The potential of point-of-care ultrasound in UK general practice

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Abstract
Ultrasound has been described as the stethoscope for the 21st century. It can rapidly answer a specific clinical question or support a procedure. Use of point-of-care ultrasound (PoCUS) by doctors has increased in the UK and internationally over the past decade. Training in PoCUS is now a core part of some undergraduate and postgraduate learning curricula. The World Organization of Family Doctors (WONCA Europe) has endorsed use of PoCUS in general practice. The rapid uptake of PoCUS in primary care in other countries suggests that the UK may soon follow suit. This article aims to provide an overview of PoCUS in primary care, including what PoCUS is, its current and potential use within primary care, limitations, legal considerations, and resources to develop an interest and skill in PoCUS as a GP in the UK.

Clinical case scenario
The clinical concerns raised in this example could be answered by point-of-care ultrasound (PoCUS) in less than 5 minutes.

An 8-year-old boy was brought to primary care with a sore mildly red tip to his penis. He had not been able to urinate properly (dribbling) for 24 hours. He was otherwise well in himself. On examination there was an almost complete congenital phimosis and mild inflammation of the foreskin (posthitis). There was slight suprapubic tenderness and no palpable bladder. A PoCUS scan was undertaken to examine for urinary retention, hydronephrosis and bladder rupture Example bladder images are presented in Figure 1 (Please note that image measurements do not correlate with the above case).

