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Accuracy of point-of-care ultrasound examination of the lung in primary care performed by general practitioners: a cross-sectional study

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Abstract

Background Lung ultrasonography (LUS) is a point-of-care imaging modality with growing potential in primary care.

Objectives While its use is well established in hospital settings, data on its accuracy when performed by general practitioners (GPs) remain limited. This study aimed to assess the diagnostic accuracy of LUS conducted by GPs following structured training.

Methods We recruited 17 GPs from various regions of the Czech Republic. They completed a two-day educational course focused on LUS. Patients with current dyspnoea (NYHA II-IV) or a history of dyspnoea within the last four weeks were included and underwent LUS to assess the presence of pleural effusion and interstitial syndrome. An independent expert sonographer, blinded to clinical data, evaluated recorded LUS video loops as the reference standard. LUS findings were categorized into A profile (presence of A lines and intact lung sliding, indicating normal aeration), B profile (three or more B lines per intercostal space in at least two intercostal spaces per hemithorax, suggesting interstitial syndrome), pulmonary consolidation and pleural effusion.

Results A total of 128 patients were enrolled in the study. A total of 768 thoracic segments were examined. A profile was identified in 642 (83.6%) segments, B profile in 108 (14.1%), pulmonary consolidation in 8 (1.0%), and pleural effusion in 12 (1.6%). For the identification of A profile, the sensitivity was 97.51% (95% CI 95.98–98.57), and the specificity was 88.10% (95% CI 81,13–93,18); for B profile, the sensitivity was 87.04% (95% CI 79,21–92,73), and the specificity was 97.73% (95% CI96,28–98,72); for pulmonary consolidation, the sensitivity was 100.0% (95% CI 63,06-100,00), and the specificity was 100.0% (95% CI 99,52–100,0); for pleural effusion, the sensitivity was 83.33% (95% CI 51,59–97,91), and the specificity was 99.87% (95% CI 99,27–100,00).

Conclusion Our findings provide important preliminary data, demonstrating that GPs can perform LUS accurately after a structured training program.

The trial registration identifier is NCT04905719.

Keywords Primary care, Point-of-care ultrasound, Lung examination, Accuracy, COVID-19

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Background

Several systematic reviews have highlighted the benefits of point-of-care ultrasound (POCUS) in primary care in many European countries and around the world, particularly for musculoskeletal, cardiovascular, abdominal, and lung examinations [1–4]. The WONCA Europe Council has unanimously endorsed the use of point-of-care ultrasound in family medicine [5]. This method, when performed by general practitioners (GPs), has the potential to improve diagnostic certainty, expedite clinical decision-making, and enhance patient management by providing immediate imaging at the point-of-care [1, 6].

One of the most typicaly uses of POCUS in primary care is lung ultrasound (LUS). Studies on LUS have been extensive in hospital settings, especially during the COVID-19 pandemic [7–25], but remain scarce in primary care [23, 26–29]. There is growing number of training courses and educational curricula for POCUS in primary care [30–34], mostly developed and based on the opinions and experiences of leading GPs in the field or through Delphi studies that evaluate the perspectives of a broader group of GPs. But there is a lack of evidence verifying the accuracy of LUS examination performed by GPs. To address this gap, we conducted a study evaluating the accuracy of LUS performed by GPs in primary care. Establishing the accuracy of LUS in primary care is a crucial step toward defining its role in routine GP practice and guiding future educational initiatives.

Methods

Problem definition

Our study aimed to assess how accurately GPs, after a structured training program, could identify key LUS findings. Specific objectives include the evaluation of (a) the presence of pleural effusion in patients with dyspnoea and (b) the presence of interstitial syndrome in the lungs of patients with dyspnoea.

Based on the initial hypothesis, it is suggested that GPs are capable of diagnosing findings outlined in the specific objectives of the study with a sensitivity and a specificity of ≥ 80%.

Table 1 Inclusion and exclusion criteria

Inclusion criteria
Age older than 18 years with following features:
Current dyspnoea (NYHA II-IV)
History of dyspnoea within the past 4 weeks
Exclusion criteria
Patient refusal to participate in the clinical study
Age younger than 18 years
Conditions preventing ultrasound examination (e.g., allergy to ultrasound gel, skin lesions that hinder safe examination)

Study methodology and protocol

All patients included in the study were examined in 17 GP practices across the Czech Republic from March 2021 to December 2021. A part of the study period was influenced by the ongoing COVID-19 pandemic.

All patients with current dyspnoea (NYHA II-IV) or a history of dyspnoea within the past 4 weeks were included in the study and underwent POCUS diagnosis for pleural effusion and interstitial syndrome. Patient inclusion in the study required informed consent to participate in the clinical study. The inclusion and exclusion criteria are sorted in Table 1.

