Intern Emerg Med (2014) 9:805–814
DOI 10.1007/s11739-014-1113-4

HTA ORIGINAL

Bedside Ultrasonography (US), Echoscopy and US Point of Care as a new kind of stethoscope for Internal Medicine Departments: the training program of the Italian Internal Medicine Society (SIMI)

Vincenzo Arienti · Rosella Di Giulio · Chiara Cogliati · Esterita Accogli · Leonardo Aluigi · Gino Roberto Corazza · Ultrasound SIMI Study Group

Received: 13 June 2014 / Accepted: 30 July 2014 / Published online: 22 August 2014

Abstract In recent years, thanks to the development of miniaturized ultrasound devices, comparable to personal computers, tablets and even to smart phones, we have seen an increasing use of bedside ultrasound in internal medicine departments as a novel kind of ultrasound stethoscope. The clinical ultrasound-assisted approach has proved to be particularly useful in assessing patients with nodules of the neck, dyspnoea, abdominal pain, and with limb edema. In several cases, it has allowed a simple, rapid and precise diagnosis. Since 2005, the Italian Society of Internal Medicine and its Ultrasound Study Group has been holding a Summer School and training courses in ultrasound for residents in internal medicine. A national network of schools in bedside ultrasound was then organized for internal medicine specialists who want to learn this technique. Because bedside ultrasound is a user-dependent diagnostic method, it is important to define the limits and advantages of different new ultrasound devices, to classify them (i.e. Echoscopy and Point of Care Ultrasound), to establish appropriate different levels of competence and to ensure their specific training. In this review, we describe the point of view of the Italian Internal Medicine Society on these topics.

Keywords Bedside ultrasound · Echoscopy · Point of care ultrasound · Internal medicine · Training

V. Arienti (✉) · R. Di Giulio · E. Accogli · L. Aluigi
Department of Internal Medicine, Internal Medicine A, Maggiore Hospital, Bologna, Italy
e-mail: vincenzo.arienti@ausl.bologna.it

C. Cogliati
Department of Internal Medicine, Internal Medicine, L. Sacco Hospital, University of Milano, Milan, Italy

G. R. Corazza
First Department of Internal Medicine, Internal Medicine and Gastroenterology, St. Matteo Hospital, University of Pavia, Pavia, Italy

Ultrasound SIMI Study Group
Ultrasound Study Group of Italian Internal Medicine Society (SIMI), Rome, Italy

Introduction

Over the past few decades we have seen a gradual aging of the general population and a change in clinical characteristics of internal medicine (IM) patients: older; affected by chronic illnesses with acute exacerbation, by multiple, often unacknowledged, co-morbidities, by a complex profile and by frailty [1–3]. We have, therefore, moved from a disease-oriented vision of medicine to an integrated multidisciplinary holistic person-oriented approach [4].

In this context, we have also moved to a new organization of the entire medical network, both outside and inside the hospital (i.e. hub and spoke hospitals). Organization of acute care hospitals and IM departments are changing according to the intensity of care and nursing complexity to assure the real need of hospitalization [5], taking into account health care demand and cost restraints in the concept of an economically sustainable health system.

Optimizing the use of limited resources is, therefore, fundamental to appraise the role of old, simple and accurate, best clinical practice, such as history and physical examination [6], and new simple diagnostic approaches, such as bedside US [7–9].

In recent years, technological improvements have allowed the development of miniaturized US devices

comparable to personal computers, tablets and even to smart phones. For many years clinicians with US expertise have supported the bedside use of US; more recently, a huge amount of evidence has established the indications and the advantages of a clinical US approach, in the concept of an ultrasound stethoscope [10–12].

Because US is an extremely user-dependent technique, we now need (a) to ensure training, during and after a medical degree, (b) to define the different levels of competence, indications, limits and characteristics of different devices (c) to establish the advantages of an appropriate use of US, integrating physical examination and clinical data. The purpose of this is to limit an approach, used increasingly more often in daily clinical practice, that is based on a direct prescription of instrumental or laboratory tests. Stimulated by the constant search for maximum efficiency, this approach is often unnecessary and costly, at the expense of the traditional physical examination.

SIMI Ultrasound Study Group

With this in mind, since 2005 the Italian Society of Internal Medicine (SIMI) has been organizing the Summer School of US, a national annual course, dedicated to IM residents. In 2009, the SIMI Study Group on US was founded to define the SIMI learning program in US. We identified all Italian IM departments with US expertise able to provide the training stages to IM residents attending the SIMI Summer School of US (Fig. 1). A national SIMI network of bedside US schools was then organized for all IM specialists who want to learn and to obtain the SIMI certificate in bedside US (Fig. 2).

The SIMI Working Group of US first defined bedside US as all examinations performed bedside by the clinician with small, portable or transportable instruments. The recent introduction of miniaturized devices made a further distinction necessary: first level bedside US, performed with pocket size devices that we will call "Echoscopy" (ES), and second level "Point of Care US" (POCUS) performed with portable instruments, as recently also stated in the European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB) [13]. In fact, the technical resolution, the size of the screen, the absence of spectral or power Doppler and different probes limit the diagnostic power of pocket size devices used for ES. On the positive side, they have the advantage of being hand-held, fitting in pockets and thus easily available to integrate every physical examination, from emergency conditions to daily examinations performed bedside, both in clinical departments as well as in the ambulatory settings (Fig. 3). POCUS can also be used in the same settings, but, although they are bulkier and heavier, they do have better resolution, a larger screen, and the technological improvements mentioned above, that provide greater diagnostic power (Fig. 4).

