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Point-of-care ultrasound for the acute abdomen in the primary health care

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Abstract:

Point-of-care ultrasound (POCUS) is a focused examination, which is performed and interpreted at the bedside by the treating physician answering a specific clinical question. It is currently utilized as an essential adjunct to physical examination in many medical specialties. Recent advances in technology have made POCUS machines portable, affordable, and could be used with minimal training even by nonradiologists. This review aims to cover the fundamental physics of POCUS and its applications for diagnosing the acute abdomen in the primary health care including the most common causes encountered by family physicians. These are acute appendicitis, acute cholecystitis, renal colic, ectopic pregnancy, acute diverticulitis, bowel obstruction, and abdominal aortic aneurysm. We hope to encourage primary care physicians to incorporate POCUS in their routine clinical practice. We also highlight challenges encountered when using POCUS in the primary health care including limited availability and the need for proper training. Furthermore, we review the POCUS results when performed by primary health-care physicians. Integrating POCUS in primary health care empowers primary health-care physicians to provide high-quality, safe, and cost-effective care to the patients.

Keywords:

Abdominal pain, acute abdomen, point-of-care ultrasound, primary care

Introduction

Primary health care is an early patient's encounter to a proper health-care system.[1,2] Primary care physicians should provide timely comprehensive care at this point of time,[3-5] including urgent and after-hours management.[6,7] Abdominal pain is the third most common out of hour's emergency presentation seen by primary care physicians and accounts for 2%–4% of all consultations in primary health care.[8-12] The acute abdomen is defined as a sudden onset of abdominal pain which requires urgent medical care.[13] It is a diagnostic challenge with many differential diagnoses that can vary from a self-limiting illness to a life-threatening condition.[14,15] Patients with acute abdomen are usually referred to hospitals for further workup.[16] Nevertheless, half of these patients do not require hospital admission.[17,18] Investigations for these patients can be resource demanding. Accordingly, an initial workup at the primary health care facility can be useful.

Point-of-care-ultrasound (POCUS) is now more frequently performed in the primary health care.[19] Nevertheless, only 6% of family physicians use nonobstetric POCUS in their practice. Only 2% of family medicine postgraduate programs in America include POCUS training.[20] POCUS allows primary care physicians to make an appropriate and accurate diagnosis during consultations.[21]

In this review, we aim to lay down the basic principles of using POCUS in diagnosing the acute abdomen and highlight its findings in the most common acute abdominal

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presentations encountered by the primary health-care physicians.

Point-of-Care Ultrasound

Point-of-care ultrasound (POCUS) is defined as a targeted ultrasound examination performed and interpreted by the physician at the bedside as part of the clinical examination.[22] POCUS answers a specific clinical question and does not replace routine detailed ultrasound studies. When combined with clinical examinations, POCUS improves diagnostic accuracy and patient's care.[23]

POCUS is a physiological study (can define the cause of shock), an on-spot clinical decision-making tool, an extension of the clinical examination that is unique (studying different regions at the same time) and safe (can be done repeatedly).[24-28] When using POCUS, primary care physicians can interpret the achieved information immediately on the bedside to guide further management.[29]

The Utility of Point-of-Care Ultrasound for Diagnosing the Acute Abdomen

POCUS is the initial imaging diagnostic tool for the acute abdomen.[14,30] The common causes of abdominal pain presenting to primary care physicians include acute appendicitis, cholecystitis, renal colic, ectopic pregnancy, diverticulitis, bowel obstruction, and abdominal aortic aneurysm (AAA).[31,32]

POCUS is a dynamic examination which can demonstrate bowel motility and blood flow.[33,34] Furthermore, it can be focused at the maximum point of abdominal tenderness which is defined by the patient. This has a sensitivity of 85% in diagnosing acute appendicitis.[35] The graded compression technique entails slow and sustained compression at the point of maximum tenderness of the bowel loops to displace intraluminal gas and visualize the underlying structures.[36,37] Furthermore, inability to compress the bowel indicates an abnormal pathology including appendicitis, intussusception, or malignancy.[14,31] POCUS could reach the diagnosis in 35%–65% of patients presenting with acute abdomen[38,39] and changed the management plan in 47% of them.[40]

Basic Physics

Understanding the basic physics of ultrasound allows physicians to properly interpret ultrasound images.[41,42] Ultrasound is a high frequency sound wave which can be transmitted through different media such as fluids and soft tissues.[43] The number of ultrasound waves per second defines the ultrasound frequency. Ultrasound machines send high-frequency ultrasound waves (2–15 MHz) through their piezoelectric crystals located in their probes and then receive the reflected waves.[44,45] High-frequency waves have low penetration but excellent resolution compared with low-frequency waves which have more deep penetration but low resolution. The brightness (B) mode produces 1 mm thin slices of black and white two-dimensional images. The images can be altered by changing the frequency of the waves, the shape of the probe, the size of the probe, and the timing of waves' emission.[41-43]