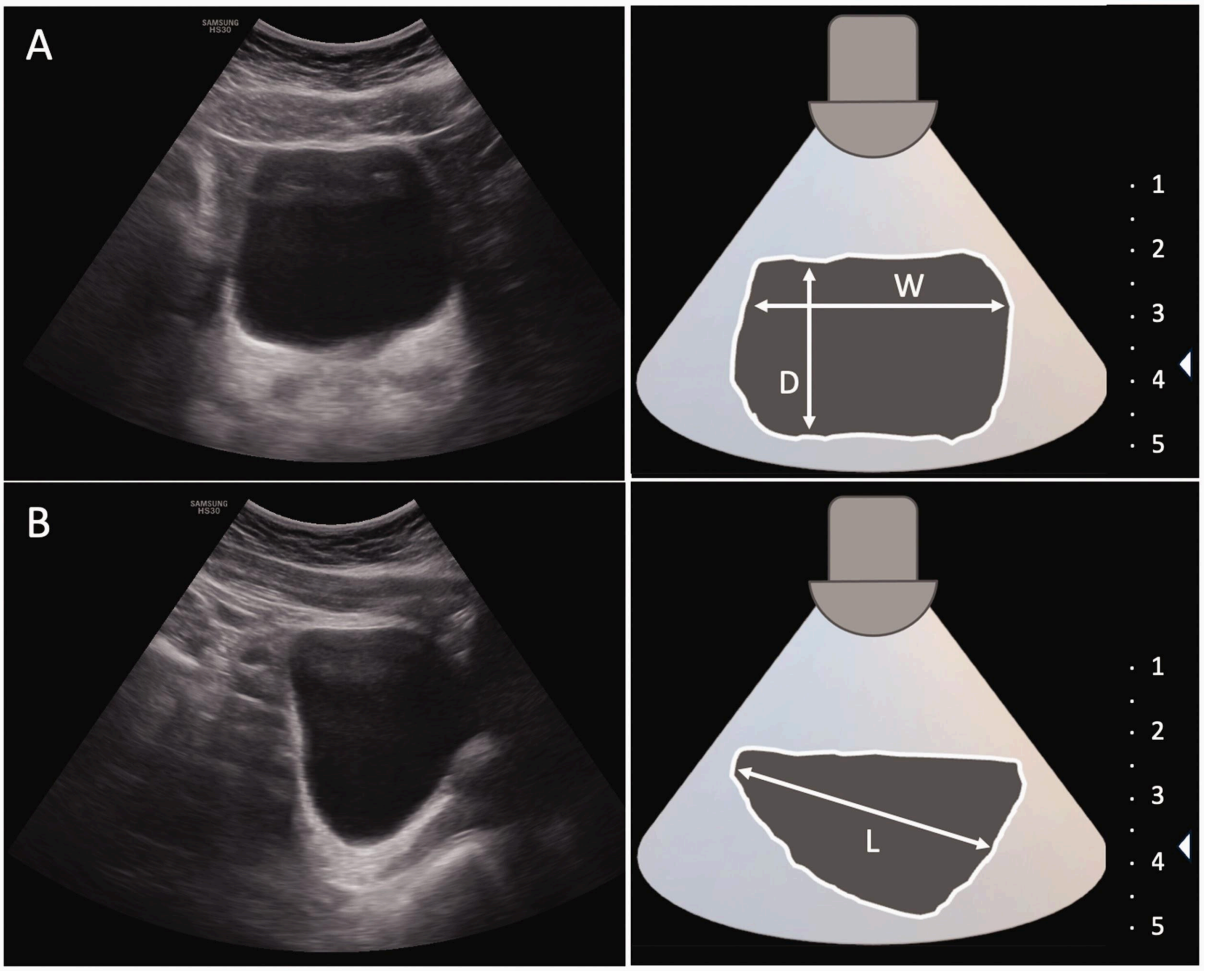

Figure 1. Transabdominal ultrasound images of the bladder in longitudinal (A) and transverse (B) planes. Number gradings (right side of image) represent centimetres. The small arrowhead is the focal point (where the ultrasound beam is most accurate). The bladder is measured in Length (L), Width (W) and Depth (D). Bladder dimensions are multiplied by a correction factor (commonly 0.72) to give a volume measurement as the bladder is not perfectly spherical (Bih et al., 1998). Ultrasound machine – Samsung HS30TM. Image taken by the authors with full participant consent for publication.

The PoCUS scan identified an anechoic (no echoes, black) structure within the bladder, in keeping with urine. Measurement of the length, width and depth of the bladder enabled calculation of bladder volume (353 mL). For children over a year the maximal bladder capacity is [(Age + 2) * 30] (Koff, 1983). The maximal bladder volume for an 8 year old would be 300 mL [(8 + 2) * 30], meaning the child was in urinary retention. The kidneys demonstrated no evidence of hydronephrosis. The child was subsequently admitted to paediatrics. He remained unable to pass urine and eventually required surgical intervention and catheter drainage.

Use of PoCUS was able to rapidly establish a diagnosis of urinary retention, despite the presence of only mild suprapubic discomfort, a non-palpable bladder and urinary dribbling. It was also able to rule out any significant complications, such as hydronephrosis and bladder rupture. The child has made a full recovery. Without a PoCUS scan, standard management options include patient-led watchful waiting with safety-netting advice, referral and wait for a

formal scan within secondary care (often weeks), or admission to secondary care with limited information. Appropriate use of a PoCUS scan can lead to reduced time to diagnosis, treatment, reduced levels of anxiety and patient suffering, and a reduction in additional healthcare presentations. There are many other examples of clinical scenarios where PoCUS can make a positive difference for patients in general practice.

What is medical ultrasound?

Ultrasound is defined as a sound frequency above that of human hearing, typically greater than 20,000 Hz. Ultrasound waves are generated through application of an electric current to a crystal structure. An ultrasound transducer has a series of crystals (often ≥128 crystals) able to emit and receive ultrasound waves. The sum of received waves is refreshed multiple times each second to generate a moving image on a screen. Medical ultrasonography began development in the early-1900s, with the first ultrasound images of abdominal disease in 1958 (Donald et al., 1958). Broadly, medical ultrasound can be therapeutic or diagnostic.

Therapeutic ultrasound uses relatively low-frequency ultrasound to generate heat. Examples of use include tendinitis, bursitis, breaking down kidney stones (lithotripsy) uterine fibroid ablation, cataract removal (phacoemulsification), tissue cutting in surgery and haemostasis (Miller et al., 2012).

