*Age and Ageing* 2024; **53:** afae165
https://doi.org/10.1093/ageing/afae165


**RESEARCH PAPER**

# Usefulness of point of care ultrasound in older adults: a multicentre study across different geriatric care settings in Spain and the United Kingdom

Paola Pastora Reinoso-Párraga[1,2], Juan Ignacio González-Montalvo[1,2,3], Rocío Menéndez-Colino[1,2,3], Stany Perkisas[4], Ivón Rivera-Deras[1], Blanca Garmendia-Prieto[5,6], Salman Javed Arain[7], Yale Tung-Chen[2,6,8], Arturo Vilches-Moraga[9,10]

[1]Department of Geriatrics, La Paz University Hospital, Madrid, Spain
[2]Research Institute La Paz (IdiPAZ), Madrid, Spain
[3]Department of Medicine. Universidad Autónoma de, Madrid, Spain
[4]University Centre for Geriatrics ZNA (Ziekenhuis Netwerk Antwerpen) University of Antwerp, Antwerp, Belgium
[5]Department of Geriatrics, Cruz Roja University Hospital, Madrid, Spain
[6]Department of Medicine, Alfonso X El Sabio University, Madrid, Spain
[7]Department of Radiology, Leeds Teaching Hospitals NHS Trust, Leeds, UK
[8]Department of Internal Medicine. La Paz University Hospital, Madrid, Spain
[9]Department of Geriatrics and Long-term Care, Hamad Medical Corporation, Doha, Qatar
[10]School of Medicine, Bolton University, Bolton, UK

Address correspondence to: Paola Pastora Reinoso-Párraga, Department of Geriatrics, La Paz University Hospital, Research Institute, La Paz (IdiPAZ), Paseo Castellana 261, 28046 Madrid, Spain. Email: paolareinosoparraga@gmail.com

## Abstract

**Background:** Point of care ultrasound (POCUS) is an imaging technique performed bedside. To date, few published studies have reported the usefulness of multiorgan POCUS in Geriatrics. The objective of this study was to describe the utility of multiorgan POCUS in the care of older adults admitted to geriatric care settings.
**Methodology:** Observational retrospective study of patients admitted to geriatric settings in Spain and UK. Multiorgan POCUS was performed when there was a specific clinical suspicion or unexplained torpid clinical course despite physical examination and complementary tests. A geriatrician with a certificate degree in comprehensive ultrasound and long-standing experience in POCUS carried out POCUS. All patients underwent multiorgan POCUS in a cephalo-caudal manner.
**Results:** Out of 368 patients admitted to geriatric units, 29% met the inclusion criteria. Average age was 85.9 years (SD ± 6.1). POCUS identified 235 clinically significant findings (2.2 per patient). Findings were classified as 37.9% confirmed diagnosis, 16.6% ruled out diagnosis, 14.9% unsuspected relevant diagnoses and 30.6% clinical follow-ups. POCUS findings led to changes in pharmacological and non-pharmacological treatment in 66.3 and 69.2% respectively, resulted in completion or avoidance of invasive procedures in 17.8 and 15.9%, respectively, facilitating early referrals to other specialities in 14.9% and avoiding transfers in 25.2% of patients.
**Conclusion:** Multiorgan POCUS is a tool that aids in the assessment and treatment of patients receiving care in geriatrics units. These results show the usefulness of POCUS in the management of older adults and suggest its inclusion in any curriculum of Geriatric Medicine speciality training.

*Keywords:* point of care ultrasound (POCUS); geriatrics care settings; multiorgan point of care ultrasound ; older people

## Key points

- Multiorgan point of care ultrasound (POCUS) might be useful in different geriatric care settings.
- POCUS is a non-invasive, well tolerated, free of ionising radiation, painless, inexpensive, versatile and fast technique, constituting an excellent screening tool in very older patients.
- Perform standard ionizing imaging tests can be challenging in patients presenting with dementia, delirium and/or functional impairment.
- POCUS has the potential to avoid transfers and procedures that could be detrimental to geriatric patients.
- POCUS allows you to avoid delays in diagnoses, make early referrals and avoid unnecessary referrals.

## Introduction

Point of care ultrasound (POCUS) is an imaging tool that provides clinicians with complete whole-body evaluations in real time and resolve specific clinical questions [1–3]. POCUS is considered the fifth pillar of physical exam in the new millennium, serving to address specific clinical uncertainties and facilitate expedited diagnosis and treatment pathways without focusing on all the details and information provided by traditional ultrasound. It does not seek to replace comprehensive ultrasound, or any other aspects of the traditional physical exam [4, 5]. POCUS enables accurate diagnosis, guides invasive procedures and facilitates timely shared decision-making, and adjustment and monitoring of treatments [6]. There are different POCUS protocols depending on the conditions and setting of patients [1, 7–14].

While the utility of general ultrasound has been extensively reported in most clinical specialities [2, 14], the use of multiorgan POCUS has been predominantly confined to Emergency, Internal and Primary Care Medicine. In specialities other than Geriatrics, the usefulness of POCUS in advanced age patients has been seldomly described [15–17]: a study about association of sonographic sarcopenia and falls in older adults presenting to the Emergency Department [15], a study about usefulness of POCUS in the evaluation of hydration in acute hospitalised older patients [16] and a clinical case of a 73-year-old patient diagnosed with dorsal elastofibroma by POCUS in Primary Care [17].

