

Ultrasonography in Gastroenterology: The Need for Training

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Keywords

Ultrasonography · Point-of-care ultrasonography · Gastroenterology · Training · Physical examination

Abstract

The use of ultrasonography (US) as an imaging modality in medicine has spread across almost every clinical specialty. This diffusion is based on the simplicity, accessibility, portability and affordability of the technique producing real-time high-resolution images using non-ionising radiation. On the other hand, this trend also extended the technique to settings other than healthcare, such as public facilities, private houses or remote sites. This tendency can be observed worldwide, from developing countries to prestigious medical schools and tertiary referral hospitals. Furthermore, point-of-care US (POCUS), i.e., US executed at the patient's bedside to obtain real-time objective information with diagnostic and clinical monitoring purposes or to guide invasive procedures, has been incorporated in many specialties. In gastroenterology, despite the essential role of endoscopy, clinical practice is highly dependent on non-endoscopic imaging techniques. However, as in other specialties, the indi-

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cations of US in gastroenterology have been increasing steadily, covering a broad range of conditions. In response to the generalised employment of US by non-radiologists, institutions such as the European Federation of Societies for Ultrasound in Medicine and Biology and the Royal College of Radiologists issued recommendations to ensure high-quality practice. These theoretical and practical requisites include performing a certain number of examinations and mandatory skills in order to achieve certification to execute unsupervised US. Therefore, there is a need for modern gastroenterology to include US as a basic skill in its clinical practice. To ensure the provision of high-quality US, adequate instruction of future specialists should be guaranteed by the gastroenterology departments and required in the residency training programme.

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Ecografia na Gastrenterologia: necessidade de formação

Palavras Chave

Ultrassonografia · Ecografia *point-of-care* · Gastroenterologia · Formação · Exame físico

Resumo

A utilização em Medicina da ultrassonografia como modalidade imagiológica expandiu-se a quase todas as especialidades clínicas. Esta difusão baseou-se na simplicidade, acessibilidade, portabilidade e baixo custo para obtenção em tempo real de imagens de alta resolução utilizando radiação não-ionizante. Por outro lado, esta corrente disseminou a técnica para além das instituições de saúde, em instalações públicas, residências privadas, ou locais remotos. Esta tendência ocorre globalmente, de países subdesenvolvidos a hospitais terciários e faculdades de medicina prestigiadas. Além disso, a ecografia *point-of-care* (EPOC), i.e., ultrassonografia realizada à *cabecira do doente* para obtenção de informação em tempo real com fins diagnósticos, de monitorização clínica ou orientação de procedimentos invasivos, tem sido assumida por muitas especialidades. Na Gastreenterologia, apesar do papel essencial da endoscopia, a prática clínica encontra-se altamente dependente de exames de imagem não-endoscópica. Contudo, como noutras especialidades, as indicações para ultrassonografia em Gastreenterologia têm crescido continuamente, cobrindo um vasto leque de patologias. No seguimento da utilização generalizada da ecografia por não-radiologistas, instituições como a *European Federation of Societies for Ultrasound in Medicine and Biology* e o *Royal College of Radiologists* publicaram recomendações para assegurar um desempenho de alta qualidade. Estes requisitos teóricos e práticos incluem números mínimos de exames e competências técnicas a alcançar para a certificação com o fim de realizar autonomamente ultrassonografia digestiva. Existe, portanto, a necessidade de a Gastreenterologia moderna incluir a ecografia como um procedimento básico na prática clínica. Para assegurar a execução de ultrassonografia de alta qualidade, a formação adequada dos futuros especialistas deve ser garantida pelos Serviços de Gastreenterologia e exigida nos Programas de Formação do Internato.

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Introduction

Since the first report of the application of ultrasonography (US) as a medical imaging modality by Dr. Tussik in 1942 [1], this technique has spread across almost every clinical specialty. This global acceptability can be explained by the unique properties of US as an imaging modality. Being a simple and accessible technique, it produces high-resolution images, providing a true real-time

anatomic and functional observation. Furthermore, the readiness of the technique, combined with affordability and the safety of using non-ionising radiation, permits its repetitive utilisation in many clinical scenarios [2–4].

The dissemination of US started in medical specialties, such as neurology [1], cardiology [5, 6] or obstetrics/gynaecology [7], whose physicians discovered the convenience of using US on demand to guide their clinical decisions several decades ago. Hence, these medical areas eventually reached a state of specialised clinical US.