Diagnostic ultrasound can be used to aid medical diagnosis, procedures, and screening. Diagnostic ultrasound uses higher-frequency sound waves (millions of Hertz (MHz)). The shape and frequency range of an ultrasound probe affects the depth and breadth of the image obtained. Commonly used probes include linear, curvilinear and phased array. Images are typically 2-dimensional (B-mode/grey-scale). Other modes include 3-dimensional, 4-dimensional, and Doppler ultrasound. An indicator on the probe enables direction and visualisation of the desired anatomical plane e.g. sagittal/longitudinal, transverse/axial, coronal/frontal, or a combination of views (oblique) (Moore, 2008). Features visualised through ultrasound images are described according to how reflective the tissue or medium is relative to surrounding structures. Standard terms include hyperechoic, hypoechoic, anechoic, or isoechoic. Ultrasound penetrates fluid and solid tissue far more easily than bone or gas. This means that imaging of the liver, spleen, and uterus are superior to imaging of the skull, chest, and abdominal areas with bowel gas. Bodily fluid is completely anechoic, appearing black on ultrasound images. This allows ultrasound to detect and differentiate fluid (e.g. blood, urine, bile, cystic fluid and ascites) from surrounding solid structures.
Ongoing improvements in ultrasound image quality, reductions in machine size and increasing affordability led to the development of PoCUS in the 1990s. PoCUS can be defined as diagnostic ultrasonography that is performed and interpreted by the attending clinician as a ‘bedside test’ (Moore and Copel, 2011). PoCUS allows the patient’s signs and symptoms to be correlated with visualised pathology through real-time dynamic images (Gluckman, 1993).

Patient perspectives on PoCUS in general practice

In general, patients view PoCUS in general practice positively. Patients have described the use of PoCUS in general practice consultations as improving the doctor–patient relationship, feeling ‘more thoroughly examined’ and ‘taken more seriously’. PoCUS can improve patients’ understanding of their health condition. It can also increase their perceived level of trust, quality of care, and overall experience of general practice (Andersen, Brodersen et al.,

2021). Patients may, however, not recognise the difference between PoCUS and an imaging-specialist's ultrasound examination within secondary care.

Current and potential use of PoCUS in UK primary care

Current use

Similar to the introduction of PoCUS within emergency medicine 10 years ago, the use of PoCUS in UK primary care is very much in its infancy. Early adopters of PoCUS within primary care come from a range of backgrounds, including those with prior UK training in other medical specialities such as cardiology, ultrasound training in overseas healthcare systems, or increasingly through structured primary care training courses in the UK. Their use of PoCUS in primary care has been helped by regulatory approval, technological improvement, and cost reduction of ultrasound devices within the UK. Within the UK, new handheld ultrasound devices can be bought for £3000–£5000, with images viewed via a cable or wireless connection to a tablet or smartphone. New ultrasound cart devices cost upwards of £10,000, with pre-used machines available at a lower cost.

Currently there are no guidelines governing the use of PoCUS within primary care in the UK. The British Medical Ultrasound Society (BMUS) has, however, published guidance on how PoCUS users outside of radiology departments should maintain professional development, practice safely and standards for clinical governance (BMUS, 2023). A great deal can be learned from other primary care systems globally. The World Organization of Family Doctors Europe (WONCA Europe), of which the RCGP is a member, has published a position statement endorsing use of PoCUS in general practice (Poppleton et al., 2024). The American Academy of Family Physicians (AAFP) has produced PoCUS guidelines for GP trainees (AAFP, 2016). The Royal Australian College of General Practitioners (RACGP) has endorsed PoCUS training courses (RACGP, 2023). Medical students in Germany and Switzerland receive training in ultrasound, with around 80% of general practitioners in these countries using PoCUS at some point in their working week (Andersen, Jensen, et al., 2019). A systematic review of international evidence has shown that PoCUS has the potential to be an important tool within primary care, with the potential to reduce healthcare costs and improve patient care (Andersen, Holden et al., 2019).