Acoustic impedance varies according to the density of different media. With increased density, particles of the media are tightly attached, leading to more reflection of ultrasound waves. Hence, an anechogenic black image represents fluids such as blood and urine, whereas soft tissue such as the liver is gray, fibrous tissue such as the diaphragm is white without a shadow (hyperechoic), and bones/stones such as gallstones are white with a shadow [Figure 1].[46,47]

Free Fluid

Traumatic bleeding, ascites, bile leak, urinary leak, and ruptured ectopic pregnancy can cause the presence of intraperitoneal free fluid. POCUS can detect up to 10 ml free intraperitoneal fluid (IPF) by experienced hands.[24,48,49] The common abdominal locations for free IPF are the 3 Ps, which are (a) perihepatic space (Morison's pouch), (b) perisplenic space (Koller's pouch), and (c) pelvis (pouch of Douglas).[50] Fluids are usually anechoic (black) [Figure 2]. Nevertheless, clotted blood can be gray and difficult to visualize. The sensitivity and specificity of ultrasonography in the detection of free IPF is over 90%.[48,49] However, one of the critical challenges with POCUS is the inability to define the type of fluid (urine, bile, blood, or ascites). Hence, correlating the sonographic findings with the clinical findings would give an accurate bedside diagnosis.

Intestinal Obstruction

Intestinal obstruction accounts for approximately 15% of acute abdominal pain presenting to the emergency department.[51] Complications of intestinal obstruction include bowel ischemia and perforation.[52] POCUS can determine the etiology of small-bowel obstruction.[53] Small-bowel loops are scanned starting from the epigastrium to the pelvis in a sweeping fashion using the linear probe (10–12 MHz). With obstruction, there is the possibility of air–fluid levels of the bowel. Gentle but graded compression can be used to displace gas and bowel contents to evaluate the bowel wall.[54]

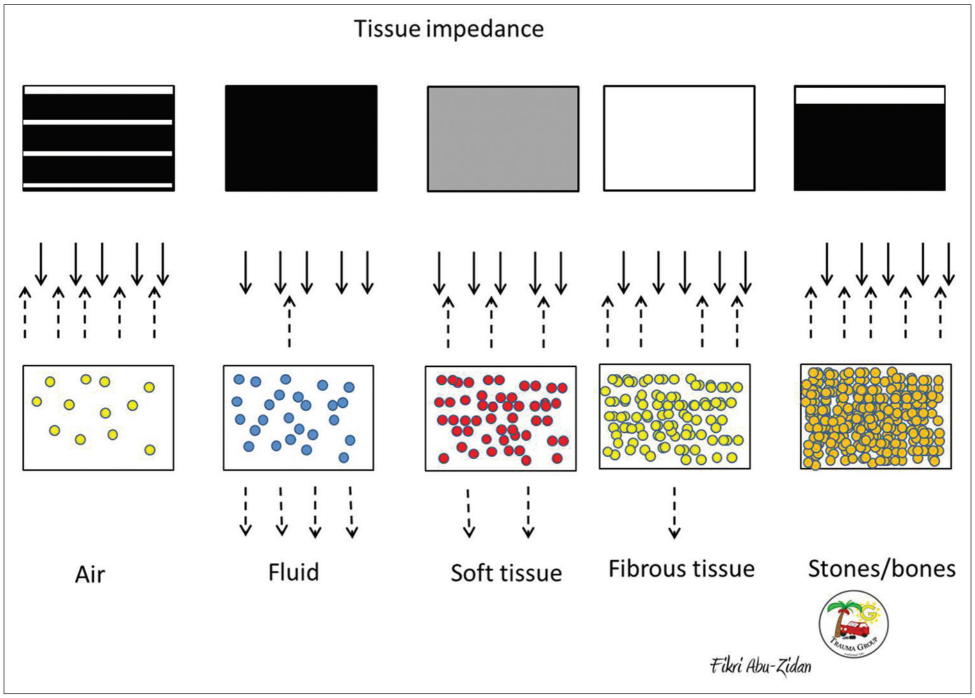

Figure 1: Denser materials reflect more ultrasound waves. Accordingly, fluid (like ascites) is black (anechoic), soft tissue (like the liver) is gray, fibrous tissue (like the diaphragm) is white without a shadow, and stones are white (hyperechoic) with a shadow. The air is very hyperechoic having reverberation artifacts. (This figure was reproduced from the study of Abu-Zidan and Cevik[42]), which is distributed under the terms of the Creative Commons Attribution 4.0 International License

Ultrasound has a sensitivity of 95% and specificity of 84% in diagnosing small-bowel obstruction.[55] POCUS is a real-time examination that can detect dynamic changes of bowel movements and show blood flow [Figure 3]. Its findings include dilated bowel loops and increased bowel wall thickness (>3 mm) with increased or decreased peristalsis.[55,56] The level of small-bowel obstruction is dependent on the visibility of the valvulae conniventes. They are more prominent in jejunal obstruction and less in the obstruction at the level of the ileum.[42]

