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Handheld Ultrasound (HHUS): Potential for Home Palliative Care

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Authors
Hendra Lo[1, 2], Nicole Eder[1, 3], David Boten[1], Christian Jenssen[1, 3], Dieter Nuernberg[1]

Affiliations
1 Brandenburg Medical University Theodor Fontane, Institute for Clinical Ultrasound (BICUS) and Faculty of Health Sciences Brandenburg, Neuruppin, Germany
2 Department of Internal Medicine – Gastroenterology, Diabetology and Hepatology, Vivantes Hospital Neukölln, Berlin, Germany
3 Department of Internal Medicine, Krankenhaus Märkisch Oderland, Strausberg, Germany

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Georg Thieme Verlag, Rüdigerstraße 14,
70469 Stuttgart, Germany

Correspondence
Mr. Hendra Lo
Brandenburg Medical University Theodor Fontane, Institute for Clinical Ultrasound (BICUS) and Faculty of Health Sciences Brandenburg,
Fehrbelliner Straße 38
16816 Neuruppin
Germany
Tel.: +49 3391 3914710,
lo_hendra@hotmail.com

ABSTRACT

Due to the severity of their disease, palliative care patients often present complex clinical symptoms and complaints like pain, shortness of breath, nausea, loss of appetite, and fatigue. Solely relying on the information available from the history and physical examination often causes uncertainty among palliative care physicians regarding treatment decisions during home visits, potentially leading to unnecessary hospitalizations or transfer to cross-sectional imaging in radiological practices. A rational approach is essential to avoid diagnostic aggressiveness while still providing the imaging information required for optimal palliative care. Bedside use of handheld ultrasound (HHUS) has the potential to expand the diagnostic and therapeutic spectrum in the case of symptom exacerbation but is still underutilized. In this review, we evaluate the potential uses of HHUS in home care settings to provide a more accurate diagnosis of the most common symptoms in palliative patients and to guide bedside interventions such as bladder catheterization, thoracentesis, paracentesis, venous access, and regional anesthesia. Specific training programs for ultrasound in palliative care are currently not available. Adequate documentation is warranted but fraught with technological and privacy issues. Expert supervision and quality assurance are necessary. Despite its limitation and challenges, we suggest that HHUS leads to improved clinical decision-making, expedited symptom relief, and reduced complications without burdening of the patient and costly transfer to hospital or specialty consultations.

Introduction

Palliative care medicine and the role of specialized outpatient care (SAPV) in Germany

Palliative care indicates a shift from cure and control of the disease to providing comfort and dignity to patients by improving their quality of life. Physical symptoms, functional deficits, and feelings of loss of control become the focus of care [1]. According to a recent study, cancer remains the most prevalent diagnosis among palliative care patients, followed by heart and lung diseases [2]. Between 1980 and 2004, the annual number of new cancer cases in Germany increased by 90 % in men and more than 40 % in women [3]. Much of this increase was due to the rise in the population's proportion of older people. Based on the favorable results of several studies, the WHO has recommended early involvement of palliative care in the course of any life-limiting illness [4].

In 2001, the European Health Committee decided to address the critical issue of palliative care at a pan-European level by setting up a committee of experts. The legal basis of receiving palliative care has previously been outlined [5]. Since 2007, there has been a legal entitlement in Germany to specialized outpatient palliative care (SAPV). SAPV is provided by multi-professional palliative care teams (PCTs), which include coordinators, palliative care physicians (PCPs), palliative care nurses (PCNs), social workers, psycho-oncologists, and chaplains [6]. These PCTs ensure high-quality palliative care for patients wishing to spend the last phase of their lives in their home environment.

In 2015 Hospice and Palliative Care Evaluation (HOPE) data showed that weakness, lack of appetite, tiredness, and pain were the main reasons for palliative care patients in Germany receiving SAPV or being admitted to palliative care units [7]. Based on 2020 data, SAPV was prescribed more than 144,795 times in Germany. Compared to just 43,721 prescriptions in 2011. This represents an increase of 231 percent [8]. In a recent study conducted in Germany, problems and symptoms impairing autonomy and mobility, but not primarily pain or dyspnea, are the main reasons for admission to inpatient palliative care wards in Germany [9].

The use of ultrasound in palliative care

Patients receiving palliative care may have multiple symptoms at the same time and therefore present with complex clinical pictures. One symptom can have very different causes requiring very different therapeutic approaches. For example, shortness of breath may be due to pleural effusions, ascites, heart failure, bronchopulmonary or neurological causes. Therefore, some studies reported increased diagnostic exams performed in the last months of a patient's life [10, 11]. The most frequently performed imaging procedure was computed tomography (CT) [12]. Raghavan et al. recently studied the association between palliative care (PC) involvement and high-cost imaging such as CT scans in cancer patients during the last three months of life. Surprisingly, PC involvement in oncological care at the end of life did not decrease high-cost imaging [13]. CT imaging is often used to clarify acute symptoms, evaluate disease progression, and decide whether to continue or change the treatment protocol [11, 12], but is associated with high costs and often causes a significant burden for palliative care patients due to transportation to the hospital or long waiting times in the emergency department. Large equipment imaging such as CT and magnetic resonance imaging (MRI) are "non-dialogic" procedures [14]: Examination procedure, diagnostic assessment by the radiologist, and discussion of the findings with the patient are separate processes in terms of time, space, and the persons involved. The radiologist and patient often have no or only brief direct contact with each other, the information on the patient's medical history usually comes from a brief referral order, and the patient usually does not learn the imaging results directly from the radiologist, but from the referring physician after the latter has received the examination report [15–17]. This may cause distance between patients and PCPs and emotional distress, and can ultimately worsen suffering in PC patients who need attention, reassurance, and sympathy rather than additional diagnostic information [18]. Therefore, information gain and potential therapeutic consequences resulting from comprehensive imaging in the end-of-life phase should be carefully weighed against these disadvantages in each case, considering co-morbidity, quality of life, and individual patient wishes. The balance between, on the one hand, purely home-based care with the limitation of physical examination possibilities and, on the other hand, the degree of apparatus-based medicine required for optimal symptom control (which in turn can give rise to unrealistic hopes of healing) is a particular challenge for palliative home-based care [19].