In Geriatrics, the usefulness of general ultrasound has been limited to the evaluation of muscle mass [18–23], while in relation to multiorgan POCUS in this speciality, there are very few publications, specifically a unique original on the use of POCUS, which was focused on highly dependent patients [24]; a series of cases on the utility for the evaluation of blood volume and alveolar-interstitial syndrome [25] and some reports of cases in an acute Care Unit [26] and in a Geriatric Home Care Programme [27]. Therefore, Geriatrics must take this step to avoid being left behind and to reach the minimal technical level of other specialities.

To date, there are no studies describing the usefulness of multiorgan POCUS in different geriatric care settings despite its potential practicality in this group of patients where cognitive and functional impairment, immobility, living with frailty and atypical presentation of disease are highly prevalent. POCUS presents itself as the perfect complement to physical examination in combination with comprehensive geriatric assessment and multidisciplinary patient-centred care.

This study aimed to describe the usefulness of POCUS (pulmonary, cardiac, abdominal, vascular, skin and soft tissues and muscular) in the diagnosis, treatment, monitoring and decision-making of older patients admitted in different geriatric care settings.

## Methods

This observational retrospective study was carried out between 1 January 2022 and 31 October 2023.

### Patient selection

Patients were selected from two tertiary city hospitals and one district general hospital located in Madrid, Spain and Greater Manchester, United Kingdom and incorporated into the study when they were cared for by geriatric teams (acute unit, functional rehabilitation unit, day hospital, home care, outpatients and perioperative care of older people undergoing surgery), when there was a specific clinical suspicion such as (pleural effusion, heart failure, pneumonia, hypovolaemia, hepatomegaly, gallbladder lithiasis, faecal impaction, acute urinary retention, deep vein thrombosis, cellulitis, among others), or in the presence of torpid clinical course (specifically those patients who, despite the proposed diagnosis and established treatment, did not show improvement, presenting symptoms such as fever, tachycardia, hypotension, dyspnea and pain). Exclusion criteria included prior confirmatory imaging and care provided by a non-geriatric team. The period of inclusion at each care setting coincided with the clinical stay of the first author (P.P.R.P.) as a fellow doctor in Geriatrics. The availability of the physician in charge of performing multiorgan POCUS was also considered.

### Epidemiological, nutritional, laboratory and geriatric assessment

A complete medical history, pharmacological reconciliation, physical examination and demographic data were documented. Functional status was assessed using the Functional Ambulation Categories (FAC) [28] and Barthel Index (BI) [29]. Cognitive status was measured using the Reisberg

Global Deterioration Scale (GDS) [30]. Nutritional Assessment was assessed using weight (Kg), height (cm), body mass index (BMI), Mini Nutritional Assessment Short Form (MNA-SF) [31], serum proteins and albumin. Frailty status was judged using the modified Rockwood Scale or Clinical Frailty Scale [32]. The socio-familial situation was assessed by personal interview. Geriatrics Syndromes were clinically evaluated, and delirium screened with the 4AT delirium assessment tool [33].

### Ultrasound data collection

A Geriatric training doctor with a certificated degree in comprehensive ultrasound, with accredited formal training and 8-years-plus experience performed the multi-organ-POCUS to all included patients. The sonographer was a clinical physician who was concurrently a resident doctor of the treating medical team. All patients underwent multi-organ POCUS in a cephalo-caudal manner. The assessment included pulmonary and cardiac ultrasound, using lung and cardiac ultrasound protocol (LUCUS protocol), abdominal ultrasound including focused assessment with sonography in trauma (FAST protocol, which included perihepatic, peri splenic, pelvic and subxiphoid longitudinal views), hepatic and biliary sonography (right subcostal view) and inferior vena cava (subxiphoid longitudinal view), muscle using ultrasound for muscle assessment in sarcopenia (SARCUS protocol), vascular (simplified compression technique of the deep venous system) and soft tissue ultrasound (evaluation of the skin and subcutaneous cellular tissue) [8, 10, 20, 34]. After the multi-organ examination, a report was issued with the most relevant findings. The findings found were classified into four groups: confirmed diagnoses, ruled out diagnoses, unsuspected clinical diagnosis and clinical follow-ups. An ultrasound finding was considered significant when it led to a significant diagnosis and/or a management adjustment.

A subgroup of acutely unwell patients underwent systematic and consecutive muscle-POCUS on day of admission, day 3 and on the day of hospital discharge, allowing for repeat two measurements in the transverse ultrasound plane (muscle thickness and muscle area) and three measurements in the longitudinal ultrasound plane (muscle thickness, fascicle length and pennation angle) following the SARCUS protocol [20].

POCUS was performed using a portable ultrasound machine (Butterfly iQ™; Butterfly Network, Inc 530 Old Whitfield Street Guilford, CT 06437 EE. UU) [35]. Measurement of muscle mass was analysed using the Image J program [36].

This study was performed in line with the principles of the Declaration of Helsinki and its subsequent amendments, fulfilling the doctor's duty to protect the life, health, dignity and integrity. The local Research Ethics Committees of the hospitals in which the study was carried out approved it. All the information obtained from the study participants was treated confidentially, complying with the Organic Law 3/2018 on Personal Data Protection with its last update on 25 July 2019.