Free Intraperitoneal Air

Reverberation artifacts occur when waves bounce between two interface media having high tissue impedance.[43,57] The waves moves forward and backward between these interfaces. This occurs when the ultrasound waves bounce between the probe and free intraperitoneal air. The ultrasound machine recognizes these waves as parallel lines with equal distance between them, resulting in a striped pattern with alternating dark and bright lines at regular intervals. There is decreased echogenicity for the deeper lines because the reflected waves become gradually less [Figure 4].[58]

Bowel gas is normally confined within the gut lumen. Gas may leak into the peritoneal cavity through a bowel perforation, which needs urgent treatment.[59] POCUS can precisely detect free intraperitoneal air. The sensitivity of detecting free intraperitoneal air by POCUS is superior to an abdominal X-ray (86% compared with 76%).[60] Ultrasound is superior to upright chest and left lateral decubitus abdominal X-rays which can miss hollow viscus perforations in 20% to 62%.[61-63] The sonographic signs of intraperitoneal air include (a) enhanced peritoneal stripe sign, (b) peritoneal stripe reverberations, and (c) focal air collections visualized as ring down artifacts.[64] The enhanced peritoneal stripe sign is a white increased echogenicity stripe under the abdominal wall fascia in supine position. The free intraperitoneal air can move when changing the patients' position (shifting phenomenon). However, there are some challenges related to sonographic detection of free intraperitoneal air including rib shadows and artifacts from air-filled lungs or colon.[65]

Acute Appendicitis

Acute appendicitis is a common disease seen by primary care physicians. It is caused by obstruction of the appendicular lumen leading to inflammation, ischemia, necrosis, and perforation of the appendix. It has a lifetime risk of 8.6% in males and 6.7% in females.[66] Approximately one-third of acute appendicitis perforate. Physicians should balance the risk of misdiagnosis against the risk of perforation.[67] POCUS is advised to be the first diagnostic modality for acute appendicitis.[68,69] Difficulty in visualizing the appendix may be encountered due to pain, obesity, and bowel gas.[29] If the appendix is visualized, POCUS has a diagnostic sensitivity of almost

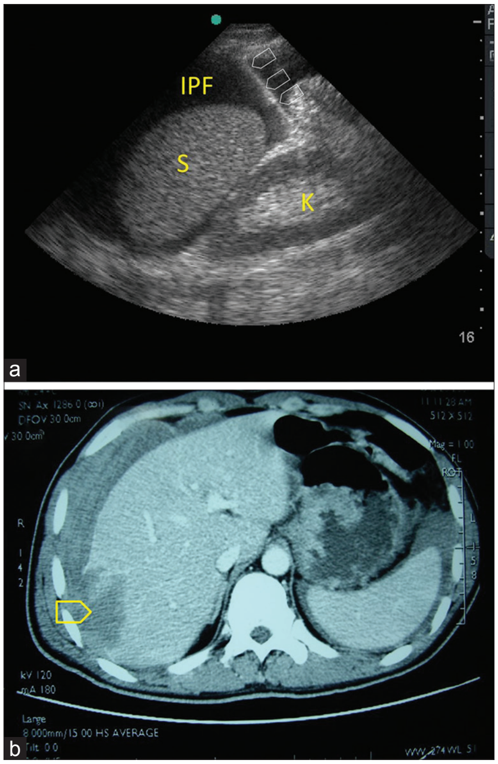

Figure 2: A heavy plywood fell on the right side of the abdomen of a 34-year-old male laborer. The patient complained of severe abdominal pain. On clinical examination, blood pressure was 110/57 mmHg and pulse rate was 66 beats/min. Point-of-care ultrasound examination (a) showed significant intraperitoneal fluid and floating fibrinous band (arrow heads). Computed tomography scan with intravenous contrast (b) confirmed the presence of liver injury (yellow arrow head). The patient was treated conservatively, but his abdomen continued to distend. Laparotomy confirmed the presence of bile leak which was successfully treated by suction drainage. K = Kidney, S = Spleen (Point-of-care ultrasound study was performed by Professor Fikri Abu-Zidan)

100% and a specificity of 85%.[70] The appendix is better visualized in thin patients having more pain and higher Alvarado scores.[71] There is a low threshold in general practice to refer patients to the hospital when suspecting acute appendicitis. The referrals are done not to miss the diagnosis, which results in more surgery.[72] Accordingly, negative appendectomies have increased up to 40%.[73]

Fat and bowel covering the appendix can be slowly displaced using the gradual compression technique. Noncompressibility of the appendix is an indication of inflammation.[31] Computed tomography (CT) scan is more accurate in diagnosing appendicitis.[74] Nevertheless, it carries a risk of radiation, especially in children and younger patients. A step-wise approach starting with POCUS before CT scan is advised.[75]

