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Review

Basic principles of ultrasound applied to infectious diseases

Principios básicos de la ecografía aplicados a las enfermedades infecciosas

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ABSTRACT

Point-of-care ultrasound (POCUS) is an increasingly valuable diagnostic tool in infectious diseases, offering real-time, bedside imaging without radiation. It enables the detection of key findings such as fluid collections, lung consolidations, abscesses, and cardiac involvement, supporting rapid diagnosis, targeted interventions, and improved outcomes. This article reviews the fundamental physical principles of ultrasound – wave propagation, acoustic impedance, resolution, and artifacts – along with technical aspects like image acquisition, probe selection, and optimization strategies. Typical sonographic appearances of pus, effusions, and vegetations are discussed, with emphasis on key interpretative elements. POCUS is presented as a clinical extension of the physical exam, enhancing bedside assessment and decision-making. Despite its many advantages, safe and effective use requires appropriate training and awareness of its limitations. This review supports the integration of point-of-care ultrasound into the diagnostic and therapeutic approach to infectious disease management.

Palabras clave:
Ecografía a pie de cama
POCUS
Enfermedades infecciosas
Imagen junto al paciente
Física de la ecografía

RESUMEN

La ecografía a pie de cama (POCUS) es una herramienta diagnóstica cada vez más relevante en las enfermedades infecciosas, ya que ofrece imágenes en tiempo real junto al paciente y sin radiación. Facilita la detección de hallazgos clave como colecciones líquidas, consolidaciones pulmonares, abscesos y afectación cardíaca, favoreciendo diagnósticos rápidos, tratamientos dirigidos y mejores resultados clínicos. Este artículo revisa los principios físicos esenciales de la ecografía—propagación de ondas, impedancia acústica, resolución y artefactos—, además de aspectos técnicos como adquisición de imágenes, selección de sondas y estrategias de optimización. También se abordan las apariencias ecográficas típicas del pus, derrames y vegetaciones, destacando elementos clave para su interpretación. POCUS se presenta como una extensión del examen físico, mejorando la valoración clínica en el punto de atención. Aunque sus beneficios son numerosos, su uso seguro requiere formación adecuada y conocimiento de sus limitaciones. Esta revisión apoya su integración como herramienta complementaria en el manejo clínico de las enfermedades infecciosas.

Introduction

Point-of-care ultrasound (POCUS) has emerged as one of the most transformative tools in bedside medicine.[1,2] It provides immediate, repeatable, and radiation-free imaging that can be directly correlated with a patient's clinical presentation. In recent years, its use has expanded beyond emergency and critical care settings, becoming an essential part of the diagnostic and therapeutic arsenal in internal medicine, particularly in the management of infectious diseases.[3,4]

Infectious syndromes often require rapid identification of complications such as pleural effusions, abscesses, endocardial vegetations, or signs of systemic involvement like hemodynamic instability. POCUS enables timely detection of these findings, frequently altering diagnostic reasoning and accelerating therapeutic decisions. Importantly, the use of ultrasound (US) at the point-of-care reduces delays associated with

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conventional imaging, avoids unnecessary patient transport, and allows for dynamic monitoring of disease progression or treatment response.[3,4]

Despite its increasing implementation, POCUS remains underused or inconsistently applied in the infectious diseases field. This may be due to limited exposure during training, variability in equipment availability, the misconception that high expertise or complex machines are required to obtain meaningful information.[5] Moreover, some members of the scientific community believe that POCUS approach is challenging, time consuming, resources loss or concern about POCUS procedures economic reimbursement and others have an important fear regarding potential medico-legal implications.[6]

Therefore, this article provides an introductory overview of the basic physical principles and technical considerations of ultrasound, with a focus on their relevance to infectious diseases. It aims to establish a shared conceptual foundation for clinicians and readers of this special issue, upon which pathology-specific applications will be developed in subsequent articles.

