# The Use Of Point-Of-Care Ultrasound In The Diagnosis And Management Of Emergency

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**Abstract**

Bedside point-of-care abdominal ultrasonography (POCUS) is becoming more often used by physicians to assess clinical signs, aid in precise diagnosis, and support treatments in critical care and emergency settings. It is necessary to create methods for evaluating acute abdominal pain using point-of-care ultrasound based on the existing data for each specific area of the abdomen. In non-trauma patients, the targeted evaluation with sonography for trauma examination may be utilized as a way to identify hemoperitoneum. Point-of-care renal Doppler ultrasound may be used for evaluating systemic hypoperfusion and kidney failure. The use of point-of-care ultrasound is also explored for the detection of abdominal and pelvic diseases. It is very beneficial for identifying gallstones and diagnosing acute cholecystitis. Using POCUS as the first imaging method is reasonable for diagnosing ureterolithiasis and evaluating pyelonephritis. It may be used with high precision to identify the existence of abdominal aortic aneurysm in individuals displaying symptoms. Additionally, it may be beneficial for diagnosing digestive system conditions including appendicitis, small bowel blockage, and gastrointestinal perforation. Furthermore, point-of-care ultrasound may serve as a medium to aid with operations. Studies have shown that performing paracentesis with the aid of ultrasound may enhance the quality of patient care. Ultrasound seems to be a promising method for confirming the correct positioning of the gastric tube. Using bladder ultrasound to estimate urine

volume may enhance the success rate in young children. Ultrasound-guided catheterization using transrectal pressure is beneficial in some male patients who have challenges with traditional urethral catheterization. While more proof is required in some areas, point-of-care abdominal ultrasound shows promise as a technique to enhance patient treatment in critical care and emergency contexts.

**Keywords:** point-of-care ultrasound, POCUS, emergency, critical care, patient treatment.

## Introduction

Point-of-care ultrasound (POCUS) is becoming more prevalent in emergency and critical care settings because to its mobility and accessibility. Clinicians are using it at the bedside to improve diagnostic accuracy, monitor fluid status, and guide operations [1]. The primary uses in the abdominal area consist of assessing injuries, biliary conditions, urinary tract issues, intrauterine pregnancy, and abdominal aortic aneurysm by a transabdominal approach [2, 3]. Furthermore, there have been evaluations and current proposals for novel uses including point-of-care abdominal ultrasound. This article is a current and comprehensive summary of point-of-care abdominal ultrasound conducted by medical professionals in emergency and critical care environments.

## Clinical symptoms and ultrasound at the point of care sudden onset of discomfort in the abdomen

Computed tomography (CT) is often more effective than ultrasound (US) as a single imaging technique for individuals with acute abdominal discomfort [4]. Laméris et al. found that using a conditional strategy with CT scans after negative or inconclusive radiology ultrasound tests resulted in the highest overall sensitivity. This approach only missed urgent conditions in 6% of cases and minimized radiation exposure by performing CT scans in only half of adult patients with acute abdominal pain [4]. Therefore, it is necessary to assess imaging techniques such as point-of-care abdominal ultrasound in relation to this matter.

An initial observational research shown that the use of ultrasound by emergency physicians (EPs) had a beneficial effect on the decision-making process and the diagnostic

evaluation of patients with nonspecific abdominal pain, as assessed by the nurse triage. Out of the 128 patients, 58 of them, which is equivalent to 45% with a 95% confidence range ranging from 36% to 54%, had an improvement in diagnostic accuracy and planned diagnostic workup with the use of ultrasound [5]? Lindelius et al. conducted a randomized research including 800 adult patients with acute abdominal discomfort. The study evaluated the effectiveness of ultrasound done by surgeons who completed a 4-week training program in US. The group that received surgeon-performed ultrasound had a 7.9% higher rate of accurate primary diagnoses compared to the control group (64.7% vs 56.8%; p=0.027) [6]. The use of ultrasound in the radiology department was notably reduced in the group that had ultrasound conducted by surgeons. However, there was no disparity between the groups in terms of the number of computed tomography (CT) scans or other exams that were requested [7].