Sonographic finding of acute appendicitis include (a) noncompressible tubular structure with a target sign having a diameter of more than 6 mm at the location of the appendix, (b) distorted irregular mucosa, (c) presence of IPF, (d) thickened omentum, and (e) presence of a fecalith [Figure 5].[42]

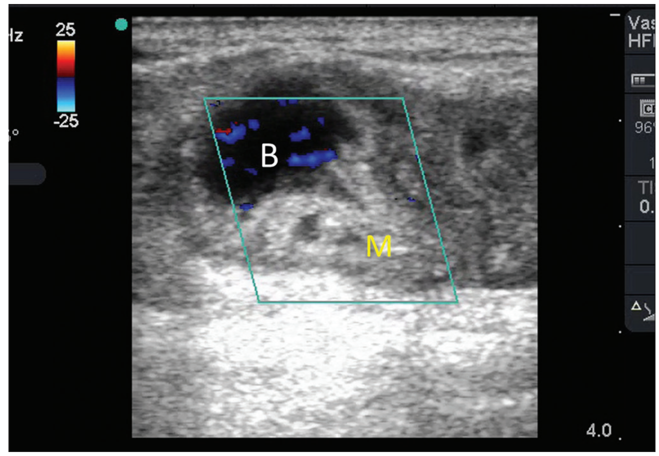

Figure 3: Point-of-care ultrasound of a strangulated epigastric hernia using a linear probe (10–12 MHZ). The hernia contained a small bowel (B). The color Doppler showed that there was no flow in the mesentery (M). Urgent surgery showed that the bowel was ischemic. (Point-of-care ultrasound study was performed by Professor Fikri Abu-Zidan)

Acute Cholecystitis

Gallstones can be detected in 10% to 15% of the adult population and majority are asymptomatic.[76,77] Acute cholecystitis is caused by gallstones in 95% of cases whereas 5% has no gall stones.[78,79] A curvilinear low-frequency (2–5 MHz) transducer is used when examining the gall bladder. During examination, the patient should be in supine position. The probe will be moved from medial to lateral on the right side of the abdomen starting from the xiphoid and following the right subcostal margin laterally. After the liver is seen, the gallbladder is localized and scanned in different planes. The diameter of the common bile duct should be measured. When doubt exists whether the structures seen are gallstones or a gall bladder wall irregularity, the patient is asked to gradually move to his/her right or left side while the probe is stable in its position in relation to the abdominal wall. The gallstones could be seen moving within the gallbladder confirming the diagnosis.

Gallstones produce a posterior acoustic shadow and an echogenic rim. Gall stones of <5 mm in diameter can be echogenic without a shadow.[80] Detecting gallbladder stones along with increased wall thickness of the gall bladder >3 mm, pericholecystic fluid, and positive Murphy's sign are diagnostic of acute cholecystitis [Figure 6].[81] Finding gallstones during POCUS which is associated with tenderness when the gallbladder is compressed with the ultrasound probe (sonographic Murphy's sign) has a 92% positive predictive value for acute cholecystitis.[78] A study on 1690 patients having abdominal pain showed that POCUS had 88% sensitivity, 87% specificity, 91% positive predictive value, and 83% negative predictive in diagnosing gall stones.[82] Patients having a negative

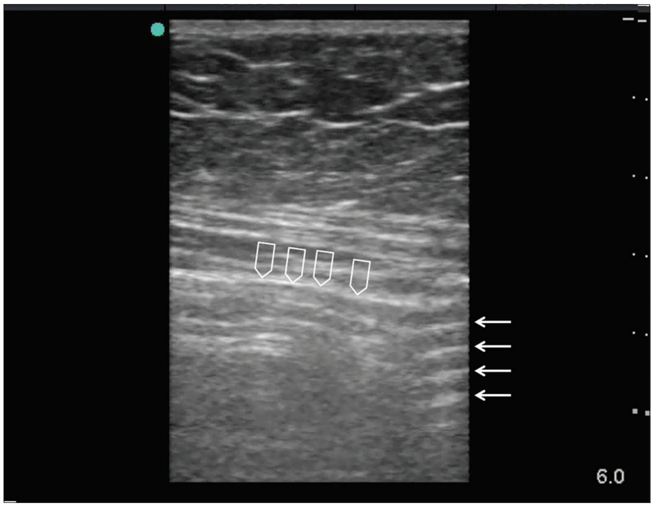

Figure 4: Classical point-of-care ultrasound findings of free intraperitoneal air. An enhanced peritoneal stripe sign (arrow heads) is a white increased echogenicity stripe located under the abdominal wall fascia in the supine position which does not move with respiration. The reverberation artifact consists of hyperechogenic parallel lines with equal distance between them (arrows). (Point-of-care ultrasound study was performed by Professor Fikri Abu-Zidan)

POCUS were unlikely to require surgery or admission for cholecystitis within 2 weeks of the study.[83]