Compared with CT and MRI, clinical ultrasound is a "dialogic" imaging modality with direct doctor-patient communication that can be integrated into the clinical examination and used directly, without temporal or spatial distance, to solve clinical problems at the bedside [14, 19–21]. It is the first and often the last diagnostic tool used and accepted by patients and doctors. It also plays a vital role in the recognition of palliative situations, providing follow-up care, identifying complications, and safely implementing palliative interventions (▶ **Table 1**) [19, 20]. The aim of this manuscript is to encourage and improve the use of handheld ultrasound (HHUS) in ambulatory PC and to highlight its benefits, as well as its limitations and challenges.

▶ **Table 1** Contributions of ultrasound in palliative care, modified from Nuernberg et al. [19]

MEDICAL CAREGIVER: During the clinical sonographic examination, an empathetic examiner can quickly create an atmosphere of trust: the unique combination of examination, dialogue, and ultrasound-specific skin contact gives the patient a feeling of undivided attention.
ONCOLOGY: Ultrasound is an essential diagnostic tool in detecting palliative situations (part of oncological staging) and allows follow-up of palliative patients with a reasonable expenditure with respect to equipment and time.
MOBILITY: Unlike other imaging methods, ultrasound with pocket-sized equipment can be used almost anywhere to clarify symptom causes, especially during in-home visits.
INTERVENTIONS: Ultrasound with pocket-sized devices enables needle guidance for palliative interventions.

The potential of handheld ultrasound (HHUS) in ambulatory palliative care

The development of mobile ultrasound systems (small cart-based systems, laptops, handheld devices) has opened up a variety of new possibilities for the use of ultrasound at the point of care (point-of-care ultrasound, POCUS) by almost all medical specialties [22]. HHUS devices have made POCUS almost completely site-independent. In palliative care, they facilitate the expansion of ultrasound diagnostics beyond ultrasound departments or palliative care wards to hospices and home care [23], thus contributing to the fulfillment of the patient's wishes to spend the last phase of life at home.

The market for HHUS devices is growing dynamically, and a wide variety of transducers, technologies, and advanced software is now available for different applications [24]. Currently available HHUS systems have either dual probes (linear and sector; linear and convex), single probes that are electronically modifiable in their array architecture, or connectivity for a selection of single probes, including intracavitary and other special transducers. In some devices, the transducer and screen form a single unit; in others, the transducer is connected to a tablet or smartphone with a cable or wirelessly. The weight of the devices varies from 110 grams to 2700 grams and the batteries allow scanning times from 40 minutes up to 4 hours with charging times starting from less than 1 hour. Most of the scanners are being used for abdominal and thoracic scanning. A detailed overview of the HHUS systems currently on the market was recently published by Dietrich et al. [25]. HHUS has already revolutionized everyday clinical practice, although it may have limited features and possibilities for fine-tuning the image, resulting in insufficient scans since small lesions can be missed or areas can be overlooked because of small screen sizes [25, 26]. It can be an excellent complement to physical examination or clinical practice where information on bedside imaging may be needed. HHUS is not a replacement for high-end ultrasound systems but rather an extension of physical examination in the daily acute and critical care work [22, 25]. Using HHUS as a diagnostic tool in palliative care patients can provide helpful information on treatment response [21] and expand the diagnostic and therapeutic spectrum in the case of symptom exacerbation regardless of where it is performed. Therefore, it allows the visual illustration of findings to support the joint decision-making of an interdisciplinary team. Some systems already enable a direct DICOM (Digital Imaging and Communications in Medicine) connection to PACS (Picture Archiving and Communication System). Almost all manufacturers offer data storage on the end device and their clouds with high-security standards. Telemedical applications (teleguidance, remote review) and support through artificial intelligence are increasingly offered [25].

Several authors have demonstrated the successful use of handheld-POCUS (HH-POCUS). For example, it has been used in hospice and outpatient clinical settings to assess bladder volume before catheterization and degree of ascites before paracentesis, thereby saving patients an uncomfortable trip to the hospital or any unnecessary catheterization [23, 27]. In a recently published study [28], we demonstrated the feasibility of using HH-POCUS as a bedside examination tool to assess some of the most common acute symptoms in palliative patients, such as pain, dyspnea, and nausea/vomiting during homecare visits by a group of general practitioners and PCPs. Considering the lack of physicians in rural regions of Germany predicted for 2030 with distances of more than 30–50 km to the nearest family practice or hospital, PCNs were included in this study. In the event of sudden deterioration of a patient's condition, they are often the first PCT members involved and could provide clinically relevant information to the PCP by using HH-POCUS. Despite being an essential part of PCTs, PCNs like other specialized and well-trained non-physician healthcare professionals are not regularly authorized to perform ultrasound examinations in Germany. Therefore, for PCNs, the indications for HH-POCUS were restricted, and a simplified examination protocol was assigned considering the lack of formal ultrasound training. We were able to demonstrate that ambulatory use of HHUS made a valuable impact on patient management and contributed to almost 50 % of treatment decisions, including medication modifications and implementation of therapeutic interventions [28]. For PC patients, this could reduce avoidable emergency department visits or hospital readmissions [29]. Therefore, HHUS is an ideal clinical examination procedure with high diagnostic efficiency and at the point of care with a particularly high potential for PC (▶ **Table 2**). It may also help to solve the dilemma of "diagnostic aggressiveness" and high costs for imaging procedures in end-stage cancer patients despite PC involvement [11, 13]. In the following sections, we will detail potential diagnostic and therapeutic applications of HHUS for common clinical symptoms in outpatient PC.

