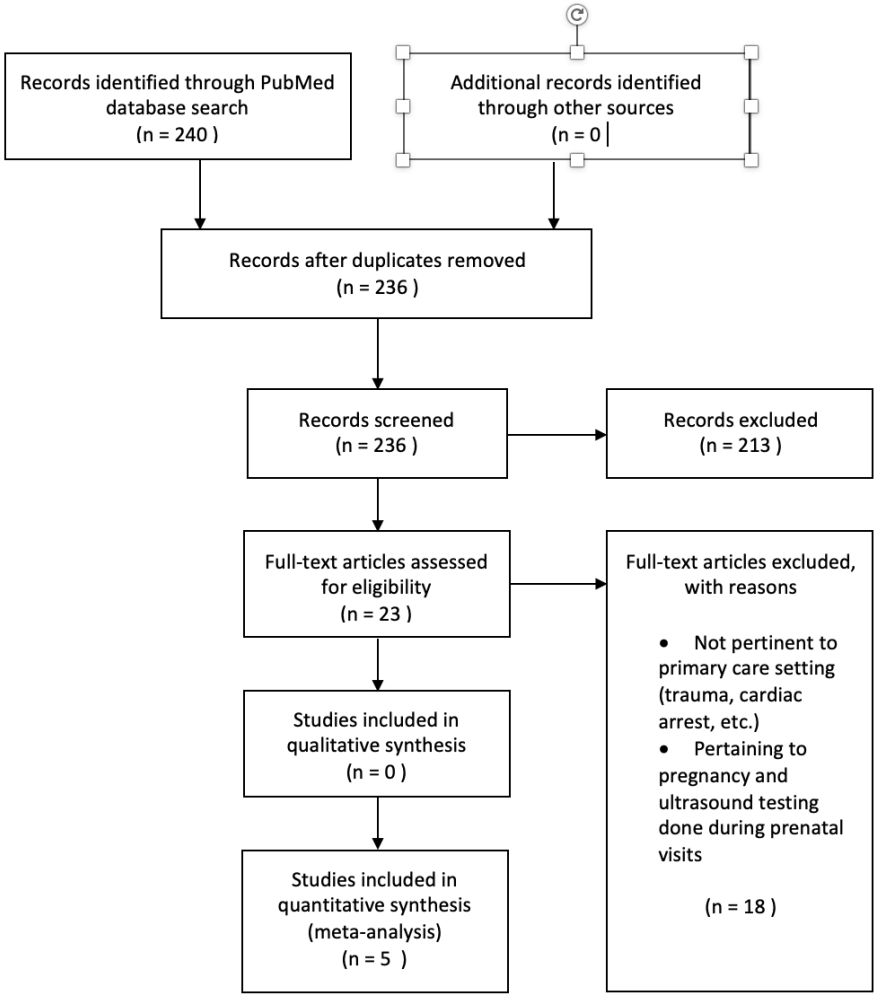
Threats

- **The development of multiple urgent care facilities in the area may deter individuals from seeking a primary care provider.**
- Continued increase in healthcare costs
- **Pandemic continues to threaten healthcare staffing solutions**
- Recent requirement to treat larger volumes of patients may threaten quality of care

Aims of the Literature Review

- Identify evidence that supports the use of POCUS in the primary care setting.
- Examine utility of POCUS.
- Identify ability of POCUS to decrease delay in diagnosis.
- Identify evidence that supports use of POCUS to improve patient outcomes.

PRISMA


PRISMA 2009 Flow Diagram
Records identified through PubMed database search (n = 240)
Additional records identified through other sources (n = 0
Records after duplicates removed (n = 236)
Records screened (n = 236)
Records excluded (n = 213)
Full-text articles assessed for eligibility (n = 23)
Full-text articles excluded, with reasons
• Not pertinent to primary care setting (trauma, cardiac arrest, etc.)
• Pertaining to pregnancy and ultrasound testing done during prenatal visits
(n = 18)
Studies included in qualitative synthesis (n = 0)
Studies included in quantitative synthesis (meta-analysis) (n = 5)

Results of the Literature Review

- POCUS has numerous purposes and is commonly used to assist in diagnosis and to perform simple procedures (Andersen et al., 2019).
- POCUS is useful in assessing multiple organ systems, providing diagnostic value to the heterogenous population seen in the primary care setting. (Andersen et al., 2019; Sorensen & Hunskaar, 2019).
- POCUS is a reliable diagnostic tool for numerous conditions (Gentilotti et al., 2022; Sorensen & Hunskaar, 2019; Gottlieb et al., 2020).
- POCUS can be utilized as an evidence-based diagnostic tool for the PCP (Anderson et al., 2019).