As concerns training and skills in the first and second levels of bedside US, the SIMI Group stated that the SIMI certificate of competence of first level of bedside US or ES is achieved by participation in (1) theory bedside US course (4 h of didactics) held every year in the SIMI National Congress, (2) theory and practical bedside US one-week course (36 h of training consisting in the participation in 75 US exams, 50 as an observer and 25 performed under an expert's supervision) in a SIMI school, according to the educational program shown in Table 1 [14].

By means of ES, the competence acquired makes it possible to answer general questions usually in terms of the presence or absence of simple, macroscopical, US findings (i.e. is pleural or pericardial or abdominal effusion present? Is the lung wet or dry? Is there a solid or liquid mass?), postponing more complex diagnosis to the second level of bedside US.

The SIMI certificate of competence of second level bedside US or POCUS is achieved by means of (1) obtaining the certificate for the first level of competence, (2) participation in one theory bedside US course (6 h of didactics), organized by one of the SIMI national schools and (3) theory and practical bedside US two-week course (72 h of training consisting of the participation in 150 US exams, 100 as an observer and 50 performed under an expert's supervision) in a SIMI school, according to the educational program shown in Table 2 [15, 16]. The teaching program of POCUS is, therefore, more complex and divided into five learning modules. With the use of POCUS, we, therefore, increase not only the clinical applications of bedside US (i.e. deep venous thrombosis, heart morphology and function, characterization of various abdominal lesions, pulmonary end neck pathologies) but we also achieve a more accurate and precise diagnosis than obtained at the preliminary ES evaluation. The competence acquired with the second level permits identification of all the conditions shown in Tables 1 and 2. In case of doubt, the patient will be re-evaluated with a "second opinion" expert physician [17], using the same device or a better performing one (i.e. transportable), or transferring the patient to the hospital US centre.

To better explain the training program for the second level of bedside US, we will now briefly describe the principal applications and advantages of POCUS in various clinical settings, as summarized in Table 2, according not to the importance of the technique in each clinical setting but to the methodology of the physical exam. This strengthens the message of a first level of bedside US for internists, as ES and POCUS, which concludes the history and physical examination, and increases the

Fig. 1 Italian distribution of US SIMI centres willing to accept students of postgraduate course of specialization school (residents) in IM who have attended the SIMI Summer School of US. Different *colour areas* are related to the number of US examinations per year (1,500–2,000 blue, 2,000–4,000 green, 4,000–9,000 *yellow*, more than 9,000 *pink*)

clinician's accuracy of the latter as an "extension of the internist's hand". Moreover, the SIMI US Study Group have planned multicenter studies aimed at evaluating the benefit of bedside US on the outcome of patients and costs in general, as a reduction of diagnostic tests and of hospital stays, in patients admitted to Internal Medicine departments.

In the 1st module we address the basic concepts of US (i.e. physics, semiotics, technical methodology of performing a US examination), the different US devices, in part mentioned above, and finally the appropriate indications for a second opinion complete US examination. All these topics are well known and widely described in the literature [18–21].

Patients with neck nodules

POCUS is a useful tool to integrate the physical examination of the neck in case of (a) a palpable nodule or mass; (b) appearance of compressive symptoms such as dysphagia, dysphonia, pain on chewing, and (c) clinical suspicion of disease, e.g. in the case of a clinical laboratory framework suggestive of hyper-hypothyroidism [22]. A mass in the neck can be due to several structures and causes: vessels and nerves, lymph nodes, salivary glands, thyroid and parathyroids. US allows not only a quick differential diagnosis between solid vs cystic masses but also identifies the mass, and the areas within the mass where we can guide a fine needle aspiration biopsy [23, 24].

Fig. 2 Italian distribution of SIMI Schools that organize theoretical and practical course of bedside US for all Internal Medicine specialists

To examine the neck by US we need high-frequency linear probes (7.5–13 MHz); no preparation is required. The swellings of the suprahyoid region are, in most of the cases, caused by an increase in volume of the salivary glands due to a salivary duct stone, or to inflammatory or expansive disease. By means of POCUS we can easily recognize (a) volume gland increases, (b) intraparenchymal hypoechoic areas due to widespread inflammation, (c) dilatation of the main duct with endoluminal lithiasis, (d) intraparenchymal hyso-hyper echoic nodules, in case of benign tumour, (e) or roundish–oval hypoechoic nodules, sometimes with calcifications and aspects of invasiveness of nearby organs, in the case of malignant disease [25, 26]. Similarly by US we can easily identify diffuse or nodular pathologies of the thyroid and differentiate solid and liquid nodules [27, 28]. Lymph nodes can increase in size in response to infectious (tuberculosis, mononucleosis, toxoplasmosis, etc.) or inflammatory (sarcoidosis, Castleman disease, etc.) and neoplastic diseases (Hodgkin's disease, metastases of solid tumours). On the basis of US findings we can define lymph nodes as normal or reactive versus pathological ones [29, 30]. In case of reactive lymph node the US architecture is preserved, the cortex is uniformly thickened and the hilum is visible and in central position. In malignant conditions the lymph nodes are frequently enlarged, with rounded shape, irregular margin, altered echo pattern and eccentrical hilum [31, 32]. For specific US findings of various pathologies of the neck we refer to related extensive and specific literature on these topics.