Renal Colic

The most common cause of renal colic is urolithiasis, which is more in males between 20 and 50 years of age. Between 3% and 15% of adults experience renal colic in their lifetime.[84,85] The main objective of POCUS when evaluating a flank pain is to detect obstructive uropathy and not stones [Figure 7].[86] Depending on the patient's habitus and operator's experience, sensitivity of POCUS for detecting hydronephrosis is 72% to 97% whereas the specificity is 73% to 98%.[86,87] Patients with ureteral calculi of >5 mm are more likely to have hydronephrosis.[88,89] Stones of <10 mm in size are likely to be managed conservatively if patients have no signs of sepsis, if the stone is unilateral, if the renal function is normal, and if the pain is controlled with analgesia.[90] Patients with hydronephrosis are more likely to have a stone >5 mm.[89] Goertz and Lotterman correlated the POCUS with CT scan findings in 129 patients having renal colic and they concluded that patients with mild or no hydronephrosis were unlikely to have stones. Majority of those who have moderate-to-severe hydronephrosis had stones >5 mm in diameter.[88]

CT scan without contrast is the gold standard imaging modality for patients with suspected renal stones.[91] Renal POCUS has a poor negative predictive value for urolithiasis in the absence of hydronephrosis compared with CT scan. Hydration with 500 ml to 1000 ml of fluid increases the chances of identifying hydronephrosis although it may increase the pain.[92] In general, POCUS

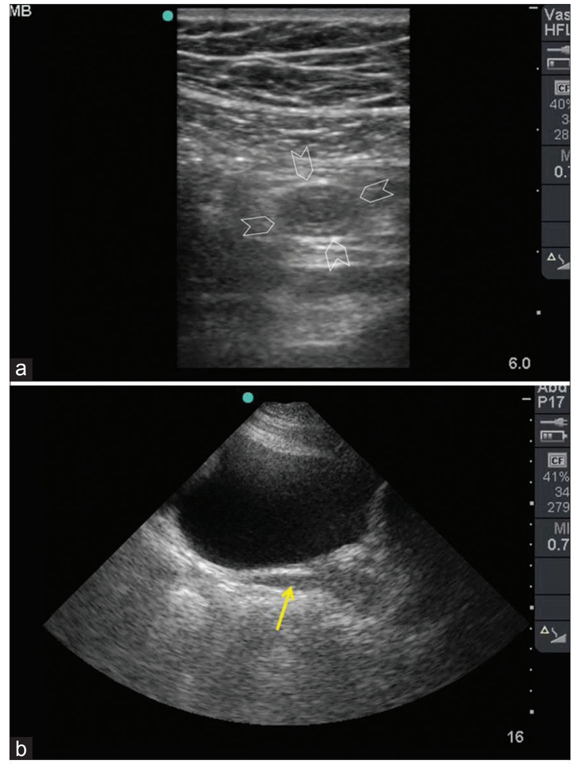

Figure 5: A 19-year-old male presented with pain in the right upper quadrant of the abdomen of 1-day duration. Abdominal examination revealed tenderness and guarding in the right upper quadrant. The patient had no fever and no leukocytosis. The patient was suspected to have acute cholecystitis. Routine ultrasound was performed by a radiologist and reported as normal. Repeated point-of-care ultrasound 12 h later (a) using a high-frequency linear probe of the abdomen showed a noncompressible tubular structure in the subhepatic region having a target sign (arrow heads). Point-of-care ultrasound (b) using a small print convex array probe with a frequency of 3–5 MHz showed minimum amount of free fluid in the pelvis (yellow arrow). Laparoscopy confirmed the presence of subhepatic acute appendicitis. (Point-of-care ultrasound study was performed by Professor Fikri Abu-Zidan)

has poor sensitivity in detecting stones. Stones that can be visualized are mainly those proximal to the ureteropelvic junction or distal to the ureterovesical junction where there is an acoustic window. It is difficult to visualize the retroperitoneal ureter between the kidney and the bladder. Occasionally, the ureter can be seen dilated indicating distal obstruction when correlated with acute abdominal pain.

Ectopic Pregnancy

Family physicians can provide first trimester care evaluating complications arising in early pregnancy. It is always essential to exclude ectopic pregnancy and pregnancy loss in women of childbearing age if presenting with abdominal pain and missed periods.[93] A full assessment of the first-trimester pregnancy using POCUS helps identify the cause of early pregnancy bleeds. The American College of Emergency Physicians approves the use of bedside ultrasound for the detection of intrauterine or ectopic pregnancy during all stages of pregnancy.[94] In a suspected ectopic pregnancy, testing