The role of handheld ultrasound in palliative care patients with dyspnea

Dyspnea is a prevalent symptom in PC patients, especially in the preterminal phase. Shortness of breath was found to be one of several factors associated with a diminished will to live [30]. The standard approach to dyspnea often relies on radiologic and laboratory results. International evidence-based recommendations for point-of-care lung ultrasound based on the review of 320 references from 1966–2011 strongly recommended using POCUS to detect pneumothorax, interstitial syndrome, lung consolidation, and pleural effusions [31]. These recommendations and the underlying evidence were updated in a 2021 European Respiratory Society statement, with a call for strengthening of the evidence through multicenter studies [32]. An EFSUMB Position Paper published in 2018 also stated that HHUS can reliably be used to determine the presence of both pulmonary edema and pleural effusions and guide thoracentesis [26]. Different validation studies have been performed in the emergency department to assess HH-POCUS's feasibility and accuracy compared to high-end-ultrasound systems, demonstrating good diagnostic agreement between HHUS devices and high-end cart-based US systems. However, the majority of these studies compared only the accuracy of measurements and quality of still images in healthy subjects, but did not evaluate the ability to detect specific pathological findings in patients who are difficult to examine [33, 34]. The utilization of HHUS devices in prehospital settings is not yet widespread. Nevertheless, a few studies have already been published showing promising diagnostic accuracy of lung ultrasound with HHUS devices in the management of acute dyspnea [35–37]. The diagnostic performance of this point-of-care strategy can be improved by including both lung and car-

▶ **Table 2** Overview of the potential of handheld ultrasound in palliative therapy monitoring, modified from Nuernberg et al. [19]. * RFA: radiofrequency ablation, TACE: transarterial chemoembolization therapy, HITT: high frequency induced thermotherapy, PEI: percutaneous ethanol injection

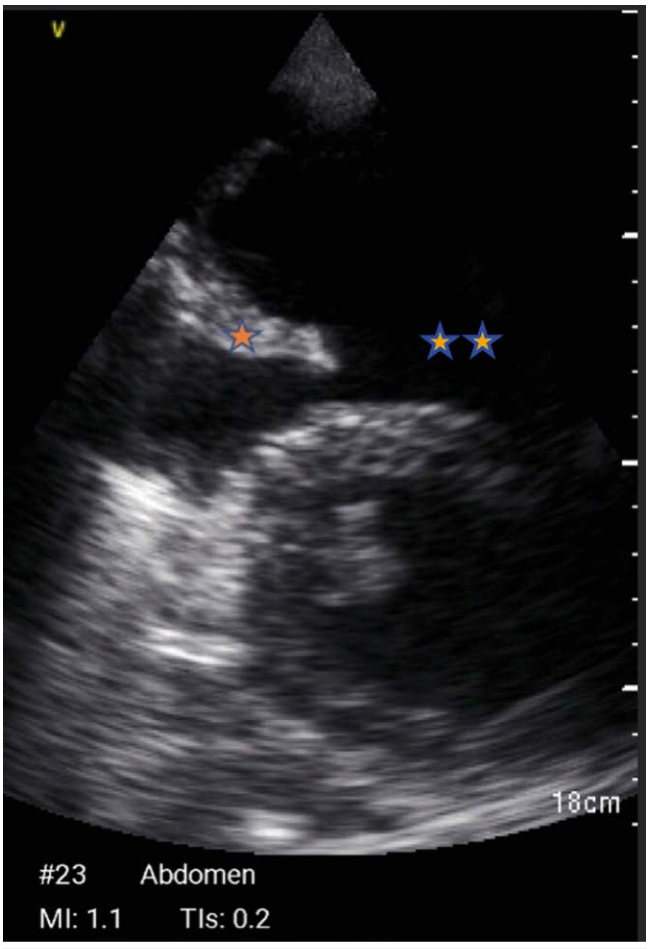
	Type of tumor/ tumor manifestation or therapeutic intervention	Goal of monitoring
Examples of palliative therapy monitoring (therapy effectiveness)	Pancreatic cancer	Assessment of local response to palliative chemotherapy
	Hepatocellular carcinoma	Assessment of size/vascularity after local therapy (RFA, HITT, PEI, TACE) * or under chemotherapy
	Liver metastasis	Assessment of number/size/vascularity after ablation or under palliative chemotherapy (RECIST)
	Ascites	Progress assessment under palliative chemotherapy or after local chemotherapy
	Pleural effusion	Progress assessment under palliative chemotherapy or after pleurodesis
	Biliary stent	Control of palliative relief of the biliary system in bile duct, liver, or pancreatic carcinoma
	Nephrostomy	Control after relief of urinary obstruction due to bladder tumor or pelvic tumor
Examples of palliative therapy monitoring (detection of side effects and complications of the therapy, complications of the tumor disease)	Complications	Goal of the monitoring
	Fever	Sonographic detection of possible causes: liver abscesses, infected urinary obstruction kidneys, obstructive cholestasis/ cholangitis, infected retention postoperative or postinterventional in abdominal/retroperitoneal
	Swollen extremities	Sonographic detection of thrombosis or compression of the pelvic veins by lymph node metastases
	Jugular vein congestion	Sonographic detection of lymph node metastases: cervical, jugular, in the upper mediastinum
	Jaundice	Sonographic diagnosis of obstructive cholestasis or chemotherapy-associated steatohepatitis (CASH)
	Dyspnea	Pleural effusions, pulmonary edema, pneumonia, atelectasis, pulmonary embolism, pneumothorax, pericardial effusion
	Coagulation disorder	Sonographic differentiation between CASH and diffuse liver metastasis, obstructive cholestasis
	Vomiting	Sonographic diagnosis of intestinal obstruction or motility disorder (retention stomach, ileus, intestinal pseudo-obstruction)
	Diarrhea	Sonographic detection of inflammatory bowel wall thickening

diac ultrasound in the initial evaluation of acutely dyspneic patients with an HHUS device [38].

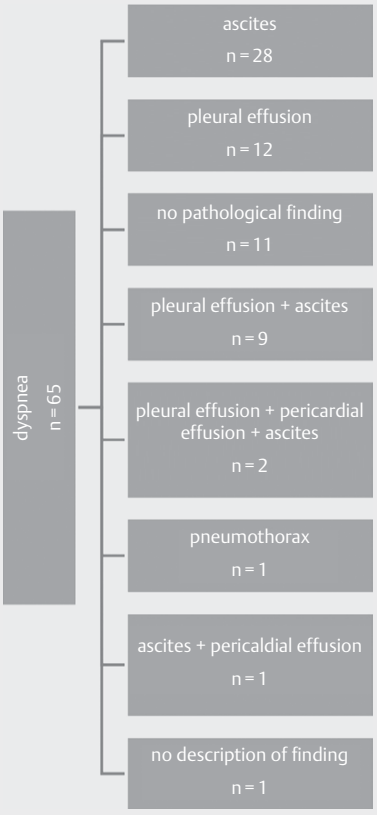
Numerous different lung ultrasound (LUS) protocols have been assessed and validated, in particular the BLUE protocol (bedside lung ultrasound in emergency) [39] and the PLUS (prehospital lung ultrasound) protocol [40]. The ideal LUS protocol for the out-of-hospital environment has not yet been defined [41]. According to a recent European Respiratory Society publication, "it is not possible to derive a universal and evidence-based thoracic ultrasound approach for any given clinical scenario" [32].