Literature Review continued

Themes	Literature Synthesis
POCUS in the Primary Care Setting	POCUS was utilized for numerous purposes, most commonly to assist in diagnosis, but also for minor procedures and general screenings (Andersen et al., 2019). Use of POCUS among general practitioners varies greatly, but its use is becoming more common in the primary care setting due to its broad useability (Sorensen & Hunskaar, 2019). The use of POCUS is common in rural Canada, as its diagnostic capabilities are useful in a setting with limited resources (Sorensen & Hunskaar, 2019). Formal training for use of POCUS in the primary care setting ranges from 4 to 320 hours, and such training covers numerous body systems (Andersen et al., 2019).
Utility of POCUS	The authors found the use of ultrasound by general practitioners had a wide range of indications and organ systems, including the abdomen, heart, lungs, blood vessels, the eye, soft tissues, the musculoskeletal system, and obstetrics. They concluded that POCUS can be a very safe and useful tool for the general practitioner to aid in the evaluation and diagnosis of numerous conditions (Sorensen & Hunskaar, 2019). A study of 574 patients revealed the use of POCUS to evaluate multiple organs and resulted in the potential for more than 100 differential diagnoses (Andersen et al., 2020).

Literature Review continued

Themes	Literature Synthesis
Reliability of POCUS	POCUS demonstrated a 94.6% sensitivity and 85.4% specificity for differentiating soft tissue infection from abscess, guiding treatment plan and antibiotic therapy (Gottlieb et al., 2020). A 90% sensitivity and 90% specificity when diagnosing bacterial pneumonia using POCUS and showed higher diagnostic accuracy than chest x-ray (Gentilotti et al., 2022). POCUS showed high sensitivity and specificity when evaluating aortic insufficiency, mitral insufficiency, pneumonia, pneumothorax, abdominal aortic aneurysm, deep vein thrombosis, hydronephrosis, cholecystitis, appendicitis (Sorensen & Hunskaar, 2019).

Conceptual Framework for Phenomenon: Donabedian Model

Structure	Process	Outcomes
• Physical environment • Technology • Equipment • Staff	• Delivery of care • Diagnosis • Treatment • Patient education	• Quality improvement • Healthcare costs • Quality of life • Patient satisfaction

(Donabedian, 1988)

Clinical Practice Question

- Will the implementation of point-of-care ultrasound in the primary care setting improve diagnostic and treatment outcomes?

Project Type and Purpose

- **Project type**:
  - Program Development for the implementation and adoption of a POCUS process in a rural primary care clinic.
  - Quality Improvement for the reduction in time to testing and time to diagnosis for those needing ultrasound testing.
- **Purpose**:
  - Improve the diagnostic and treatment outcomes of patients in a primary care clinic when experiencing delay in ultrasound testing.

PROJECT PLAN

Project Objectives

- Engage stakeholders to gain buy-in.
- Attend POCUS training.
- Develop process for documentation of POCUS in the EMR.
- Create a Policy & Procedure for use of POCUS.
- Develop worksheet for CPT and ICD-10 coding.
- Reduce time to testing and time to diagnosis for patients needing ultrasound.
- Obtain patient feedback using post-POCUS surveys.

Project Design

- **Program Development**
  - Development of a process for improvement of diagnostic outcomes in terms of decreased wait-times, reduced time to diagnosis, and improved patient satisfaction.
- **Evidence Based Practice**
  - Implement and evaluate the effectiveness of the POCUS process.

Current State of the Organization:

- Primary care patients can have delayed diagnostic testing when ultrasound is required.
  - Requires out-of-clinic testing or referral to other specialty.
  - Barriers in scheduling outpatient testing.
- Delay in diagnostic results.
- Delay in treatment and outcomes.
- Decreased patient satisfaction can result.
- Mission: To provide the best value in healthcare as defined by quality outcomes and cost.