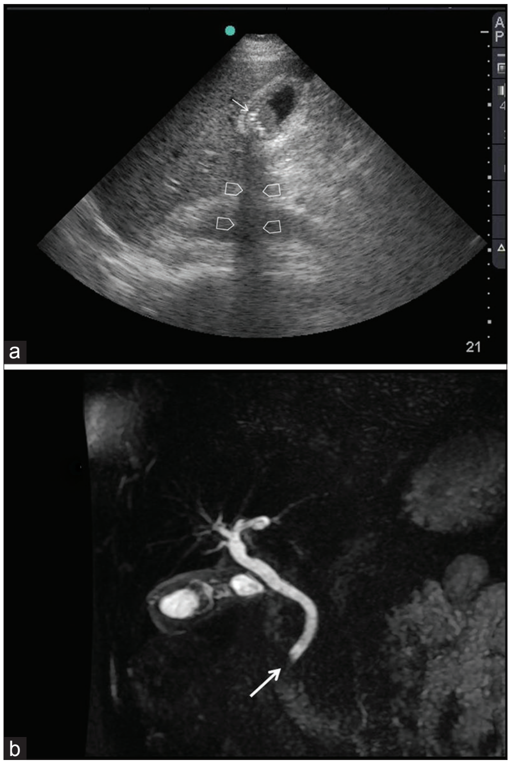

Figure 6: A 61-year-old male presented with abdominal pain, fever, rigors, and jaundice. Abdominal examination revealed tenderness and guarding in the right upper quadrant. The patient had no leukocytosis and his bilirubin was high (60 μmol/L). Serum amylase was normal. Point-of-care ultrasound examination (a) showed the presence of gall stones (white arrow) with a shadow (arrow heads), thickened wall of the gall bladder, normal diameter of the common bile duct (5 mm), and a normal pancreas. Magnetic resonance cholangiopancreaticography (b) showed a suspected filling defect in the distal end of the common bile duct (white arrow) with no significant dilatation. There was diffuse thickening of the wall of the gallbladder associated with multiple small gall stones. Laparoscopic cholecystectomy confirmed the presence of acute cholecystitis. The intraoperative cholangiogram was normal. (Point-of-care ultrasound study was performed by Professor Fikri Abu-Zidan)

Figure 7: A 27-year-old male presented with pain in the right iliac fossa of 1-day duration with tenderness and guarding. He did not have fever or leukocytosis. There was no loin tenderness. He was admitted as a case of acute appendicitis and planned for surgery. Point-of-care ultrasound (a) has shown a dilated pelvis of the right kidney (arrows). Computed tomography abdomen without contrast (b) confirmed the presence of hydronephrosis on the right side (arrow head) with traceable ureter due to a stone in the lower ureter close to the urinary bladder with a diameter of 3.4 mm (yellow arrow). The stone was removed using endoscopic ureteroscopy and the patient was discharged in a good condition. L = Liver, K = Kidney (Point-of-care ultrasound study was performed by Professor Fikri Abu-Zidan)

urine for pregnancy along with POCUS would be the best method to get an accurate diagnosis and appropriate management [Figure 8]. POCUS is mainly done to look for free IPF and its volume[95] and also the presence or absence of intrauterine pregnancy.[96] Viability of early pregnancy can be confirmed by POCUS in women having vaginal bleeding. Combining POCUS with the clinical findings, measuring the inferior vena cava diameter, and evaluating the heart define the hypovolemic or septic nature of the shock if present.[25,97] Abnormal adnexal findings such as tubal rings, complex masses, or live extra uterine embryos can be occasionally seen.[98]

One of the challenges of doing POCUS is missing an ectopic pregnancy. Occasionally, interstitial pregnancy, which is an ectopic gestation in the intrauterine part of the fallopian tube, can be missed for an intrauterine pregnancy.[99] Transvaginal ultrasound performed by an expert is advised in doubtful cases of ectopic pregnancy.[100,101]

Diverticulitis

Diverticulitis is a common cause of abdominal pain in adults resulting from inflammation of a colonic diverticulum. Patients can present with fever, acute abdominal pain, bleeding per rectum, or urinary symptoms. Diverticulitis is seen in 15% to 25% of patients having diverticulosis.[102] The accuracy of clinical examination for diverticulitis is low.[103] Taking appropriate history and physical examination along with POCUS improves the diagnosis. The differential diagnosis includes appendicitis, urolithiasis, or urinary tract infection. Liljiegeren *et al*. in a systematic review recommended ultrasound as the first choice for diagnosing diverticulitis.[104] Similarly, Laméris *et al*. did a systematic review on graded compression technique of ultrasound in diagnosing diverticulitis and reported a sensitivity and specificity of 90% and 89%, respectively. Nevertheless, CT scan is more accurate than ultrasound in diagnosing diverticulitis.[105,106]

Mural thickening of the bowel with a paucity of luminal content may indicate inflammatory bowel