Statistical analysis was performed using SPSS statistic programme for Windows, 26.0 version, and data reported as mean and standard deviation, number and percentage.

## Results

A total of 368 older patients with an average age of 85.9 years (standard deviation -SD- ±6.1) were admitted between 1 January 2022 to 31 October 2023 to various geriatric care settings: 141 acute geriatric unit, 45 in surgical wards (perioperative care of older people undergoing surgery team), 63 in care homes, 84 geriatric outpatients and 35 in the functional rehabilitation unit and day hospital. Of these, 107 (29%) had torpid clinical course or specific clinical suspicion and underwent multiorgan POCUS (Figure 1).

Table 1 shows general baseline characteristics, presence of geriatric syndromes and percentage of frailty. This is a sample of geriatric patients, majority female, with a mild–moderate capacity for basic activities of daily living and walking, cognitive impairment, risk of malnutrition and frailty.

Figure 1 and Table 2 show the main POCUS findings. In total, 235 findings were documented: 89 (37.9%) confirmed diagnoses, 39 (16.6%) ruled out diagnosis, 35 (14.9%) unsuspected significant diagnoses and 72 (30.6%) clinical follow-ups.

The average number of POCUS findings for each patient was 2.2 (total findings 235 in 107 patients), the most common involving the cardiovascular, genitourinary and hepatobiliary systems, followed by changes in muscle mass during hospital admission.

The changes that occur in muscle mass during hospitalisation in acute wards were evaluated in 30 patients of these, 96.7% presented a decreased in muscle mass: 24.6% in the muscle thickness, 29.8% in the area and 31.1% in the pennation angle of rectus femoris muscle, constituting 12.3% of the total of findings.

Figure 2 shows a graphic representation of the main findings found by multiorgan POCUS applied in different geriatrics care settings.

POCUS led to changes in pharmacological and non-pharmacological strategies in 66.3 and 69.2% of patients respectively, confirmed the need to perform or avoid more invasive procedures in 17.8 and 15.9% of individuals, respectively, and instigated urgent referrals to other specialities in 14.9% of cases. Unnecessary in hospital transfers (transfers for carrying out other complementary tests) were avoided in 25.2% of patients (Table 3).

## Discussion

In this cohort of older patients undergoing geriatric care in various clinical settings in the UK and Spain, POCUS appeared to be a useful technique enabling clinicians to confirm or rule out clinical diagnoses, guiding changes in pharmacological and non-pharmacological treatments, and