Detection of abdominal and pelvic lesions provides a comprehensive evaluation of the evidence about the use of point-of-care abdominal ultrasound for detecting each specific lesion that might cause acute abdominal discomfort. Point-of-care ultrasound (US) methods for evaluating acute abdominal pain should be tailored based on the existing evidence for each specific location of the abdomen.

Hemoperitoneum is a condition where blood accumulates in the abdominal cavity. In trauma patients, abdominal ultrasound is often utilized to do a focused assessment using sonography for trauma (FAST) evaluation. The FAST (Focused Assessment with Sonography for Trauma) technique offers a rapid assessment of the peritoneal cavity to identify the presence of free fluid, which is a direct indication of hemoperitoneum and an indirect indication of damage to the organs. The sensitivity and specificity of the Focused Assessment with Sonography for Trauma (FAST) in detecting free intraperitoneal fluid were found to be between 64% and 98% and between 86% and 100%, respectively. The varying outcomes may be attributed to disparities in clinical expertise and reference criteria [8].

Patients experiencing hemodynamic collapse may exhibit increased sensitivity and need less time for the procedure. Wherrett et al. conducted a study where they found that doing an abdominal evaluation using FAST took an average of 19 ± 5

seconds in the positive group and 154 ± 13 seconds in the negative group ($p < 0.001$). The study included 69 hypotensive blunt trauma patients and showed that the assessment had a high level of accuracy.

Considering the use of a comprehensive or partial FAST examination is a rational approach for assessing spontaneous hemoperitoneum in non-trauma patients. The origin of spontaneous hemoperitoneum might have several origins, which can be categorized as gynecologic, hepatic, splenic, vascular, or coagulopathic disorders [10]. Spontaneous hemoperitoneum often manifests as sudden abdominal discomfort, with or without a decrease in blood pressure. Spontaneous hemoperitoneum should be promptly identified during the first assessment, since the collapse may become evident in some individuals. Case reports provide insight into the use of bedside ultrasound for identifying intra-abdominal free fluid, which may assist in diagnosing the underlying reasons. However, there is a limited number of original research that have investigated the utility of this technique [11].

Hemoperitoneum, which is the presence of blood in the peritoneal cavity, is often caused by gynecologic diseases in women of reproductive age. These illnesses include the rupture of the gestational sac in ectopic pregnancy and the bleeding or rupture of an ovarian cyst. In these cases, ultrasound is commonly used as the main imaging method. Rodgerson et al. conducted a retrospective research that showed how using abdominal ultrasound done by emergency physicians (EPs) to identify patients with probable ectopic pregnancy and fluid in Morison's pouch reduced the time taken to diagnose and treat the condition [12]. In a research that observed patients over time, Moore et al. revealed that out of 242 patients who were believed to have ectopic pregnancy, 10 of them had fluid in Morison's pouch when abdominal ultrasound was conducted. Out of these ten patients, nine of them immediately required surgery due to a ruptured ectopic pregnancy. The researchers determined that the presence of free intraperitoneal fluid in Morison's pouch in individuals suspected of having an ectopic pregnancy may be quickly detected by ultrasound and can indicate the need for medical intervention [13].

**Reduced blood flow and impaired kidney function**

Doppler ultrasonography is recommended as a diagnostic technique for evaluating renal blood flow. The Doppler-based resistive index (RI) is determined by subtracting the end-diastolic velocity from the peak systolic velocity, and then dividing the result by the peak systolic velocity in an interlobar or arcuate artery. The normal value for the RI is 0.58 ± 0.10. Values greater than 0.70 are often recognized as abnormal [14]. Corradi et al. found that normotensive polytrauma patients without biochemical evidence of hypoperfusion who had a renal Doppler RI higher than 0.7 upon arrival at the emergency room were likely to develop hemorrhagic shock during the first 24 hours. The odds ratio was 57.8, with a 95% confidence interval of 10.5-317.0, and a p-value of less than 0.001. Nevertheless, the diameter of the inferior vena cava (IVC) and the caval index did not have prognostic value in these individuals. The researchers postulated that the majority of the patients were in a state of normal blood volume upon their arrival [15]. While more comprehensive investigations are required, a heightened renal Doppler RI may have greater prognostic value for hemorrhagic shock compared to the IVC diameter and caval index [15].