We recruited GPs, medical doctors with full postgraduate specialization in family medicine, practising in general medicine across the Czech Republic, with access to the ultrasound device. The call for participation was made through the magazine of the Czech Society of General Practice. GPs interested in the study were invited to provide their contact information and background characteristics by completing a small information form specifically designed for this purpose. A total of 75 GPs expressed their willingness to participate, and 17 participants of the study were selected from this pool. We purposely selected participants for maximum variation in the following background characteristics: age, gender, experience as a GP, experience with ultrasonography, regional location in the Czech Republic, urban vs. rural practice, and organisational aspects of the practice (single handed, group practice). Recruitment was aimed at 15–17 participants.

The investigators completed a two-day educational course on LUS with a predefined structure specifically tailored for the needs of GPs in the Czech Republic. During the course, the participating GPs received both theoretical and hands-on training, consisting of 8 h of practical sessions using standardized ultrasound models and volunteering patients to familiarize themselves with probe positioning, common lung artefacts, and pleural effusion detection techniques, along with 8 h of theoretical instruction.

All patients who met the inclusion criteria were recruited consecutively and underwent a structured POCUS lung examination. Number of potentially eligible patients who were missed was not recorded. The POCUS lung examination was performed according to the BLUE protocol (Bedside Lung Ultrasound in Emergency) at a total of six locations (three on each hemithorax) in the following order:

1) Upper BLUE point on the right.
2) Lower BLUE point on the right.
3) PLAPS point (Posterior or lateral Alveolar and/or Pleural Syndrome) on the right.
4) Upper BLUE point on the left.

5) Lower BLUE point on the left.
6) PLAPS point on the left [35].

A convex ultrasound probe was used for the examination. The depth of imaging was set to 10 cm for the upper and lower BLUE points and 15 cm for the PLAPS point. The probe was placed on the chest in a sagittal plane, perpendicular to the ribs. The assessment was conducted over several at least three respiratory cycles. Ideally, the patient was in a seated position, but the examination could also be performed alternatively in a semiseated or lying position.

At each examination point, the findings were classified as follows:

- A profile.
- B profile.
- Pulmonary consolidation.

Additionally, the presence or absence of:

- pleural sliding.
- pleural effusion.

The examination results were written in a structured recording form (Fig. 1), and a video loop of at least 6 s was recorded from each examined point. The duration of the examination was always measured and documented. Representative images of various lung ultrasound patterns considered in this study and their descriptions are sorted in Fig. 2.

Patients with dyspnoea who underwent POCUS lung examination were indicated for follow-up expert ultrasound of the lungs, chest X-ray, or CT lung scans as per the indications of the GPs. The follow-up of the results of these examinations was not part of the study.

Given the differing sensitivity and specificity of individual follow-up examinations and primary LUS [16, 19], subsequent blind assessment of each examination in the form of video loop recordings by a single independent sonographic expert was chosen as the reference criterion. All assessments were conducted by a single independent sonographer (radiologist) at the end of the study in one session, ensuring consistency in evaluation. To maintain objectivity, individual GPs were not informed of the assessment results during the study, allowing their clinical decision-making regarding treatment and further patient management to remain unaffected. Figure 3 illustrates patient flow.

With an anticipated kappa agreement of 0.8 ± 0.1 and an assumed noninclusion rate of 10% of potential candidates, the preliminary calculation estimated a sample size of at least 110 patients.

The diagnostic accuracy of LUS examination was assessed by measuring sensitivity, specificity, positive and negative likelihood ratios, positive and negative