Patients with cardio-respiratory diseases

Dyspnea represents the most common symptom encountered in internal medicine practice in a hospital setting [33], very often associated with a multidisease condition. For this reason, a holistic clinical approach and an integrated bedside US cardiopulmonary evaluation of a dyspnoic patient represents a major challenge for internists, both in terms of appropriate diagnosis/therapy and health resource use.

Fig. 3 Echoscopy with a "pocket size" instrument in an IM department. US scan of left kidney performed by a resident under supervision

Fig. 4 Point of Care US performed bedside by a "tablet" like instrument. US scan of abdominal aorta

While US has been for years considered inadequate to explore the lung, evidence has now been collected demonstrating that lung US offers high accuracy not only in the identification and quantification of pleural effusion [34, 35], but also in the differential diagnosis of respiratory insufficiency [36]. Pneumothorax [37], pulmonary edema [36, 38], and pneumonia [39] are indeed recognized with an accuracy definitely higher than the standard chest X-ray study. In addition, a preserved sonographic 'normal' pattern in the presence of a dyspnoic patient and congruent anamnestic/laboratory data, may guide the clinician towards the diagnosis of recurrent acute phase of chronic obstructive pulmonary disease or pulmonary embolism (PE) [36]. A recent document from the Consensus Conference on Lung US [40] reported a large number of studies showing the potentiality of lung US in triage, diagnosis, follow-up and even prognosis, of patients referred for dyspnoea. Lung US is easily performed with portable devices and most of the evidence has been collected in the emergency setting, searching for mainly dichotomous answers to basic clinical questions (Is there pleural effusion? Is there a sign of pneumothorax, pulmonary edema or interstitial disease, pneumonia or atelectasia?). It has been demonstrated that a short training period is required to correctly recognize pneumothorax, pulmonary edema or signs of pulmonary fibrosis [41–43]; pleural fluid as well as diffuse interstitial syndrome are easily detected even with pocket size US devices, such as ES described above [43–45].

Table 1 Echoscopy—diagnostic power and use

Pleural, pericardial, peritoneal effusions (p/a, extent)
Wet or dry lung (p/a)
Dilated heart ventricles (p/a)
Severe cardiac systolic dysfunction (p/a)
Collapsible inferior vena cava (p/a)
Palpable or suspected abdominal mass (p/a, solid vs liquid)
Atrophy or megaly of abdominal viscera (p/a)
Hydrops of the gallbladder (p/a, large stones)
Hydronephrosis (p/a)
Intestinal and biliary obstruction (p/a)
Abdominal aortic aneurysm (p/a)
Bladder outlet obstruction (p/a)
Thoracentesis, paracentesis US-assisted
Catheter into the bladder[a] (p/a)

p/a presence vs. absence

[a] Also performed by the nursing staff

The same approach has been applied in the last decade to echocardiography and it has been demonstrated that even briefly trained physicians can obtain crucial information regarding heart dimension and function with good reproducibility compared to expert echocardiographers, thus implementing physical examination even by means of ES [46–49]. Of course, a clinician at the bedside cannot substitute extensive echocardiograpy; nevertheless, with the help of ES the clinician can rapidly obtain important

Table 2 Point of Care US, diagnostic power and use

1st module: Fundamentals in US
Fundamentals of clinical bedside US examination
Bedside US devices
Indications for referral to second opinion or expert levels:
Fundamental US
Contrast Enhancement US (CEUS)
Interventional US
2nd module: Patients with neck nodules
The nodule of the neck: clinical approach
Normal US findings
Salivary gland disease
The thyroid nodule
Superficial lymphadenopathy
3rd module: Patients with cardio-respiratory diseases
Dyspnoea: clinical approach
Normal US findings
Pleural and pericardial effusion
Interstitial pathology, pleural or pulmonary consolidations, pneumothorax
Dimensions of cardiac chambers
Normokinesis, hypokinesis, hyperkinesia: inspective EF
Severe valvulopaty
US-guided thoracentesis
4th module: Patients with abdominal diseases
Acute abdomen: clinical approach
Normal US findings
Ascites and abdominal masses
Focal parenchymal lesions (>2 cm)
Jaundice, cholelithiasis, cholecystitis, cholangitis
Renal failure, hydronephrosis, renal stones
Abdominal aortic aneurysm (surgery or follow-up?)
Bowel obstruction, appendicitis, diverticulitis, IBD and tumours
US-guided paracentesis
5th module: Patients with limb edema
"Swollen" leg: clinical approach
Normal US findings
Deep venous thrombosis (DVT)

information about the diagnosis and the optimal treatment management: is a significant systolic or diastolic dysfunction present? Are there signs of pericardial effusion, cardiac tamponade or a hemodynamically significant pulmonary embolus [50]?

Lung and cardiac US, associated with evaluation of the inferior vena cava (IVC) for estimation of intravascular volume status, can furnish an integrated approach (Fig. 5), useful not only for diagnosis but also for monitoring critical patients and guiding therapeutic intervention—for example during fluid [51] or diuretic administration [52]. In the same context as the multiorgan approach, it has been demonstrated that adding compression US (CUS) to lung and cardiac US (is there a deep vein thrombosis?) increases the accuracy of diagnosis of PE, reducing the need for computed tomography pulmonary angiography (CTPA) [53].