Steps are being taken to adapt lessons learned internationally to primary care within the United Kingdom (Martino et al., 2020; Krasucki and Savage, 2022). UK-based research in primary care PoCUS is growing, albeit from a limited base (Martino et al., 2020). Current studies in the UK and Europe are considering the most effective PoCUS scans and training methods for primary care, with findings supporting development of an ultrasound core curriculum for primary care (EFSUMB, 2023). The emerging consensus is that ultrasound skills require time to develop, facilitated by ongoing practice, training, mentorship and assessment. Primary care clinicians are sharing their experiences of using PoCUS and the influence it's having on their patient care (Pursglove, 2023). Training in PoCUS is being introduced at an undergraduate level within a number of UK medical schools, increasing likely future interest and capacity for PoCUS within UK Primary care (Apenteng and Lilford, 2023).

Indications

A clinician will take a medical history taking and physical examination within primary care. As part of the same consultation, PoCUS can then be used to answer a specific clinical question within a short time frame – typically less than 5 minutes. Examples include ‘is this patient’s right upper quadrant pain caused by gallstones?’; ‘does the patient have a uterine pregnancy?’; or ‘does this patient have urinary retention?’. A list of indications for PoCUS within primary care can be found in Table 1. Beyond answering a specific question, PoCUS can also be used to increase precision of procedures in general practice including ultrasound guidance of injections and minor surgery. Given the breadth of the RCGP learning curriculum, general practice stands to benefit the most from PoCUS out of any medical speciality.

	Indication	**Mean Likert score (1-5)**	**Level of agreement (%)**
1	Bladder volume	4.71	100
2	Gallstones	4.71	97.6
3	Living intrauterine pregnancy	4.61	92.7
4	Foetal position	4.54	92.7
5	Localisation of intrauterine device	4.51	95.1
6	Free abdominal fluid	4.49	85.4
7	Subcutaneous abscess	4.49	97.6
8	Hydronephrosis	4.44	95.1
9	Cholecystitis	4.44	92.7
10	Abdominal aortic aneurysm	4.41	85.4
11	First trimester bleeding	4.39	85.4
12	Bakers cyst	4.37	85.4
13	Deep vein thrombosis	4.37	82.9
14	Gestational age	4.32	80.5
15	Achilles tendonitis and tendon rupture	4.29	85.4
16	Subcutaneous tumours (lipoma, atheroma)	4.27	82.9
17	Localisation of foreign body	4.27	85.4
18	Shoulder injection	4.20	73.2

19	Pleural effusion	4.20	75.6
20	Knee joint effusion	4.20	73.2
Other listed uses: Pericardial effusion, subacromial/subdeltoid bursitis, biceps tendinitis, tenosynovitis and tendon rupture, injection/aspiration of Baker's cyst, rotator cuff tendinitis and/or ruptures (partial or full), ultrasound-guided abscess drainage, varicocele/hydrocele, injection/aspiration knee joint, elbow joint effusion, trochanteric bursitis.			

Table 1. A prioritised list of scanning modalities and procedures by level of importance (mean) and consensus (level of agreement) amongst Scandinavian GPs using PoCUS.Adapted from Løkkegaard et al. (2020).

What the future holds

Patients within the UK are living longer with a higher burden of disease and disability. Secondary care services are becoming more specialised, with a shift in routine healthcare provision from hospitals to primary care. Uptake and development of PoCUS within UK primary care is currently led by local primary care interest groups, GP trainees exposed to PoCUS within secondary care, and advocates of PoCUS from other clinical specialities. These individuals are developing learning resources and guidelines for UK primary care (see resources). Official endorsement of PoCUS by the UK medical colleges and societies would enable accreditation of a UK-based training programme. Wider uptake of PoCUS within UK primary care would be supported by a NHS implementation strategy including resources for purchasing and maintaining equipment, time for training and delivery, and clear curricula, training routes and continuing medical education (Akanuwe et al., 2023). Research and audit within primary care would refine this strategy, enhance governance structures, and support development of best practice including patients' healthcare experience and care outcomes. It remains to be seen whether PoCUS will be a UK general practice special interest undertaken by 'practice experts' or an integrated tool available to every general practitioner.