Methods: Project Plan

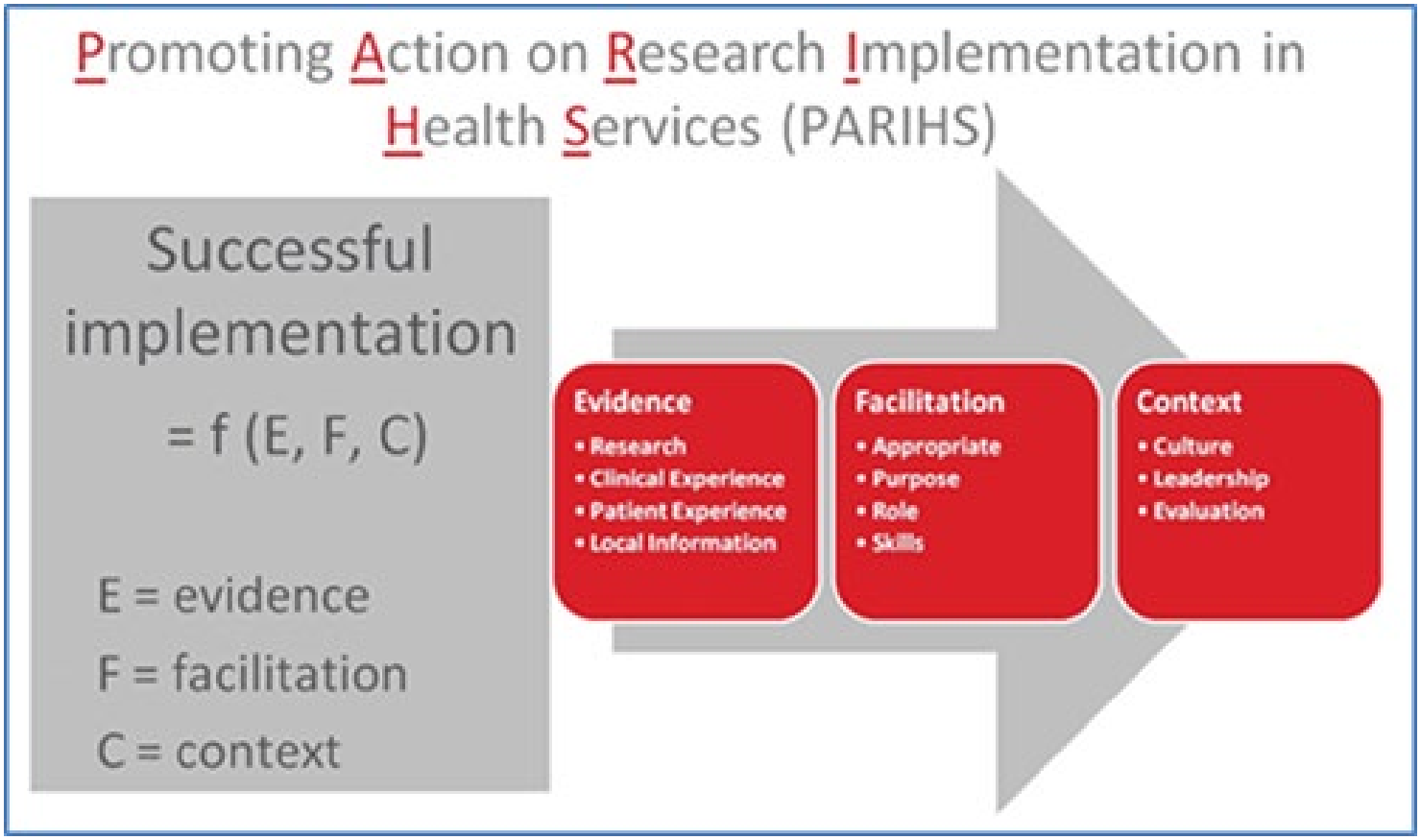
- Setting and Participants
- Stakeholders
- Implementation Framework
- Purpose and objectives
- Implementation strategies
- Evaluation and measures
- Timeline
- Sustainability


Key Stakeholders
Patients
-will be receiving POCUS services
Larger Health System
-Oversees multiple primary care clinics
Primary Care Providers:
-will be performing and interpreting POCUS services
Billing Department:
-will ensure there is proper reimbursement for POCUS services
Payers
-Medicare
-Medicaid
-Private Insurance
IT Department:
-will aid in implementation of POCUS device and process for storing images

Implementation Framework

- Promoting Action on Research Implementation in Health Services (PARIHS).
  - Evidence
    - Research, clinical experience, patient experience, local knowledge.
  - Facilitation
    - Appropriateness, purpose, role, skills.
  - Context
    - Culture, leadership, evaluation.
- How PARIHS fits:
  - Evidence supports POCUS in numerous clinic setting for the enhancement of patient care (Sorensen & Hunskaar, 2019; Bornemann & Barreto, 2018).
  - Many patients require ultrasound evaluation.
  - POCUS device has been purchased.
  - Physician enthusiasm.
  - Managerial support.