Patients with abdominal diseases

Acute abdominal pain represents one of the most frequent causes of admission in internal medicine departments; moreover, it is also a symptom often arising during the hospital stay. The clinical approach to acute abdominal pain is now particularly enriched by small bedside US machines, as an excellent integrated tool to physical examination. Bedside US in abdominal pathology often allows a rapid and definitive diagnosis, excludes suspected diseases or indicates successive and appropriate investigations. In fact, by mean of ES we can immediately define the presence or absence of macroscopic pathology, described in Table 1 [13], and by mean of POCUS we can detect a larger number of the abdominal diseases listed in Table 2 [7, 8].

Bedside US can clearly demonstrate the presence or absence of peritoneal effusion as its quantification and represents a quick and secure method for paracentesis, performed for both therapeutic and diagnostic purposes, particularly useful in the latter case when the amount of fluid is small [54–56]. Abdominal masses such as abdominal aortic aneurysms (AAA) are also easy diagnosed with a sensitivity and specificity in emergency departments of 99 and 98 %, respectively [57]. Bedside US, performed as ES or POCUS, can clearly determine the presence of the aneurysm but with the second method we can better measure its diameter, define the morphology and its localization (above and below the renal arteries), evaluate thrombosis, and recognize cases that require urgent computed tomography (CT) angiography and surgery [58]. Hypertrophy and atrophy of the abdominal viscera (liver, spleen, kidney, etc.), like abdominal pathologies that present other morphologic changes are examples of important advantages and opportunities of bedside US [59].

A recent study shows that simple ES is sufficient both to delineate abdominal disease, and to detect abdominal focal lesions larger than 2 cm in diameter in 97.4 % and in 97 % of cases, respectively [49]. In cases of fortuitously discovered liver lesions, a precise characterization can be reached at second opinion level in the hospital US centre by contrast-enhanced US (CEUS) [60, 61]. This approach, that starts from ES and arrives at CEUS, makes it possible to select patients who may benefit from CEUS, contrast-enhanced computed tomography (CECT) or contrast-enhanced magnetic resonance imaging (CEMRI), and is

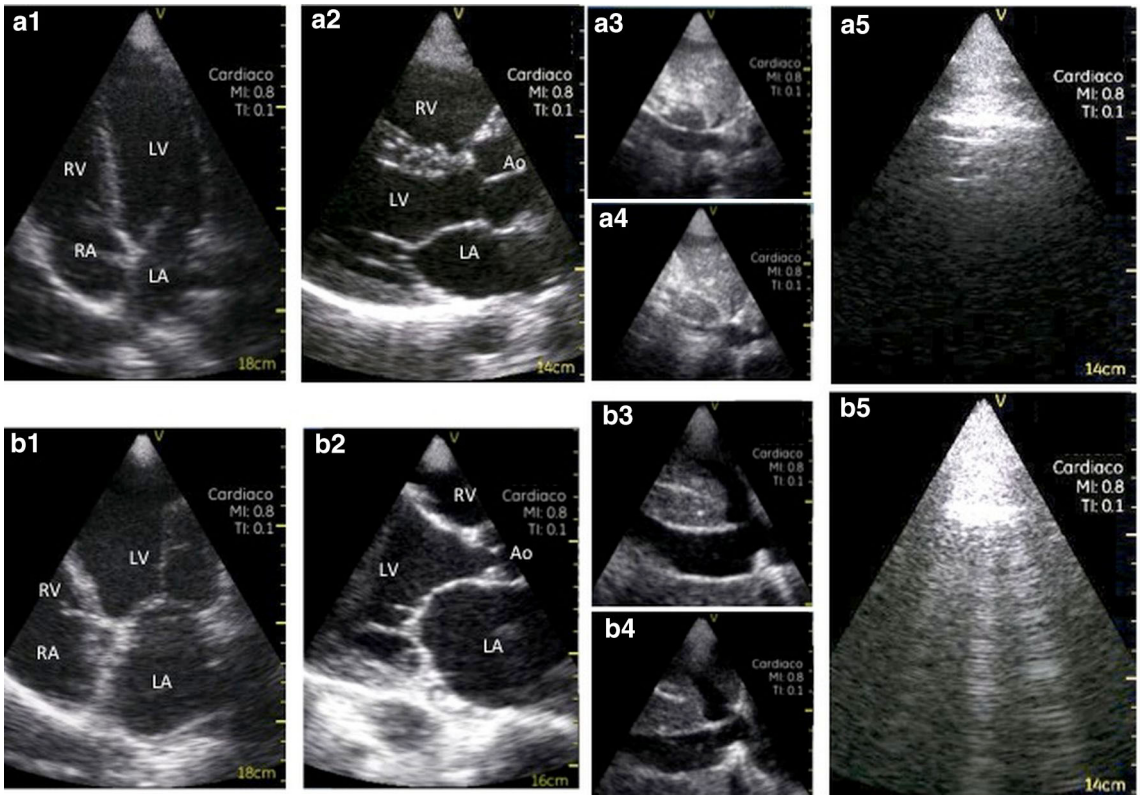

Fig. 5 Example of a normal subjects (‘**a**’ panels) and a heart failure patient (HF) (‘**b**’ panels); scans have been obtained with pocket size ultrasound device. Notice in normal subject preserved dimensions of left atrium and ventricle (**a1**, **a2**), collapsibility of IVC during inspirations (**a4**) and ‘dry’ lung (**a5**); in HF: dilatated left atrium and ventricle (**b1**, **b2**), non collapsibility of IVC (**b4**) and ‘wet lung’ characterized by multiple B-lines (**b5**)

