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REPORTS OF ORIGINAL INVESTIGATIONS

Point-of-care ultrasonography in Ukraine: a survey of anesthesiologists-intensivists participating in ultrasonography courses

L'échographie ciblée en Ukraine : une enquête auprès des anesthésiologistes-intensivistes participant à des cours d'échographie

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Abstract

Purpose *Despite the potential value of point-of-care ultrasonography (POCUS) in resource-limited environments, it is not widely used in low- and middle-income countries compared with high-income countries. We sought to evaluate the current POCUS practice of Ukrainian anesthesiologists who attended POCUS courses to guide future POCUS training in Ukraine.*

Methods *We conducted a 25-question web-based survey. It was distributed to 255 participants of POCUS courses held in Ukraine in 2023. The survey sections described current POCUS practice, perception of POCUS value, POCUS skills self-assessment, and perceived barriers to implementing POCUS in clinical practice.*

Results *Two hundred and forty-four out of 255 course participants completed the survey, representing 214 unique respondents. Those who self-rated their skills identified themselves as either novices or beginners in areas of POCUS knowledge (118/157, 75%), image acquisition (110/158, 70%), image interpretation (117/158, 74%), and integration into clinical decision-making (105/155, 68%). Among all survey responders, 55% (118/214) reported using POCUS for vascular access procedures, 45% (97/214) for trauma assessment, and 44% (93/214) for regional anesthesia. Reported barriers to POCUS*

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implementation included lack of ultrasound devices (101/214, 47%) and lack of trained faculty (112/214, 52%).
Conclusion *Among anesthesiologists who participated in POCUS courses in Ukraine, the majority were in early stages of ultrasound practice. Respondents identified POCUS applications not currently practiced and evaluated barriers to POCUS use. Based upon these survey findings, we propose the following measures in Ukraine: 1) developing a standardized national POCUS curriculum; 2) increasing the number of experienced instructors of POCUS; and 3) acquiring ultrasound devices to support clinical applications of POCUS, especially in the Central, Southern, and Eastern regions.*

Résumé
Objectif *Malgré la valeur potentielle de l'échographie ciblée (POCUS) dans les environnements à ressources limitées, cette modalité n'est pas très répandue dans les pays à revenu faible et intermédiaire par rapport aux pays à revenu élevé. Nous avons cherché à évaluer la pratique actuelle des anesthésiologistes en Ukraine qui ont suivi des cours d'échographie ciblée afin d'orienter la future formation en POCUS dans ce pays.*
Méthode *Nous avons mené un sondage en ligne de 25 questions. Il a été distribué à 255 personnes ayant suivi des cours de POCUS organisés en Ukraine en 2023. Les sections de l'enquête décrivaient la pratique actuelle en échographie ciblée, la perception de sa valeur, l'auto-évaluation des compétences en POCUS et les obstacles perçus à sa mise en œuvre dans la pratique clinique.*
Résultats *Deux cent quarante-quatre des 255 personnes ayant pris part au cours ont répondu au sondage, représentant 214 répondant·es uniques. Les personnes ayant auto-évalué leurs compétences se sont identifiées comme novices ou débutantes dans les domaines de la connaissance de l'échographie ciblée (118/157, 75 %), de l'acquisition d'images (110/158, 70 %), de l'interprétation d'images (117/158, 74 %) et de l'intégration dans la prise de décision clinique (105/155, 68 %). Parmi toutes les personnes ayant répondu à l'enquête, 55 % (118/214) ont déclaré utiliser l'échographie ciblée pour les procédures d'accès vasculaire, 45 % (97/214) pour l'évaluation des traumatismes et 44 % (93/214) pour l'anesthésie régionale. Les obstacles signalés à la mise en œuvre de l'échographie ciblée comprenaient le manque d'appareils d'échographie (101/214, 47 %) et le manque de professeur·es formé·es (112/214, 52 %).*
Conclusion *Parmi les anesthésiologistes qui ont participé aux cours d'échographie ciblée en Ukraine, la majorité en étaient aux premiers stades de la pratique de l'échographie. Les répondant·es ont identifié les applications de l'échographie ciblée qui ne sont pas actuellement pratiquées et ont évalué les obstacles à son utilisation. Sur la base des résultats de cette enquête, nous proposons les mesures suivantes en Ukraine : 1) la création d'un programme national normalisé d'échographie ciblée; 2) l'augmentation du nombre d'instructrices et instructeurs expérimenté·es en échographie ciblée; et 3) l'acquisition d'appareils d'échographie pour soutenir les applications cliniques de cette modalité, en particulier dans les régions du Centre, du Sud et de l'Est du pays.*