In our recently published HH-POCUS study [28], the most common findings in PC patients with dyspnea (n = 65) were a large amount of ascites (n = 28), followed by pleural effusion (n = 11) (▶ **Fig. 1**) and a combination of both pleural effusion and ascites (n = 9) (▶ **Fig. 2**). PCNs reported that in 30 patients with fluid diagnosed in the abdominal cavity, dyspnea (30 %), pain (26.7 %), and a combination of pain and dyspnea (10 %) were the most frequent symptoms that occurred with ascites.

Based on these results, 29 bedside paracentesis procedures and one pleural drainage were performed, 9 patients had their medications changed, and no complications were reported during these POCUS-guided procedures. While thoracentesis or placement of a tunneled catheter guided by HHUS can improve the patient's quality of life nearing the end of life in symptomatic pleural effusion [42], not all patients with malignant pleural effusion should have a pleural intervention performed since some patients may not benefit from such procedures. In particular this is the case with septated effusions or with normal diaphragmatic excursions [43, 44]. Performed by an experienced operator, LUS may potentially guide the selection of patients who may benefit from those who might have a poor response to a permanent drain. With the use of speckle tracking imaging analysis and M-mode, entrapped lung can be identified prior to effusion drainage, allowing upfront choice of the definitive management option [32, 45]. Complications, in particular, pneumothorax and bleeding (hematoma, hemothorax, hemorrhage), are less common with ultrasound guidance which also has been shown to increase clinical efficacy [46].



▶ **Fig. 1** Image from VSCAN Extend Handheld Ultrasound system demonstrating pleural effusion of a patient during home care visit. * shows atelectasis in the lower lobe of the lung. ** shows pleural effusion.



▶ **Fig. 2** Pathological findings detected by HH-POCUS scans performed by palliative care physicians (PCP) (Lo H et al., unpublished data, 2020) [28].

The role of handheld ultrasound in palliative care patients with suspected ascites

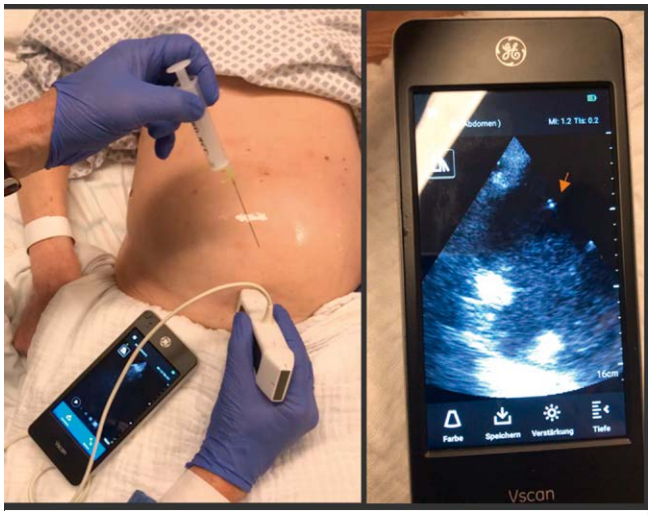
In PC patients, ascites may have a range of different causes and may be multifactorial. In terminal chronic heart or kidney failure, ascites is an expression of hypervolemia, no longer responding to diuretics. In oncological patients, ascites is often due to peritoneal carcinomatosis (malignant ascites) and is then usually resistant to diuretic treatment. On the other hand, ascites in tumor patients may also be due to albumin deficiency and/or portal hypertension caused by extensive liver metastasis or portal vein occlusion and then be treatable with diuretics [20, 47–50]. Therefore, therapeutic approaches also differ in oncologic PC patients, and diagnostic ascites aspiration with evaluation of biochemical markers of peritoneal carcinomatosis (e. g., serum ascites albumin difference, cholesterol, carcinoembryonic antigen) and cytological examination may be necessary for therapeutic decisions in cases of unclear etiology [20]. A large amount of fluid accumulation in the peritoneal cavity (▶ **Fig. 3**) can cause abdominal distention, pain, nausea and vomiting, dyspnea, fatigue, anorexia, and excessive weight gain, which can lead to immobility of patients [51]. Although therapeutic interventions are not curative in most cases, they improve quality of life by relieving distressing physical symptoms [52]. While ultrasound-guided interventions like paracentesis could be done safely in homecare settings, there is still little information on the use of HHUS in homecare settings among PCPs to enhance clinical decision-making in outpatient PC [23, 53]. Of 123 HH-POCUS examinations performed by PCPs on 79 PC patients in our previous HH-POCUS-study, 18 HH-POCUS-guided paracentesis procedures were performed immediately during the first home visit to relieve the patient's symptoms [28].

Because the causes of ascites are often not treatable, recurrence of ascites and the need for repeated paracentesis must be expected in PC patients. For example, one of the patients recruited in the study mentioned above [28] required ten paracentesis procedures during follow-up home visits throughout the study. Although paracentesis could be done without imaging, some studies have found significantly fewer complications in ultrasound-guided paracentesis [54, 55]. In our HH-POCUS study, no complications were reported during the procedures performed with HHUS guidance [28]. Ultrasound guidance gives the practitioner greater confidence in conducting the procedure, for example, in the presence of septations or in the case of unanticipated aspiration of bloody ascites. In patients with abdominal distension, the absence of fluid can be an important clinical finding because unnecessary and risky paracentesis can be avoided. In conclusion, HHUS may facilitate more precise decisions on further treatment of patients with suspected ascites, support safe performance of paracentesis, and eliminate repeated hospital admissions (▶ **Fig. 4**).