PARIHS



(Kitson et al., 2008)

Implementation Strategies & Elements

- **Local Needs Assessment**
  - Staff interviews
  - Meeting with project team members
- **Assess Readiness: Identify Barriers and Facilitators**
  - Organizational Assessment
  - SWOT Analysis
  - Meetings
- **Stakeholder Engagement**
  - Onsite or offsite meetings
  - Emails
  - Project updates
- **Facilitation**
  - Communication
  - Collaboration: billing department, IT department
- **Access new funding**
  - HRSA grant
- **POCUS training**
- **Policy and Procedure for POCUS**
- **Obtain and use patient feedback**
  - Patient surveys

(Powell et al., 2015)

Evaluation and Measures

- Implementation strategies
  - Readiness assessment
  - Stakeholder engagement
  - Process development
- Patient outcomes
  - Time to testing
  - Time to diagnosis
  - Patient satisfaction
- System outcomes
  - Reimbursement

Evaluation & Measures (handout)

Topic	Concept	How Measured	When Measured	Who Measures
Implementation Strategies	Assess for change readiness	Organizational Assessment and SWOT Analysis	Pre implementation	DNP Student
	Engage Stakeholders	Face-to-face and email communication	Pre implementation	DNP Student
	Develop CTP code and ICD-10 POCUS worksheet		Pre implementation	DNP Student
	Develop Butterfly Cloud storage process		Pre implementation	DNP Student
Patient Outcomes	Time to testing	EHR audit	Pre (All ultrasounds ordered in previous 3 months) Post (March1, 2023-March 31, 2023) implementation	DNP Student
	Time to diagnosis	EHR Audit	Pre (All ultrasounds ordered in previous 3 months) Post (March 1, 2023-March 31, 2023) implementation	DNP Student
	Patient satisfaction	Survey	Post (March 1, 2023-March 31, 2023) implementation	DNP Student
System Outcomes	Reimbursement	Audit	Post implementation	DNP Student