Getting started with PoCUS

Diagnostic ultrasound is a user-dependent medical investigation requiring knowledge of clinical indications, practical skills in device use, and ability to interpret and accurately record scan findings. A number of UK and international curricula and resources exist to support the learner to develop and maintain their knowledge and skills in ultrasound (see Box 1). Learning resources include face-to-face and online courses (both specialist and general practice focussed), educational websites, podcasts, social media feeds, mobile applications, and case cards (Sundhed, 2023). The BMUS, European Young Family Doctors Movement (EYFDM) and the European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB) provide professional communities of practice for general practitioners. These professional networks provide peer mentorship, allowing members to share their ideas and experiences. Formal training courses and professional networks also allow identification of trainers/mentors, which can be valuable in improving technique and clinical competency.

Box 1. Learning resources for PoCUS in general practice.

Learning resources

BMUS:

- Podcast series - PoCUS under the spotlight - www.bmus.org/education-and-cpd/cpd-resources/specialty-pages/npocus/pocus-under-the-spotlight

General Resources:

- www.bmus.org/education-and-cpd/cpd-resources/specialty-pages/npocus
- POCUS 101 - www.pocus101.com
- 123 Sonography - https://123sonography.com/
- POCUS: Point-of-care ultrasound certification academy - www.pocus.org/
- https://twitter.com/ecoapcat (App store) in Spanish
- Case cards

Curriculum guidance

- Royal College of Radiologists - Recommendations for specialists practising ultrasound independently of radiology departments: safety, governance and education. https://www.rcr.ac.uk/posts/recommendations-specialists-practising-ultrasound-independently-radiology-departments-safety
- Faculty of Sports and Exercise Medicine: www.fsem.ac.uk/fsem-uk-guidelines-for-musculoskeletal-ultrasonography-in-sport-and-exercise-medicine/
- AAFP: Recommended curriculum guidelines for family medicine residents: point of care ultrasound. www.aafp.org/dam/AAFP/documents/medical_education_residency/program_directors/Reprint290D_POCUS.pdf.

Courses

- GUSI – https://globalultrasoundinstitute.com/en/
- Primary Care PoCUS – https://primarycarepocus.co.uk
- Bromley emergency - www.bromleyemergency.com/our-courses/ultrasound-for-primary-care
- University postgraduate courses in medical ultrasound at Derby, KCL, and Teeside.

Organisations and interest groups

- Primary care pocus - https://primarycarepocus.co.uk
- BMUS
- EYFDM
- EFSUMB - https://efsumb.org
- American College of Emergency Physicians (ACEP) Emergency Ultrasound Section - www.acep.org/emultrasound

Uses of PoCUS in primary care internationally

Denmark

Very few Danish GPs used PoCUS a decade ago. This changed after the Center for General Practice at Aalborg University and the Danish Society of Ultrasound in Family Medicine partnered to develop a structured programme for implementation. Today around 15% of Danish GPs are using PoCUS in their daily practice. They have been supported by increasing consensus on PoCUS use and training in general practice, as well as the development of practice guidelines and concise learning resources (Sundhed, 2023). Initial

adopters of ultrasound in Denmark customised their own PoCUS training by attending courses within other medical specialties (Andersen et al., 2022). This resulted in varying applications of PoCUS examinations in general practice. The introduction of guidelines helped to standardise practice and reduce risk of potential harm, particularly as a result of advanced or unfocused ultrasound examinations (Andersen, Jensen et al., 2021).
PoCUS is not part of standard general practice specialty training programmes in Denmark. Interested general practitioners can attend a tailored PoCUS course on three levels: Level 1 half-day 'appetiser' courses, providing an insight into guidelines, equipment, and requirements, including short hands-on practical sessions. Level 2 courses incorporate a 3-month introductory educational programme with mentorship, continuous theoretical and practical training of increasing complexity, and individual feedback on performance. Participants learn to master 10 basic PoCUS applications and implement PoCUS into their clinical practice. Level 3 courses cover more complex PoCUS applications, including identification and management of less-common pathologies. Danish GPs participate in continuing medical education groups or additional courses to maintain scanning skills over time, including the Danish Society of Ultrasound in Family Medicine annual conference.
Use of PoCUS in Danish general practice continues to develop. The biggest barrier to further expansion is the lack of financial reimbursement for equipment and performing PoCUS in primary care. We feel this is likely to change with time, particularly as data demonstrating the impact of PoCUS on patient care, general practitioner workload, and healthcare costs increases.