▶ **Fig. 3** Image from VSCAN Extend Handheld Ultrasound system demonstrating perihepatic ascites of a patient during home care visit.

The role of handheld ultrasound in palliative care patients with dysuria

Urologic emergencies such as upper and lower urinary tract obstruction, urinary tract infection, and bladder hemorrhage are frequent in palliative care patients [56]. Ureteric obstruction can result from tumor compression or direct tumor invasion. Bladder outlet obstruction leading to urinary retention can be due to mechanical factors involving the bladder neck, prostate, or neuronal damage of the bladder. Focused bedside ultrasound to examine the kidneys and the urinary tract can provide rapid diagnostic information in lower abdominal pain or renal failure cases. The measurement of residual urinary volumes is often one of the first encounters that junior doctors have with ultrasound [29]. As shown in our HH-POCUS study mentioned above, brief training can enable PCNs to use HHUS to control the position of the transurethral catheter, monitor the residual urinary volumes after transurethral catheter removal, and detect renal obstruction [28]. With the availability of HHUS devices during home visits, PCPs and PCNs can make immediate bedside decisions about whether to reposition or insert urinary catheters under HH-POCUS control, reducing the time to relief and the need for emergency room visits in patients with clinically suspected lower urinary tract obstruction.



▶ **Fig. 4** Image demonstrating ascites in lower abdomen. HHUS is used to demonstrate the needle tip position (red arrow) and therefore allows safe bedside paracentesis in outpatient settings.

Other potential indications of handheld ultrasound in palliative homecare patients

Diagnosis of venous thromboembolism

Cancer is associated with an increased risk of thromboembolism, which may be further increased by co-morbidities and immobility [57]. However, thromboembolism is also a frequent complication among non-cancer palliative care patients [58]. Focused compression sonography can be performed at the bedside using HHUS devices and spare patients an unnecessary transfer to the hospital [59]. In the case of a positive finding for venous thromboembolism, PCPs can make an on-site treatment decision.

Ultrasound guidance in difficult peripheral venous access

Based on robust evidence [60], guidelines recommend an in-plane or out-of-plane technique using a linear high-frequency probe to avoid unnecessary pain and increase the likelihood of successful cannulation in patients with difficult peripheral venous access [61]. Recently, a review demonstrated that non-physician medical personnel (paramedics, nurses, emergency department technicians) are able to achieve competence in ultrasound-guided peripheral venous access placement in patients with anticipated cannulation difficulties with relatively little training [62].

Ultrasound guidance of peripheral nerve blocks

Ultrasound has been successfully used to facilitate peripheral nerve blockade of the upper and lower extremity. This method can also be used for the treatment of cancer-related pain. It has been used to deliver adequate palliative analgesia [63] and is a valuable tool to improve safety, success rate, and patient comfort [64].

Detecting ileus and monitoring disease progress

Patients with advanced peritoneal carcinomatosis may experience acute or subacute bowel obstruction. When bowel obstruction is being considered in a patient with unresectable peritoneal carcinomatosis, HH-POCUS can provide timely and “just enough” clini-

cal information at the bedside to make a decision regarding further treatment and hospital admission [29].

Limitation and Challenges

Training

When performing HH-POCUS, it is crucial to be aware of device performance limitations and the competence of the person performing the imaging. Becoming proficient in ultrasound does require adequate training. We believe there is an urgent need to integrate POCUS into palliative care curricula. However, the amount of theoretical and practical training required to provide sufficient practical skills for the use of POCUS in palliative care has to be further evaluated in prospective studies. Specific training programs for POCUS in PC are not currently available in Germany, but the German Society of Ultrasound in Medicine and Biology (DEGUM) is trying to set up a suitable training program for HH-POCUS in the form of a DEGUM module. The European Federation of Societies in Ultrasound in Medicine and Biology (EFSUMB) with its EUROSON School on Interventional Ultrasound offers structured training of ultrasound-guided interventions using HHUS systems. Such training modules would supplement basic sonographic training but not replace it.

In Germany, there is a great reluctance to educate non-physician health care providers in performing POCUS. Given the limited availability of physicians for home visits, especially in rural areas, it seems essential to optimize outpatient PC so that specialized PCNs as part of PCTs can also receive appropriate ultrasound training. The results of our recently published study indicate that PCNs could be assigned to answer simple diagnostic questions on POCUS examinations after a brief training period [28]. This result is in good agreement with other preliminary reports that non-physician health care providers can be trained to accurately acquire and interpret ultrasound images [65, 66]. Another option to assist less experienced examiners is ultrasound teleconsulting. It is now technically feasible with almost all HHUS devices to transmit ultrasound images and a visual impression of the patient and the positioning of the probe to a remote expert. In a web-based live conference, the process and quality of the HH-POCUS examination can be optimized in real time [67]. Comparative studies need to clarify whether basic training on a conventional ultrasound system can help reduce the potential for error associated with the limited image quality of HHUS devices [25]. In addition, good supervision and quality control is essential when medical services are delegated to non-physician health care providers. Current systems only meet the requirements of verifiable image documentation to a limited extent. National and International Ultrasound Societies like DEGUM and EFSUMB in the future should offer regular POCUS training programs and certification for non-physician medical professionals.

Documentation and data security

Adequate documentation of ultrasound examinations is required by the EFSUMB as a quality requirement [68] and is legally mandatory in several European countries. However, HH-POCUS performed by the PCT at the patient's bedside at home challenges traditional ways of storing ultrasound images and reporting results. In most cases, HHUS devices are not connected to a PACS or RIS. Establishing legally acceptable technical solutions for storing HH-POCUS images while guaranteeing data security is urgently necessary to enable the examiner or a remote expert to review the findings in comparison to other imaging findings [22, 26]. On the other hand, there must be room for simplified documentation of acutely required bedside POCUS examinations and interventions. It is currently recommended to document clinically relevant pathological findings in the patient's medical record since HH-POCUS examinations will be undertaken as part of the clinical examination [26].