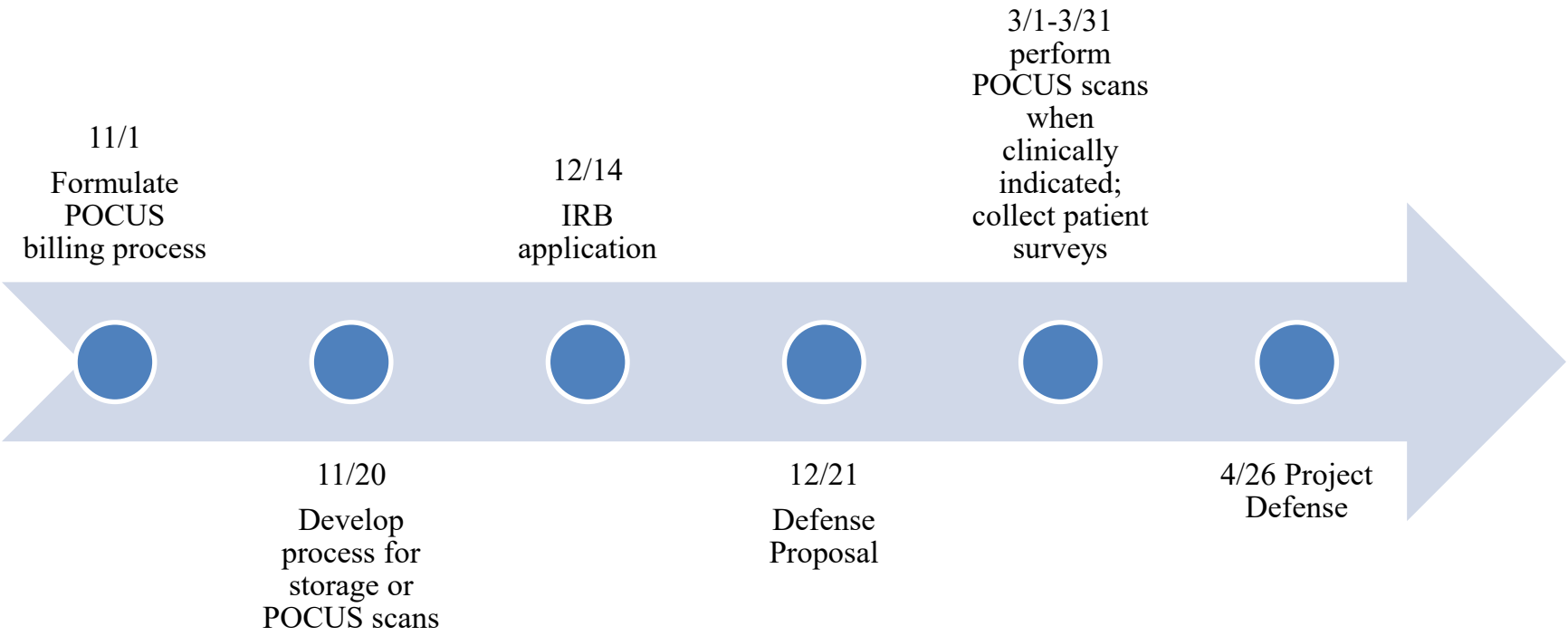
Ethical Considerations

- Protected health information from patient surveys will be stored in REDCap (Research Electronic Data Capture).
- IRB determined not human subjects research.
- No conflicts of interest.

Budget & Resources

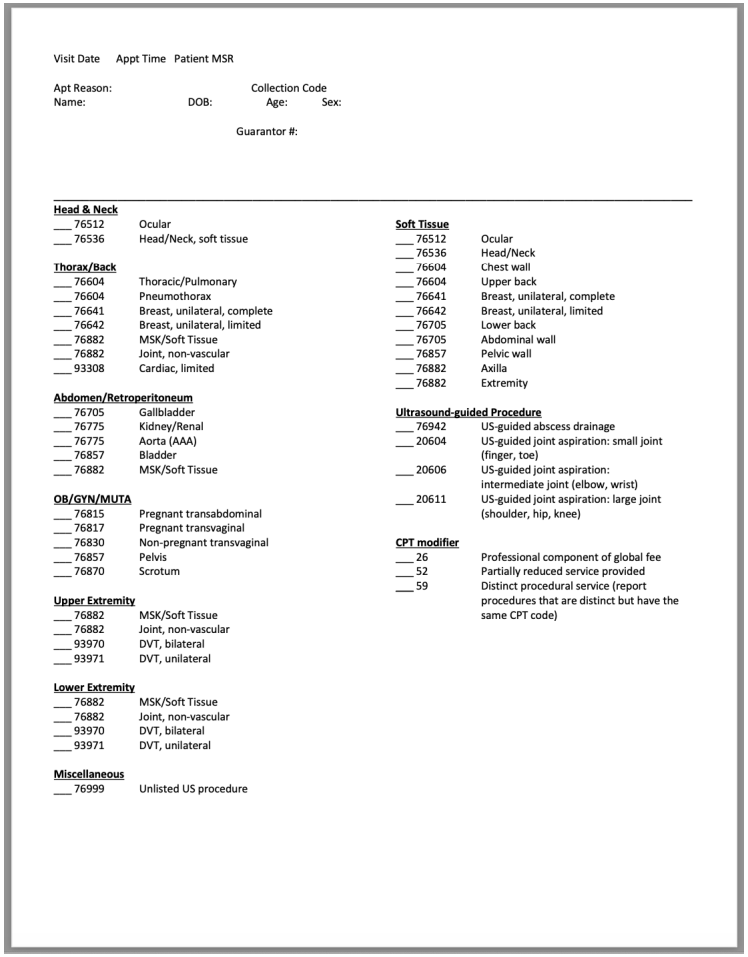
Estimated Reimbursement for POCUS scan		
Average reimbursement for 1 POCUS scan	$86.55	
Reimbursement for 52 POCUS scans		$4,500.60
HRSA Funding		
POCUS, Butterfly membership, iPad		$2,919
Total		$7,419.60
Expenses for Implementation of Project		
POCUS training class	$950	
Physician time for POCUS training $95/hr, 30 hours	$2,850	
Purchase of POCUS and 1 year Butterfly membership	$2,419	
Total		$6,219
Revenue + Grant Funding - Expenses		**$1,200.60**