In the past couple of decades, the development of smaller, portable and less expensive devices has generalised the access to US from primary to intensive care, from home-based palliative medicine to operating rooms and emergency departments. Moreover, this trend can be observed worldwide, from rural areas in developing countries to top-quality medical schools and tertiary referral hospitals [8–17].

Point-of-Care US

In this context, diverging from the classical comprehensive US evaluation, the concept of *point-of-care US* (POCUS) was created to define a new way of using US in medicine [2, 3, 15]. In this modality, clinicians perform US *at the patient's bedside* to obtain immediate answers to concrete questions concerning the diagnosis, evolution of the disease or response to therapy. On the other hand, the real-time localisation of structures with POCUS is also used to guide diagnostic and therapeutic interventions. Examples include the protocol of Extended-Focused Assessment with Sonography for Trauma (E-FAST) [18–21] or using US to guide the placement of a central venous catheter [22–27]. The clinical settings where POCUS can be applied are almost unlimited and include healthcare venues (clinics, wards, emergency departments or intensive care units), private houses, public facilities or remote places, such as airplanes, oil platforms or space stations [4, 23, 28–34].

Given all these developments, and following the paradigm of specialties such as cardiology or obstetrics/gynaecology, other areas of medical care have included US in their clinical practice according to their requirements [10, 26–28, 30, 35–37]. We can define 3 broad subtypes of US performed by non-radiologists [38]:

- *diagnostic/descriptive* (routine echocardiography or morphological examination of the foetus);
- *clinical observation* (E-FAST, evaluation of the intravascular volume status to adjust resuscitation procedures); and
- *interventional* (to guide a central catheter insertion or peripheral nerve blockade).

The Role for US in Gastroenterology

In gastroenterology, the endoscopic visualisation of the mucosa of the digestive tract has always been one of the key components in the training and practice of clinicians. Concurrently, up-to-date care in this specialty is obligatorily supported by multiple imaging modalities. Nevertheless, the previously stated trend for the use of US by non-radiologists has found great adherence in gastroenterology, and US is increasingly seen as a basic skill among gastroenterologists [2, 39–43].

For us, essentially clinicians, the possibility of using this affordable and non-invasive technique for the real-time evaluation of structures ranging from solid organs to hollow viscera or surrounding structures is of great interest. For instance, in some cases, the origin of abdominal symptoms lies in thoracic, abdominal or pelvic non-digestive organs. Furthermore, US allows a real-time dynamic and interactive observation of the motility of the digestive tract. This evaluation has almost no effect on the function of the organ, in contrast with endoscopic examinations or motility tests that require the insertion of luminal probes.

Already common practice in many countries [41, 42, 44], this change of paradigm is ultimately related to the concept of *digestive US*. This patient-centred approach is carried out by the gastroenterologist who, while performing US, integrates the visual information obtained under a clinical perspective with the known medical history, symptoms and signs of that concrete patient. The doctor following the patient is the most suitable intervenient to use this *abdominal palpation guided by US* as an extension of the physical examination and clinical history.

Using this methodology, as in other specialties, the fields of application encompass the above-mentioned 3 aspects of diagnosis, clinical monitoring or interventional guidance. These include, for example, screening for hepatocellular carcinoma in cirrhotic patients (diagnostic/descriptive) [45–48], monitoring of inflammatory bowel disease (IBD) activity (clinical monitoring) [49–55] or percutaneous therapy of hepatocellular carcinoma (interventional guidance) [56–58]. Regarding some of the abdominal and pelvic conditions that can be identified by digestive US, an abridged list is presented in Table 1 [2, 40, 43, 59, 60].