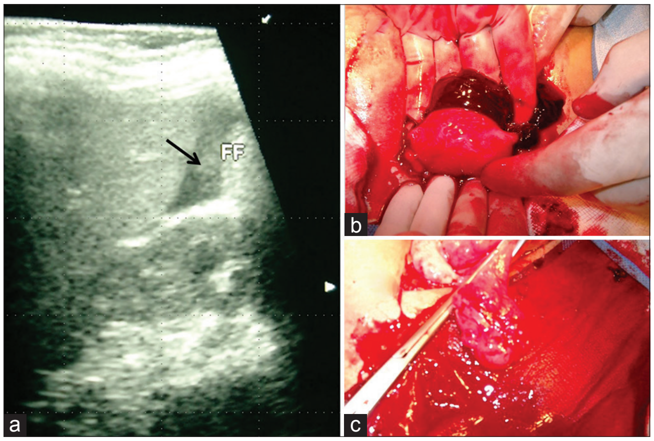

Figure 8: A 23-year-old married female presented with right lower abdominal pain of 1-day duration. Her last menstrual period was 2 weeks before. Her blood pressure was 120/70 mmHg, and her pulse rate was 90 beats/min. On examination, she did not look sick, and her abdomen was soft and lax. There was mild tenderness in the right iliac fossa. Abdominal ultrasound (a) showed free intraperitoneal fluid (black arrow). Pregnancy test was urgently requested and was positive. The patient had a laparotomy which showed one and half liters of blood (b) caused by an ectopic pregnancy located in the right fallopian tube which was excised (c). The patient had a smooth postoperative recovery. (Courtesy of Professor Fikri Abu-Zidan)

disease.[107] The diagnostic findings of the inflamed bowel include (a) thickened bowel wall >4–5 mm, (b) echogenic inflamed fat, (c) noncompressibility, and (d) loss of peristalsis [Figure 9].[34,108] Colonic wall layers are usually preserved in diverticulitis compared with malignant tumors in which layers are distorted.[109] Bedside POCUS can also detect other complications of diverticulitis including free IPF, free intraperitoneal air, and abscess formation.[110,111]

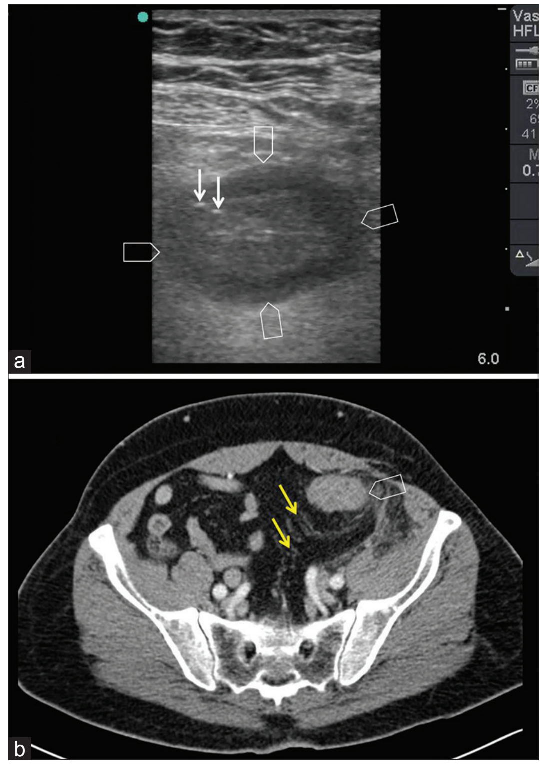

Figure 9: A 52-year-old male presented with pain in the left iliac fossa of 3-day duration. He had no history of bleeding or constipation. On clinical examination, there was a tender mass in the left iliac fossa. Point-of-care ultrasound (a) has shown a target sign at the site of the sigmoid colon (arrow heads) suggestive of acute diverticulitis. Sparse gas is seen within the colon (white arrows). Computed tomography scan with IV contrast confirmed the findings (b) with the presence of the mass (arrow head) and inflamed peritoneum (yellow arrows). (Point-of-care ultrasound study was performed by ProfessorFikri Abu-Zidan)

Abdominal Aortic Aneurysm

AAA is found in 2% to 5% of the population above 50 years of age.[112] AAA occurs when the aorta below the renal arteries expands to a diameter of >3 cm.[113] Ruptured AAA is a life-threatening emergency condition having a high mortality.[114] The risk of rupture of an aneurysm increases with its increased diameter.[115] Diagnostic delay occurs because AAA may mimic other pathologies including renal colic or acute diverticulitis.[112] AAAs are often clinically silent; hence, early screening is advised. POCUS examination in patients with cardiovascular risk factors such as age>70 years, smoking, hypertension, peripheral vascular disease, dyslipidemia, or diabetes detected 71% of AAA's.[116,117]

Ultrasound is the gold standard for AAA screening and diagnosis having a sensitivity of 94% to 99% and specificity of 98% to 100%.[118-122] In a Japanese study of 1731 patients who underwent community screening for AAA, small AAAs were missed by physical examination.[123] In contrast, a study used a hand-held ultrasound device for AAA screening on randomly selected 1010 male patients aged more than 60 years. It found that patients who were diagnosed with AAA had a smaller aortic diameter (3.5 cm) compared with patients diagnosed incidentally (4.7 cm diameter) [Figure 10].[124] This study supports the use of POCUS for screening AAAs in the primary care setting.