Timeline


11/1
Formulate POCUS billing process
11/20
Develop process for storage or POCUS scans
12/14
IRB application
12/21
Defense Proposal
3/1-3/31
perform POCUS scans when clinically indicated; collect patient surveys
4/26 Project Defense

Process Documents

- Policy and Procedure
- CPT coding worksheet
- ICD-10 code worksheet
- POCUS survey



Visit Date Appt Time Patient MSR

Apt Reason: Collection Code
Name: DOB: Age: Sex:

Guarantor #:

Head & Neck
___76512 Ocular
___76536 Head/Neck, soft tissue

Thorax/Back
___76604 Thoracic/Pulmonary
___76604 Pneumothorax
___76641 Breast, unilateral, complete
___76642 Breast, unilateral, limited
___76882 MSK/Soft Tissue
___76882 Joint, non-vascular
___93308 Cardiac, limited

Abdomen/Retroperitoneum
___76705 Gallbladder
___76775 Kidney/Renal
___76775 Aorta (AAA)
___76857 Bladder
___76882 MSK/Soft Tissue

OB/GYN/MUTA
___76815 Pregnant transabdominal
___76817 Pregnant transvaginal
___76830 Non-pregnant transvaginal
___76857 Pelvis
___76870 Scrotum

Upper Extremity
___76882 MSK/Soft Tissue
___76882 Joint, non-vascular
___93970 DVT, bilateral
___93971 DVT, unilateral

Lower Extremity
___76882 MSK/Soft Tissue
___76882 Joint, non-vascular
___93970 DVT, bilateral
___93971 DVT, unilateral

Miscellaneous
___76999 Unlisted US procedure

Soft Tissue
___76512 Ocular
___76536 Head/Neck
___76604 Chest wall
___76604 Upper back
___76641 Breast, unilateral, complete
___76642 Breast, unilateral, limited
___76705 Lower back
___76705 Abdominal wall
___76857 Pelvic wall
___76882 Axilla
___76882 Extremity

Ultrasound-guided Procedure
___76942 US-guided abscess drainage
___20604 US-guided joint aspiration: small joint (finger, toe)
___20606 US-guided joint aspiration: intermediate joint (elbow, wrist)
___20611 US-guided joint aspiration: large joint (shoulder, hip, knee)

CPT modifier
___26 Professional component of global fee
___52 Partially reduced service provided
___59 Distinct procedural service (report procedures that are distinct but have the same CPT code)

