Re-examining physical findings with point-of-care ultrasound: a narrative review

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ABSTRACT

The art of physical examination has continued to be practised by physicians largely unchanged for over 200 years. Ultrasound, once the domain of the radiologist, is now being increasingly used by emergency physicians and intensivists to make rapid, accurate diagnoses at the point-of-care. We review the growing body of evidence supporting point-of-care ultrasound (PoCUS) as the preferred alternative to many aspects of the cardiovascular, respiratory, abdominal and neurological examinations in internal medicine. Compared with physical examination, PoCUS may increase diagnostic accuracy and patient satisfaction; reduce unnecessary investigations and healthcare costs; be shared with experts for a second opinion; and have automated decision-support applied to improve diagnosis. Further research is needed to identify the ideal combination of physical and PoCUS techniques to establish a gold-standard 'hybrid' approach to bedside assessment.

Despite originating over 200 years ago, the physical examination continues to be practised by modern physicians largely unchanged.[1] It is traditionally said to contribute between 10 and 20 percent of the final diagnosis,[2,3] however, many clinical signs are known to be unreliable.[4] In contrast, point-of-care ultrasound (PoCUS), defined as targeted ultrasound examination performed and interpreted by the physician at the bedside, is increasingly recognised as a useful extension to the physical examination.[5] PoCUS began progressing in the 1990s when ultrasound devices became more portable and affordable.[6] Further advancement continued in the 2000s as devices became smaller with higher quality images, and since 2011, smartphone-based devices have become readily accessible.[7–9]

The Society of Critical Care Medicine and American College of Emergency Physicians have recognised the advantages of PoCUS and published evidence-based guidelines for its use,[10,11] however, the American and Royal Australasian Colleges of Physicians are yet to recommend its use. While a careful history and examination will likely remain the foundation of diagnosis, we consider the growing body of evidence supporting PoCUS as the preferred alternative to certain aspects of the physical examination, and consider how physicians might integrate PoCUS into routine clinical assessment.

Methods

We searched MEDLINE (PubMed), Scopus, Web of Science and Google Scholar for English-language studies published until June 1, 2016, that compared the diagnostic accuracy of PoCUS with either physical examination or some gold-standard (eg conventional ultrasound or computed tomography). We also undertook hand searches of bibliographies of collated articles. Studies were included if they used desktop to pocket-sized ultrasound devices, and were mutually agreed upon by the authors.

Comparison between physical examination and point-of-care ultrasound

Cardiovascular examination

The stethoscope, invented by French physician René Laennec in 1816, revolutionised the cardiovascular examination and continues to symbolise the medical profession two-hundred years since its development.[1] However, many authors anticipate that with increasing access to PoCUS, and accuracy approaching that of standard echocardiography, the stethoscope will soon be of limited value for assessing the cardiovascular system.[6,9]

Indeed in 142 patients with abnormal findings on standard echocardiography, cardiologists were able to identify 82% of abnormalities by PoCUS, but only 47% by physical examination.[12] Furthermore, those using PoCUS were less likely to request further investigations in patients who retrospectively had normal echocardiography, saving an estimated $60 per patient.[12] Medical students with 18 hours of training in PoCUS were more effective in diagnosing valvular and non-valvular cardiac disease than board-certified cardiologists using physical examination alone.[13] Students' sensitivity and specificity for valvular disease using PoCUS were 89% and 91% compared with the cardiologists' physical examination, yielding 50% and 90% respectivity.[13]

Assessing volume status is another important aspect of the cardiovascular examination, however, traditional techniques are known to be poorly sensitive and specific.[14] Students using PoCUS after 10 hours of training had a sensitivity of 100% for estimating high central venous pressure (CVP), whereas cardiology fellows using standard jugular venous pressure assessment had a lower sensitivity of 86%.[15] Another study found that PoCUS had positive and negative predictive values (PPV, NPV) of 97% and 96% respectively for estimating low CVP.[16]

Respiratory examination

Modern physical examination originated when the Austrian physician, Leopold Auenbrugger, first described chest percussion in 1761.[1] Auenbrugger's technique continues to assist with the diagnosis of consolidation, effusion and masses. However, key components of the respiratory examination have poor sensitivity and specificity. For example, dullness on percussion has a sensitivity between 4 and 26 percent for predicting pneumonia.[4] As a result there is increasing support for assessing respiratory disease with PoCUS.[17] Compared with computed tomography (CT) as the gold-standard, physicians diagnosed pleural effusion and alveolar consolidation via physical examination with 61% and 36% accuracy respectively, while PoCUS yielded accuracies of 93% and 97% respectively.[18] Furthermore, when assessing ambulatory patients with chronic heart failure, 81% of patients with no crackles on auscultation had a significant number of 'B-lines' seen with PoCUS, correlating with a higher New York Heart Association functional class and higher NT-proBNP levels.[19] Similarly, in asymptomatic rheumatoid arthritis patients, PoCUS had a sensitivity of 89% for diagnosing interstitial lung disease (ILD) when compared with high resolution CT,[20] while fine crackles on auscultation was only 60% sensitive for diagnosing biopsy-proven ILD in symptomatic patients.[21] Finally, PoCUS was able to differentiate between asthma, pulmonary embolism, pneumothorax and pneumonia in 90.5% of patients with acute respiratory failure in the intensive care unit.[22]