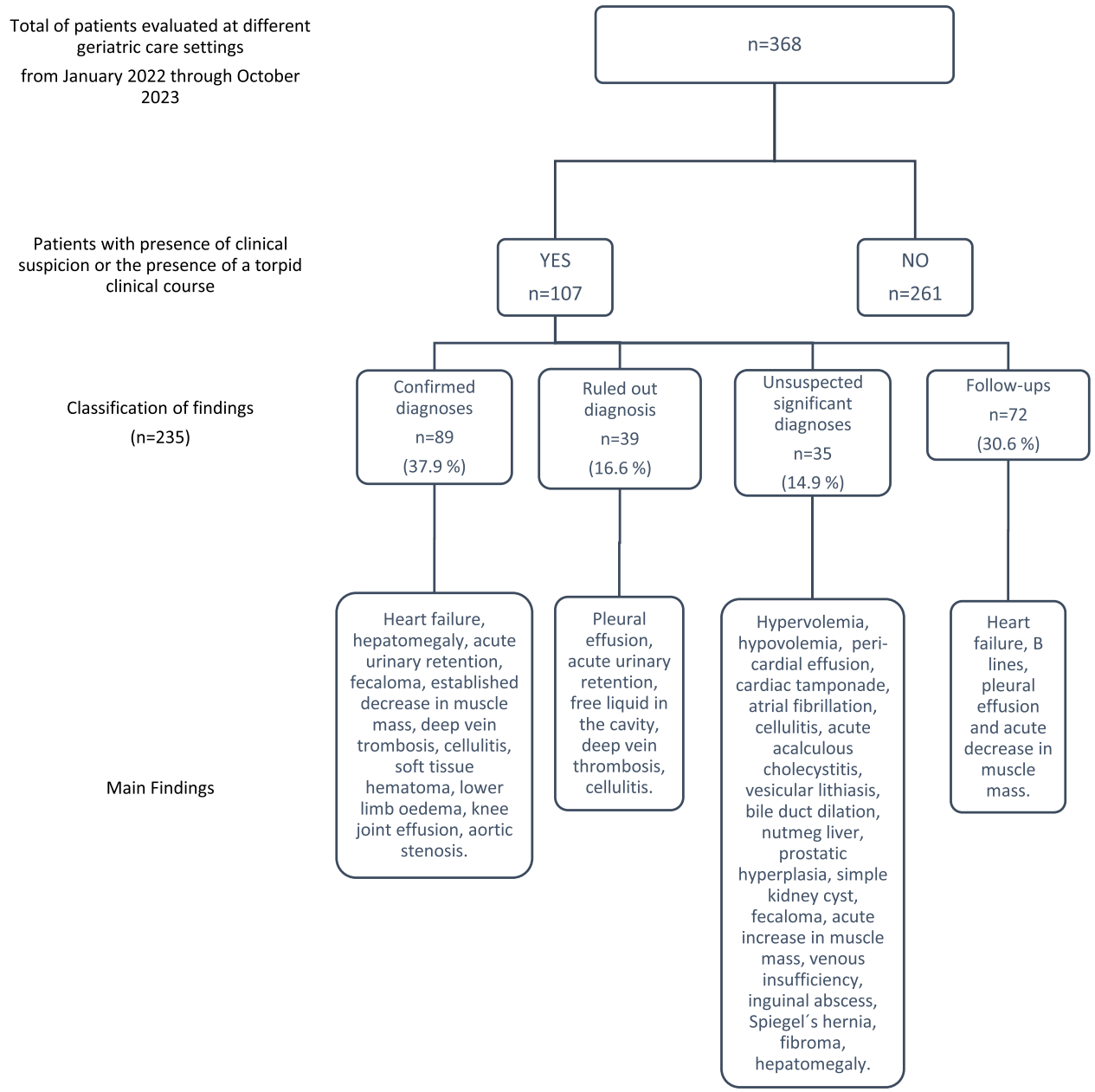


Figure 1. STROBE flow diagram showing the number of patients admitted to geriatric care settings, patients assessed by POCUS and the findings.

facilitating timely referrals to other specialities streamlining patient management. Almost 30% of patients benefited from the use of this cost-effective exploratory technique. The most common diagnostic findings involved the cardiovascular and abdominal systems together with monitoring of muscle mass.

POCUS in patients under an Internal Medicine team with an average age 15 years younger than those included in our cohort [14], detected unsuspected relevant diagnoses in 86 patients (27.7%), and conditioned therapeutic modification in 60 patients (19.3%). This study implied that a higher diagnostic yield in older patients with a higher degree of dependency, as is usually the case in patients admitted under geriatric teams.

In older populations, ultrasound reports have been published [18–27], but none describing multiorgan POCUS in different geriatric care settings, and these studies did not include comprehensive geriatric assessment. In these published studies, the number of cases was smaller, and the conditions evaluated by ultrasound were very specific. We believe this study is the first to report the advantages of multiorgan POCUS in older patients admitted to different geriatric care settings. Baseline characteristics of the patients in this study did not differ significantly from those admitted

Table 1. Baseline characteristics of patients assessed by POCUS in several geriatric care settings ($n = 107$)

| Demographic parameters | | |
|---|---|---|
| Age (years) | 85.9 | (±6.1) |
| Sex | | |
| Women | 54 | (50.5) |
| Geriatric care settings | | |
| Acute Unit | 33 | (30.8) |
| Geriatric outpatient clinic | 29 | (27.1) |
| Geriatric Home Care | 22 | (20.6) |
| Functional Rehabilitation Unit and Day Hospital | 14 | (13.1) |
| Perioperative care of Older People undergoing Surgery Units | 9 | (8.4) |
| Baseline geriatric assessment | | |
| BI | | |
| Independence or mild impairment (≥60) | 77 | (71.9) |
| Moderate impairment (40–60) | 19 | (17.8) |
| Severe dependence (<40) | 11 | (10.3) |
| FAC | 33 | (30.8) |
| Does not walk or requires help to do it (FAC 0–3) | 29 | (27.1) |
| Indoor independence (FAC 4) | 45 | (42.1) |
| Outdoors independence (FAC 5) | | |
| Reisberg Global Deterioration Scale (GDS) | | |
| No cognitive impairment, very mild cognitive impairment or mild cognitive impairment (GDS 1–3) | 70 | (65.4) |
| Moderate cognitive impairment or moderate–severe cognitive impairment (GDS 4–5) | 29 | (27.1) |
| Severe cognitive impairment or very severe cognitive impairment (GDS 6–7) | 8 | (7.4) |
| Nutritional assessment | | |
| Weight (Kg) | 65.95 | (±15.70) |
| Height (m) | 1.63 | (±0.095) |
| BMI (Kg/m$^2$) | 24.75 | (±5.14) |
| Serum Total Protein (g/L) | 6.24 | (±1.41) |
| Albumin (g/L) | 3.47 | (±0.91) |
| Mini nutritional assessment, short version (MNA-SF) | | |
| Malnutrition (MNA-SF ≤7) | 51 | (47.5) |
| Risk of malnutrition (MNA-SF 8–11) | 43 | (40.6) |
| Normal (MNA-SF ≥ 12) | 13 | (11.9) |
| Frailty assessment | | |
| Clinical-Frailty-Scale (Rockwood) ≥ 5 | 57 | (53.3) |
| Geriatric syndromes | | |
| Previous falls | 48 | (52.7) |
| Delirium (4AT delirium assessment tool) | 97 | (40.7) |

Data presented as mean (±SD) or *n* (%).

to geriatric units across the globe, and displayed significant functional and cognitive impairment, multimorbidity and advanced chronological age.

In our cohort of patients, POCUS resulted in changes to pharmacological and non-pharmacological treatments in 66.3 and 69.2% of cases. This positive effect was superior to the 20–40% therapeutic adjustments reported in a systematic review on the usefulness of POCUS in patients hospitalised under internal medicine that confirmed a similar rate (34%) of unsuspected diagnosis [37]. Other studies carried out strictly in Emergency Departments have shown that multiorgan POCUS is beneficial in this setting, one of them found that POCUS was potentially beneficial in 27.0% of all patients, while another showed positive findings in 39.3% of all included patients, in both cases lower than our study [38, 39].