Renal Doppler RI may be used to identify early renal dysfunction or predict the short-term reversibility of acute kidney injury (AKI) in critically sick patients [16–18]. A preliminary investigation shown that the evaluation of renal perfusion using color Doppler, which is a semi-quantitative method, was more straightforward to execute compared to the RI method. Additionally, it was found that the color Doppler method may provide comparable information to the RI method [16]. The research also discovered that untrained operators, such as critical care residents, were able to conduct both the semi-quantitative evaluation using color Doppler and the RI with excellent feasibility and reliability. This was achieved after a half-day training session [16]. Utilizing Doppler ultrasound may be beneficial in evaluating renal blood flow; yet, further extensive investigations employing consistent techniques are necessary to validate these findings and elucidate its contributions to the treatment of patients with acute kidney injury (AKI) [19].

**Identification of abdominal and pelvic abnormalities**

**Gallstone and acute cholecystitis**

Radiology ultrasound (US) is well recognized for its high utility in detecting gallstones and diagnosing acute cholecystitis [20]. A systematic review and meta-analysis were done to evaluate the use of surgeon-performed ultrasound (US) for suspected gallstone disease with radiology US or pathological examination, which are considered the gold standard investigations. After applying the search criteria, a total of eight studies were identified, including a sample size of 1019 patients. The combined sensitivity was 96% (95% confidence interval [CI], 93.4% - 97.9%), while the specificity was 99% (95% CI, 98.3% - 99.8%) [21]. However, when it comes to identifying gallstones, EP interpretation has been shown to have a sensitivity ranging from 86% to 96% and a specificity ranging from 78% to 98% [22].

Gallstones are present in almost 95% of individuals with acute cholecystitis. However, the presence of gallstones alone is not sufficient to diagnose acute cholecystitis. During the process of doing an ultrasound, other observations such as thickness of the gallbladder wall, presence of fluid around the gallbladder (pericholecystic fluid), and the identification of a sonographic Murphy sign may provide more precise details [20]. In a prospective observational study conducted by Summers et al., they found that EP-performed US had a sensitivity of 87% (95% CI, 66-97%), specificity of 82% (95% CI, 74-88%), positive predictive value of 44% (95% CI, 29-59%), and negative predictive value of 97% (95% CI, 93-99%) for detecting acute cholecystitis in 164 enrolled patients. Furthermore, the test attributes of ultrasound done by electrophysiologists (EP) were comparable to those of ultrasound performed by radiologists. The research showed that patients with a negative outcome are unlikely to need cholecystectomy or hospitalization within 2 weeks after their first presentation, based on the significant negative predictive value [23].

**Uses assisting procedures**

**Paracentesis**

The guidance provided in the US allows for clear visibility of the place where the needle is inserted, ensuring the safe execution of paracentesis. A nationwide database was used to perform an observational cohort research in order to investigate the impact of US advice on the likelihood of experiencing bleeding problems during paracentesis. Out of a

total of 69,859 individuals who had paracentesis, 0.8% (n=565) encountered bleeding problems. After accounting for the kind of medical procedures performed, the length of hospital stay prior to the paracentesis, and the reasons for admission, the use of US advice decreased the likelihood of bleeding issues by 68% (odds ratio, 0.32; 95% CI, 0.25–0.41). According to the statistics, there is a correlation between the use of US guidelines and a lower likelihood of problems during paracentesis [24]. A randomized research including 100 patients showed that the success rate of US-assisted paracentesis done by EPs with different levels of expertise was 95%, whereas the success rate of the conventional approach was 65% ($p = 0.0003$) [25]. Emergent paracentesis guided by ultrasound has been shown in case series to result in a substantial change in treatment for some unstable patients who have a positive FAST assessment [26]. As previously stated, performing paracentesis with the aid of ultrasound has been shown to enhance patient care. Moreover, the identification of the precise location of the inferior epigastric artery prior to paracentesis might provide a more dependable method to prevent difficulties [27].