Furthermore, the development of new ancillary ultrasonographic techniques has broadened the indications for US, shifting from a mostly morphological description to a more physiological evaluation. In recent years, these advances in areas such as contrast-enhanced US (CEUS)

Table 1. Examples of abdominal and pelvic conditions identified by ultrasonography

Organ	Pathological conditions
Liver	Focal lesions: cysts, benign and malignant tumours, metastatic disease, abscesses Diffuse lesions: steatosis, cirrhosis
Gallbladder and bile ducts	Cholelithiasis, acute and chronic cholecystitis, gallbladder tumours Bile duct obstruction including level of obstruction Intrahepatic duct gas and stones
Pancreas	Pancreatitis (acute and chronic) Pancreatic duct stones, pancreatic duct dilatation, pancreatic tumours
Portal venous system	Portal venous distension, varices, thrombosis, ascites and loculated fluid collections
Gastrointestinal tract	Gastrointestinal tract benign and malignant tumours Diverticulosis and diverticulitis Inflammatory bowel disease (stricturing and fistulising disease; disease activity) Ischaemic colitis, mesenteric ischaemia Appendicitis Functional assessment in irritable bowel syndrome
Spleen	Splenic enlargement Focal lesions: benign and malignant tumours, infarct, traumatic lesions
Kidneys	Size, hydronephrosis and masses
Miscellaneous	Aortic aneurism Mesenteric and peritoneal pathologies (e.g., ascites) Pelvic and abdominal abscesses, collections and masses

or elastography have been particularly relevant to areas such as hepatology and IBD.

For instance, the use of micro-bubble ultrasound contrast agents has allowed, among other indications, the characterisation of focal liver lesions in cirrhotic and non-cirrhotic patients according to the patterns of vascularisation, the study of portal vein thrombosis or the monitoring of the effects of ablative therapies for hepatocellular carcinoma [44, 61–63]. On the other hand, non-hepatic indications for CEUS include the management of IBD (estimation of disease activity, distinction between fibrous and inflammatory strictures, characterisation of suspected abscesses or to confirm and follow the route of

fistulas) or pancreatic diseases (to characterise pancreatic focal lesions or to depict necrotic areas in the context of acute pancreatitis) [43, 50, 51, 53, 54, 63–65].

Likewise, the use of elastography or the representation of the elasticity of tissues according to the observed deformation that occurs in response to an applied force has several validated indications in clinical US [66–68]. Concerning hepatology, the evaluation of the degree of hepatic fibrosis by a non-invasive method, such as ultrasound elastography, is probably the most disseminated utilisation [67, 69–71]. Conversely, in IBD, elastography has been used to distinguish between fibrotic and inflammatory strictures [49, 52–54, 64, 66, 67, 70, 72–74].

The Importance of Training in US

Given the increasing interest of so many clinicians from several medical specialties in using US examination in daily practice, there is a concern to ensure high-quality US services in every setting. Consequently, several national and European training boards have issued recommendations regarding training and certification of non-radiologists executing US-based procedures [38, 59, 75]. These documents include standards for theoretical knowledge and practical skills, including performing a certain number of examinations and mandatory skills in order to execute unsupervised US.

The learning process in US starts with the theoretical knowledge of anatomical structures, pathological entities and the technique, followed by an evolving ability to perform the examination itself from supervised to independent practice [40]. The recommendations concerning US practice usually comprehend progressive degrees of expertise, ranging from level 1 practitioners, who are able to perform unsupervised common US explorations, to level 3 practitioners, reserved to experts dedicated to teaching and research in US.

Training Curriculum for Gastroenterology and Hepatology

The *Blue Book* or *Speciality Training Programme and Curriculum for Gastroenterology and Hepatology* was created by the European Section and Board of Gastroenterology and Hepatology (ESBGH) with the objective of defining a standard of training for European gastroenterology residents [75]. The document defines a common core

curriculum with theoretical and practical requirements to practice autonomously as a gastroenterologist and hepatologist.

The ESBGH, while recognising that, concerning US, there are different realities throughout Europe, defines it as a basic competence of gastroenterologists, who should undergo training in order to use it with a diagnostic purpose and to guide interventional procedures, such as paracentesis or liver biopsy. For this reason, the document states that training centres should ensure that there is equipment for performing US and US-guided hepatic biopsy. The *Blue Book* also includes an advanced training module in US related to endoscopic ultrasound [75].

Objectives of Training in US in Gastroenterology

The Royal College of Radiologists' (RCR) *Ultrasound Training Recommendations for Medical and Surgical Specialties* [38] and the European Federation of Societies for Ultrasound in Medicine and Biology's (EFSUMB) "Minimum Training Recommendations for the Practice of Medical Ultrasound" [59] both recommend specific training milestones and objectives for gastroenterologists performing US. Before enrolling into practical training, trainees should undergo introductory theoretical instruction on anatomy, physics and artefacts, equipment characteristics and imaging modalities, examination techniques and methods. Usually, this preparation is accomplished through formal courses [59].