Keywords anesthesiology · critical care · point-of-care ultrasonography (POCUS) · practice standardization · survey · Ukraine

Point-of-care ultrasonography (POCUS)—the use of ultrasound at the patient's bedside for image acquisition, interpretation, and clinical decision-making by the health care professional delivering care to the patient—has been adopted by various medical specialties worldwide.[1,2] Use of POCUS can assist rapid and enhanced diagnostic reliability, support procedural guidance, and reduce exposure to ionizing radiation.[2] These benefits may be of particular value to patients in countries affected by war, such as Ukraine.[3]

During wartime, underfunded health care systems experience further stresses including the destruction of infrastructure, limited access to medical equipment and electrical power, an increased patient workload due to war-related injuries, medical personnel becoming refugees, and displacement of civilian populations from their usual source of medical care. Point-of-care ultrasonography can play a role in a disrupted health care system as it enables physicians to assess patients and initiate treatments in real time.[4] Additionally, hand-held ultrasound systems (HUS) can be effectively used in prehospital settings with limited electrical power sources, facilitating medical interventions on the battlefield or during transportation.[5,6]

Despite the advantages of POCUS in austere situations, its adoption and use may be hampered by lack of training, resources, and standardization, previously reported in both high-income countries (HIC)[7,8] and low- and middle-income countries (LMIC),[9,10] as classified by the World Bank. Understanding these barriers and exploring potential solutions is essential to ensuring that medical professionals can maximize the benefits of POCUS in Ukraine, where armed conflict presents significant challenges to the Ukrainian health care system.[11] In Ukraine, anesthesiology and intensive care are taught as a single specialty over a three-year postgraduate training program (replaced a former two-year program in 2022–2023). Following this training, anesthesiologists lead and staff

all intensive care units in Ukraine with very few exceptions. As of 2023, approximately 7,500 anesthesiologists practice in Ukraine.[12] We sought to investigate the current state of POCUS practice among a subset of Ukrainian anesthesiologists who attended POCUS courses delivered by the Society of Critical Care Medicine (SCCM) and Help Ukrainian Hospitals, Inc. (HUH), both USA-based organizations, in Ukraine during 2023, from whom we sought to identify perceived barriers to POCUS use in clinical practice. The insights will help inform the design of future POCUS education in Ukraine, with ongoing commitment from USA-based charities.[13]

Methods

This survey study was reviewed by the Investigational Review Board of Advocate Aurora Health and was classified as nonresearch (IRB# 2023.166). A cross-sectional, web-based survey was conducted in Ukraine between February and April 2023. The survey was initially written in English and reviewed by the USA authors with prior experience in POCUS surveys.[14] To ensure its relevance to Ukrainian practitioners, we sought input from the Ukrainian Society of Anesthesiology and Intensive Care, addressing concerns related to the context of the Ukrainian health care system. Ukrainian-speaking authors then translated the survey into Ukrainian and ensured the questions were culturally relevant.

The 25-question survey (Electronic Supplementary Material [ESM] eTable 1) was structured around five domains to gain a comprehensive understanding of POCUS practice in Ukraine. The first section captured demographics of survey respondents (age, gender, number of years since graduation from medical school, geographic location, and type of hospital practice in Ukraine). The second section assessed the current state of POCUS practice at the respondent's practice setting; availability of ultrasound devices; individual, departmental, or community-based POCUS training; consultations with other specialists for image interpretation; usual indications; daily applications; and image management. The third section evaluated perception of POCUS, exploring respondents' understanding of its value in patient care and postgraduate education, attitudes towards implementing a POCUS program at their hospitals, support for the creation of national guidelines, and the perceived importance of certification in POCUS in Ukraine. The fourth section, POCUS skills self-assessment, asked respondents to self-assess their competency in knowledge of indications, image acquisition, image interpretation, and integration of findings into clinical decision-making. The fifth section assessed perceived barriers to POCUS implementation in the respondent's practice by rating obstacles such as equipment scarcity, time constraints, financial limitations, scarcity of training opportunities, lack of trainers, difficulties in image interpretation, and the absence of national recommendations on a four-point Likert scale, distinguishing between easily surmountable (1 or 2 points) and more challenging (3 or 4 points) barriers.