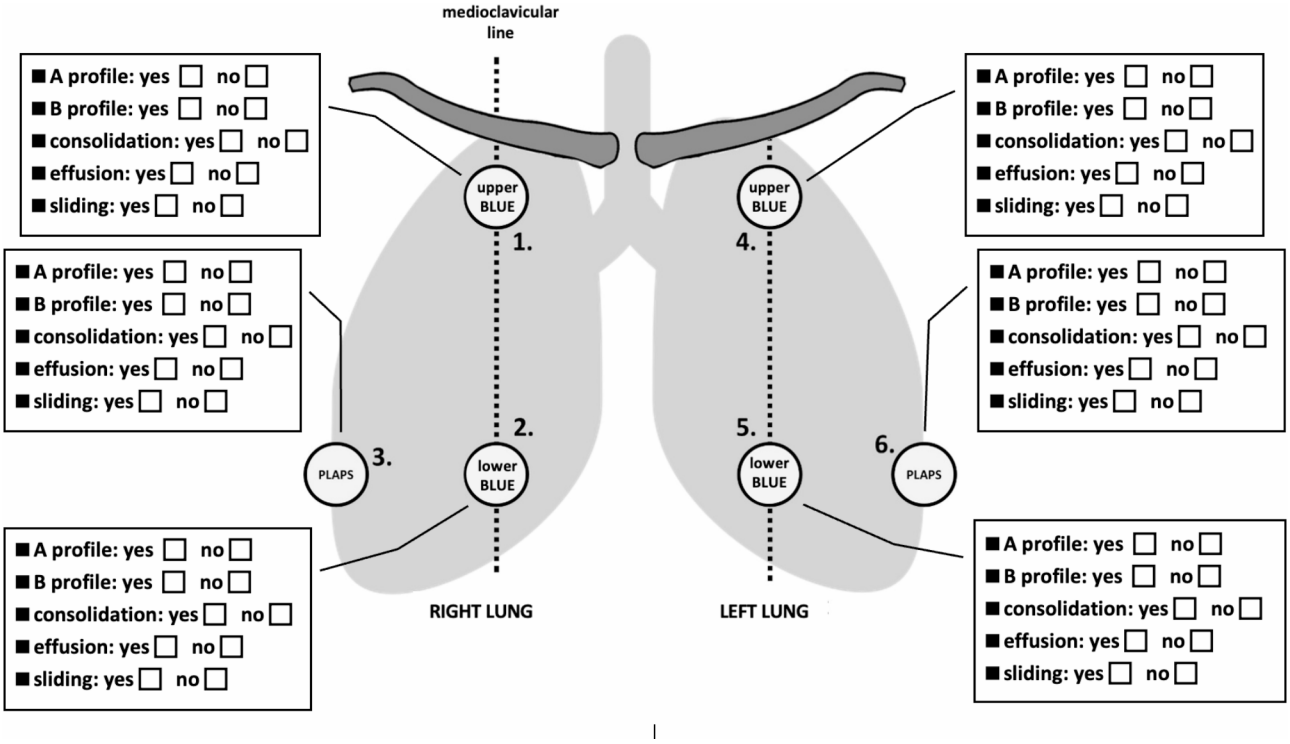
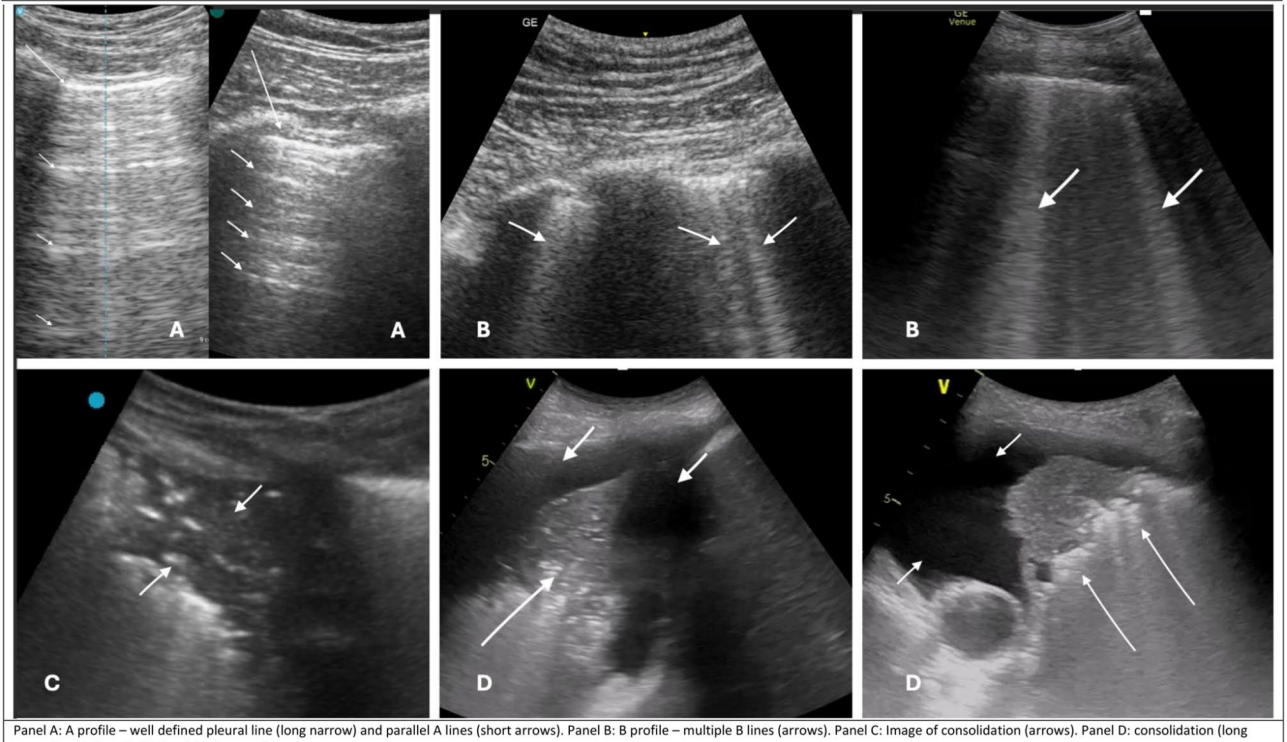