According to the EFSUMB document [59], gastroenterologists should execute 5–10 examinations per week, reaching a minimum of 300 examinations before performing US unsupervised in practice, although different learning rates will be accomplished by each trainee. The training activity frequency could be intermittent, although interruptions longer than 3 months should be avoided and a yearly minimum of 100 procedures is suggested. These examinations should be supervised by a level 2 practitioner (or a level 1 practitioner with at least 2 years of experience). At this level, to become competent to perform unsupervised digestive US examinations, they should be capable of observing the normal abdominal anatomy, of recognising anatomical variants and most of the pathological conditions and of acknowledging the need for a second opinion or further investigation. The specific necessary aptitudes defined by the EFSUMB are specified in Table 2 [59].

Table 2. EFSUMB minimum ultrasound training requirements for level 1 gastroenterological ultrasound practitioners

Knowledge base	Physics and technology, ultrasound techniques and administration
Sectional and ultrasonic anatomy	Liver Gallbladder Bile ducts Pancreas Spleen Kidneys, bladder and adrenal glands Other structures (uterus, ovaries, lymph nodes, vessels, hollow digestive tube)
Pathology in relation to ultrasound	Liver: cysts, benign and malignant tumours, metastatic disease, fatty change, cirrhosis Biliary system: gallbladder stones, acute and chronic cholecystitis, gallbladder tumours, bile duct obstruction, including level of obstruction, intrahepatic duct gas and stones Pancreas: pancreatitis (acute and chronic), duct stones, duct dilatation, pancreatic tumours Portal venous system and spleen: splenic enlargement, portal venous distension, varices, thrombosis, ascites and loculated fluid collections Kidneys: size, hydronephrosis and masses Other structures: gastrointestinal masses and masses of gynaecological origin including cysts, tumours, fibroids and unexpected pregnancy
Liver – to be able to:	Perform a thorough ultrasound examination of the liver in different scan planes Recognise normal hepatic anatomy and variants Recognise normal and abnormal liver texture, such as fatty change and anatomical variants Recognise focal lesions and be able to determine those requiring further investigation Recognise normal hepatic and portal venous anatomy within the liver Perform ultrasound controlled biopsy for the evaluation of parenchymal liver disease
Gallbladder and bile ducts – to be able to:	Perform a thorough evaluation of the biliary system Recognise normal ultrasonic anatomy of the biliary system and its frequent normal variants Recognise abnormalities of the gallbladder wall Recognise gallbladder stones Be able to assess bile duct dilatation at intra- and extrahepatic levels
Pancreas – to be able to:	Perform a thorough examination of the pancreas Recognise the limitations of pancreatic ultrasound because of bowel gas Recognise solid and cystic tumours within the head and body of the pancreas Recognise the changes seen in pancreatitis (acute and chronic) Recognise pancreatic duct dilatation and pancreatic duct stones
Portal venous system and spleen – to be able to:	Evaluate the size of the spleen and recognise focal lesions Evaluate the portal vein and its diameter and the presence of portal venous thrombosis
Other – to be able to:	Recognise abdominal aortic aneurysm Recognise hydronephrosis and other renal abnormalities Recognise free and loculated fluid collections Recognise lymphadenopathy Recognise gynaecological and other pelvic abnormalities
Bowel – to be able to:	Recognise normal stomach, small and large bowel Recognise focal intestinal abnormalities and understand the principles of further investigation Recognise intestinal obstruction

EFSUMB, European Federation of Societies for Ultrasound in Medicine and Biology.

Table 3. EFSUMB ultrasound training requirements for level 2 gastroenterological ultrasound practitioners