Achieving the appropriate diagnostic balance in the last phase of life

There is increasing debate on how cancer patients are treated near end of life. Aggressive diagnostic imaging in this situation is contrary to the goal of leaving PC patients in the familiar home environment and may impair quality of life and incur high costs. The benefit of intense imaging approaches on patient outcomes has proven difficult to assess, and treatment changes associated with imaging findings often do not benefit patients at the end of their life [12]. It is therefore critical to adopt a rational and patient-centered approach. PC does not mean "abandonment of care" [69]. Treating patients with terminal diseases is never curative. However, PC patients require management of intercurrent conditions that compromise the quality of precious time remaining before death. Due to the time-sensitive nature of their patients' illness, PCPs often rely solely on the information available from the history and physical examination for medical decision-making during home visits. Using HHUS as a diagnostic tool in PC patients, while avoiding transport to the hospital, allows for symptom-oriented acquisition of reliable imaging information to expand the diagnostic and therapeutic spectrum in the event of symptom exacerbation at the bedside, alleviate symptoms without delay, and reduce the complications of specific palliative interventions.

Conclusion

Given changing demographics and a physician shortage in rural areas with often overcrowded emergency departments, HH-POCUS is capable of reducing the burden of avoidable acute care visits for PC patients. As a supplement to good history taking and physical examination, HH-POCUS can enable more accurate diagnoses, more precise and rapid clinical decisions, and needle-guidance of palliative interventions. Thus, compared to referral to a specialized practice or hospital for imaging or simple palliative interventions, the use of bedside HH-POCUS has the potential to save time and resources and lessen the burden on PC patients associated with inconvenient transportation and waiting times. Notwithstanding its tremendous potential, we believe HH-POCUS is still underutilized by PCPs. According to a recent survey in Austria, this is related to a lack of confidence and training, limited availability and equipment costs, and concerns about clinical issues, such as challenging anatomy [70]. Remote experts supervising HH-POCUS examinations via teleconsulting could help address these issues and reduce diagnostic uncertainty in selected cases.

In summary, HHUS is ideally suited to meet the specific diagnostic needs in the care of palliative and terminally ill patients. It helps

to fulfill their wish to spend the final period of life in their home environment, prevents inappropriately aggressive diagnostic interventions, and reduces high costs for hospital-based and radiologist-performed imaging procedures in end-of-life patients.

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Conflict of Interest

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References

[1] Teunissen SC, Wesker W, Kruitwagen C et al. Symptom prevalence in patients with incurable cancer: a systematic review. J Pain Symptom Manage 2007; 34: 94–104. doi:10.1016/j.jpainsymman.2006.10.015

[2] Engeser P, Leutgeb R, Glassman J et al. Identifying Palliative Patients in General Practice: Focusing on the Place of Death and the Vital Role of Specialized Home Palliative Care: An Observational Study. J Palliat Med 2020. doi:10.1089/jpm.2020.0037. doi:10.1089/jpm.2020.0037

[3] Robert-Koch-Institut. Krebs in Deutschland 2015/2016. 2019. doi:http://dx.doi.org/10.25646/5977. doi:http://dx.doi.org/10.25646/5977

[4] Vanbutsele G, Pardon K, Van Belle S et al. Effect of early and systematic integration of palliative care in patients with advanced cancer: a randomised controlled trial. Lancet Oncol 2018; 19: 394–404. doi:10.1016/s1470-2045(18)30060-3

[5] Recommendation Rec (2003) 24 of the Committee of Ministers to member states on the organisation of palliative care. . In: Council of Europe; 2003

[6] Palliative Care in Germany – Perspectives for Practice and Research. In. Halle (Saale): German National Academy of Sciences Leopoldina and Union of German Academies of Sciences and Humanities 2015

[7] Lindena G. HOPE 2015 Basisbogen: Tabellen.

[8] SAPV Frequenzstatistik nach Erst- und Folgeverordnungen, Sonderauswertung, KBV; Versicherte gem. KM6-Statistik, BMG. 2019

[9] Coym A, Ullrich A, Hackspiel LK et al. Systematic symptom and problem assessment at admission to the palliative care ward – perspectives and prognostic impacts. BMC Palliat Care 2020; 19: 75. doi:10.1186/s12904-020-00576-3

[10] Earle CC, Neville BA, Landrum MB et al. Trends in the aggressiveness of cancer care near the end of life. J Clin Oncol 2004; 22: 315–321. doi:10.1200/jco.2004.08.136

[11] Massa I, Balzi W, Altini M et al. The challenge of sustainability in healthcare systems: frequency and cost of diagnostic procedures in end-of-life cancer patients. Support Care Cancer 2018; 26: 2201–2208. doi:10.1007/s00520-018-4067-7

[12] Hu YY, Kwok AC, Jiang W et al. High-cost imaging in elderly patients with stage IV cancer. J Natl Cancer Inst 2012; 104: 1164–1172. doi:10.1093/jnci/djs286

[13] Raghavan K, Copeland TP, Rabow M et al. Palliative care and imaging utilisation for patients with cancer. BMJ Support Palliat Care 2019. doi:10.1136/bmjspcare-2018-001572 doi:10.1136/bmjspcare-2018-001572

[14] Maio G. Medicine and the holistic understanding of the human being: ultrasound examination as dialog. Ultraschall Med 2014; 35: 98–107. doi:10.1055/s-0034-1366182

[15] Glazer GM, Ruiz-Wibbelsmann JA. The invisible radiologist. Radiology 2011; 258: 18–22. doi:10.1148/radiol.10101447

[16] European Society of Radiology (ESR): Rockall A, Brady AP, Derchi LE. The identity and role of the radiologist in 2020: a survey among ESR full radiologist members. Insights Imaging 2020; 11: 130. doi:10.1186/s13244-020-00945-9

[17] Rockall AG, Justich C, Helbich T et al. Patient communication in radiology: Moving up the agenda. Eur J Radiol 2022; 155: 110464. doi:10.1016/j.ejrad.2022.110464

[18] McCaffrey N, Bradley S, Ratcliffe J et al. What Aspects of Quality of Life Are Important From Palliative Care Patients' Perspectives? A Systematic Review of Qualitative Research. J Pain Symptom Manage 2016; 52: 318–328 e315. doi:10.1016/j.jpainsymman.2016.02.012