Results: Outpatient Ultrasound

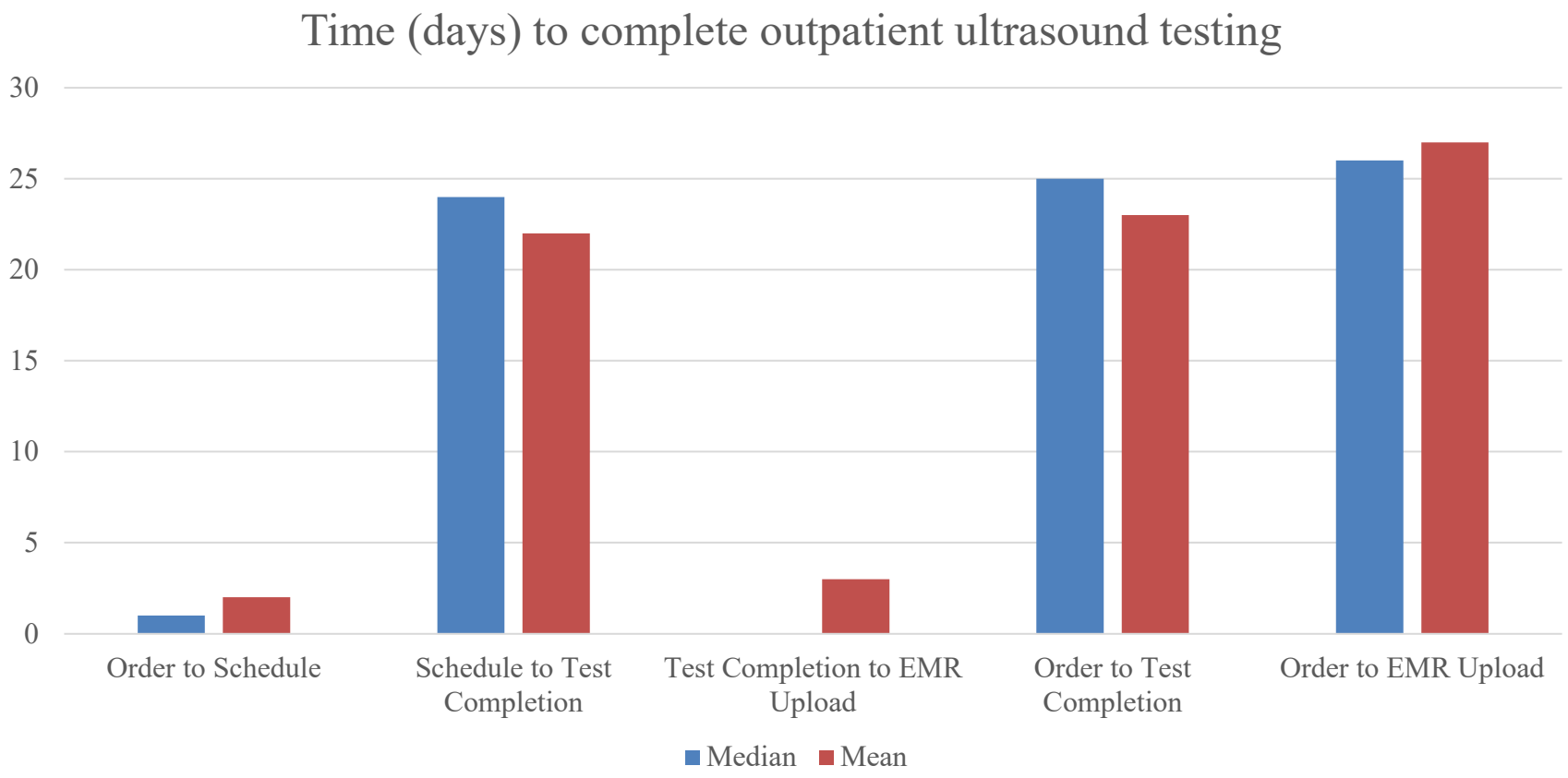
- Chart audit (n = 51) October 2, 2022 – January 2, 2023
- Removed from audit results:
  - 6 echocardiograms
  - 7 pelvis with transvaginal
  - 4 ordered with diagnostic mammography
- 34 ultrasounds used for analysis

Results

Time to Outpatient Ultrasound Testing (days)

	Median	Mean
Order placed by provider – Ultrasound scheduled by medical assistant	1	2
Ultrasound scheduled by medical assistant – Ultrasound completed in outpatient radiology department	24	22
Ultrasound completed in outpatient radiology department – Results uploaded into EMR	0	3
Order Placed by provider – Ultrasound completed in outpatient radiology department	25	23
Order placed by provider – Results uploaded into EMR	26	27

Results: Outpatient Ultrasound



Results: POCUS

- 1 POCUS performed.
- Patient presented with posterior knee swelling.
  - POCUS was performed same-day.
  - DVT was ruled out.
  - Referral to orthopedics.
  - Eliminated necessity for vascular US.
- Patient survey

Discussion

- Current ultrasound process has multiple steps, each providing opportunity for delays in care.
  - Takes nearly 4 weeks.
- POCUS can significantly reduce time to testing and time to diagnosis.
  - Provides convenience to patient.
  - May reduce anxiety regarding testing.
- Limitations
  - Some insurance providers require prior authorization.
  - Short window for post-implementation data collection.

Implications for practice

- Valuable and reliable diagnostic tool for the rural setting.
- Can reduce time to diagnosis.
- Minimization of patient anxiety.
- Can improve patient satisfaction.
- Potential revenue.
- Competitive advantage.

Sustainability Plan

- Focus on 3.
  - Continue enhancing provider skill set when performing POCUS.
- Train other provider in office to use POCUS.
- An average of 6 POCUS scans must be performed annually to cover the cost of Butterfly iQ membership.

Dissemination

- Share results with project site and larger organization.
- Manuscript submission to JAANP.

Summary

- POCUS can be used to evaluate a wide range of conditions.
- It has utility in the primary care setting.
- Can significantly reduce time to testing at project site.
- Convenient for patients in a rural setting.
- Potential for revenue.