Core physics and imaging concepts

US imaging is based on the propagation of mechanical waves through biological tissues and the analysis of the echoes reflected from acoustic interfaces. Understanding the physical principles behind US is essential for accurate image acquisition, interpretation, and artifact recognition – particularly in the context of dynamic and heterogeneous processes such as infections.[2,7–10]

Sound wave propagation

US refers to sound waves with frequencies above 20,000 Hz, with diagnostic US imaging typically employing frequencies range between 2 and 20 MHz. These waves propagate longitudinally through tissues at a speed influenced by the tissue's acoustic impedance, a property determined by both the density of the tissue and the speed of sound within it. When US encounters a boundary between tissues with different impedance, part of the wave is reflected towards the transducer, part is refracted, part is absorbed and part spreads on the surface of the tissue: the summation of these four phenomena allows the image formation.[7,8]

The greater the impedance mismatch, the higher the amplitude of the reflected echo and the lower the transmitted energy – a relationship illustrated in Fig. 1. Soft tissues are generally assumed to have a propagation velocity of approximately 1540 m/s, a simplification embedded in the beamforming algorithms of most ultrasound machines.[7–9]

In detail, the interaction of US waves with tissues is determined by several physical phenomena:

- **Reflection** occurs at interfaces where there is a mismatch in impedance. The amount of energy reflected (echo) depends on the impedance gradient and angle of incidence. This is the basis for image generation.
- **Refraction** arises when sound waves cross an interface at an oblique angle between tissues of differing propagation velocities, resulting in beam distortion or lateral displacement.
- **Scattering** occurs with small or irregular interfaces and contributes to the characteristic speckled appearance of many tissues.
- **Attenuation** is the loss of wave amplitude as it travels through tissue, due to absorption and scattering. It increases with frequency, limiting penetration at higher frequencies.[7–10]

These interactions shape the fundamental trade-off in US: higher frequencies yield better axial resolution but poorer penetration, making them suitable for superficial structures, whereas lower frequencies provide deeper penetration with lower resolution.[7,9]

Table 1
Physical properties of tissues relevant to ultrasound propagation.

Tissue	Speed of sound (m/s)	Density (kg/m^3)	Acoustic impedance (MRayl)
Air	330	1.2	0.0004
Fat	1450	950	1.3
Water	1480	1000	1.48
Brain	1540	1030	1.6
Liver	1560	1050	1.64
Muscle	1580	1060	1.66
Bone	4000	1900	7.75

The physical properties of various tissues relevant to US propagation – including sound velocity, density, and acoustic impedance are summarized in Table 1 . Of note is the remarkable difference in acoustic impedance between air and biological tissues, which is at the origin the strong reflection and scattering observed at air–tissue interfaces. This results in poor transmission beyond gas-containing structures, causing shadowing, image dropout, or reverberation artifacts.[7–9] Clinically, this phenomenon underlies both the US limits in assessing aerated lung parenchyma and the usefulness of artifacts like the A-lines or "dirty shadowing" to infer the presence of intraluminal or subcutaneous air.[9,11]

Image formation and resolution

US images are generated by measuring the time and amplitude of returning echoes. The system assumes that sound waves travel in straight lines at a constant speed; deviations from this assumption give rise to artifacts – some diagnostically useful, others potentially misleading.[7,8]

Resolution refers to the system's ability to distinguish between two closely spaced structures and comprises several components:

- **Axial resolution** depends on the spatial pulse length and improves with higher frequencies. It determines the ability to separate structures along the path of the US beam.
- **Lateral resolution** is determined by beam width and focusing, affecting the ability to distinguish objects side by side.
- **Temporal resolution**, defined by frame rate, is critical for assessing dynamic processes such as cardiac motion, vascular pulsatility, or bowel peristalsis.[7–9]

In addition, the field of view and slice thickness influence the ability to detect small or anechoic infectious foci. These parameters are particularly relevant when assessing subtle collections, abscesses, or fluid layers, where limited resolution or inappropriate probe selection may lead to misinterpretation.[7,8,10]