Sectional and ultrasonic anatomy	Detailed understanding of gastrointestinal, mesenteric, peritoneal, omental, vascular and retroperitoneal anatomy
Pathology in relationship to ultrasound	An understanding of disease processes which affect the peritoneal cavity, its mesenteries, ligaments and compartments An understanding of the pathways of spread of intraperitoneal and retroperitoneal disease An understanding of the role of ultrasound contrast agents in differentiating between different types of focal liver lesions Hollow digestive tube tumours and other masses
Competencies to be acquired	Perform a comprehensive ultrasound examination of all of the solid organs within the abdomen Be able to evaluate the small bowel for focal or diffuse disease Be able to evaluate the large bowel for the presence of diverticular disease and its complications, tumours and obstruction Be able to evaluate the peritoneal cavity, its mesenteries, compartments and the omentum for the presence of infective or malignant disease Be able to undertake ultrasound-guided drainage of peritoneal fluid collections Be able to evaluate the hepatic and portal venous systems using spectral, colour and power Doppler ultrasound Be able to undertake ultrasound-guided biopsy of focal liver lesions Be able to undertake endoscopic ultrasound Be able to undertake an ultrasound contrast examination of the liver Be able to undertake some percutaneous ultrasound-guided therapeutic procedures, such as radiofrequency ablation, percutaneous ethanol injection, laser and microwave tumour ablation

EFSUMB, European Federation of Societies for Ultrasound in Medicine and Biology.

To perform US as a level 2 practitioner, gastroenterologists should have at least 1 year of experience as level 1 clinicians and complete a set of a further 500 examinations. This practice should be supervised by a level 3 practitioner (or a level 2 practitioner with at least 2 years of experience). Besides mastering the pathological conditions required for level 1, at this level, they should accept and manage referrals from level 1 practitioners and perform teaching activities (undergraduate level and supervision of level 1 practice). Therefore, level 2 clinicians should recognise and correctly diagnose almost all conditions and should thus identify also changes and conditions of structures that are more challenging to evaluate by US. Additionally, level 2 practitioners should become competent in more advanced ultrasonographic techniques and interventional procedures. Table 3 presents the skills that should be accomplished at this level according to the RCR and EFSUMB recommendations [38, 59].

In level 3, experts controlling all the requisites for level 1 and 2 should be mostly or fully dedicated to advanced US, training, research and development of new areas.

Competency Assessment

In spite of the goal to provide high-quality services, digestive US practitioners still lack clear quality indicators or performance measures, in contrast to other areas, such as gastrointestinal endoscopy [76, 77]. The requisites for the 3 levels of expertise defined by the RCR and EFSUMB are fairly broad boundaries that state what is expected of these clinicians [38, 59]. Still, they should not aim merely to fulfil the required minimum levels but rather to enrol into a lifelong learning process according to the individual context (areas of dedication, prevalence of disorders, etc.) [40].

Maintenance of Skills

Despite achieving competency in digestive US, clinicians should have regular ultrasonographic activity to maintain practical skills. According to the RCR *Ultrasound Training Recommendations for Medical and Surgical Specialties*, level 1 practitioners should perform at least 250 scans annually [38]. At all levels of expertise, clinicians should audit their practice, attend regular

multidisciplinary meetings, keep up with the latest published evidence and participate in courses and congresses [59].

The Portuguese Reality in US Training

As in other European countries [41, 42, 44], in Portugal there is a positive trend towards digestive US performed by gastroenterologists. Nevertheless, it seems that there is still some distance to go. Currently, few gastroenterology departments ensure regular high-quality US services, much less regular training in US. The Portuguese curriculum requires, besides the training in the radiology departments, only a minimum of 50 clinical US examinations, and the specific period of training in clinical US is optional.

The Portuguese Group of Ultrasound in Gastroenterology (GRUPUGE) has played a determinant role in the divulgation of US among gastroenterologists. The initiatives include, among others, the implementation of hands-on courses, such as the annual 2-day course of introduction to US, the pre-congress course at the National Congress *Semana Digestiva* and other more specific courses on IBD or liver elastography. On the other hand, there are incentives such as prizes for the works on US or the creation of grants to promote investigation in this area.

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Conclusion

There is a considerable amount of evidence to support the use of US by gastroenterologists [2, 4, 21, 44, 60], and an increasing number of statements and guidelines support this practice [2, 38, 43, 56–59, 62, 63, 66–69, 71, 75]. In spite of the recommendations in the *Blue Book* of the ESBGH regarding training in US, there is a heterogeneous distribution of the utilisation of this basic skill by European gastroenterologists.

The Portuguese reality has been marked by a very positive trend towards a more frequent routine utilisation of US, based on adequate training and research in this technique. Nonetheless, maybe it is time to adjust the requirements of the Portuguese curriculum of gastroenterology to guarantee this need for training in US. However, for that, far more departments competent in digestive US education are needed.

Disclosure Statement

The authors have no conflicts of interest to declare.

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