Abdominal examination

Examination of the abdomen includes assessment for organomegaly and ascites. Compared with a gastroenterologist experienced in ultrasound, experienced physicians using traditional physical examination underestimated the vertical liver span (VLS) by an average of 6.7cm, with a wide interobserver variability. In contrast, medical students using PoCUS after 10 hours of training overestimated the VLS by 1.5cm.[23] Physical examination is equally challenging for determining the spleen size, with sensitivities ranging between 0 and 64 percent for palpation compared with conventional ultrasound.[24] PoCUS, when compared to conventional ultrasound, has a difference in mean spleen measurement of 0.6cm.[25] Physical techniques for assessing ascites are arguably better than for liver and spleen size, with one study finding the fluid wave as the best technique, with a PPV of 95% and NPV of 51%. However, in the same study, PoCUS was superior with a PPV of 95% and a NPV of 86%, and allowed for safer paracentesis.[26]

Compared with conventional ultrasound, detection of abdominal aortic aneurysms via abdominal palpation has a sensitivity of 68% and specificity of 75%,[27] while PoCUS has a sensitivity of 93% and specificity of 97%.[28]

Neurological examination

PoCUS is possibly most limited for assessing neurological disorders, although it still has useful applications. In patients presenting with transient ischaemic attack or stroke, auscultation for carotid atherosclerosis has a PPV of 25% and a NPV of 99% when compared with conventional ultrasound.[29] In contrast, non-sonographers using PoCUS were comparable to sonographers using conventional ultrasound, with 90% agreement for plaque presence.[30] While direct ophthalmoscopy to assess papilledema is challenging for non-ophthalmologists,[31] PoCUS-guided measurement of the optic nerve sheath diameter has a PPV of 95.4% and a NPV of 100% for predicting raised ICP in the emergency department.[32]

What does this mean for traditional physical examination?

With even brief training, PoCUS appears to be superior to many aspects of the traditional physical examination in arriving at the correct diagnosis. In addition to diagnostic accuracy, PoCUS has many other benefits. Firstly, it may reduce the need for further investigations, such as CT scans, resulting in reduced healthcare costs and patient harm.[33–35] Secondly, PoCUS is likely to enhance rather than detract from the doctor-patient relationship by allowing the patient to visually share in the diagnostic process. Indeed, previous studies have confirmed increased patient satisfaction using PoCUS.[34,36] Thirdly, unlike traditional physical examination, PoCUS produces digital images that can be shared with experts for a second opinion, integrated with the electronic health record, and in the future, have decision-support tools applied to aid diagnosis.[37,38] Finally, because timely, accurate diagnoses can be made at the point-of-care, PoCUS may reduce the length of inpatient stay.[39,40]

This raises the issue of why we have not come to integrate PoCUS into internal medicine education and practice. Perhaps the most significant obstacle to routine PoCUS use is physicians themselves. Historically, medicine has been slow to modify time-honoured practices. Auenbrugger's percussion technique was not widely accepted until being popularised by Jean Corvisart over 40 years after its discovery,[1] and Laennec's stethoscope was claimed to unnecessarily separate the physician from the patient.[41] However, a number of institutions, such as Harvard Medical School and the University of South Carolina have successfully implemented ultrasound curricula for undergraduates and graduates.[6,42]

Access to ultrasound devices remains a barrier, however, smartphone-based devices can cost as little as $199 per month.[43] Moreover, an economic analysis has suggested that implementation of PoCUS is cost-effective in internal medicine.[44] There is also theoretical concern that widespread use of PoCUS will lead to unnecessary investigations because of false positive findings.[6] However, as previously noted, cardiologists were less likely to request further tests when using bedside echocardiography to complement physical examination.[12] Furthermore, patients who underwent PoCUS to assess abdominal pain in the emergency department were less likely to undergo further investigation than those who did not.[34] Another concern is missed diagnoses due to overconfidence in one's ultrasound skills.[6] Although this is a potential source of error,[45] unlike traditional physical examination techniques, PoCUS is electronic, allowing the images to be reviewed for a second opinion or audited for quality improvement.

As physicians, our primary role is to diagnose and treat medical conditions. With the growing body of evidence presented in this article we feel that in PoCUS, there is an accurate, cost effective and patient-acceptable tool to aid us in more effectively completing this task. Therefore, we suggest a novel approach to examining patients in internal medicine, combining only the most useful and evidence-based clinical signs with complementary PoCUS techniques.[46] Additionally, the pace at which this field is evolving begs for broad updates in medical school curricula, teaching hospitals, internal medicine training programs and continued medical education. Importantly, PoCUS is user-dependent and as its use becomes more mainstream, robust guidelines around competency, appropriate use and limitations must be put in place. As other specialties continue to embrace this field, we must complete our own, internal medicine-specific research comparing different combinations of clinical and ultrasound techniques with regards to predictive values, patient outcomes and cost. This should provide the evidence for a paradigm shift in what is rapidly becoming the new standard in physical diagnosis.

Competing interests:

Nil.

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