not only accurate but also appropriate and inexpensive [62]. Jaundice, suspicion of biliary colic or acute cholecystitis, are easy to diagnose by ES as a dilatation of the intrahepatic bile ducts, gallbladder hydrops and large gallbladder stones. In the same clinical conditions, POCUS can document with more detail the morphological US signs of acute cholecystitis (presence of thickened walls or fluid peripheral collections), presence of biliary sludge or pus, infundibulum microlithiasis, and causes of distal common bile duct obstruction.

Similarly, in acute renal failure a simple ES allows the differential diagnosis between obstructive and non-obstructive diseases (i.e. bladder globe, hydronephrosis) and, in cases of renal colic, POCUS can better document small stones [63]. Gastrectasia and the diagnosis of the severity of bowel obstruction [64] are also easy to show by ES. Although US of the gastrointestinal tract is generally a second level survey, by means of POCUS, as an adjunct to clinical and laboratory data, it can help to diagnose some diseases or indicate successive investigations: such as for bowel wall thickening or “pseudokidney” in the case of diverticulitis, inflammatory bowel disease, appendicitis or tumours [64–67].

Patients with limb edema

“Swollen leg” represents a frequent clinical case in internal medicine, which can be from a number of possible causes, [68] and whose early diagnosis can indicate the best medical treatment that may prevent possible complications [69]. In fact, swollen leg, especially when unilateral, can be due to deep vein thrombosis (DVT), and this requires prompt diagnosis and treatment to avoid the risk of PE. Clinical examination, even if carried out with the aid of a suitable pre-test score [70–72], does not always enable an accurate diagnosis. US findings, provided by colour and power Doppler, integrate clinical information and represent the fastest way to reach a definitive diagnosis [73, 74]. Technological US innovation is today available to clinicians with instruments that are easy to use and compact in size, very suitable for point of care diagnosis without specialized backgrounds necessarily needed. In particular, CUS for the diagnosis of DVT is a very easy manoeuvre, that can be acquired with a brief period of training, and that can be done easily with a linear probe and a simple B-Mode US system. The deep venous vessels of the lower limbs are compressed with the probe, and their complete

collapsibility makes it possible to exclude DVT [75]. In this "facilitated" or simplified way, CUS is confined to the femoro-popliteal segments [76] (the only one validated in the literature), and the presence of thrombosis is confirmed when complete compressibility of the vessel is not possible (Fig. 6). Proximal venous thrombosis exposes the patient to a higher risk of PE if compared to the distal forms, and US recognition of the two forms is, therefore, important both for diagnosis and treatment [77, 78]. This does not exclude a time-delayed study of the entire venous system that may be performed with more complex ultrasound equipment and by highly skilled operators.

The use of bedside US evaluation of patients with signs and symptoms of PE has been controversial [79]. CTPA is considered the gold standard for the diagnosis of PE, and is frequently performed in patients with cardiopulmonary complaints. However, indiscriminate use of CTPA results in significant exposure to ionizing radiation and contrast. Recently a screening ultrasound protocol has been proposed for patients suspected of having PE to predict the need for CTPA: the examination consists of a limited echocardiogram, thoracic ultrasonography and lower extremity deep venous compression study [80]. This protocol has been considered suitable for the diagnosis of PE with high specificity, especially for pregnant women to avoid the high foetal radiation exposure risk. However, its poor sensitivity implies that further testing may be necessary to fully rule out a pulmonary embolism. Moreover, the venous compression study may be applied at the same time and in the same way to exclude superficial venous thrombosis (SVT) that, when located near a junction with the deep venous system, requires the same treatment as DVT because of the exposure of the subject to the same high risk of PE [74, 78]. As for other applications of bedside US, this technique needs basic knowledge of normal and pathological findings (in this case regarding superficial and deep venous systems and other nearby structures), it requires a short period of training with expert tutors for the correct application of the methodology [81], and should be considered a routine part of the learning paths of all doctors of internal medicine.

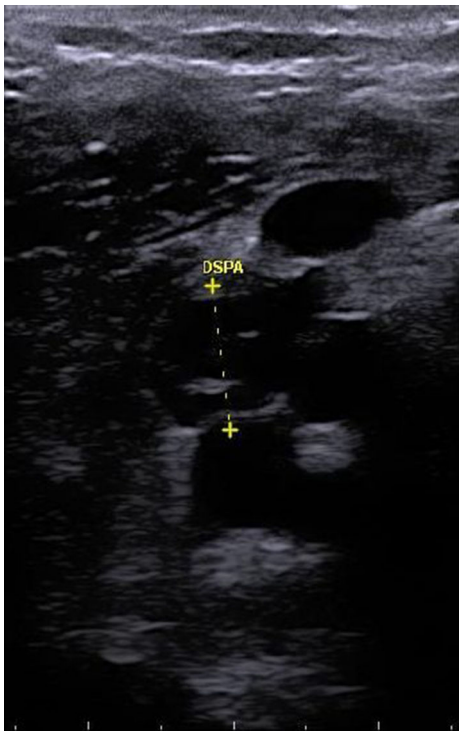

Fig. 6 Point of Care US performed bedside with superficial probe. Acute deep vein thrombosis of the popliteal vein (*short axis*): the vessel is enlarged, filled with echoes and not compressible