Modes of ultrasound imaging

B-mode (brightness mode) is the foundational imaging modality. It provides a bidimensional grayscale image where the brightness of each pixel corresponds to the amplitude of the returned echo. B-mode enables real-time visualization of organ structure, interfaces, and pathologies such as fluid collections, consolidations, or soft tissue abnormalities. It is the default mode in most POCUS applications and forms the basis for other advanced modalities.[7,11]

M-mode (motion mode) displays the movement of structures along a single scan line over time. It is particularly useful in settings where precise temporal resolution is needed, such as assessing lung sliding in pneumothorax diagnosis or quantifying cardiac wall motion. In lung POCUS, the presence of the "seashore sign" on M-mode confirms normal parietal and visceral pleural apposition, whereas a "barcode" or

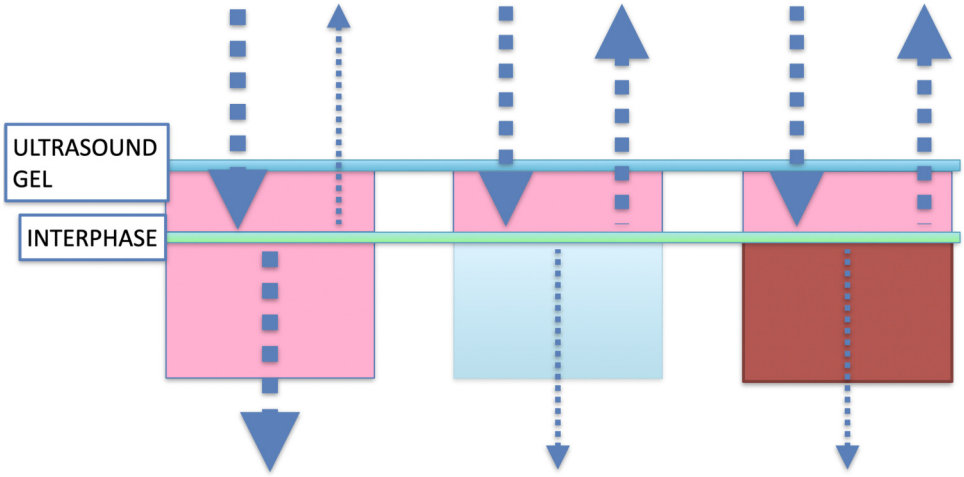


Fig. 1. Acoustic impedance, tissue interface, and echo amplitude. When an ultrasound wave encounters a boundary between two tissues with different acoustic impedance, a portion of the wave is reflected while the rest continues to propagate. The greater the impedance difference between the two media, the higher the amplitude of the reflected echo and the lower the proportion of sound transmitted across the interface.

"stratosphere" sign is indicative of pneumothorax. In patients with suspected pleuritis or pericarditis, M-mode may aid in confirming the presence and dynamics of effusions.[7,9,11]

Doppler US is used to evaluate the presence, direction, and fluid flow speed. While not always essential in POCUS, its use can provide valuable information in selected infectious disease contexts. Color Doppler superimposes flow information on the B-mode image, allowing visualization of vascular patterns within inflammatory masses or verifying vascularity in lymph nodes or suspected abscesses. Power Doppler, more sensitive to low-velocity flow, is useful in poorly perfused or small-caliber vessels. Pulsed-wave Doppler provides spectral analysis and quantification of flow velocity at a specific point, occasionally helpful in evaluating vascular complications of infection (e.g., thrombosis, hyperemia).[7,8,11]

Artifacts relevant to infection

US artifacts, traditionally considered like imaging limitations, can offer valuable diagnostic information, particularly in infectious diseases. Understanding their physical basis and distinguishing features helps clinicians differentiate between true pathology and misleading appearances. Fig. 2 summarizes the most relevant artifacts, their underlying mechanisms, typical sonographic appearances, and clinical implications in infectious contexts.[3,11–14]