**Verification of the positioning of the gastric tube**

Gastric tube insertion is a frequently conducted procedure in emergency and critical care settings. Following the procedure, the positioning of the tube is usually assessed by visually examining the contents obtained during aspiration and by listening for sounds produced when air is introduced into the tube. Furthermore, it is advisable to do a chest X-ray in the majority of instances to verify accurate positioning. Nevertheless, a chest X-ray has several drawbacks such as radiation exposure, delayed confirmation, and financial implications. Multiple recent studies have shown that the United States is a viable method for confirming the correct positioning of the gastric tube. The techniques include verifying the presence of the tube in the stomach [28], examining the stomach or duodenum with or without the introduction of a mixture of normal saline and air [29], and inspecting the cervical esophagus and stomach with or without the introduction of air [30] or a mixture of normal saline and air [31]. The vision may be influenced by the diameter of the tube [28] and the amount of gas in the gastrointestinal system [31]. When the tube's tip in the stomach is confirmed either direct visibility or the detection of dynamic fogging caused by the instillation, ultrasound may be used as an alternative

imaging method to a chest X-ray in some individuals, in addition to physical tests.

**Urethral catheterization**

Urethral catheterization is often carried out to conduct a urinalysis and culture, address acute urinary retention, and monitor urine flow in emergency and critical care situations. If there is little clarity about the presence or quantity of urine in the bladder prior to urethral catheterization, then it is sometimes necessary to repeat this operation in order to gather urine for analysis and culture. Using bedside bladder ultrasound to estimate urine volume has been shown to improve the success rate of the first try in infants under the age of 2 [32,33].

Occasionally, adult male patients may have challenges while undergoing routine catheterization. In these instances, the patient's discomfort and injury to the urethra might occur due to frequent and futile efforts without visual guidance, often necessitating a visit with a urologist. In their pilot study, Kameda et al. reported that transabdominal ultrasound, conducted by emergency medical personnel, can identify the tip of the catheter in certain sections of the posterior and bulbar urethra. They also found that ultrasound-guided catheterization with transrectal pressure seems to be a safe and beneficial alternative for male patients who face challenges with standard urethral catheterization [33].

**6. Summary**

It is necessary to create methods for evaluating acute abdominal pain using point-of-care abdominal ultrasound based on the available information for each specific area of the abdomen. In non-trauma patients, a FAST examination might be a useful approach for detecting hemoperitoneum. Point-of-care renal Doppler ultrasound may be used for evaluating systemic hypoperfusion and renal failure. Point-of-care ultrasound is also used to identify abdominal and pelvic lesions. It is beneficial for identifying gallstones and diagnosing acute cholecystitis. It is appropriate to use it as the primary imaging method for diagnosing ureterolithiasis and evaluating pyelonephritis. It may be used with high precision to identify the existence of abdominal aortic aneurysm in symptomatic individuals. Additionally, it might be beneficial for the identification of gastrointestinal disorders. Furthermore, point-of-care ultrasound may serve as a medium to aid with

operations. Performing paracentesis with the guidance of ultrasound has been shown to enhance the quality of patient care. The United States seems to be a promising method for confirming the positioning of a gastric tube. Furthermore, using bladder ultrasound to estimate urine volume might enhance the success rate in young children. Ultrasound-guided catheterization with transrectal pressure is beneficial for male patients who have challenges with traditional urethral catheterization. While some domains may need further proof, point-of-care abdominal ultrasound shows promise as a technique to enhance patient treatment in emergency and critical care settings.

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