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Opinion Article

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Point-of-Care Ultrasound in Nephrology: A Message from Young Nephrologists

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ABSTRACT

Point-of-care ultrasound (POCUS) is emerging as a valuable adjunct tool to medical history and physical examination, enhancing the diagnosis and management of diseases. Even though it was initially concentrated in intensive care units and emergency departments, its application has now expanded to various medical specialties, including nephrology. Point-of-care ultrasound has become very useful in the assessment of native and graft kidneys, arteriovenous access assessment, procedural guidance, and the objective evaluation of volume status, which sometimes might be clinically difficult. Notably, it has been quite useful in volume assessment in patients with chronic liver disease and acute kidney injury. The incorporation of POCUS into nephrology education and practice has gained a momentum, and Portugal has set a good example. Despite its various challenges and limitations, as a group of young nephrologists, we believe that a structured training program for POCUS is needed, which will culminate in its wide adoption in daily practice.

Keywords: Point-of-care ultrasound, POCUS, volume assessment

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What is Point-of-Care Ultrasound?

Point-of-care ultrasound (POCUS) represents a cutting-edge approach in medical diagnostics, utilizing portable ultrasound devices to conduct real-time imaging directly at the patient's bedside. Unlike traditional ultrasound procedures, which are typically conducted by specialized physicians within dedicated imaging departments, POCUS enables frontline clinicians to swiftly acquire diagnostic information during the physical examination process. Its versatility spans various medical disciplines, including nephrology, emergency medicine, critical care, and cardiology.[1] Immediate feedback provided by POCUS facilitates a rapid assessment of anatomical structures and physiological functions, thereby facilitating prompt decision-making in various clinical scenarios. Point-of-care ultrasound has emerged as an indispensable tool for expedited evaluations, procedural guidance, and patient monitoring across diverse clinical settings, significantly enhancing the delivery of patient care due to its accessibility and immediacy.

In the realm of nephrology, POCUS finds extensive application in the assessment of native and graft kidneys, objective evaluation of volume status, arteriovenous access assessment, and procedural guidance (Figure 1).[2,3] Moreover, POCUS has demonstrated efficacy in enhancing clinicians' ability to recognize and interpret ultrasound images, underscoring its potential utility in medical education and training programs.[4,5] The increasing adoption of POCUS within nephrology

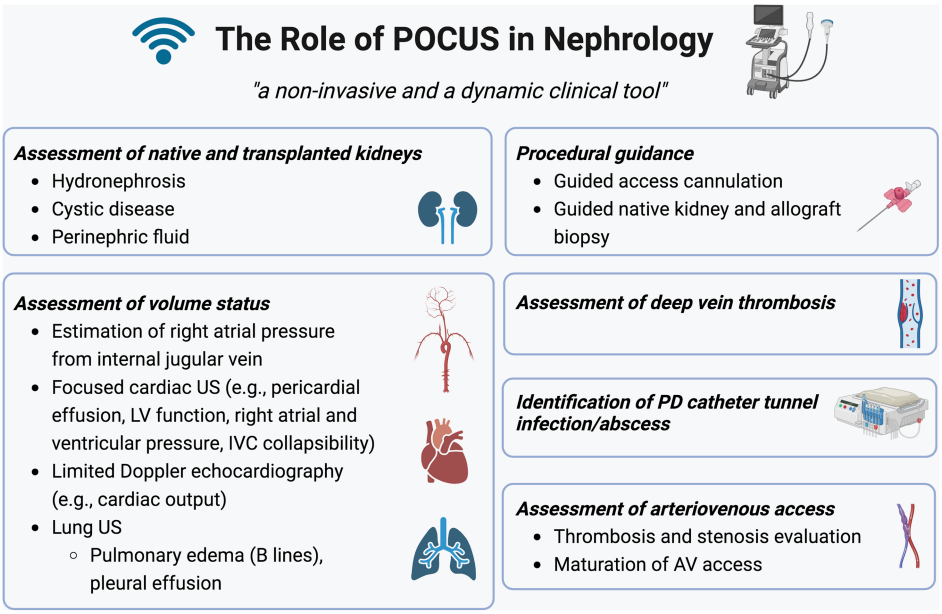

Figure 1. POCUS and its current and potential applications in nephrology. Created with BioRender.com. AV, arteriovenous; IVC, inferior vena cava; LV, left ventricle; POCUS, point-of-care ultrasound; PD, peritoneal dialysis; US, ultrasound.

is evident from recent trends, as evidenced by a national survey in the United States highlighting its expanding role and its integration into nephrology fellowship training programs.[6] However, challenges persist in the widespread implementation of POCUS, including limited prior experience among residents and barriers to its seamless incorporation into routine clinical practice.[7]

Use of Point-of-Care Ultrasound in Daily Practice

Point-of-care ultrasound enhances the physical exam with real-time ultrasonographic information, becoming the fifth pillar alongside inspection, palpation, percussion, and auscultation. While specialties such as emergency medicine, anesthesiology, cardiology, and several others have long integrated POCUS into their daily routines, its adoption in nephrology is just beginning.[8] This is especially true in Türkiye, where its potential is yet to be fully realized.