Image acquisition and optimization

The reliability POCUS depends not only on its correct indication, but on the acquisition of high-quality images and the ability to interpret them within the clinical context. Sub-optimal technique can lead to false reassurance, misdiagnosis, or missed complications. A structured approach to image acquisition – including appropriate probe selection, patient positioning, machine setting adjustments, and scanning technique are essentials for optimize diagnostic result, especially in infectious disease scenarios where subtle findings may have significant clinical implications.[7–9]

Probe selection and ergonomics

Selecting the appropriate probe is essential to optimize image quality and diagnostic accuracy. Transducers differ in frequency, footprint, image shape, and penetration depth, which determine their suitability for different clinical applications. A comparative overview of probe types, technical characteristics, and infectious disease uses is summarized in Fig. 3.[8,9,15,16]

Proper ergonomics are also critical, especially during prolonged or repeated scans. The transducer should be held lightly between the fingers to allow fine motor control, with machine controls positioned within easy reach. The orientation marker must consistently align with the screen convention, typically to the left of the screen or superior aspect in longitudinal views, to allow consistent interpretation.[8,11,16]

Machine settings and image optimization

Most US machines offer a wide range of adjustable parameters, many of which directly influence image quality. Understanding and manipulating these controls is essential to differentiate normal anatomy from pathological findings.[8,11,15,16]

- **Depth** should be adjusted so that the structure of interest is centered and occupies at least half the vertical field. Overly deep settings reduce frame rate and resolution; insufficient depth may omit relevant distal findings such as posterior enhancement or shadowing.
- **Gain** controls the overall brightness of the image by amplifying returning echoes. Uniform gain settings may fail to account for differential attenuation at depth. Time-gain compensation (TGC) allows selective amplification by depth, enabling balanced brightness across the image and facilitating detection of both superficial and deep pathology.
- **Focus** improves lateral resolution at a specific depth and should be set at or just below the target structure. Failure to position the focus appropriately leads to blurred or poorly defined images, particularly problematic in evaluating small abscesses, vegetations, or lymph nodes.
- **Dynamic range** determines the grayscale compression: a low dynamic range produces a high-contrast image useful for outlining abscess walls or fluid–tissue interfaces, whereas a high dynamic range better reveals subtle gradations within edematous tissues.
- **Harmonic imaging** enhances image clarity by filtering out side-lobe artifacts and improving signal-to-noise ratio. It is particularly useful in obese patients or when evaluating poorly defined lesions.

Preset configurations (e.g., "lung," "abdomen," "vascular") provide convenient starting points, but manual fine-tuning is often necessary during the exam because it allows the physician to best optimize the image.

Operators should be prepared to adjust settings dynamically as they scan, especially when moving from fluid-filled to air-filled or calcified structures.[8,16]