Acknowledgments The authors wish to thank the other components of the SIMI Ultrasound Study Group (Domanico A, De Fazio C, Piscaglia F, Loffredo L, Parrinello G, Baldini L, Pretolani P, Polimeni L, Del Ben M, Carnevale Maffé G, Testa A, Fracanzani AL, Vidili G, Bracco C) for their contribution to the discussion in various meetings of the group. Financial support for this study was provided by the Ultrasound Centre of Research and Education, Internal Medicine A, Maggiore Hospital, Bologna, Italy).

Conflict of interest None.

References

1. Nobili A, Licata G, Salerno F et al (2011) Polypharmacy, length of hospital stay, and in-hospital mortality among elderly patients in internal medicine wards. The REPOSI study. Eur J Clin Pharmacol 67:507–519
2. Haggerty JL (2012) Ordering the chaos for patients with multimorbidity. BMJ 345:e5915
3. Barnett K, Mercer SW, Norbury M et al (2012) Epidemiology of multimorbidity and implications for healthcare, research, and medical education: a cross-sectional study. Lancet 380:37–43
4. Dammacco F (2012) Internal medicine and the holistic approach to the patient between globalization and advanced technologies. Recenti Prog Med 103(6):248–255
5. Jencks SF, Williams MV, Coleman EA (2009) Rehospitalizations among patients in the medicare fee-for-service program. N Engl J Med 360(14):1418–1428
6. Verghese A, Brady E, Kapur CC et al (2011) The bedside evaluation: ritual and reason. Ann Intern Med 155:550–553
7. Arienti V, Camaggi V (2011) Clinical applications of bedside ultrasonography in internal and emergency medicine. Intern Emerg Med 6(3):195–201
8. Moore CL, Copel JA (2011) Point-of-care ultrasonography. N Engl J Med 364:749–757
9. Solomon SD, Saldana F (2014) Point-of-care ultrasound in medical education-stop listening and look. N Engl J Med 370(12):1083–1085
10. Waider W, Craige E (1975) First heart sound and ejection sounds: echocardiographic and phonocardiographic correlation with valvular events. Am J Cardiol 35:3
11. Wherry DC (1998) Potential of a hand-held ultrasound in assessment of the injured patient. Cardiovasc Surg 6(6):569–572
12. Salustri A, Trambaiolo P (2003) The "ultrasonic stethoscope": is it of clinical value? Heart 89(7):704–706