Fig. 1 Structured recording form for lung POCUS examination according to the BLUE protocol (bedside lung ultrasound in emergency) used in the study

	A profile	B profile	Consolidation	Pleural effusion
Description	A pattern seen on lung ultrasound where horizontal reverberation artifacts (A lines) are present with sliding intact. Normal air-to-fluid ratio in the lungs (aerated profile, A – "air").	A pattern seen on lung ultrasound characteristic by the presence of ≥ 3 B lines in ≥ 2 intercostal spaces. Describing interstitial lung syndrome with the picture of oedematous lung - increase amount of fluid in lungs. (B – "brightness", previously known as the "comet-tail artifact")	Describe alveolar syndrome with the picture of consolidated lung (nonaerated and stiff lung parenchyma - replacement of normal air-filled alveoli with fluid, pus, blood, or cellular material)	Defined as the presence of anechoic or hypoechoic fluid within the pleural space, typically seen between the parietal and visceral pleura.
Findings	A lines: horizontal, hyperechoic (bright) lines originating from the pleura (the interface between aerated and nonaerated areas) and repeating below the pleura for a certain distance. Sliding: A shimmering movement seen on real-time ultrasound indicating sliding of the visceral pleura over the parietal pleura.	B lines: Vertical hyperechogenic lines originating from the pleura and transferring all across the screen to the bottom, moving with respiration. Their presence eliminates the presence of A lines.	Subpleural hypoechogenic areas with an echogenic air bronchogram or hypoechogenic fluid bronchogram	Anechoic fluid collection between the lung and chest wall.
Can be found in that conditions	Normal lung Bronchial asthma COPD Pulmonary embolism (patient with acute dyspnoea)	Pulmonary oedema Pneumonia (in early stages) Interstitial lung disease ARDS	Pneumonia (in late stages) ARDS Atelectasis	Heart failure Pneumonia Empyema Malignant effusion Haemothorax

COPD - Chronic obstructive pulmonary disease
ARDS - Acute respiratory distress syndrome



Panel A: A profile – well defined pleural line (long narrow) and parallel A lines (short arrows). Panel B: B profile – multiple B lines (arrows). Panel C: Image of consolidation (arrows). Panel D: consolidation (long arrows) and pleural effusion (short arrows).

Fig. 2 Representative images of various lung ultrasound patterns considered in this study and their descriptions

predictive values, overall accuracy, and the kappa measure of agreement. Post-test probability was also calculated. A p-value of <0.05 was considered statistically significant.

The study is registered on ClinicalTrials.gov with the identifier NCT04905719 (Registration Date: 25. 4. 2021). https://clinicaltrials.gov/ct2/show/NCT04905719?term=ultrasound%26cntry=CZ%26draw=2%26rank=1.

The study received ethical approval from the Institutional Ethics Committee of the University Hospital Hradec Králové on May 25, 2021, with reference number 202106 P10. The study was conducted in accordance with the Declaration of Helsinki and relevant national regulations. Patient inclusion in the study required informed consent to participate in the clinical study. All participants provided informed consent prior to their involvement.

Results

A total of 128 patients were enrolled in the study. The characteristics of the 128 patients and 17 GPs included in the study are detailed in Tables 2 and 3. In all enrolled