[19] Nuernberg D, Jenssen C, Frohlich E et al. [Ultrasound in palliative care medicine, Part II]. Z Gastroenterol 2017; 55: 582–591. doi:10.1055/s-0043-104780

[20] Nürnberg D, Jenssen C, Cui X et al. [Ultrasound in palliative care medicine]. Z Gastroenterol 2015; 53: 409–416. doi:10.1055/s-0034-1399127

[21] Chernack B, Knowlton SE, Kohler MJ. The Use of Ultrasound in Palliative Care and Hospice. Am J Hosp Palliat Care 2017; 34: 385–391. doi:10.1177/1049909115625960

[22] Dietrich CF, Goudie A, Chiorean L et al. Point of Care Ultrasound: A WFUMB Position Paper. Ultrasound Med Biol 2017; 43: 49–58. doi:10.1016/j.ultrasmedbio.2016.06.021

[23] Landers A, Ryan B. The use of bedside ultrasound and community-based paracentesis in a palliative care service. J Prim Health Care 2014; 6: 148–151

[24] Global Handheld Ultrasound Imaging Devices Market, 2020-2030. Roots Analysis Private Ltd., May 2020

[25] Dietrich CF, Bulla P, Dudwiesus H et al. Perspectives and Challenges of hand-held Ultrasound. Z Gastroenterol. 2022 Sep 28. doi: 10.1055/a-1901-9394. Online ahead of print.

[26] Nielsen MB, Cantisani V, Sidhu PS et al. The Use of Handheld Ultrasound Devices – An EFSUMB Position Paper. Ultraschall Med 2019; 40: 30–39. doi:10.1055/a-0783-2303

[27] Korpi S, Salminen VV, Piili RP et al. Therapeutic Procedures for Malignant Ascites in a Palliative Care Outpatient Clinic. J Palliat Med 2018; 21: 836–841. doi:10.1089/jpm.2017.0616

[28] Lo H, Frauendorf V, Wischke S et al. Ambulatory Use of Handheld Point-of-Care Ultrasound (HH-POCUS) in Rural Brandenburg – A Pilot Study. Ultraschall Med 2022; 43: 584–591. doi:10.1055/a-1354-5958

[29] Breakey N, Osterwalder J, Mathis G et al. Point of care ultrasound for rapid assessment and treatment of palliative care patients in acute medical settings. Eur J Intern Med 2020; 81: 7–14. doi:10.1016/j.ejim.2020.08.007

[30] Tataryn D, Chochinov HM. Predicting the trajectory of will to live in terminally ill patients. Psychosomatics 2002; 43: 370–377. doi:10.1176/appi.psy.43.5.370

[31] Volpicelli G, Elbarbary M, Blaivas M et al. International evidence-based recommendations for point-of-care lung ultrasound. Intensive Care Med 2012; 38: 577–591. doi:10.1007/s00134-012-2513-4

[32] Laursen CB, Clive A, Hallifax R et al. European Respiratory Society statement on thoracic ultrasound. Eur Respir J 2021; 57. doi:10.1183/13993003.01519-2020

[33] Biais M, Carrié C, Delaunay F et al. Evaluation of a new pocket echoscopic device for focused cardiac ultrasonography in an emergency setting. Crit Care 2012; 16: R82. doi:10.1186/cc11340

[34] Blaivas M, Brannam L, Theodoro D. Ultrasound image quality comparison between an inexpensive handheld emergency department

(ED) ultrasound machine and a large mobile ED ultrasound system. Acad Emerg Med 2004; 11: 778–781. doi:10.1197/j.aem.2003.12.030

[35] Rüttermann V. [Pulmonary sonography-a valuable supplement to basic diagnostics for timely outpatient clarification of cough and dyspnea]. Internist (Berl) 2020; 61: 13–20. doi:10.1007/s00108-019-00721-y

[36] Holthof N, Wipplinger F, Lienert J et al. Point-of-Care Ultrasound Diagnosis of Community-Acquired Pneumonia in a High-Altitude, Resource-Poor Setting. Prehosp Emerg Care 2021; 25: 839–843. doi:10.1080/10903127.2020.1852352

[37] Ienghong K, Cheung LW, Tiamkao S et al. The Utilization of Handheld Ultrasound Devices in a Prehospital Setting. Prehosp Disaster Med 2022; 37: 355–359. doi:10.1017/s1049023x22000644

[38] Sforza A, Mancusi C, Carlino MV et al. Diagnostic performance of multi-organ ultrasound with pocket-sized device in the management of acute dyspnea. Cardiovasc Ultrasound 2017; 15: 16. doi:10.1186/s12947-017-0105-8

[39] Lichtenstein DA, Mezière GA. Relevance of lung ultrasound in the diagnosis of acute respiratory failure: the BLUE protocol. Chest 2008; 134: 117–125. doi:10.1378/chest.07-2800

[40] Laursen CB, Hänselmann A, Posth S et al. Prehospital lung ultrasound for the diagnosis of cardiogenic pulmonary oedema: a pilot study. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine 2016; 24: 96. doi:10.1186/s13049-016-0288-2

[41] Donovan JK, Burton SO, Jones SL et al. Use of Point-of-Care Ultrasound by Non-Physicians to Assess Respiratory Distress in the Out-of-Hospital Environment: A Scoping Review. Prehosp Disaster Med 2022; 37: 520–528. doi:10.1017/s1049023x22000711

[42] Segaline N, Wang J, Bethancourt B et al. The Role of Ultrasound-Guided Therapeutic Thoracentesis in an Outpatient Transitional Care Program: A Case Series. Am J Hosp Palliat Care 2019; 36: 927–931. doi:10.1177/1049909119837517

[43] Psallidas I, Yousuf A, Talwar A et al. Assessment of patient-reported outcome measures in pleural interventions. BMJ Open Respir Res 2017; 4: e000171. doi:10.1136/bmjresp-2016-000171

[44] Muruganandan S, Azzopardi M, Thomas R et al. The Pleural Effusion And Symptom Evaluation (PLEASE) study of breathlessness in patients with a symptomatic pleural effusion. Eur Respir J 2020; 55: 1900980. doi:10.1183/13993003.00980-2019