13. Piscaglia F, Dietrich CF, Nolsoe C et al (2013) Birth of "echoscopy": the EFSUMB point of view. Ultraschall Med 34:92
14. Sicari R, Galderisi M, Voigt JU et al (2011) The use of pocket-size imaging devices: a position statement of the European association of echocardiography. Eur J Echocardiogr 12(2): 85–87
15. Mjølstad OC, Andersen GN, Dalen H et al (2013) Feasibility and reliability of point-of-care pocket-size echocardiography performed by medical residents. Eur Heart J Cardiovasc Imaging 14(12):1195–1202
16. Via G, Hussain A, Wells M, Reardon R et al (2014) International evidence-based recommendations for focused cardiac ultrasound. J Am Soc Echocardiogr 27(7):683.e1–683.e33
17. Valentin L (2000) Training and accreditation: a report from the EFSUMB education and professional standards committee. EFSUMB Newslett 14:20
18. Sanders RC, Winters TC (2007) Clinical sonography: a practical guide. Lippincott Williams & Wilkins, Philadelphia
19. Kuntz K, Henningsen C, Youngs D (2013) Clinical guide to sonography, II edn. Elsevier, NJ
20. Holm HH, Skjoldbye B (1996) Interventional ultrasound. Ultrasound Med Biol 22(7):773–789
21. Claudon M, Dietrich CF, Choi BI et al (2013) Guidelines and good clinical practice recommendations for Contrast Enhanced Ultrasound (CEUS) in the liver—update 2012: a WFUMB-EFSUMB initiative in cooperation with representatives of AFSUMB, AIUM, ASUM, FLAUS and ICUS. Ultrasound Med Biol 39(2):187–210
22. Hegedus L (2004) Clinical practice: the thyroid nodule. N Engl J Med 351:1764–1771
23. Gharib H, Papini E (2007) Thyroid nodules: clinical importance, assessment, and treatment. Endocrinol Metab Clin North Am 36:707–735
24. Gharib H (1994) Fine-needle aspiration biopsy of thyroid nodules: advantages, limitations, and effect. Mayo Clin Proc 69:44–49
25. Alyas F, Lewis K, Williams M et al (2005) Diseases of submandibular gland as demonstrated using high resolution ultrasound. Br J Radiol 78:362–369
26. Yousem DM, Kraut MA, Chalian AA et al (2000) Major salivary gland imaging. Radiology 216:19–29
27. Hankerson M, Seif D, Mailhot T et al (2012) Thyroid evaluation in a patient with thyrotoxicosis with bedside ultrasound. West J Emerg Med 13(6):514
28. Klima G, Rothlauer W (2000) Sonography of the thyroid gland in practice and in the clinic. Acta Med Austriaca 27(2):42–44
29. Rettenbacher T (2012) Sonographie der peripheren lymphknoten Teil 1: Normalbefunde und B-Bild-Kriterien. Ultraschall Med 31:344–361
30. Ying M, Ahuja A, Metreweli C (1998) Diagnostic accuracy of sonographic criteria for evaluation of cervical lymphadenopathy. J Ultrasound Med 17:437–445
31. Esen G (2006) Ultrasound of superficial lymph nodes. Eur J Radiol 58:345–359
32. Ahuja AT, Ying M, Ho SY et al (2008) Ultrasound of malignant cervical lymph nodes. Cancer Imaging 8:48–56
33. Duckitt R, Palsson R, Bosanska L et al (2010) Common diagnoses in internal medicine in Europe 2009: a pan-European, multi-centre survey. Eur J Intern 21:449–452
34. Yang PC, Luh KT, Chang DB et al (1992) Value of sonography in determining the nature of pleural effusion: analysis of 320 cases. AJR Am J Roentgenol 159:29–33
35. Schleder S, Dornia C, Poschenrieder F et al (2012) Bedside diagnosis of pleural effusion with a latest generation hand-carried ultrasound device in intensive care patients. Acta Radiol 53(5):556–560
36. Lichtenstein DA, Meziere GA (2008) Relevance of lung ultrasound in the diagnosis of acute respiratory failure: the BLUE protocol. Chest 134:117–125
37. Lichtenstein DA, Menu Y (1995) A bedside ultrasound sign ruling out pneumothorax in the critically ill. Lung Sliding. Chest 108:1345–1348
38. Gargani L, Frassi F, Soldati G et al (2008) Ultrasound lung comets for the differential diagnosis of acute cardiogenic dyspnoea: a comparison with natriuretic peptides. Eur J Heart Fail 10:70–77
39. Reissig A, Copetti R, Mathis G et al (2012) Lung ultrasound in the diagnosis and follow-up of community-acquired pneumonia. A prospective, multicenter, diagnostic accuracy study. Chest 142(4):965–972
40. Volpicelli G, Elbarbary M, Blaivas M et al (2012) International evidence-based recommendations for point-of-care lung ultrasound. Intensive Care Med 38:577–591. doi:10.1007/s00134-012-2513-4
41. Noble V, Lamhaut L, Capp R (2009) Evaluation of a thoracic ultrasound training module for the detection of pneumothorax and pulmonary edema by prehospital physician care providers. BMC Med Educ 6920-9-3
42. Schnobrich DJ, Olson AP, Broccard A, Duran-Nelson A (2013) Feasibility and acceptability of a structured curriculum in teaching procedural and basic diagnostic ultrasound skills to internal medicine residents. J Grad Med Educ 5(3):493–497
43. Cogliati C, Antivalle M, Torzillo D.(2014) Standard and pocket-size lung ultrasound devices can detect interstitial lung disease in rheumatoid arthritis patients. Rheumatology 53(8):1497–1503
44. Schleder S, Dornia C, Poschenrieder F et al (2012) Bedside diagnosis of pleural effusion with a latest generation hand-carried ultrasound device in intensive care patients. Acta Radiol 53:556–560
45. Bedetti G, Gargani L, Corbisiero A, Frassi F, Poggianti E, Mottola G (2006) Evaluation of ultrasound lung comets by hand-held echocardiography. Cardiovasc Ultrasound 4:34
46. Galderisi M, Santoro A, Versiero M et al (2010) Improved cardiovascular diagnostic accuracy by pocket size imaging device in non-cardiologic outpatients: the NaUSiCa (Naples Ultrasound Stethoscope in Cardiology) study. Cardiovasc Ultrasound 26(8):51
47. Panoulas VF, Daigeler AL, Malaweera AS (2013) Pocket-size hand-held cardiac ultrasound as an adjunct to clinical examination in the hands of medical students and junior doctors. Eur Heart J Cardiovasc Imaging 14(4):323–330
48. Razi R, Estrada JR, Doll J et al (2011) Bedside hand-carried ultrasound by internal medicine residents versus traditional clinical assessment for the identification of systolic dysfunction in patients admitted with decompensated heart failure. J Am Soc Echocardiogr 24:1319–1324
49. Liebo M, Israel R, Lillie E et al (2011) Is pocket mobile echocardiography the next-generation stethoscope? A cross-sectional comparison of rapidly acquired images with standard transthoracic echocardiography. Ann Intern Med 155(1):33–38
50. Korcarz CE, Pellikka PA, Rahko PS et al (2013) Focused cardiac ultrasound: recommendations from the American Society of echocardiography. J Am Soc Echocardiogr 26:567–581
51. Lichtenstein D, Karakitsos D (2012) Integrating lung ultrasound in the hemodynamic evaluation of acute circulatory failure (the fluid administration limited by lung sonography protocol). J Crit Care 5:533.e11–533.e19
52. Volpicelli G, Caramello V, Cardinale L et al (2008) Bedside ultrasound of the lung for the monitoring of acute decompensated heart failure. Am J Emerg Med 26:585–591
53. Nazerian P, Vanni S, Volpicelli G et al (2014) Accuracy of point-of-care multiorgan ultrasonography for the diagnosis of pulmonary embolism. Chest 145(5):950–957