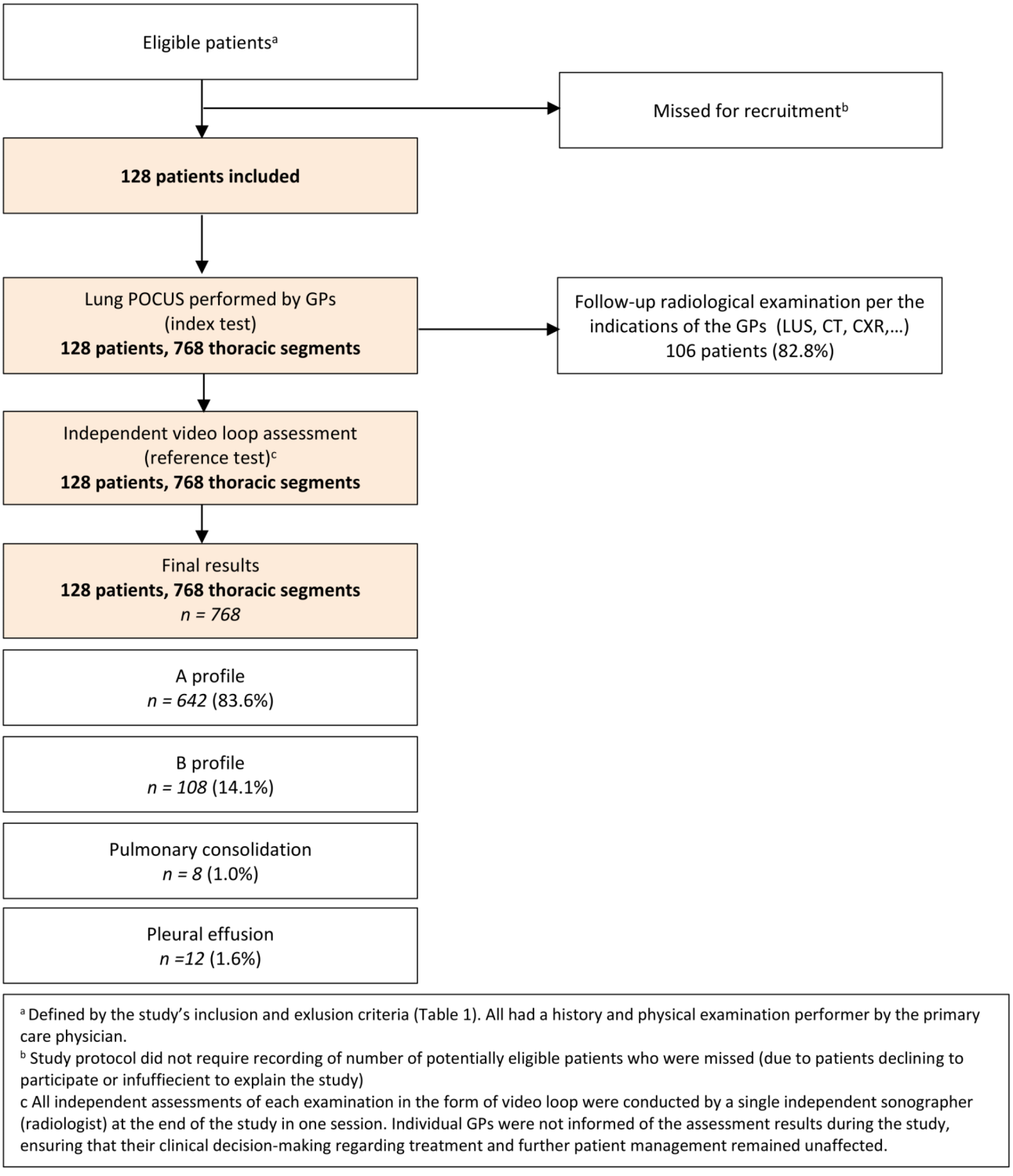


Fig. 3 Flow chart documenting participants included in the study

patients, all examined segments were successfully imaged, and all patients were included in the analysis. The age of the participants was 54.4 ± 16.1 years, 43.7% of whom were men. The average duration of the lung ultrasound examination was 257 ± 147 s. A follow-up radiological examination was indicated for 82.8% of the patients.

In 128 patients, a total of 768 thoracic segments were examined via ultrasound. Among all patients, A profile was identified in 642 (83.6%), B profile was identified in

Table 2 Characteristics of the GPs included in the study

Characteristic	No
Age	
30–40 years	7
41–50 years	7
51–65 years	3
Gender	
Male	13
Female	4
Experience as GP	
More than 20 years	2
10–20 years	10
Less than 10 years	5
Experience with ultrasound in GP	
Yes	7
No	10
Practise location	
Urban	6
Rural	11
Organizational aspects of the practice	
Single-handed	14
Group practice	3

Table 3 Characteristics of the patients included in the study ($n = 128$)

Characteristic	Value
Age, years, mean ± SD	54.4 ± 16.1
Gender, male, No. (%)	56 (43.7)
Gender, female, No. (%)	72 (56.3)

108 (14.1%), pulmonary consolidation was identified in 8 (1.0%), and pleural effusion was identified in 12 (1.6%). Table 4 summarizes the accuracy of identifying different ultrasound findings in each segment in all patients by comparing the findings observed by GPs and by expert evaluation of the recorded findings. Table 5 shows a comprehensive evaluation of the findings in the whole single lung, including comparisons between the left and right lungs.

Overall, LUS examination in primary care performed by GPs reached very high sensitivity and specificity with a substantial degree of agreement.