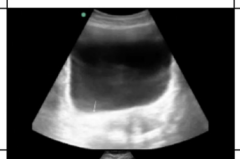
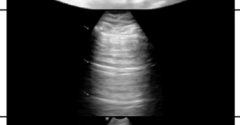
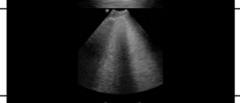
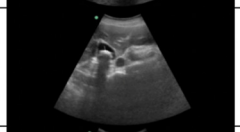
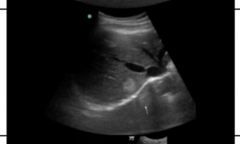
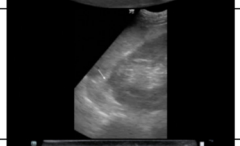
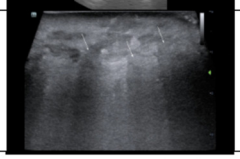
Artifact	Image	Sonographic appearance	Mechanism	Relevance and pitfalls
Posterior acoustic enhancement		Increased echogenicity distal to anechoic/hypoechoic area.	Low attenuation through fluid; more sound reaches distal tissues.	Suggests abscess, infected cyst, complex fluid collection, or empyema. May mimic hypervascular tissue; confirm with compressibility or Doppler.
Reverberation (A-lines)		Equally spaced horizontal lines fading with depth.	Repeated reflection between strong reflectors (e.g., soft tissue–air interface).	Seen in subcutaneous emphysema, gas-forming infections, or normal aerated lung. Must not be confused with B-lines (pathological vertical
Comet-tail / Ring-down		Bright vertical streaks extending without fading.	Resonance of closely spaced interfaces or gas bubbles.	Strongly associated with emphysematous infections, gas in abscesses, or necrotizing infections.
Acoustic shadowing		Dark anechoic area behind dense/reflective structure.	Sound is completely absorbed or reflected.	Seen with gas, calcified granulomas, parasitic cysts, or foreign bodies. Deep structures may be obscured; use multiple angles.
Mirror image		Duplication of structure across a reflective interface (e.g., diaphragm).	Beam reflected off curved highly reflective surface.	May simulate thoracic masses, subdiaphragmatic abscess, or consolidation. Confirm with anatomical consistency; disappears with angle change.
Edge artifact (refraction shadow)		Linear hypoechoic shadow projecting from rounded structure margins	Refraction and divergence at fluid–tissue interface.	Supports fluid content in cysts, necrotic tumors, or abscesses. Can be mistaken for septations or loculations.
Dirty shadowing		Heterogeneous shadow with mixed echoes behind gas-filled area.	Partial reflection/scattering from gas bubbles.	Seen in bowel gas, gas gangrene, or gas-forming abscesses. Differentiates from clean shadow (e.g., bone or calcification).

Fig. 2. Ultrasound artifacts and their relevance in infectious disease settings.

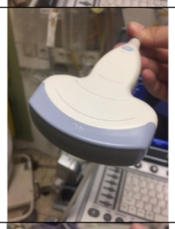
Transducer	Image	Frequency (MHz)	Image Shape	Depth Resolution	Typical uses in infectious diseases	Strengths	Limitations
Linear		7–15	Rectangular	Superficial (0–5 cm)	Cellulitis, superficial abscesses, lymphadenitis, vascular access, necrotizing fasciitis.	High resolution; fine detail of soft tissue and vessels.	Limited penetration; not suitable for thoracic/ abdominal imaging.
Curvilinear		2–5	Wide convex arc	Intermediate to deep	Intraabdominal abscesses, pyelonephritis, cholecystitis, peritoneal fluid, lung ultrasound, pleural effusions.	Wide field of view; good penetration.	Lower resolution for superficial structures.
Phased-array		1–5	Sector (fan-shaped)	Deep (narrow access)	Lung ultrasound, pericardial effusion, endocarditis screening, septic cardiomyopathy	Small footprint; ideal for cardiac and intercostal windows.	Lower spatial resolution; learning curve for interpretation.

Fig. 3. Probe types and their applications in infectious disease ultrasound.

Scanning technique

A systematic scanning technique, combined with appropriate patient positioning, is essential to optimize image quality, ensure diagnostic accuracy, and accommodate the variable clinical conditions seen in infectious diseases. Each anatomical region should be evaluated in at least two orthogonal planes – typically longitudinal and transverse – to characterize lesions and avoid mistaking artifacts for pathology. Probe movements should be deliberate and multidimensional, including sliding, tilting, rotating, and fanning, and should incorporate graded compression when evaluating soft tissue or bowel.[8,11,16]