MAIN POINTS

- Point-of-care ultrasound represents a cutting-edge approach in medical diagnostics, utilizing portable ultrasound devices to conduct real-time imaging at the bedside.
- It has started to become the fifth pillar of physical examination, alongside inspection, palpation, percussion, and auscultation.
- In nephrology, it finds extensive application in the assessment of native and graft kidneys, objective evaluation of volume status, arteriovenous access assessment, and procedural guidance.
- Implementation of POCUS into nephrology training and practice has clearly gained momentum.
- A structured training program for POCUS is needed in our country, which is expected to lead to its wide adoption in daily clinical practice.

Point-of-care ultrasound assists nephrologists in managing a broad spectrum of clinical situations, from outpatients to critically ill individuals in the intensive care unit (ICU). Basic training allows for the quick dismissal of postrenal causes of acute kidney injury (AKI) and straightforward evaluation of kidney size. These capabilities expedite care and minimize the need for extensive radiologic studies. Although the aim is to obtain the highest quality images with the best technique possible, this is not always feasible. Hence, POCUS does not replace formal diagnostic and detailed ultrasonographic studies when required.[9] Beyond ultrasound examination of the urinary tract, POCUS extends to evaluating arteriovenous fistulas (AVFs) and pre-creation vessel assessment.[10] With proper training, it has been shown that it can even predict the risk of preeclampsia by measuring the resistivity index of the ophthalmic artery.[11]

Volume status assessment, which is crucial in nephrology, is greatly enhanced by POCUS. Traditional physical exams often fall short in evaluating volume overload in our patients, including those in the ICU. Point-of-care ultrasound improves congestion detection through lung and vascular ultrasound, focused echocardiography, and assessments of portal vein pulsatility or kidney venous impedance index. Notably, it has been found to be quite useful for volume assessment in patients with chronic liver disease and AKI, further preventing unguided volume expansion which may lead to premature or delayed diagnosis of hepatorenal syndrome.[12] Nevertheless, these techniques require a higher degree of education.[10] With the invention of

high-quality hand-held devices, they can also be employed in consultation for patients outside the nephrology wards. Point-of-care ultrasound also plays a vital role in guiding nephrology procedures, such as ultrasound-guided kidney biopsies and central venous catheter insertions. These common practices have improved safety and efficacy, leading to reduced complications and better outcomes.[13] Here, we have provided a glimpse of the use of POCUS in daily practice with 2 clinical pearls.

Clinical Pearls

Case 1: Basic POCUS

A 72-year-old male patient in the cardiovascular ICU was consulted for diuretic resistance. Following a fairly uncomplicated coronary artery bypass grafting 7 days ago, his urine output dropped considerably despite increased doses of loop diuretics. A poor-quality image obtained by the consultant nephrologist with a hand-held device revealed a distended bladder, leading to the diagnosis of urinary retention (Figure 2). The distended bladder may sometimes not be detected by physical examination, especially in obese patients. On the contrary, the use of POCUS may also prevent unnecessary bladder catheterization before the imaging. The patient was discharged home with his preoperative serum creatinine levels after a Foley catheter placement. This case demonstrates how basic POCUS can significantly alter patient care, even with suboptimal image quality.

Case 2: Advanced POCUS

A 60-year-old male patient from another medical center without a nephrologist was consulted before a coronary angiogram since his serum creatinine level was 1.45 mg/dL. Edema was found in the examination, which led to a focused cardiac evaluation. The images showed a severely thickened left ventricle. Furthermore, the nephrologist recognized a granular appearance of the myocardium and a very small left ventricular cavity despite a preserved ejection fraction, which altogether raised the possibility of cardiac amyloidosis. The consultant cardiologist was notified and demonstrated all typical findings of cardiac amyloidosis using echocardiography (Figure 3). The coronary angiogram was canceled, and the patient was diagnosed with plasma cell leukemia causing cardiac amyloidosis. This case shows how advanced POCUS with high-end technology can aid in patient management.