Discussion

Our study

A total of 128 patients were included in the clinical study, which corresponds to the anticipated sample size. The sex distribution was balanced (43.7% male, 56.3% female). POCUS examinations, as a part of routine clinical assessment, should not extend the duration of the examination. In the Czech Republic, patient consultations with GPs typically last between 5 and 15 min, and the average duration of lung ultrasonography in the study (257 ± 147 s) aligns with this condition.

Lung ultrasonography performed by GPs demonstrated high diagnostic accuracy. The sensitivity and specificity for A-profile were 97.51% and 88.10%, respectively, and for B-profile, 87.04% and 97.73%. Pulmonary consolidation (100%) and pleural effusion (99.87%) showed excellent specificity, likely due to their low prevalence in the primary care cohort.

The high specificity observed in our study reflects the unselected nature of the primary care population, where many patients lack major lung pathology. In contrast, hospital-based POCUS is applied to high-risk patients, leading to a higher prevalence of pathology. Consequently, the sensitivity estimates in our study have wider confidence intervals because of the lower number of positive cases. These findings highlight the importance of interpreting POCUS accuracy within the primary care context.

The results of other studies from primary care settings are consistent with our findings (below). Our study employed a different examination protocol (the BLUE protocol), worked with a larger patient cohort, focused on a different spectrum of patients with dyspnoea, and used a different reference criterion, an independent ultrasonographer. This approach was chosen to ensure

Table 4 Accuracy of identifying different ultrasound findings in each segment

	A profile		B profile		pulmonary consolidation		pleural effusion	
	value	95% CI	value	95% CI	value	95% CI	value	95% CI
Sensitivity (%)	97.51	95.98–98.57	87.04	79.21–92.73	100.00	63.06–100.00	83.33	51.59–97.91
Specificity (%)	88.10	81.13–93.18	97.73	96.28–98.72	100.00	99.52–100.00	99.87	99.27–100.00
Positive Likelihood Ratio (%)	8.19	5.09–13.17	38.30	23.10-63.49	-	-	630.00	87.42-4540.08
Negative Likelihood Ratio (%)	0.03	0.02–0.05	0.13	0.08–0.22	0.00	-	0.1	0.05–0.59
Positive Predictive Value (%)	97.66	96.29–98.53	86.24	79.08–91.22	100.00	-	90.91	58.12–98.63
Negative Predictive Value (%)	87.40	80.98–91.87	97.88	96.58–98.69	100.00	-	99.74	99.07–99.93
Accuracy (%)	95.96	94.32–97.24	96.22	94.62–97.46	100.00	99.52–100.00	99.61	98.86–99.92
kappa measurement of agreement (κ ± SE)	0.853 ± 0.026		0.844 ± 0.028		1.000 ± 0.000		0.868 ± 0.076	

Table 5 Comprehensive evaluation of the findings in the whole single lung, including comparisons between the left and right lungs, was performed

	A profile				**B profile**			
	right lung		**left lung**		**right lung**		**left lung**	
	value	**95% CI**	**value**	**95% CI**	**value**	**95% CI**	**value**	**95% CI**
Sensitivity (%)	97.78	92.20-99.73	95.83	89.67–98.85	88.89	73.94–96.89	96.43	81.65–99.91
Specificity (%)	92.11	78.62–98.34	96.88	83.78–99.92	97.83	92.37–99.74	97.00	91.48–99.38
Positive Likelihood Ratio	12.39	4.18–36.71	30.67	4.45-211.19	40.89	10.33-161.82	32.14	10.52–98.20
Negative Likelihood Ratio	0.02	0.01–0.10	0.04	0.02–0.11	0.11	0.05–0.29	0.04	0.01–0.25
Positive Predictive Value (%)	96.70	90.82–98.86	98.92	93.04–99.84	94.12	80.17–98.45	90.00	74.66–96.49
Negative Predictive Value (%)	94.59	81.59–98.57	88.57	74.77–95.30	95.74	89.93–98.27	98.98	93.40-99.85
Accuracy (%)	96.09	91.12–98.72	96.09	91.12–98.72	95.31	90.08–98.26	96.88	92.19–99.14
kappa measurement of agreement (κ ± SE)	0.906 ± 0.041		0.899 ± 0.044		0.882 ± 0.047		0.911 ± 0.044	
post test probability for positive result (%)	84.2		91.5		94.6		91.9	
post test probability for negative result (%)	0.8		1.4		4.5		1.4	
	pulmonary consolidation				pleural effusion			
	right lung		left lung		right lung		left lung	
	value	95% CI	value	95% CI	value	95% CI	value	95% CI
Sensitivity (%)	100.00	15.81–100.00	100.00	39.76–100.00	66.67	9.43–99.16	75.00	19.41–99.37
Specificity (%)	100.00	97.11–100.00	100.00	97.07–100.00	99.20	95.62–99.98	99.19	95.59–99.98
Positive Likelihood Ratio (%)	100.00	-	100.00	-	83.33	10.11–687.20	93.00	12.18-709.83
Negative Likelihood Ratio (%)	0.00	-	0.00	-	0.34	0.07–1.67	0.25	0.05–1.38
Positive Predictive Value (%)	100.00	-	100.00	-	66.67	19.52–94.28	75.00	28.22–95.82
Negative Predictive Value (%)	100.00	-	100.00	-	99.20	96.16–99.84	99.19	95.75–99.85
Accuracy (%)	100.00	97.16–100.00	100.00	97.16–100.00	98.44	94.47–99.81	98.44	94.47–99.81
kappa measurement of agreement (κ ± SE)	1.000		1.000		0.659 ± 0.226		0.742 ± 0.176	
post test probability for positive result (%)	97.7		97.2		97.3		97.0	
post test probability for negative result (%)	-		-		12.7		8.1	