This study detected serious potentially treatable diseases such as cardiac tamponade and aortic stenosis early on, enabling urgent review by cardiology teams and invasive lifesaving interventions. Other pathologies such as atrial fibrillation and acute cholecystitis were also detected, resulting in establishment of anticoagulant therapy, antibiotic treatment and referral to emergency general surgery. In addition, some of our patients assessed at home were diagnosed and treated with a favourable outcome, avoiding unnecessary hospital admission. POCUS also proved helpful in ruling out acute urinary retention, deep vein thrombosis, joint-pleural effusions and ascites. As a result, POCUS avoided unnecessary invasive procedures.

Our data identified a loss of muscle mass during hospitalisation in 96.7% of the patients, and confirmed reductions in rectus femoris muscle mass thickness, muscle mass area and pennation angle in 24.6%, 29.8% and 31.1%, respectively. This is significantly higher than previously reported data showing decreased muscle mass in half of participants [23]. For this reason, we believe that muscle measurement should be routinely included in the examination of geriatric patients, since combined with other morphofunctional

Table 2. Findings of POCUS in this cohort of older adults admitted to geriatric care settings

| | *n* | % |
|---|---|---|
| **Total findings** | 235 | 100 |
| Cardiovascular | 106 | (45.1) |
| (Heart failure, B lines, pleural effusion, hypervolaemia, hypovolaemia, pericardial effusion, aortic stenosis, cardiac tamponade, atrial fibrillation, ruled out pleural effusion) | | |
| Urinary tract | 41 | (17.4) |
| (Confirmation and/or dismissal of acute urine retention, prostatic hyperplasia, simple kidney cyst) | | |
| Hepatobiliary | 15 | (6.4) |
| (Hepatomegaly, acute acalculous cholecystitis, vesicular lithiasis, bile duct dilation, nutmeg liver) | | |
| Gastrointestinal | 6 | (2.6) |
| (Faecal impaction, ruled out ascites, inguinal abscess, Spiegel's hernia) | | |
| Muscle diagnoses | 37 | (15.7) |
| (Acute or established decrease in muscle mass, acute increase in muscle mass) | | |
| Vascular diagnoses | 16 | (6.8) |
| (Confirmation or dismissal of deep vein thrombosis, venous insufficiency) | | |
| Skin and soft parts diagnoses | 8 | (3.4) |
| (Cellulitis, soft tissue hematoma, lower limb oedema, cellulitis, ruled out Knee joint effusion) | | |
| Pulmonary diagnosis | 4 | (1.7) |
| (Confirmation of pneumonia) | | |
| Others | | |
| (Fibroma and ultrasound-guided catheter placement) | 2 | (0.9) |

Data presented as raw numbers and percentages.

assessment techniques, it could be especially beneficial in monitoring sarcopenia and the response to nutritional and physical intervention (exercises and functional rehabilitation).

It is noteworthy that the spectrum of care settings studied has been very broad from acute care and perioperative care of older people undergoing surgery, where multiorgan POCUS helped confirm diagnoses and make quick decisions, to functional recovery unit or geriatric home care where it has allowed decisions to be made without the need to refer patients to hospitalisation areas with more diagnostic technology, also allowing adjustments and initiation of pharmacological treatment, as well as modifying non-pharmacological treatments in clinically acute patients. Considering the results of this study, POCUS could be recommended in patients under the care of specialists in Geriatric Medicine, and these clinicians should be offered the opportunity to train and gain experience in POCUS.

Furthermore, we want to highlight that professionals who consider integrating it into their clinical practice must consider that for its correct application, regulated training accredited by universities or scientific societies is essential. POCUS requires time to achieve formal training, but once staff are trained, implementation is quick (∼10–15 min). It would be recommended that at least one person from each section of the Geriatrics services should have formal training in POCUS. However, probably in the future it could be generalised to all Geriatricians and even be part of Geriatrics residency training programmes.

Nowadays ultraportable equipment can be used to perform POCUS and its estimated cost is 3000 euros. Most of these devices do not involve additional maintenance costs, providing the benefit of portability, which is especially useful in patients with a geriatric profile, because these patients can present geriatric syndromes such as sensory deprivation, immobility, cognitive impairment and in whom there is often an atypical presentation of clinical symptoms.

This study has several strengths: this is the first study that assesses the role of multiorgan POCUS in different geriatric care settings, it included typical geriatric patients all undergoing standard comprehensive geriatric assessment, and this permitted assessing the applicability and profitability of POCUS across different environments and teams. Numbers of patients included in this analysis are significantly larger than in previous studies where ultrasound was used but not multiorgan POCUS.

Furthermore, in our study a single geriatrician was in charge of data collection, which is notable since in other study inter-rater bias has forced 31.5% of the examinations to be discarded.