The survey was administered to anesthesiologists prior to attending a POCUS course delivered by either the SCCM or HUH. The Ukrainian Society of Anesthesiology and Intensive Care selected the attendees at the SCCM courses in Lviv in March 2023, all of attendees viewed as future leaders in POCUS programs. Help Ukrainian Hospitals, Inc. courses were held in several cities (Lviv, Dnipro, Rivne, Kalush, and Kosiv) during February–April 2023, with attendees selected by the local hospital leaders to champion POCUS practice in their hospitals. At all courses, handheld ultrasound devices were distributed so that at least one device would be allocated to each hospital represented during the course. The SurveyMonkey® (SurveyMonkey Inc., San Mateo, CA, USA) platform, which blocks repeat submissions from the same device, ensured single survey entry.

Data analyses

We examined each web-based survey entry for duplicate entries. Duplicate entries were recognized by the same participant's name and/or email address. When duplicate entries were identified, only the earlier answers by the same respondent were used for analysis. We performed descriptive analyses using raw numbers, medians, and proportions as appropriate. The survey design allowed participants without a well-established individual POCUS practice to skip certain practice-related questions, as those questions referred to details of POCUS practice. In a subgroup analysis of responses by geographic region, we assessed for differences in clinical practice and barriers to implementation of POCUS between 1) regions of the country (Western, Central, and combination of results from the Southern and Eastern regions due to a low number of participants from the Southern region), 2) classification of hospitals (municipal, regional, and military hospitals), and 3) teaching designation of the hospital (teaching *vs* nonteaching). The Wilcoxon rank-sum (Mann–Whitney) test or nonparametric equality-of-medians tests were used to compare medians of continuous variables between the two or more groups, accordingly, and Pearson Chi square tests were used to compare categorical variables between the specified above groups. We implemented the Benjamini–Yekutieli (BY) procedure that is designed to control the false discovery rate under arbitrary dependence

assumptions among the tests applied. Significance was defined by the *P* value lower than critical value under the BY procedure. Data were analyzed using Stata/IC 14.2 for Mac (StataCorp LLC, College Station, TX, USA). Graphs were created using Mathematica version 12.1.0 (Wolfram, Champaign, IL, USA).

Results

Two hundred and forty-four entries from 255 course participants were received, representing a 95.7% response rate. Of these 244 responses, 214 were unique respondents, as some anesthesiologists had attended more than one POCUS course. Fifty-five participants without previous individual POCUS experience and one participant with previous individual POCUS experience skipped certain practice-related questions, which was allowed by the survey design. In addition, up to nine other respondents chose to skip certain practice-related questions. As a result, there were 20–30% missing data per question about existing ultrasound programs and image management practices, applications, and indications for use of POCUS (Tables 1 and 2). Given that data were not missing at random but rather from within the group of respondents without previous individual POCUS experience (with one exception), we chose to report proportions with the denominator representing the entire cohort of respondents ($N = 214$), unless otherwise specified.

Table 1 presents demographic information and current use of POCUS at the respondents' practice settings. Respondents came from 19 out of 27 (70%) provinces (*oblasts*) of Ukraine. Participant's ages ranged between 23 and 66 yr, with the majority being male (136/214, 64%). The highest proportion of respondents came from Western region (144/214, 67%) and were primarily affiliated with academic teaching hospitals (124/214, 62%). Participants were evenly split between municipal (99/214, 46%) and regional hospitals (106/214, 50%), with a small military hospital representation (9/214, 4%). Prior POCUS experience was reported by 120/214 (56%) participants. Of those anesthesiologists who reported previous individual POCUS experience, 33/120 (28%) had not attended any ultrasound course in the past five years, and 24/120 (20%) had taken only an online course. Few practitioners stored images consistently, i.e., greater than 50% of the time on a device (5/214, 2%) or in the cloud (1/214, 1%) and few generated reports in the medical record (12/214, 6%). Eight percent (18/214) of the respondents reported participation in quality improvement processes related to POCUS.