54. Seitz K, Vasilakis D, Ziegler M (2003) Efficiency of a portable B-scan ultrasound device in comparison to a high-end machine in abdominal ultrasound. Results of a pilot study. Ultraschall Med 24:96–100
55. Schleder S, Dendl LM, Ernstberger A et al (2013) Diagnostic value of a hand-carried ultrasound device for free intra-abdominal fluid and organ lacerations in major trauma patients. Emerg Med J 30(3):e20
56. Landers A, Ryan B (2014) The use of bedside ultrasound and community-based paracentesis in a palliative care service. J Prim Health Care 6(2):148–151
57. Rubano E, Mehta N, Caputo W et al (2013) Systematic review: emergency department bedside ultrasonography for diagnosing suspected abdominal aortic aneurysm. Acad Emerg Med 20:128–138
58. Kuhn M, Bonnin RL, Davey MJ et al (2000) Emergency department ultrasound scanning for abdominal aortic aneurysm: accessible, accurate, and advantageous. Ann Emerg Med 36(3):219–223
59. Barreiros AP, Cui XW, Ignee A et al (2014) EchoScopy in scanning abdominal diseases: initial clinical experience. Z Gastroenterol 52(3):269–275
60. Dietrich CF, Sharma M, Gibson RN et al (2013) Discovered fortuitously liver lesions. World J Gastroenterol 19:3173–3188
61. Burns PN, Wilson SR (2007) Focal liver masses: enhancement patterns on contrast-enhanced images-concordance of US scans with CT scans and MR images. Radiology 242:162–174
62. Seitz K, Bernatik T, Strobel D et al (2010) Contrast-enhanced ultrasound (CEUS) for the characterization of focal liver lesions in clinical practice (DEGUM Multicenter Trial): CEUS vs. MRI-a prospective comparison in 269 patients. Ultraschall Med 31:492–499
63. Dalziel PJ, Noble VE (2013) Bedside ultrasound and the assessment of renal colic: a review. Emerg Med J 30(1):3–8
64. O'Malley ME, Wilson SR (2003) US of gastrointestinal tract abnormalities with CT correlation. Radiographics 23:59–72
65. Kessler N, Cyteval C, Gallix B et al (2004) Appendicitis: evaluation of sensitivity, specificity and predictive values of U.S., Doppler U.S., and laboratory findings. Radiology 230:472–478
66. Millet I, Alili C, Pages E et al (2012) Infection of the right iliac fossa. Diagn Interv Imaging 93:441–452
67. Arienti V (2006) Ecografia clinica del tratto gastroenterico, Athena edn. Modena, Italy
68. Ely JW, Osheroff JA, Chambliss ML et al (2006) Approach to leg edema of unclear etiology. Am Board Fam Med Mar-Apr 19(2):148–160
69. Nyamekye I, Merker L (2012) Management of proximal deep vein thrombosis. Phlebology 27(Suppl 2):61–72
70. Wells PS, Anderson DR, Bormanis J et al (1997) Value of assessment of pretest probability of deep-vein thrombosis in clinical management. Lancet 350(9094):1795–1798
71. Wells PS, Anderson DR, Rodger M et al (2003) Evaluation of D-dimer in the diagnosis of suspected deep-vein thrombosis. N Engl J Med 349(13):1227–1235
72. Wells PS, Owen C, Doucette S et al (2006) Does this patient have deep vein thrombosis? JAMA 295(2):199–207
73. Schellong SM, Gerlach H, Hach-Wunderle V et al (2009) Diagnosis of deep-vein thrombosis: adherence to guidelines and outcomes in real-world health care. Thromb Haemost 102(6):1234–1240
74. Antignani PL, Benedetti-Valentini F, Aluigi L et al (2012) Diagnosis of vascular disease. Ultrasound investigation-guidelines. Int Angiol 31(5 Suppl 1):1–77
75. Landefeld CS (2008) Noninvasive diagnosis of deep vein thrombosis. JAMA 300:1696–1697
76. Goodacre S, Sampson F, Thomas S et al (2005) Systematic review and meta-analysis of the diagnostic accuracy of ultrasonography for deep vein thrombosis. BMC Med Imaging 5:6
77. Dupras D, Bluhm J, Felty C et al (2013) Institute for clinical systems improvement. Venous thromboembolism diagnosis and treatment. http://bit.ly/VTE0113. Updated Jan 2013
78. Shannon M, Bates SM, Jaeschke R et al (2012) Diagnosis of DVT: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest 141(2):351–418
79. Koenig S, Chandra S, Alaverdian A et al (2014) Ultrasound assessment of pulmonary embolism in patients receiving computerized tomography pulmonary angiography. Chest 145(4):818–823
80. Patel AN, Nickels LC, Flach FE et al (2013) The use of bed side ultrasound in the evaluation of patients presenting with signs and symptoms of pulmonary embolism. Cases Rep Emerg Med 2013:312632
81. Gloviczki P, Comerota AJ, Dalsing MC et al (2011) The care of patients with varicose veins and associated chronic venous diseases: clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum. Vasc Surg 53:2S–48S