A limitation of this study is that this is an operator dependent technique, which can reduce external validity. Adequate training and supervision of those carrying out the technique is essential, and checks and balances must be put in place as use of this technique becomes more widespread. In addition, there may be a risk of selection bias; there was no control group either. While the sample size of this study is limited, it stands as the inaugural research of its kind conducted across various geriatric care settings. It is an exploratory and observational study and does not purport to conclusively address the study topic. Even though it is a retrospective study, it serves the purpose of substantiating the need for further prospective studies to validate and complement the outlined findings,

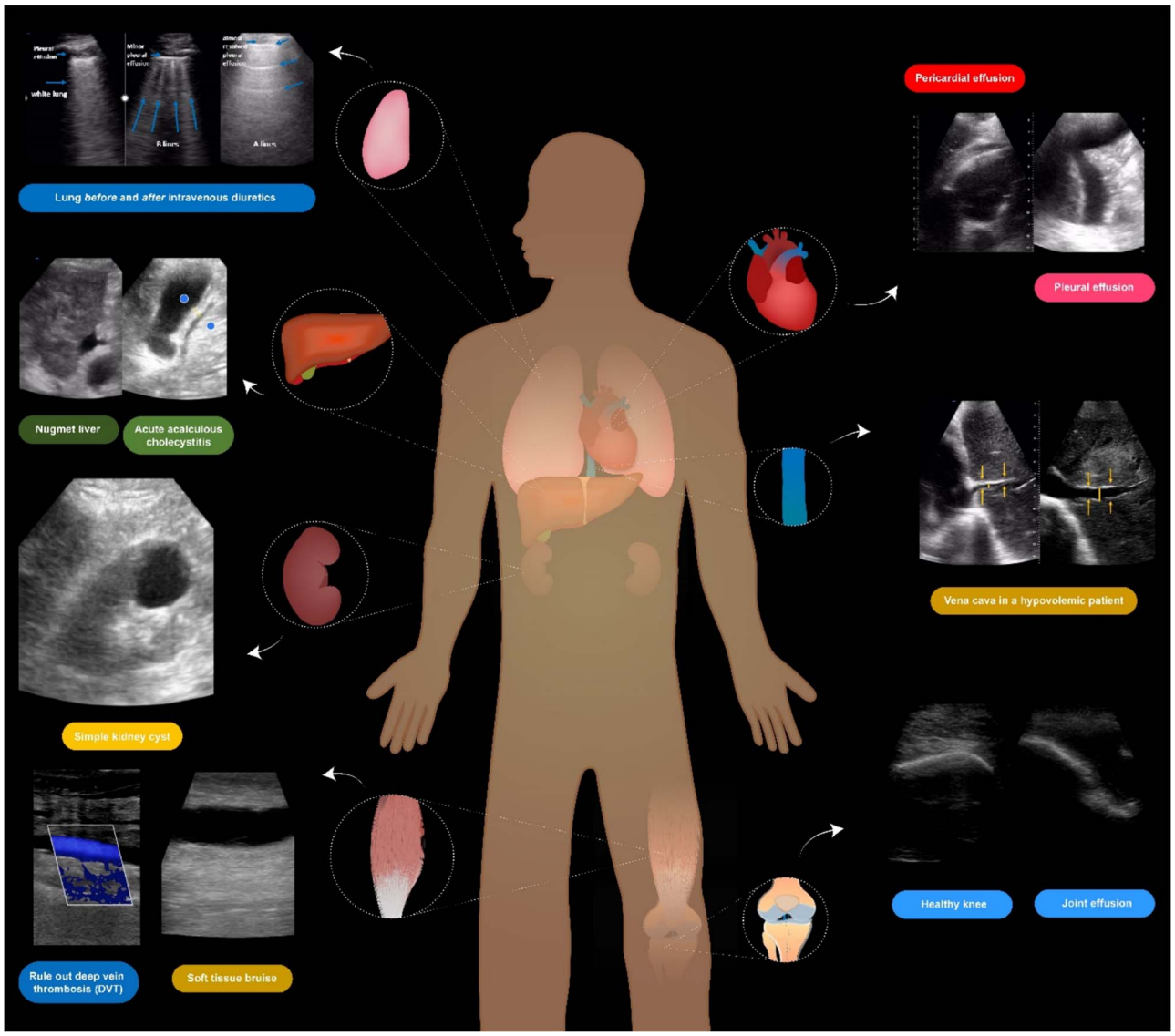


Figure 2. Graphic representation of findings identified by POCUS in different Geriatrics care settings.

thereby better defining the future applicability of POCUS in Geriatrics.

While the study did not specifically focus on cost benefit analysis, which is a crucial consideration for future research, it can be inferred that POCUS did not lead to an escalation in healthcare expenses. Instead, it likely streamlined patient management by facilitating early referrals to other specialities, averting unnecessary transfers to Emergency Departments from home, and minimising unwarranted test, among other benefits. These efficiencies could potentially result in cost savings while also providing the added benefit of diagnosing patient at the bedside, enhancing patient comfort.

Besides, although POCUS has multiple advantages as an imaging technique, it must be said that compared to a scanner, the latter can be more efficient in terms of tumour staging and providing greater accuracy.

In summary, POCUS is a painless, non-invasive, ionising radiation-free and cost-effective technique performed with a portable instrument. It provides instant dynamic images instead of screenshots enabling interpretation at the patient's bedside by the responsible clinician. POCUS can provide customised imaging based on the signs and symptoms of each patient, provides validation for specific diagnoses, facilitates timely decision-making regarding initiation, monitoring, and adjustment of treatments without the delay and the inconvenience of transportation to other hospital areas and guides invasive procedures improving success and reducing complications that could have a negative impact on these frail patients.

The progressive expansion of this technique in the care of older patients, and its inclusion in the specialist training curriculum of Geriatric Medicine should be promoted [40].