Optimal acoustic windows are influenced by patient positioning. While supine positioning is often sufficient, lateral decubitus, upright posture, or limb elevation can markedly improve visualization of target structures. This is especially relevant in patients with soft tissue infections, intraabdominal collections, or pleural effusions. In cardiac imaging, the left lateral decubitus view improves apical visualization, though may not be feasible in unstable or dyspneic patients. Dynamic elements such as respiratory motion and vascular pulsation can help confirm findings, particularly when patient cooperation is limited.[3,11,17]

A practical summary of recommended transducer types, ultrasound modes, and patient positions for common infectious scenarios is provided in Table 2 .[3,11,17,18]

Interpretation fundamentals in infectious contexts

US interpretation in infectious diseases relies on recognizing a limited set of sonographic patterns that reflect underlying pathological processes such as fluid accumulation, tissue inflammation, gas formation, or necrosis. These core findings appear across diverse infections and can be reliably identified with focused training. Fig. 4 outlines the most relevant and recurring ultrasound appearances encountered in infectious disease evaluation.[3,17–24]

POCUS as an extension of the physical exam

POCUS is increasingly regarded as a "fifth pillar" of the physical exam – complementing inspection, palpation, percussion, and auscultation – by providing real-time, bedside information that enhances diagnostic accuracy, especially when classical signs are subtle or absent in infectious diseases.[25,26] Rather than replacing traditional methods, POCUS augments them by allowing immediate hypothesis testing: Is there fluid? Is there an abscess? Is cardiac function preserved?[11,17,18]

Its focused, question-driven nature aligns with clinical reasoning and enables rapid decision-making. For example, lung ultrasound can identify consolidation, effusion, or interstitial syndrome in febrile patients with respiratory symptoms, while in hypotensive patients, it helps assess preload, cardiac function, or detect tamponade or right ventricular strain.[11,17,18]

POCUS enhances the sensitivity of bedside assessment beyond what auscultation or percussion can detect.[18] Small pleural effusions (as little as 5–20 mL) or posterior consolidations may go unnoticed without ultrasound.[19,20] In elderly or immunosuppressed patients, where abdominal tenderness may be absent, POCUS can reveal signs of peritonitis or localized perforation through bowel wall thickening, free fluid, or abscesses.[11,23]

In endocarditis, where physical signs are often late or nonspecific, POCUS can identify vegetations or pericardial effusion, prompting more comprehensive echocardiographic evaluation.[3,24]

By integrating sonographic findings with clinical and laboratory data, POCUS expedites diagnosis, source control, and targeted therapy. Serial exams allow dynamic monitoring of disease course and response to treatment. Critically, it also supports antimicrobial stewardship by helping distinguish bacterial from non-bacterial infections and confirming resolution before de-escalation.[3,11,17,18]

Limits and operational considerations

US is a safe imaging modality that uses no ionizing radiation and carries negligible biological risk, making it particularly suitable for repeated bedside use in infectious disease settings, including in vulnerable populations such as children, pregnant women, or critically ill patients.[7–9] However, its apparent simplicity and accessibility may foster overconfidence, overuse, or misinterpretation if its inherent limitations are not properly recognized.[27]

Operator dependency and learning curve

POCUS is highly operator-dependent. Image acquisition, interpretation, and clinical integration require dedicated training, hands-on practice, and ongoing feedback. Misinterpretations may stem from poor technique, inappropriate settings, or limited anatomical knowledge and they waste precious time and credibility. Novice users are especially prone to mistaking artifacts for pathology or missing subtle but clinically important findings. The learning curve varies across applications. Soft tissue and pleural assessments are relatively straightforward, while cardiac, abdominal, or vascular evaluations demand more advanced skills. Without structured education and supervision, the risk of diagnostic error increases significantly.[2,4,5,27–29]

Technical and anatomical limitations

Various factors may compromise image quality and diagnostic performance. These include unfavorable body habitus, subcutaneous emphysema, surgical dressings, bowel gas, or distorted anatomy. Infections located in deep or retroperitoneal compartments may fall outside the reach of ultrasound, requiring complementary imaging modalities such as CT or MRI. Similarly, small vegetations, early abscesses, or initial stages of osteomyelitis may be below the resolution threshold of POCUS.[3,5,17]