an objective evaluation of image quality, considering it the "gold standard" in terms of the technical quality of ultrasound examination. This methodology did not allow for the assessment of the clinical interpretation of LUS findings.

The bedside lung ultrasound in emergency (BLUE) protocol, originally developed for emergency and intensive care settings, is widely used in hospital-based and prehospital environments, including ambulances and field emergencies. Given the similarities between prehospital emergency medicine and general practice - both requiring rapid assessments and broad diagnostic considerations, its adaptation for primary care was a logical step. The protocol's simplicity, portability, and high diagnostic accuracy (>85% sensitivity, >96% specificity for pulmonary oedema and pneumonia) [7] make it well-suited for routine GP practice. The use of a convex probe and six standardized scanning points, it allows efficient differentiation of pneumonia, pleural effusion, heart failure, asthma/COPD, and pulmonary embolism without prolonging the consultation time.

Since no standardized LUS protocol exists for primary care, the BLUE protocol has become the most practical and widely used LUS method in Czech general practice.

Patient positioning affects the visibility of lung ultrasound artefacts due to gravitational movement of pleural effusions and circulatory congestion. GPs primarily examine dyspnoeic patients in a seated or semi-seated position, which is common in primary care, with fewer cases in a supine position. Training emphasized that fluid shifts with gravity, making effusions more detectable in an upright position (PLAPS point) and less visible in supine patients. As GPs were specifically trained on this topic, no subgroup analysis based on patient position was conducted. This may partly explain the lower sensitivity in detecting effusions than other findings.

Limitations

(1) The main limitation of this study is that it does not assess the impact of POCUS findings on GPs' clinical decision-making. In primary care, POCUS is an extension of clinical examination rather than a standalone diagnostic tool, requiring integration with patient history and other diagnostic methods. Unlike traditional ultrasonography, which focuses on identifying patterns, GPs interpret ultrasound syndromes within the full clinical context. Our study compared ultrasound findings between GPs and expert sonographers (radiologists) to ensure objective image quality assessment rather than to evaluate the accuracy of clinical decision-making. Since diagnosis and treatment decisions are influenced by multiple factors beyond ultrasound alone, we did not track whether POCUS altered management plans or led to further radiologic testing.

(2) The relatively small sample size is a limitation of this study. Collecting high-quality primary care data is challenging due the time constraints of GPs' time and high patient turnover, which limits research participation. Despite this, our study represents one of the largest cohorts assessing LUS accuracy in primary care. While the sample size was sufficient for common findings (A-profile, B-profile), rarer findings (pleural effusion, pulmonary consolidation) would benefit from a larger cohort to increase the statistical power. The inclusion of 17 GP practices may also reflect a selection bias, as participation was likely driven by GPs with a strong interest in ultrasonography.

(3) The study did not assess GPs' ability to perform ultrasound correctly, as potential errors during POCUS examinations may not have been detected in video loop reviews. The study protocol may have introduced incorporation bias, as the reference standard relied on video recordings rather than direct examinations, with video quality potentially influencing specialist assessments. In the Czech Republic, LUS expertise is limited outside of emergency medicine and general practice, with a shortage of specialists experienced in LUS interpretation. While real-time expert evaluation could have introduced variability and logistical challenges, the use of a single expert reviewing standardized video loops ensured greater consistency and minimized interobserver bias.

(4) The study did not track the dynamics of the GPs' examination skills over time (learning curve), which presents a challenge for our further research and the development of an educational curriculum and a POCUS training school.