[45] Salamonsen MR, Lo AKC, Ng ACT et al. Novel use of pleural ultrasound can identify malignant entrapped lung prior to effusion drainage. Chest 2014; 146: 1286–1293. doi:10.1378/chest.13-2876

[46] Mercaldi CJ, Lanes SF. Ultrasound guidance decreases complications and improves the cost of care among patients undergoing thoracentesis and paracentesis. Chest 2013; 143: 532–538. doi:10.1378/chest.12-0447

[47] Hodge C, Badgwell BD. Palliation of malignant ascites. J Surg Oncol 2019; 120: 67–73. doi:10.1002/jso.25453

[48] Ayantunde AA, Parsons SL. Pattern and prognostic factors in patients with malignant ascites: a retrospective study. Ann Oncol 2007; 18: 945–949. doi:10.1093/annonc/mdl499

[49] Parsons SL, Watson SA, Steele RJ. Malignant ascites. Br J Surg 1996; 83: 6–14. doi:10.1002/bjs.1800830104

[50] Ramamoorthy V, Rubens M, Saxena A et al. Prevalence and Inpatient Hospital Outcomes of Malignancy-Related Ascites in the United States. Am J Hosp Palliat Care 2020. doi:10.1177/1049909120928980: 1049909120928980 doi:10.1177/1049909120928980

[51] Miller D, Nevadunsky N. Palliative Care and Symptom Management for Women with Advanced Ovarian Cancer. Hematol Oncol Clin North Am 2018; 32: 1087–1102. doi:10.1016/j.hoc.2018.07.012

[52] Quest TE, Marco CA, Derse AR. Hospice and palliative medicine: new subspecialty, new opportunities. Ann Emerg Med 2009; 54: 94–102. doi:10.1016/j.annemergmed.2008.11.019

[53] Dhamija E, Thulkar S, Bhatnagar S. Utility and potential of bedside ultrasound in palliative care. Indian J Palliat Care 2015; 21: 132–136. doi:10.4103/0973-1075.156465

[54] Patel PA, Ernst FR, Gunnarsson CL. Evaluation of hospital complications and costs associated with using ultrasound guidance during abdominal paracentesis procedures. J Med Econ 2012; 15: 1–7. doi:10.3111/13696998.2011.628723

[55] Keil-Ríos D, Terrazas-Solís H, González-Garay A et al. Pocket ultrasound device as a complement to physical examination for ascites evaluation and guided paracentesis. Intern Emerg Med 2016; 11: 461–466. doi:10.1007/s11739-016-1406-x

[56] Russo P. Urologic emergencies in the cancer patient. Semin Oncol 2000; 27: 284–298

[57] Riondino S, Ferroni P, Del Monte G et al. Venous Thromboembolism in Cancer Patients on Simultaneous and Palliative Care. Cancers (Basel) 2020; 12: 1167. doi:10.3390/cancers12051167

[58] White C, Noble S, Swan F et al. Hospice inpatient deep vein thrombosis detection (HIDDen) in advanced non-malignant diseases': a longitudinal pilot study. BMJ Support Palliat Care 2020. doi:10.1136/bmjspcare-2019-002039 doi:10.1136/bmjspcare-2019-002039

[59] Pujol S, Laurent J, Markarian T et al. Compression with a pocket-sized ultrasound device to diagnose proximal deep vein thrombosis. Am J Emerg Med 2018; 36: 1262–1264. doi:10.1016/j.ajem.2018.03.076

[60] van Loon FHJ, Buise MP, Claassen JJF et al. Comparison of ultrasound guidance with palpation and direct visualisation for peripheral vein cannulation in adult patients: a systematic review and meta-analysis. Br J Anaesth 2018; 121: 358–366. doi:10.1016/j.bja.2018.04.047

[61] Jenssen C, Brkljacic B, Hocke M et al. EFSUMB Guidelines on Interventional Ultrasound (INVUS), Part VI – Ultrasound-Guided Vascular Interventions. Ultraschall Med 2016; 37: 473–476. doi:10.1055/s-0035-1553450

[62] Burton SO, Donovan JK, Jones SL et al. Can Non-Physician Providers Use Ultrasound to Aid in Establishing Peripheral IV Access in Patients Who are Difficult to Cannulate? A Scoping Review. Prehosp Disaster Med 2022; 37: 535–546. doi:10.1017/s1049023x22000796

[63] Klepstad P, Kurita GP, Mercadante S et al. Evidence of peripheral nerve blocks for cancer-related pain: a systematic review. Minerva Anestesiol 2015; 81: 789–793

[64] Schwemmer U, Markus CK, Brederlau J et al. [Ultrasound-guided peripheral nerve blockade]. Anasthesiol Intensivmed Notfallmed Schmerzther 2006; 41: 481–490. doi:10.1055/s-2006-949510

[65] Swamy V, Brainin P, Biering-Sørensen T et al. Ability of non-physicians to perform and interpret lung ultrasound: A systematic review. Eur J Cardiovasc Nurs 2019; 18: 474–483. doi:10.1177/1474515119845972

[66] Robertson TE, Levine AR, Verceles AC et al. Remote tele-mentored ultrasound for non-physician learners using FaceTime: A feasibility study in a low-income country. J Crit Care 2017; 40: 145–148. doi:10.1016/j.jcrc.2017.03.028

[67] Ramsingh D, Van Gorkom C, Holsclaw M et al. Use of a Smartphone-Based Augmented Reality Video Conference App to Remotely Guide a Point of Care Ultrasound Examination. Diagnostics (Basel) 2019; 9:. doi:10.3390/diagnostics9040159

[68] Wustner M, Radzina M, Calliada F et al. Professional Standards in Medical Ultrasound – EFSUMB Position Paper (Long Version) – General Aspects. Ultraschall Med 2022. doi:10.1055/a-1857-4435 doi:10.1055/a-1857-4435

[69] Dean AJ, Melniker LA. Hospice and palliative medicine ultrasound: a new horizon for emergency medicine? Acad Emerg Med 2010; 17: 330–332. doi:10.1111/j.1553-2712.2010.00688.x

[70] Dawson J, Le B, Eastman P. Australian Palliative Physicians' Perceptions of Clinician Performed Ultrasound Scanning. J Palliat Med 2020; 23: 4. doi:10.1089/jpm.2019.0373