Table 2 presents common applications of POCUS and indications for its use. Abdominal ultrasound, including Focused Assessment of Sonography in Trauma (FAST), was the most used (97/214, 45%), followed by chest (lung) ultrasound (91/214, 43%). The three most common indications for POCUS use were guidance of vascular access procedures (118/214, 55%), assessment of trauma patients (97/214, 45%), and guidance for regional anesthesia (93/214, 44%). A vast majority 202/214 (94%) recognized the importance of integrating POCUS into clinical practice and 173/214 (81%) viewed POCUS as useful or very useful. While 154/214 (72%) respondents believed the establishment of a POCUS certification program would improve the quality of patient care, only 79/214 (37%) respondents perceived that a certification program would effectively increase POCUS use in clinical practice.

Figure 1 depicts the self-rated skills of the respondents who answered specific questions about POCUS skills. Of those, most identified themselves as either novices or beginners in areas of knowledge (118/157, 75%), image acquisition (110/158, 70%), image interpretation (117/158, 74%), and integration into clinical decision-making (105/155, 68%).

Figure 2 highlights the barriers to POCUS practice. The absence of national guidelines, a deficit of faculty trained in POCUS, and a scarcity of ultrasound devices were identified as high or insurmountable barriers by 36% (78/214), 47% (101/214), and 58% (125/214) of respondents, respectively.

Electronic Supplementary Material eTables 2–4 show subgroup analysis comparing survey results by geographical region and type of hospital practice. Respondents from the combined Southern and Eastern regions reported higher use of transthoracic echocardiography compared with respondents from the Western and Central regions. There were no other differences reported by respondents from different geographic regions. There were no differences between the respondents from local, regional, and military hospitals (ESM eTable 3) or teaching and nonteaching hospitals (ESM eTable 4) in clinical applications or indications for POCUS use, and barriers to POCUS implementation in clinical practice.

Discussion

To our knowledge, this is the first survey of POCUS practice among any group of Ukrainian physicians prior to or during the conflict. Our survey respondents represent only a small proportion of Ukrainian anesthesiologists (214/7,500, 3%), and the selection process led by the Ukrainian Society of Anesthesiology and Intensive Care (for SCCM-led courses) and local hospital leaders (for HUH-led courses) was biased towards active or future

Table 1 Characteristics of survey participants

Baseline characteristic*	All participants $N = 214$	Missing data n (%)
Age (yr), median [IQR]	31 [27–43]	0 (0%)
Sex		1 (1%)
Female	77/214 (36%)	
Male	136/214 (64%)	
Years since graduating medical school		0 (0%)
< 3 years	62/214 (29%)	
4–7 years	48/214 (22%)	
8–10 years	10/214 (5%)	
> 10 years	94/214 (44%)	
Regions of the country		0 (0%)
West	144/214 (67%)	
Central	32/214 (15%)	
East	6/214 (3%)	
South	32/214 (15%)	
Practice pattern > 50% of dedicated time		0 (0%)
Anesthesiology	104/214 (50%)	
Critical care medicine	78/214 (38%)	
Emergency medicine	53/214 (29%)	
Surgery/trauma	34/214 (23%)	
Cardiothoracic surgery	10/214 (7%)	
Type of hospital practice		0 (0%)
Local hospital	99/214 (46%)	
Regional hospital	106/214 (49%)	
Military hospital	9/214 (4%)	
Teaching hospital		1 (1%)
No	80/214 (38%)	
Medical students only	8/214 (4%)	
Interns/residents	65/214 (31%)	
Others	60/214 (28%)	
Any prior POCUS experience	120/214 (56%)	0 (0%)
Access to ultrasound device	145/214 (68%)	56 (26%)
Presence of ultrasound-proficient faculty in the department	97/214 (45%)	56 (26%)
Prior POCUS education		56 (26%)
None	65/214 (31%)	
Online courses only	26/214 (12%)	
1-day course	26/214 (12%)	
2–5 days	33/214 (15%)	
5–10 days	5/214 (2%)	
> 10 days	3/214 (1%)	
Ultrasound program in the department	13/214 (6%)	58 (27%)
Use of consultative (e.g., radiology) ultrasound service		57 (27%)
Never	8/214 (4%)	
Sometimes	41/214 (19%)	
Often	72/214 (34%)	
Very often	36/214 (17%)	