Artifacts may also confound interpretation if not properly identified. Mirror images, posterior shadowing, and acoustic enhancement can simulate or obscure pathology. Familiarity with typical artifact patterns and the use of multiple scanning planes help reduce false positives and negatives.[11–14]

Scope of practice and clinical integration

POCUS reinforces clinical judgment and enhances the physical examination[25,26] but must be used with a clear understanding of its scope and constraints. It does not replace comprehensive imaging when warranted, nor can it substitute for microbiological data, laboratory testing, or surgical evaluation. Rather, it complements these by providing rapid, focused information that guides early clinical decisions.[2,5,25–27]

A negative scan does not rule out infection. In a febrile patient, a normal US should not deter further investigation if clinical suspicion remains high. Conversely, positive findings must be interpreted within the broader clinical context to avoid premature diagnostic closure or anchoring bias.[3,11,17]

US practice requires proper documentation, structured reporting, and a low threshold to escalate care or pursue additional diagnostics when uncertainty persists.[25–29]

Ultrasound machine and probes safety and disinfection

An important aspect that must not be overlooked when using POCUS – particularly in the management of infectious diseases – is the protection of the equipment and its proper sanitization, especially given the documented correlation between infection outbreaks and improper use of ultrasound devices.[6,30,31]

The experience gained during the SARS-CoV-2 pandemic, when lung ultrasound played a crucial role in managing patients with COVID-19-

Table 2
Recommended probe–mode–position combinations for common infectious scenarios.

Infection type	Ideal probe	Most useful modes	Recommended patient position	Notes
Pneumonia/ARDS	Phased-aray or curvilinear	B-mode, M-mode	Supine or semi-upright	Intercostal windows; posterior zones best in sitting/lateral position.
Pleural effusion/empyema	Curvilinear	B-mode, Doppler	Sitting or lateral decubitus	Free fluid layers posteriorly; color Doppler helps differentiate from consolidation.
Intraabdominal abscess	Curvilinear	B-mode, graded compression	Supine	Consider decubitus to displace bowel gas.
Cholecystitis/cholangitis	Curvilinear	B-mode, color Doppler	Supine or left lateral decubitus	Assess wall thickening, Murphy sign, pericholecystic fluid.
Cellulitis/superficial abscess	Linear	B-mode, compression	Supine, with limb elevated or abducted	Compression differentiates phlegmon from abscess.
Necrotizing fasciitis	Linear	B-mode	Supine	Look for subcutaneous gas, fascial fluid.
Endocarditis	Phased-array	B-mode, color Doppler, M-mode	Left lateral decubitus (if tolerated), otherwise supine	Focused cardiac views; may require multiple windows.
Pyelonephritis/renal abscess	Curvilinear	B-mode	Supine	Posterior acoustic window; flank tenderness may guide probe placement
Septic arthritis/tenosynovitis	Linear	B-mode, color Doppler	Supine or position allowing full joint extension	Compare with contralateral side; joint effusion vs. synovial thickening.