Germany
Ultrasound has a long-standing history in Germany and is used on a daily basis by most doctors in primary care. Indications for use are wide ranging and can include, but are not limited to, evaluating abdominal pain, thyroid disease or soft tissue complaints (Schaubroeck, 2021). In recent years, more focussed PoCUS has been gradually adopted in some primary care practices, especially for house or care home visits, where PoCUS can help avoid unnecessary hospitalisation (Lo et al., 2019). Emergency services use PoCUS to detect acute pathologies, for example FAST scans (Focussed Assessment with Sonography for Trauma). In primary care PoCUS is more often used to identify or monitor subacute conditions, helping to shape management and decide if admission is necessary. Examples include differentiating bowel obstruction from other forms of abdominal discomfort and to guide community management of fluid overload in congestive cardiac failure. Some practices also offer cerebral artery Doppler diagnostics to spot and monitor plaque progress.
Within Germany, implementing ultrasound in family medicine is complicated by strict guidelines on data storage and the high costs of digital technology, particularly for single doctor practices. Another obstacle is the low level of reimbursement for ultrasound diagnostics under the public health insurance, despite it saving costs for the wider system through frequently preventing hospital admission. As a result, some doctors in family medicine are choosing not to undertake training or to offer fewer ultrasound services in their practice.

Spain
The use of ultrasound in family medicine varies across Spain. GPs can use ultrasound for a broad range of indications in their routine consultations, including abdominal, thyroid, musculoskeletal, and heart disease. GPs skilled in ultrasound often support their colleagues by reviewing patients who would benefit from a PoCUS examination.

Healthcare is overseen by the 17 regional governments in Spain. Many of the regional family medicine societies have their own ultrasound study groups and courses. The Catalan Institute for Health provided portable ultrasound machines to a number of health centres within their locality during the COVID-19 pandemic, seeing their benefit to community-focussed care. The Catalan Society of Family and Community Medicine (CAMFiC) oversees general practitioner training in ultrasound within Catalonia. Trainees undertake 100 hours of training, followed by a tutorial period to become proficient in PoCUS. Members of CAMFiC founded the EcoAP ultrasound interest group 10 years ago. It now has almost 200 members, of which 25% are general practice trainers in ultrasound. The EcoAP group provides ongoing ultrasound training for family medicine doctors and trainees. Training materials include resources on ultrasound techniques, clinical scenarios within family medicine, and the associated level of training and competency for each indication. Members of EcoAP have undertaken a prioritisation exercise to establish a framework of applications, skills and a training for PoCUS (Conangla-Ferrin et al., 2022). More recently a mobile app - EcoAPP has been developed providing a rapid access basic guide to clinical ultrasound in primary care (CAMFiC, 2023). Features include solutions to commonly encountered doubts and problems, a compilation of anatomical and pathological images, diagrams and illustrations, details on measurement, and templates for reporting findings.