Table 1 continued

Baseline characteristic*	All participants $N = 214$	Missing data n (%)
Image management, activity > 50% of the time		
Saving to the device	5/214 (2%)	63 (29%)
Saving into the cloud	1/214 (1%)	65 (30%)
Writing a report in chart	12/214 (6%)	64 (30%)
Review with others/experts	18/214 (8%)	63 (29%)

*All data are presented as *n*/total *N* (%), unless otherwise specified

IQR = interquartile range; POCUS = point-of-care ultrasound

Table 2 Clinical uses of POCUS (applications and indications)

POCUS applications and indications	Participants $N = 214$	Missing data n (%)
Applications, *n*/total *N* (%)		
FOCUS	58/214 (27%)	56 (26%)
TTE	16/214 (8%)	56 (26%)
Chest ultrasound	91/214 (43%)	56 (26%)
Abdominal ultrasound	97/214 (45%)	56 (26%)
Diagnostic vascular ultrasound	33/214 (15%)	56 (26%)
Ultrasound for vascular access	87/214 (41%)	56 (26%)
Intraoperative TEE	9/214 (4%)	56 (26%)
TEE during cardiac arrest	7/214 (3%)	56 (26%)
Comprehensive TEE	4/214 (2%)	56 (26%)
Indications, *n*/total *N* (%)		
Shock	87/214 (41%)	56 (26%)
Respiratory failure	65/214 (30%)	56 (26%)
Identification of source of infection	29/214 (14%)	56 (26%)
Trauma	97/214 (45%)	56 (26%)
Estimation of intracranial pressure	12/214 (6%)	56 (26%)
Acute renal failure	18/214 (8%)	56 (26%)
Deep venous thrombosis	27/214 (13%)	56 (26%)
Bedside procedures (pericardiocentesis, paracentesis, thoracentesis)	42/214 (20%)	56 (26%)
Vascular access	118/214 (55%)	56 (26%)
Regional anesthesia	93/214 (44%)	56 (26%)

FOCUS = focused cardiac ultrasound; POCUS = point-of-care ultrasound; TEE = transesophageal echocardiography; TTE = transthoracic echocardiography

POCUS champions in the country. Among ultrasound course participants, the survey results show early stages of expertise in POCUS, with 68% or more of respondents considering themselves either novices or beginners in all aspects of POCUS practice (knowledge of indications, image acquisition, interpretation, and medical decision-making), and substantial barriers for the integration of POCUS into anesthesia and intensive care practice. The vast majority of our survey respondents recognized POCUS as an important diagnostic skill. The combination of the above factors points to a fertile ground for future POCUS training and practice in Ukraine.

Prior to attending our POCUS workshops, the primary clinical applications of POCUS among survey respondents included using ultrasound for guidance of vascular access procedures (55%), assessment of trauma patients (45%), and guidance for regional anesthesia (44%). These findings align with patterns observed in other surveys of clinicians in LMICs.[9,15] Fewer than 50% of respondents to our survey reported using POCUS for the most common diagnostic indication—trauma. More than half the respondents (55%) used ultrasound only to guide vascular access. These findings underscore the need for better POCUS educational opportunities, perhaps by mandating structured ultrasound training as part of the anesthesiology residency, as in Canada and the USA. Although most survey respondents recognized the diagnostic value of POCUS, key systemic barriers interfered with its wider adoption. Among respondents, lack of ultrasound equipment, and trained faculty were the two most frequently reported barriers.