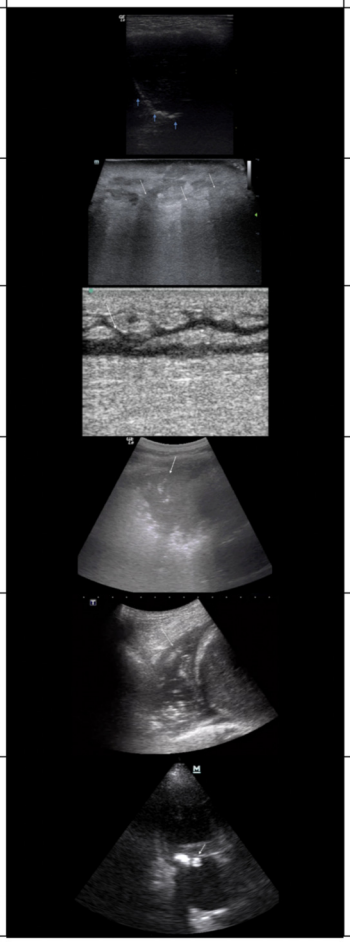
Sonographic pattern	Image	Appearance	Suggestive of	Key differentiators
Hypoechoic fluid collection		Anechoic or with internal echoes; posterior enhancement.	Abscess, empyema, infected cyst.	Non-compressible; hyperemic rim; debris or septations.
Dirty shadowing / reverberation		Hyperechoic foci with shadowing or repeating lines.	Gas-forming infections, subcutaneous emphysema	"Dirty" (heterogeneous) vs. "clean" shadow (e.g., bone); A-lines.
"Cobblestone" subcutaneous tissue		Hypoechoic edema separated by echogenic septa.	Cellulitis	Compressible; absence of discrete collection.
Lung hepatization		Homogeneous, liver-like parenchyma with dynamic air bronchograms.	Pneumonia	Differentiates from atelectasis (no movement in air bronchograms).
Anechoic pleural/ pericardial effusion		Free or loculated fluid around lung or heart; may contain echoes if infected.	Empyema, pericarditis	Use of dependent views; septations or debris suggest infection.
Mobile echogenic mass on valve		Irregular mass attached to valve leaflet, often oscillating.	Endocarditis	Better seen in TEE; correlates with embolic risk and bacteremia.

Fig. 4. Core ultrasound findings in infectious diseases.

related interstitial viral pneumonia,[32] highlighted not only the added value of POCUS but also the imperative to avoid further spreading infectious agents.[33]

As a first measure, it is essential to cover ultrasound probes when used on skin with open lesions or wounds, during US-guided vascular access cannulation, due to the potential risk of accidental blood contamination, and in any situation where there is a potential risk of infectious disease transmission.

In addition, good medical practice – aligned with recommendations from the World Health Organization (WHO) and the American Institute of Ultrasound in Medicine (AIUM) – calls for thorough cleaning, disinfection, and decontamination of ultrasound machines and probes both before and after each use, to ensure the safety of both patients and healthcare professionals.[34,35]

Conclusions and future perspectives

POCUS has emerged as a transformative tool in the management of infectious diseases. Its capacity to deliver real-time, repeatable, and radiation-free imaging at the bedside improves diagnostic accuracy, expedites source identification and control, and contributes meaningfully to antimicrobial stewardship. When integrated into the physical examination, it allows clinicians to identify complications earlier, perform interventions with greater precision, and dynamically monitor disease progression and treatment response.

A solid grasp of US physics, image optimization techniques, and common artifacts is essential for effective practice. Equally important are a clear understanding of its limitations, structured training pathways, and deliberate clinical integration. Used thoughtfully, POCUS serves as a bridge between clinical suspicion and prompt, evidence-informed decision-making.

With ongoing technological advances and increasing availability of handheld devices, the reach of POCUS in infectious disease care will likely continue to grow. Key future directions include the development of standardized training curricula, formal incorporation into diagnostic and therapeutic guidelines, and expanded research into its clinical and economic impact. This special issue aims to provide the foundational knowledge and practical tools needed to support this evolving paradigm and foster the safe, effective, and evidence-based use of POCUS in infectious diseases. Moving forward, professional societies and healthcare institutions must take a leading role in developing evidence-based curricula, ensuring that all clinicians – not just early adopters – acquire the competencies required to use POCUS effectively and safely. With appropriate investment in education and research, POCUS will not only complement but also elevate the standard of care in infectious disease management.

Institutional review board statement

The study was conducted in accordance with the Declaration of Helsinki.

Informed consent

No informed consent was necessary.

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Data availability

Not applicable.

Conflicts of interest

The authors declare no conflict of interest.

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