France

Between 2016 and 2018, the use of PoCUS by general practitioners in France increased by 68%. A recent cross-sectional study of 1175 general practitioners and trainees revealed that 16.8% of GPs currently use ultrasound in their daily practice (Varenne and Hagiu, 2023). Interest among GP trainees is growing, with 91.2% expressing enthusiasm towards ultrasound. For general practitioners keen on integrating ultrasound into their practice, educational pathways are available through university diplomas and an expanding array of continuous medical education in PoCUS. Although no formal certification is required to use PoCUS, the generation of a detailed report is mandatory for billing purposes (Couture and Dasse-Hartaut, 2021). Furthermore, ultrasound training is increasingly being incorporated into the university curriculum for family practice residents (Gaumont-Darcissac, 2022). This growing enthusiasm for ultrasound in general practice led to the establishment of the French National Society for Ultrasound in General Practice (SNECHO-MG) in 2023. Key clinical applications (the SONOSTHETHO list) were formulated in 2013 following a DELPHI consensus, which has since been further revised (Camard et al., 2024). These include diagnosing various abdominal conditions, monitoring aneurysms, identifying thrombosis, assessing effusions, evaluating thyroid issues, confirming early pregnancy or miscarriage, in addition to identifying soft tissue abnormalities. The French Higher Authority for Health has recently called for greater research on ultrasound usage by general practitioners in France. Current challenges to wider adoption of PoCUS in French general practice include training accessibility, the extensive time required for skill acquisition, and financial investment (Varenne and Hagiu, 2023).

Limitations and legal aspects of PoCUS

Diagnostic ultrasound has been used in healthcare for many years without evidence of harm to patients (Barnett, 2002). A review by Sorensen and Hunskaar (2019) identified that generalists can safely use PoCUS in a wide range of clinical settings to aid diagnosis and better the care of their patients. Unlike X-ray or computerised tomography (CT) scans, ultrasound does not expose patients to ionising radiation. Furthermore, ultrasound can offer

superior diagnostic accuracy for pneumonia than chest X-ray (Martinez et al., 2021). However, effective use of ultrasound requires clinician proficiency, knowledge of appropriate indications and interpretation, and recognition of its strengths and limitations (Moore and Copel, 2011). PoCUS has the potential to increase diagnostic accuracy, reduce time to diagnosis, and reduce the requirement for other investigations or imaging in some situations. Unselective use of ultrasound can lead to an increase in false positive findings, insufficient explorations of false negative findings, and unnecessary requests for additional investigations or interventions. Inappropriate imaging or investigations risk increased healthcare expenditure and patient harm, without additional benefit. Such factors can be minimised through implementation of structured training, quality assurance, and monitoring of patient-centered outcomes for PoCUS within primary care (Cormack et al., 2019). PoCUS scans are a less extensive examination than full ultrasound or CT scans, resulting in fewer incidental findings and overdiagnosis of clinical unimportant conditions.

Medicolegal considerations vary between countries. There is clear value in assessing medicolegal risk in order to avoid potential harm to the patient, clinician or healthcare organisation. A retrospective review of lawsuits in the USA involving diagnostic PoCUS identified 70 legal cases across healthcare, none of which related to family medicine physicians being subjected to adverse legal action (Reaume et al., 2021). Where PoCUS is available in healthcare, lack of use has been cited as a cause of harm (Blaivas and Pawl, 2012). As with all novel technologies, increased uptake of PoCUS will likely lead to the development of national/local guidelines and regulatory frameworks within UK primary care to improve quality and safety (Conlon et al., 2022). This can be supported through data collection on its appropriate and inappropriate use, and its impact on care outcomes.

Conclusion

PoCUS offers a range of potential benefits to clinical practice, patient care, and clinician satisfaction within UK primary care. Awareness of PoCUS is increasing among general practitioners and medical students, in addition to the development of learning curriculum and resources. The use of PoCUS in UK primary care will likely increase over the coming years, following in the footsteps of other primary care systems across the globe. The development of training pathways for PoCUS in primary care, financial reimbursement for implementation and delivery, in addition to greater endorsement by national medical organisations/societies and health policymakers would support this process.

Key points

- PoCUS aims to answer a specific clinical question or support a procedure
- PoCUS offers the potential to improve patient care and satisfaction within primary care
- Use of PoCUS has increased in a number of medical specialities and primary care systems over the past decade
- Use of PoCUS in UK primary care is developing, supported by early adopters, curriculum development and lessons learned internationally

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