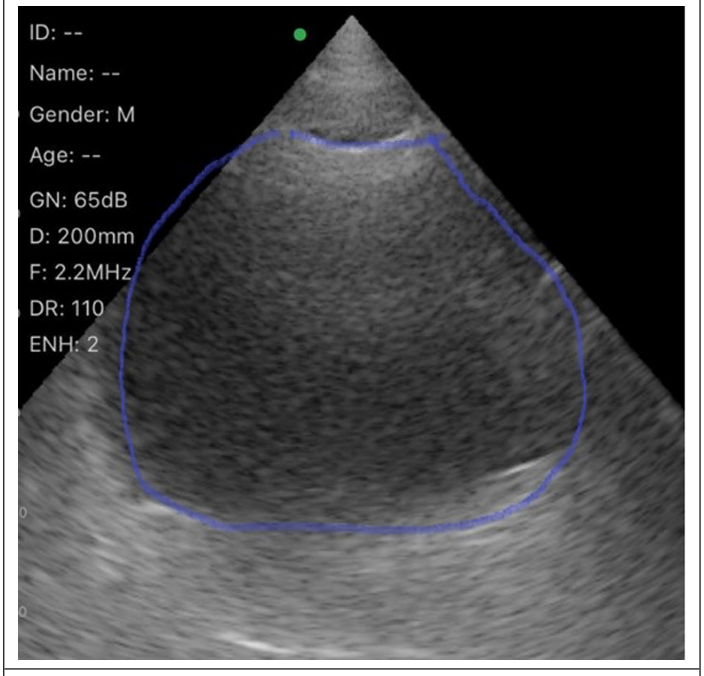

Figure 2. Suprapubic image with suboptimal quality. The purple circle shows the borders of the bladder. Written informed consent was obtained from the patient.

Implementation of Point-of-Care Ultrasound into Nephrology Training and Practice

The incorporation of POCUS into nephrology education and practice has gained a momentum. Several institutions in the United States, Canada, and Europe have integrated POCUS into medical school curricula and nephrology fellowship training programs.[14,15] However, to the best of our knowledge, neither the European nor the American nephrology boards have established a competency guide for this practice. Despite the increasing interest in POCUS, in many centers, practices are often conducted through short workshops or rotations in other specialties such as emergency medicine and intensive care due to the lack of experienced faculty and equipment.[9] To establish a successful POCUS program, there is a primary need for experienced and enthusiastic faculty members. Moreover, the inclusion of new procedures and diagnostic methods, especially POCUS, can potentially increase the interest in nephrology education, which has been declining in recent years. Below, we look at the example of Portugal, a country with more established POCUS training programs.

Example of Portugal

In Portugal, the integration of POCUS into clinical practice varies significantly across medical specialties. While it has become

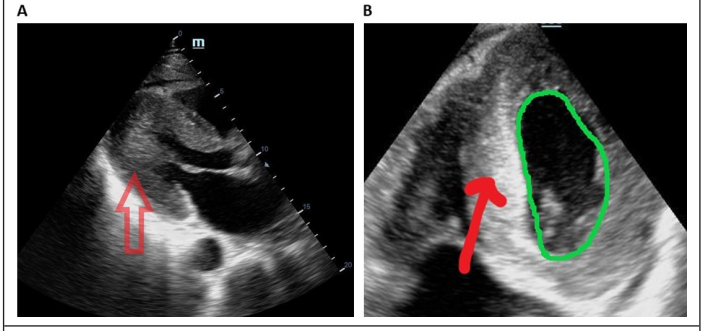

Figure 3. (A) Parasternal long-axis view, showing a severely thickened left ventricle and septum (red arrow). (B) A close-up image from an apical 4-chamber view. Concentric hypertrophy of the left ventricle is noted. The red arrow shows granular appearance of the myocardium, whereas very small ventricular cavity is marked with green. Written informed consent was obtained from the patient.

mandatory for intensive care trainees, nephrology has been slower to adopt this practice.[16] Also, in internal medicine, dedicated training programs for POCUS are integrated into the residency curriculum, reflecting its crucial role in emergency and critical care scenarios.[17,18] Conversely, nephrology training traditionally emphasizes ultrasound mostly for procedural guidance. Despite nephrologists' routine use of ultrasound for vascular access assessment and mapping in Portugal, formal POCUS training has not been integrated into the standard curriculum as well.[19] Consequently, those interested in POCUS within nephrology have historically sought fragmented training opportunities abroad due to the absence of structured programs domestically.[8]