A curvilinear low-frequency (2–5 MHz) probe is used for scanning the aorta. The aorta should be initially scanned longitudinally [Figure 10a]. The marker of the probe is then tilted 90° to the right side to visualize the transverse cross section of the aorta [Figure 10b]. The aorta should be completely scanned starting from the epigastrium till the distal bifurcation. The outer diameter should be included in the measurement. A thrombus can be occasionally seen within the aneurysm. Color Doppler is useful to study the flow within the aneurysm. The presence of free intraperitoneal fluid may indicate a ruptured aortic aneurysm.

AAA imaging by POCUS can be done efficiently by primary care physicians even with minimal training[116] and was highly correlated with the hospital-based studies. It had a sensitivity and specificity of 100% and

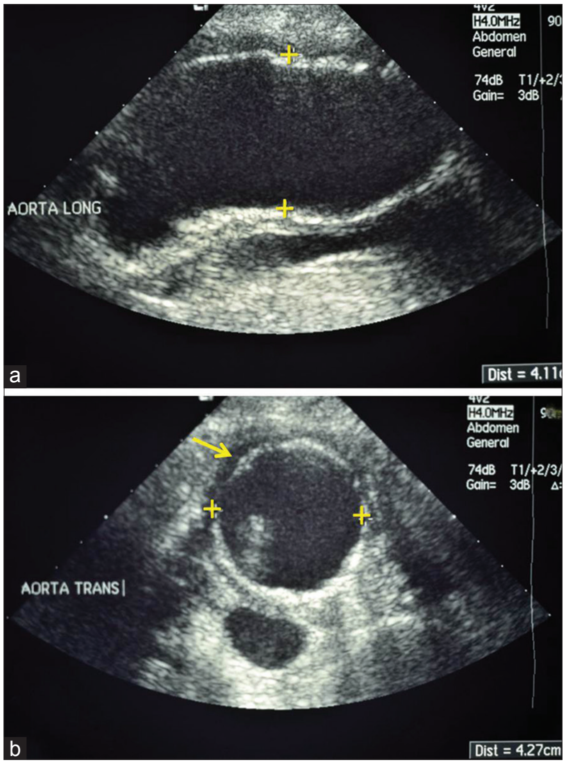

Figure 10: A 75-year old male presented with severe abdominal pain and an unexplained shock. Blood pressure was 70/50 mmHg. Point-of-care ultrasound in both longitudinal (a) and cross section (b) showed a pulsatile aortic aneurysm of 4.27 cm diameter with fluid leakage around it (yellow arrow). Urgent laparotomy confirmed the presence of a ruptured aortic aneurysm. (Courtesy of Professor Fikri Abu-Zidan)

was done within an average of 3.5 min.[121] Nevertheless, screening for AAA by general practitioners was associated with a high false positive rate of 21.4%.[124] Furthermore, AAA screening can be challenging in obese patients.

The Importance of Training

POCUS use in general practice is still limited because of the required time, lack of training, and financial constraints. Understanding the basic physics of ultrasound and having proper hands-on training allows primary care physicians to use this useful tool. Providing community-based ultrasound reduces waiting time for having a routine ultrasound. Furthermore, POCUS has the same results when done by general practitioners compared with radiologists.[125] With recent innovations and technological advances, ultrasound machines have become affordable as a point-of-care device. They have become smaller, portable, and easier to use. Accordingly, ultrasound training has been included in many undergraduate and postgraduate training programs.[12,126,127] Training is important before using POCUS.[128,129] Structured training allows family physicians to perform abdominal ultrasound with high accuracy. Family physicians became confident in performing POCUS after 16 h of learning. The average time spent by family physicians in performing POCUS studies was <10 min.[130]

Performing an ultrasound by primary care physicians gives patients high satisfaction.[131] We propose the use of POCUS for the initial evaluation of patients presenting with acute abdomen as an adjunct to clinical examination at primary health care. To achieve this, there should be structured educational programs supported by proper credentialing processes.

Conclusions

POCUS has become an integral part of clinical medicine. There has been limited use of POCUS by primary care physicians despite its accuracy and its affordable costs. POCUS is anticipated to become a standard care diagnostic tool used by primary care physicians in the near future. More training and research is needed to advance the use of POCUS in primary health care. There should be a push to integrate POCUS in the family medicine curricula and support training for the future generation of primary health-care physicians.

Author contribution statement

Moien AB Khan participated in the idea, critically read the literature, drafted the first version of the paper, and approved its final version. Fikri M Abu-Zidan had the idea, critically read the literature, drew and supplied the clincial images, wrote sections of the paper, repeatedly edited the paper and approved its final version.

Ethical Approval and Consent to participate

The images of cases have been collected over a period of 30 years. The paper does not have information or images that can identify any patient. Images are mainly radiological except one operative image for a patient treated 19 years ago. She could not be contacted after this long period of time to get her written consent.

Funding

None.

Conflicts of interest

All authors declare that they have no conflict of interest.

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