Table 3. Summary of the 224 POCUS -guided-management decisions in 107 patients admitted to different geriatric care settings

| | | % of total clinical management decisions | % of total patients |
|---|---|---|---|
| Pharmacological treatment | 71 | (31.7) | (66.3) |
| Dose adjustment of diuretic treatment | 39 | (17.4) | (36.4) |
| Initiation of antibiotics | 16 | (7.1) | (14.9) |
| Changes to pain control medication | 7 | (3.1) | (6.5) |
| Commencement of laxatives +/− enemas | 4 | (1.8) | (3.7) |
| Initiation of intravenous hydration | 3 | (1.3) | (2.8) |
| Commencement of anticoagulation | 1 | (0.4) | (0.9) |
| Commencement of alpha 1 blocker therapy | 1 | (0.4) | (0.9) |
| Non-pharmacological treatment | 74 | (33.0) | (69.2) |
| Commencing protein supplements | 37 | (16.5) | (34.6) |
| Exercise prescription | 37 | (16.5) | (34.6) |
| Procedures performed | 19 | (8.5) | (17.8) |
| Bladder catheter placement | 17 | (7.6) | (15.9) |
| Ultrasound-guided cannula placement | 1 | (0.4) | (0.9) |
| Pericardiocentesis | 1 | (0.4) | (0.9) |
| Procedures avoided | 17 | (7.6) | (15.9) |
| Bladder catheter placement avoided | 17 | (7.6) | (15.9) |
| Early referrals to other specialities | 16 | (7.1) | (14.9) |
| General surgery | 5 | (2.2) | (4.7) |
| Cardiology | 4 | (1.8) | (3.7) |
| Rheumatology | 2 | (0.9) | (1.9) |
| Geriatric acute unit | 2 | (0.9) | (1.9) |
| Angiology and vascular surgery | 1 | (0.4) | (0.9) |
| Digestive | 1 | (0.4) | (0.9) |
| Urology | 1 | (0.4) | (0.9) |
| Transfer avoidance | 27 | (12.1) | (25.2) |

Data presented as raw numbers and percentages.

For all of the above, we believe that this model has the potential to be an efficient alternative to the traditional model, and more studies should be carried out to confirm these findings.

**Declaration of Conflicts of Interest:** None declared.

**Declaration of Sources of Funding:** None declared.

## References

1. Narula J, Chandrashekhar Y, Braunwald E. Time to add a fifth pillar to bedside physical examination: inspection, palpation, percussion, auscultation, and insonation. *JAMA Cardiol* 2018; **13**: 346–50.
2. Nelson WG, Rosen A, Pronovost PJ. Reengineering the physical examination for the new millennium?. *JAMA* 2016; **315**: 2391–2.
3. Dietrich CF, Goudie A, Chiorean L *et al.* Point of care ultrasound: a WFUMB position paper. *Ultrasound Med Bio* 2017; **43**: 49–58.
4. Moore CL, Copel JA. Point-of-care ultrasonography. *N Engl J Med* 2011; **364**: 749–57.
5. Morris AE. Point-of-care ultrasound: seeing the future. *Curr Probl Diagn Radiol* 2015; **44**: 3–7.
6. American College of Emergency Physicians. Emergency ultrasound guidelines. *Ann Emerg Med* 2009; **53**: 550–70.
7. Perera P, Mailhot T, Riley D, Mandavia D. The RUSH exam: rapid ultrasound in shock in the evaluation of the critically lll. *Emerg Med Clin North Am* 2010; **28**: 29–56.
8. Blackbourne LH, Soffer D, McKenney M *et al.* Secondary ultrasound examination increases the sensitivity of the FAST exam in blunt trauma. *J Trauma* 2004; **57**: 934–8.
9. Lichtenstein DA. BLUE-protocol and FALLS-protocol: two applications of lung ultrasound in the critically ill. *Chest* 2015; **147**: 1659–70.
10. Russell FM, Ehrman RR, Cosby K *et al.* Diagnosing acute heart failure in patients with undifferentiated dyspnea: a lung and cardiac ultrasound (LuCUS) protocol. *Acad Emerg Med* 2015; **22**: 182–91.
11. Breitkreutz R, Price S, Steiger HV *et al.* Focused echocardiographic evaluation in life support and peri-resuscitation of emergency patients: a prospective trial. *Resuscitation* 2010; **81**: 1527–33.
12. Kennedy Hall M, Coffey EC, Herbst M *et al.* The '5Es' of emergency physician-performed focused cardiac ultrasound: a protocol for rapid identification of effusion, ejection, equality, exit, and entrance. *Acad Emerg Med* 2015; **22**: 583–93.
13. Nagre AS. Focus-assessed transthoracic echocardiography: implications in perioperative and intensive care. *Ann Card Anaesth* 2019; **22**: 302–8.
14. Casado-López I, Tung-Chen Y, Torres-Arrese M *et al.* Usefulness of multi-organ point-of-care ultrasound as a complement to the decision-making process in internal medicine. *J Clin Med* 2022; **11**: 2256.
15. Wongtangman T, Thatphet P, Shokoohi H *et al.* Association of sonographic sarcopenia and falls in older adults presenting to the emergency department. *J Clin Med* 2023; **12**: 1251–61.
16. Hrabovsky V, Skrobankova M, Zdenek L *et al.* Point-of-care ultrasound (POCUS) in acute hospitalized older patients