Individual-level barriers (such as lack of time, financial support, and interest) were viewed as easier to overcome than systemic barriers (e.g., lack of devices, absence of national guidelines, and lack of trained faculty). More than 50% of survey respondents identified shortage of ultrasound devices as a major hurdle, echoing findings from other LMIC settings.[15,16] To surmount this barrier, hospitals must purchase ultrasound equipment.[16,17] Relatively low-cost portable handheld devices that use a tablet or smartphone for a screen could offer a cost-effective solution for Ukrainian anesthesiologists.[18]

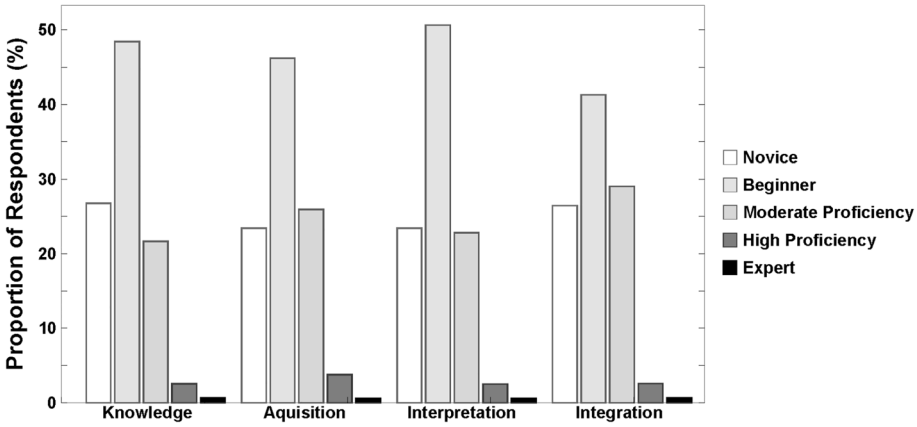

Fig. 1 Self-assessed ultrasound knowledge. The majority of survey respondents identified themselves as either novices or beginners across all domains of point-of-care ultrasound (knowledge, image acquisition, image interpretation, and integration into clinical decision-making). Very few identified themselves as having a high proficiency or being experts.

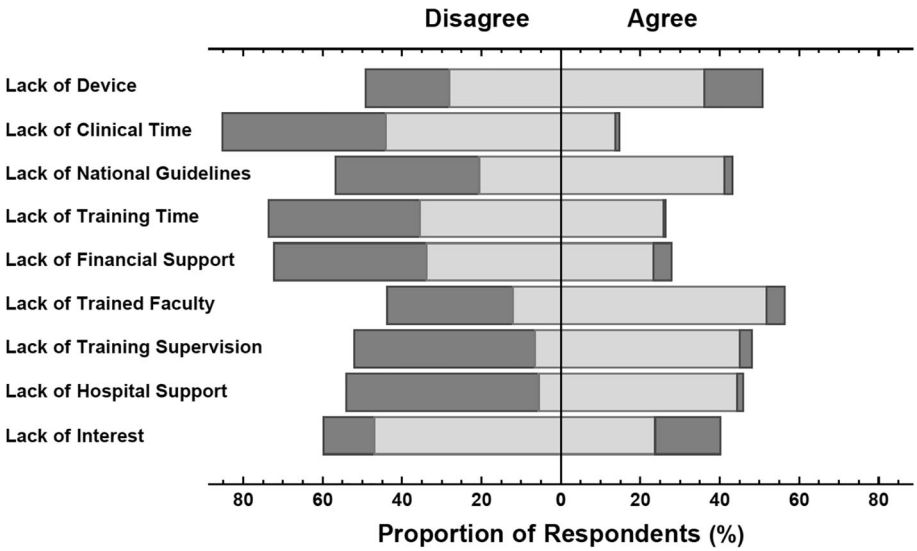

Fig. 2 Self-identified barriers to practice of POCUS. Nine barriers to practice of POCUS were assessed using a four-point Likert scale. Answers to low and moderate barriers were considered as disagreeing with the statement on the barrier listed on the left-hand side of the figure, whereas high and insurmountable barriers were considered as agreeing with the statement on the barrier.