DNP Essentials

- Essential II: Organizational and systems leadership for quality improvement and systems thinking

- Essential IV: Information systems/technology and patient care technology for the improvement and transformation of health care

- Essential VI: Interprofessional collaboration for improving patient and population health outcomes

References

Andersen, C. A., Holden, S., Vela, J., Skovdal, R., & Jensen, M. B. (2019). Point-of care-ultrasound in general practice: A systematic review. *The Annals of Family Medicine, 17*(1), 61-69. https://doi.org/10.1370/afm.2330

Andersen, C. A., Brodersen, J., Davidsen, A. S., Graumann, O., & Jensen, M. B. (2020). Use and impact of point-of-care-ultrasonography in general practice: A prospective observational study. *British Medical Journal Open, 10*. doi:10.1136/ bmjopen-2020-037664

Barbic, D., Chenkin, J., Cho, D. D., Jelic, T., & Scheuemeyer, F. X. (2017). In patience presenting to the emergency department with skin and soft tissue infections what is the diagnostic accuracy of point-of-care ultrasonography for the diagnosis of Abscess compared to the current standard of care? A systematic review and meta-analysis. *British Medical Journal Open, 7*(e13688). doi:10.1136/bjmopen-2016-013688

Bhagra, A., Tierney, D. M., Sekiguchi, H., & Soni, N. J. (2016). Point-of-care ultrasonography for primary care physicians and general internists. *Mayo Clinic Proceedings, 91*(12), 1811-1827. http://dx.doi.org/10.1016/j.mayocp.2016.08.023

Bornemann, P, & Barreto, T. (2018). Point-of-care ultrasonography and family medicine. *American Family Physician, 98*(4), 200-202.

Donabedian, A. (1988). The quality of care: How can it be assessed?. *JAMA. 260* (12). 1743–1748.

Gentilotti, E., Nardo, P., Cremonini, E., Gorska, A., Mazzaferri, F., Canziani, L. M., Hellou, M. M., Olchowski, Y., Poran, I., Leeflang, M., Villacian, J., Goossens, H., Paul, M., & Tacconelli, E. (2022). Diagnostic accuracy of point-of-care tests in acute community-acquired lower respiratory tract infections. A systematic review and meta-analysis. *Clinical Microbiology and Infection, 28*, 13-22.

Gottlieb, M., Avila, J., Chottiner, M., & Peksa, G. D. (2020). Point-of-care ultrasonography for the diagnosis of skin and soft tissue abscesses: A systematic review and meta-analysis. *Annals of Emergency Medicine, 76*(1), 67-77. https://doi.org/10.1016/j.annemergmed.2020.01.004

Jurevicius, O. (2021). *McKinsey 7S Model*. https://strategicmanagementinsight.com/tools/mckinsey-7s-model-framework/

References

Kitson, A. L., Rycroft-Malone, J., Harvey, G., McCormack, B., Seers, K., & Titchen, A. (2008). Evaluating the successful implementation of evidence into practice using the PARiHS framework: Theoretical and practical challenges. *Implementation Science, 3*(1), 1-12. doi:10.1186/1748-5908-3-1

McGahan, J. P., Pozniak, M. A., Cronan, J., Pellerito, J. S., Kenneth, S. L., Blaiva, M., Cooperberg, P., & Klein, H. (2015). Handheld ultrasound: Threat or opportunity. *Applied Radiology, 44*(3), 20-25. doi:10.37549/AR2166

McKinsey & Company. (2008). Enduring ideas: The 7-S framework. *McKinsey Quarterly*. https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/enduring-ideas-the-7-s-framework

Powell, B. J., Waltz, T. J., Chinman, M. J., Damschroder, L. J., Smith, J. L., Matthieu, M. M., Proctor, E. K., & Kirchner, J. E. (2015). A refined compilation of implementation strategies: Results from the Expert Recommendations for Implementing Change (ERIC) project. *Implementation Science, 10*(21), 1-14. doi:10.1186/s13012-015-0209-1

Rycroft-Malone, J. (2004). The PARIHS Framework—A framework for guiding the implementation of evidence-based practice. *Journal of Nursing Care Quality, 19*(4), 297-304.

Sorensen, B, & Hunskaar, S. (2019). Point-of-care ultrasound and primary care: A systematic review of generalist performed point-of-care ultrasound and unselected populations. *Ultrasound Journal, 11*(31), 1-29. https://doi.org/10.1186/s13089-019-0145-4

The British Medical Ultrasound Society. (n.d.). *The history of ultrasound*. https://www.bmus.org/for-patients/history-of-ultrasound/