focused on hydration. *Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub* 2023; **167**: 1–6.
17. Mazer T, Gagi KN, Bishop M. Elastofibroma dorsi: case report with point of care ultrasound primary care applications. *POCUS J* 2021; **6**: 60–3.
18. Zhu S, Lin W, Chen S *et al.* The correlation of muscle thickness and pennation angle assessed by ultrasound with sarcopenia in elderly Chinese community dwellers. *Clin Interv Aging* 2019; **14**: 987–96.
19. Yamada M, Kimura Y, Ishiyama D *et al.* Differential characteristics of skeletal muscle in community-dwelling older adults. *J Am Med Dir Assoc* 2017; **18**: .807.e9–807.e16.
20. Perkisas S, Bastijns S, Baudry S *et al.* Aplicación de la ecografía para la evaluación muscular en sarcopenia: actualización SARCUS 2020. *Eur Geriatr Med* 2021; **12**: 45–59.
21. Narici M, McPhee J, Conte M *et al.* Age-related alterations in muscle architecture are a signature of sarcopenia: the ultrasound sarcopenia index. *J Cachexia Sarcopenia Muscle* 2021; **12**: 973–82.
22. Madden KM, Feldman B, Arishenkoff S, Meneilly GS. Point-of-care ultrasound measures of muscle and frailty measures. *Eur Geriatr Med* 2021; **12**: 161–6.
23. López E, Neira M, Menéndez R *et al.* Muscle mass loss measured with portable ultrasound in hospitalized older adults: the ECOSARC study. *J Nutr Health Aging* 2024; **28**: 100010.
24. Fröhlich E, Beller K, Muller R *et al.* Point of care ultrasound in geriatric patients: prospective evaluation of a portable handheld ultrasound device. *Ultraschall in der Medizin* 2021; **6**: 60–3.
25. Reinoso-Párraga PP, Vilches-Moraga A. Is point of care ultrasound (POCUS) useful for the evaluation of blood volume and alveolar-interstitial syndrome in older patients? Series of cases. *Rev Esp Geriatr Gerontol* 2023; **58**: 167–9.
26. Reinoso-Párraga PP, Vilches-Moraga A. Point of care ultrasound (POCUS) in the evaluation of an older frail adult: case report. *Rev Esp Geriatr Gerontol* 2023; **58**: 101373.
27. Garmendia Prieto B, Somoano Sierra A, Reinoso-Párraga P, Gómez Pavón J. Application of 'point-of-care-ultrasound' (POCUS) in a geriatric home care (AGD): a case report. Spanish. *Rev Esp Geriatr Gerontol* 2022; **57**: 241–3.
28. Holden MK, Gill KM, Magliozzi MR *et al.* Clinical gait assessment in the neurologically impaired. Reliability and meaningfulness. *Phys Ther* 1984; **64**: 35–40.
29. Mahoney FI, Barthel DW. Functional evaluation: Barthel index. *Md State Med J* 1965; **14**: 61–5.
30. Reisberg B, Ferris SH, de Leon MTC. The Global Deterioration Scale for assessment of primary degenerative dementia. *Am J Psychiatry* 1982; **139**: 1136–9.
31. Vellas B, Guigoz YGP. The mini nutritional assessment (MNA) and its use in grading the nutritional state of elderly patients. *Nutrition* 1999; **15**: 116–22.
32. Rockwood K, Song X, MacKnight C *et al.* A global clinical measure of fitness and frailty in elderly people. *Can Med Assoc J* 2005; **173**: 489–95.
33. Bellelli G, Morandi A, Davis D *et al.* Validación del 4AT, un nuevo instrumento para el cribado rápido del delirio: un estudio en 234 personas mayores hospitalizadas. *Envejecimiento* 2014; **43**: 496–502.
34. García de Casasola G, Torres Macho J. *Manual de Ecografía Clínica. Servicio de Medicina Interna*. Madrid, España: Hospital Infanta Cristina. https://es.slideshare.net/optimus141071/manual-de-ecografia-clinica-casasola-1pdf (4 December 2023, date last accessed).
35. Handheld portable ultrasound machine, advanced POCUS. https://www.butterflynetwork.com/ (4 December 2023, date last accessed).
36. Image J. https://imagej.softonic.com/ (4 December 2023, date last accessed).
37. Cid-Serra X, Hoang W, El-Ansary D *et al.* Clinical impact of point-of-care ultrasound in internal medicine inpatients: a systematic review. *Ultrasound Med Biol* 2022; **48**: 170–9.
38. Weile J, Frederiksen CA, Laursen CB *et al.* Point-of-care ultrasound induced changes in management of unselected patients in the emergency department—a prospective single-blinded observational trial. *Scand J Trauma Resusc Emerg Med* 2020; **28**: 47.
39. Weile J, Laursen CB, Frederiksen CA *et al.* Point-of-care ultrasound findings in unselected patients in an emergency department-results from a prospective observational trial. *BMC Emerg Med* 2018; **18**: 60.
40. Gogtay M, Choudhury R, Williams J. Point-of-care ultrasound in geriatrics: a national survey of VA medical centers. *BMC Geriatr* 2023; **23**: 605.

**Received 2 February 2024; editorial decision 15 July 2024**