POCUS = point-of-care ultrasonography

Collaboration with medical device manufacturers might make these devices more affordable.[19] For example, SCCM provided more than 80 hand-held ultrasound devices and HUH provided an additional ten devices to POCUS course participants in 2023. One approach to address the shortage of cardiac probes for commonly used laptop-type ultrasound machines would be for hospitals to purchase state-of-the-art hand-held devices.[13]

Lack of formalized training standards for POCUS complicates competency verification.[20–22] National guidelines could facilitate consistent POCUS education and practice across Ukraine, like successful European and USA initiatives.[23–25] Scarcity of trained faculty and mentorship represent another barrier common in resource-limited environments.[23] Building a cadre of POCUS-proficient faculty could run in parallel with device acquisition, involving in-person mentorship programs, tele-ultrasound, and remote consultation services.[26–28]

Results from the current survey identified areas where future research could benefit the advancement of POCUS practice in Ukraine. Lack of equipment and trained faculty show the bottleneck in implementing POCUS practice, highlighted by our survey respondents. Studies should examine a variety of strategies, such as in-person mentorship or tele-consultation, to understand their impacts on clinician competence. Only 6% of survey respondents reported having POCUS training programs for resident physicians in their departments, consistent with POCUS training in Ukraine being at a very early stage. Future research should also investigate the optimal way to integrate POCUS into postgraduate training in Ukraine. Such studies should determine the impact of such training on trainee competence, confidence, and propensity to use POCUS in their future practice.

Our study has several limitations. Out of an estimated 7,500 anesthesiologists in Ukraine, this survey reached 214 (3%) anesthesiologists who attended our courses, though the response rate among course participants was

96% (244/255), with some respondents participating in more than one course. Attendees were selected by the leadership of Ukrainian Society of Anesthesiology and Intensive Care Medicine based on their potential as leaders in their specialty, English language proficiency, and interest in POCUS. Likely, these individuals had more experience and interest in ultrasonography than the broader anesthesiology community. The survey respondents represented the anesthesiology community broadly across different regions of the country from teaching and nonteaching institutions, but military representation was limited. Our subgroup analyses across different geographical areas suggested that challenges and practices are similar among course participants throughout Ukraine. Additionally, the survey design permitted respondents without an established POCUS practice to skip questions related to this topic. This design led to an incomplete response rate for some questions, particularly those questions about existing ultrasound programs, image management practices, and self-assessment of ultrasound knowledge. Nevertheless, elimination of these questions and answers for anesthesiologists without an active POCUS program at their hospitals was not likely to affect our conclusions.

In conclusion, this survey of POCUS practice among a subset of anesthesiologists in Ukraine revealed recognition of POCUS's value and significant barriers to its integration into clinical practice. Based upon our survey findings, we propose the following interventions in Ukraine: 1) developing a standardized national POCUS curriculum with defined best practices and competence assessment; 2) building a solid faculty base proficient in teaching POCUS clinical integration and quality assurance skills; and 3) procuring ultrasound devices particularly those with cardiac probes to support clinical applications of POCUS especially in the Central, Southern, and Eastern regions. Progressing toward these goals may enhance the quality of medical care in Ukraine and provide insights for other LMICs.

Author contributions *Vladyslav Dieiev*, *Rom A. Stevens*, *Aliaksei Pustavoitau*, and *José L. Díaz-Gómez* contributed to all aspects of this manuscript, including study conception and design; acquisition, analysis, and interpretation of data; and drafting the main manuscript text. *Pedro Salinas* and *Oleksandr Pavlysh* contributed to the conception and design of the study. *Sergii Dubrov*, *Vadim Gudzenko*, *Pedro Salinas*, *Rom A. Stevens*, and *Oleksandr Pavlysh* contributed to the acquisition of data. *Nataliya Matolinets*, *Olga Kravets*, *Daria Krishtafor*, *Stepan Cherniaiev*, and *Sergii Dubrov* contributed to the analysis and interpretation of data. All authors reviewed and substantively revised the manuscript.

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