However, in late 2021, the landscape of POCUS training for nephrologists in Portugal began to evolve with the introduction of the first immersive course designed specifically for them by POCUSX. This comprehensive course, titled "Nephrology-applied Point-of-care Ultrasound," is tailored for individuals without prior POCUS experience. It employs a blended learning approach encompassing theoretical modules on basic ultrasonography principles, kidney and bladder ultrasound, lung ultrasound, basic echocardiography (FOCUS), and POCUS related to dialysis access.[20] The practical component of the course features a full-day session with hands-on training on healthy models and kidney patients, complemented by case discussions. The small group sizes ensure personalized instruction, maintaining a trainer-to-trainee ratio of 1:4. After completing the course, participants gain access to an online community facilitated by the course instructors, fostering continuous learning, image sharing, and case discussions.

The curriculum aligns with recommendations from the American Society of Diagnostic and Interventional Nephrology (ASDIN) for basic POCUS training for nephrologists, attracting over 120 participants, primarily nephrology residents.[21] This enthusiastic response underscores the growing demand for POCUS within the nephrology community in Portugal, although facilitated by a sponsor from a pharmaceutical company.

Despite the success of dedicated POCUS training initiatives, its integration into routine clinical practice remains limited due to a lack of mentorship and equipment access.[22] Innovative solutions like POCUS teams offering POCUS as a "service" have been proposed, where POCUS experts provide on-demand bedside evaluations and guidance.[23-25] Leveraging the expertise of interventional nephrologists in ultrasound, this model has shown promise in emergency settings and could catalyze broader POCUS adoption within nephrology departments. Furthermore, the increasing availability of portable and cost-effective ultrasound devices is facilitating POCUS uptake, especially in outpatient dialysis units. Several major private dialysis providers in Portugal are either deploying or in the process of acquiring portable ultrasound equipment for their clinics, signaling a broader trend toward ultrasound integration at the point of care.

Limitations

Point-of-care ultrasound is operator dependent, although this limitation applies to all examinations provided with ultrasound. This includes not only the application of the technique but also its correct interpretation and inclusion in the disease management process. This limitation further increases the significance of expertise and adequate training. False positive and negative results and incidental findings without proper clinical context have reached 20% in various studies.[26] Misinterpretations and incidental findings may prolong the diagnostic process, delay treatment, and cause anxiety and increased costs for patients through unnecessary examinations. From the patients' perspective, pathological findings, difficult maneuvers, and lack of privacy might result in a negative experience, especially during severe illness.[27] Fear of missed diagnosis and wrong interpretation are the most important concerns for nephrologists as well.[28] Notably, while this technique can be time-consuming, it is necessary to ensure that this examination is carried out with the same effectiveness in a shorter period of time.[29]

From the evidence perspective, the effects of POCUS on clinical outcomes and mortality still remain elusive compared to the conventional clinical approach.[30] Methodological problems such as heterogeneous and small patient populations and a lack of standardized methods lead to a high risk of bias and a low level of evidence.[31] In addition, the findings of these studies conducted with selected patients may not be adaptable to the general population.

Moreover, the lack of POCUS guidelines for nephrologists, which could eliminate many of the mentioned barriers, remains a major impediment to the embracement and implementation of this skill. Another obstacle to the widespread use of POCUS is the availability and cost of the equipment, especially in developing countries. Currently, handheld devices are priced between $2000 and $15 000.[32] While these prices may seem high, it should be noted that they are much cheaper than cart-based ultrasound devices, which are usually priced from $20 000 to more than $100 000.[33] Notably, POCUS has been reported to decrease healthcare costs by at least $1000 to $2000 per patient by reducing unnecessary requests from radiology.[34] In acute heart failure settings, the implementation of POCUS has also been associated with shorter hospital stays, thereby further decreasing costs.[35] Cost-effectiveness of POCUS still remains to be fully demonstrated with further studies focusing on the aforementioned aspects.

A Message from Young Nephrologists

In conclusion, POCUS offers nephrologists a powerful tool to enhance patient care by providing immediate bedside information. As technology advances and more nephrologists gain proficiency in POCUS, its role in nephrology is expected to grow,

improving diagnostic accuracy and patient outcomes despite suffering from several challenges and limitations in its current form of practice. A structured training program encompassing both theoretical and practical components is essential for its effective use in the nephrology community.[36] Unfortunately, we currently lack this crucial curriculum aspect in Türkiye. Therefore, as a group of young nephrologists, we believe that it is time to act now.

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Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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