(5) During the study period, two waves of the COVID-19 pandemic in the Czech Republic likely contributed to a higher prevalence of B profile findings (A profile 83.6%, B profile 14.1%), necessitating adjustments in the statistical evaluation. Before COVID-19, two distinct entities of the B profile are typically assessed, each with a clear clinical impact: multiple B lines in a single area (focal B profile), indicating localized interstitial syndrome (e.g., pneumonia), and multiple B lines in multiple areas (bilateral B profile), representing diffuse interstitial syndrome, most commonly seen in cardiogenic pulmonary oedema or ARDS. However, COVID-19 and other viral pneumonias introduce atypical intermediate LUS patterns, blurring previously established diagnostic distinctions. Due to this diagnostic overlap, the B profile was analysed as a single combined entity in this study.

(6) In our study, patients with current dyspnoea (NYHA II-IV) or a history of dyspnoea in the last four weeks were included, regardless of whether they had previous consultations with other healthcare professionals. Some patients may have been seen by other specialists (e.g., pulmonologists, emergency physicians) or undergone prior imaging (chest X-ray, CT), so they may have been aware of previous medical findings, and GPs may have had knowledge of various chronic conditions from the patient's medical history. This could have potentially influenced the independent diagnostic accuracy of lung ultrasound.

POCUS of the lungs and its position in diagnosis

Many studies suggest the potential benefits of using lung POCUS in primary care and other specializations [4, 7–25, 28, 29, 36] GPs often face the challenge of making rapid, yet accurate, clinical decisions. LUS offers non invasive and real-time visualization of lung pathology. This can lead to quicker interventions, better patient outcomes, and potentially reduced healthcare costs.

In the Czech Republic, lung pathologies are typically diagnosed via chest X-rays and CT scans, which require patient transport, increasing infection risk and radiation exposure. While chest X-rays have lower accuracy and CT scans are costly, lung POCUS provides a cost-effective, portable, and radiation-free alternative, allowing for repeated bedside examinations. Currently, LUS is widely used only by GPs and emergency medicine physicians, while its adoption in other specialties remains limited. This may be due to traditional reliance on X-rays and CT scans and the lack of clear guidelines for broader implementation.

Lung ultrasound is significantly more reliable than posterior-anterior chest X-rays for diagnosing community-acquired pneumonia in adults. Meta-analyses by Ye et al. and Alzahrani et al. reported a sensitivity > 85% for lung ultrasound and a specificity > 90%, compared to chest X-ray sensitivity of 77% and specificity of 91% [7, 37]. Several studies have also demonstrated the prognostic value of lung ultrasound in COVID-19 patients [23, 38]. Pulmonary ultrasonography challenges the traditional reliance on chest X-rays as the gold standard for

pneumonia diagnosis, with chest CT being the most reliable method, followed by lung ultrasound and then chest X-ray.

LUS accuracy and main previously published studies from GP settings

Spanish study by Rodriguez et al. [27] examined 82 patients, including pediatric patients, with 28 GPs performing LUS after 40 h of abdominal ultrasound training and 5 h of lung ultrasound training. GPs scanned the entire hemithorax rather than specific static views. The reported sensitivity was 87.8% and specificity 58.5%, with chest radiography as the reference standard. Compared with lung ultrasound Chest X-rays have lower sensitivity for pneumonia detection, particularly in early stages, with findings delayed by 24–48 h. This may have resulted in false-positive POCUS findings, which were actually false-negative chest radiographs rather than LUS inaccuracies. Ideally, the reference standard should be the most reliable diagnostic tool, with CT being a more appropriate choice, although it remains less accessible in primary care.

The Danish study by Strøm et al. [29] examined 91 patients and involved 9 GPs who had completed a one-day hands-on training in focused lung ultrasound (FLUS). Using a 14-zone FLUS protocol, the study assessed GPs' ability to perform lung ultrasound for suspected community-acquired pneumonia in primary care. After training, GPs achieved acceptable image quality in more than 92% of cases, with 78% agreement on pathological findings compared to respiratory medicine specialists. The most common finding was focal B-lines, while larger consolidations were less common. Additionally, FLUS influenced diagnostic and therapeutic decisions in 32% of cases, emphasizing its clinical value and potential for broader implementation in general practice.

Conclusion

Our findings provide important preliminary data, demonstrating that GPs can perform LUS accurately after a structured training program. Future multicenter studies with an expanded patient cohort will be valuable for further validating the accuracy of LUS in primary care.

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Author contributions

DH, DZ, RM were involved in the conception and design of the study. BS review and approved the study methodology. DH, DZ, RM and BS collected the data, DH, RS conducted the analsysis. DH edited the manuscript before subsmission. All the authors have read and approved the final draft of the manuscript before submission.

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Data availability

The dataset used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study received ethical approval from the Institutional Ethics Committee of the University Hospital Hradec Králové on May 25, 2021, with reference number 202106 P10. The study was conducted in accordance with the Declaration of Helsinki and relevant national regulations. Patient inclusion in the study required informed consent to participate in the clinical study. All participants provided informed consent prior to their involvement.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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