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How to achieve the long-term goals of EUS training——survey on the performance of diagnostic EUS by newly trained endosonographers and analysis of the influencing factors

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Abstract

Objectives This study endeavors to evaluate the integration of endoscopic ultrasonography (EUS) by trainees upon their return to the hospital and discern the influencing factors.

Methods A questionnaire survey was administered to trainees who completed EUS training at the Department of Gastroenterology, Nanjing Drum Tower Hospital from October 2016 to April 2022. The impact of various factors, including trainees' characteristics, working conditions, and EUS procedure numbers during training was analyzed.

Results 65 valid questionnaires were categorized into two groups based on the median number of EUS procedures performed by trainees within one year post-training: a group with fewer EUS cases (< 30 cases) and a group with more EUS cases (≥ 30 cases). Significant differences were found in annual EUS procedures ($P < 0.001$), endoscopic ultrasound-guided fine needle aspiration (EUS-FNA) cases ($P < 0.001$), and complete scan rates ($P = 0.007$). Favorable conditions for trainees in performing EUS included higher-level hospitals ($P = 0.001$), more hospital beds ($P = 0.015$) and department beds ($P = 0.033$), greater annual endoscopy volume ($P < 0.001$), a longer prior duration of the use of EUS on the hospital ($P = 0.003$), higher departmental EUS volume ($P < 0.001$) and presence of established staff endosonographers ($P < 0.001$). Additionally, trainees in the group with more EUS cases had more guidance from experienced colleagues ($P = 0.009$). Multivariate logistic regression analysis highlighted annual endoscopy volume and EUS volume as independent influencing factors.

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Conclusion Tertiary hospitals with larger bed capacities and high endoscopy volumes foster optimal EUS skill development among trainees. Moreover, factors such as longer duration of EUS implementation, increased caseload and guidance from experienced colleagues all contribute to the professional growth of trainees.

Clinical trial number Not applicable.

Keywords EUS training, Influencing factors, Questionnaire survey, Trainees

Introduction

Endoscopic ultrasonography (EUS), pioneered in the 1980s, has emerged as a cornerstone in diagnosing and treating digestive system ailments, particularly those affecting the biliopancreatic system. Its distinct advantages, including multi-angle visualization, closer proximity to target tissues, superior resolution, and continuous observation capability, have rendered it indispensable in clinical practice. The integration of advanced techniques such as contrast-enhanced endoscopic ultrasonography (CEH-EUS), endoscopic ultrasonography elastography (EUS-EG), and endoscopic ultrasound-guided fine needle aspiration or biopsy (EUS-FNA/B) has progressively enhanced the accuracy of diagnosis and differential diagnosis in biliary and pancreatic diseases [1, 2, 3]. Furthermore, the expanding role of EUS-based interventional procedures in managing these conditions underscores its growing importance [4]. The widespread adoption of EUS contributes substantially to elevating the overall standard of care in diagnosing and treating digestive system disorders, particularly those affecting the biliopancreatic system.

Mastering the technique of EUS demands systematic training and repeated and focused personal investment from endoscopists, constituting a lengthy and arduous process. Numerous factors influence the learning curve and the quality of learning. The European Society of Gastrointestinal Endoscopy (ESGE) has outlined comprehensive curriculum requirements for EUS training, with the apprenticeship model representing the traditional approach [5]. The objectives of EUS training encompass both short-term and long-term goals. In the short term, trainees aim to determine the appropriate use of EUS and to enhance their independent operational skills, while the ultimate long-term objective is to safely and successfully perform EUS. Notably, the primary goal of EUS training is to equip participants with the capacity to sustainably perform EUS procedures [6, 7]. Despite our center's active involvement in EUS training during their 6 months training period, return visits have revealed instances where trainees struggle to integrate EUS into their routine practice upon returning to their hospitals, despite mastering EUS operational skills during training. How can we better realize the long-term objectives of EUS training? This critical question remains largely unexplored in current research.

The objective of this study is to administer a questionnaire survey among EUS trainees at our center, with the aim of examining the integration of EUS practices in their respective hospital settings post-training and analyzing the factors influencing this implementation. The findings from this investigation will offer valuable insights into the selection of EUS trainees and the establishment of effective developmental platforms within hospital departments.

Methods

Participants

The study participants consisted of trainees who underwent linear EUS training at the Department of Gastroenterology, Nanjing Drum Tower Hospital, from October 2016 to April 2021. A structured questionnaire was distributed to the trainees via the Internet.

Methods and content of the questionnaire

The questionnaire was collaboratively developed by two senior tutors specializing in EUS at the Department of Gastroenterology, Nanjing Drum Tower Hospital. It encompassed a comprehensive set of 39 questions, organized into three distinct sections: (1) gathering trainees', departmental, and hospital-related data, (2) elucidating EUS training particulars, and (3) documenting EUS procedures and any subsequent complications post-trainee hospital integration. The entire questionnaire is available in the Appendix. Owing to the travel constraints imposed by the Covid-19 pandemic, all questionnaires were administered via web-based delivery.

The term "EUS" as mentioned in the questionnaire specifically refers to linear EUS examinations. The total training duration was defined as the cumulative learning time within the gastroenterology department of Nanjing Drum Tower Hospital, encompassing study periods in both the endoscopy center and ward. More precisely, the duration of EUS training indicated the timeframe dedicated to observing and performing EUS procedures following the apprenticeship model at the endoscopy center. The complete scanning rate of EUS anatomic landmarks pertains to the success rate achieved when scanning all relevant sites, including, but not limited to, the portal vein confluence, celiac trunk, pancreas, gallbladder, common hepatic duct, common bile duct, and ampulla [8]. Regarding our definition of "Number of EUS procedures,"

it refers to the number of cases in which trainees independently complete a comprehensive scan across three anatomical stations during the training period. On one hand, to ensure patient safety, trainees are only permitted to perform scans in the duodenal bulb and descending portion after demonstrating proficiency in gastric scanning. On the other hand, to minimize procedure and anesthesia time, trainees typically complete scans at only 1–2 stations per patient in most cases. As a result, before completing scans across three stations, trainees have already accumulated a substantial number of EUS procedures. Furthermore, all trainees are assessed using The EUS and ERCP Skills Assessment Tool (TEESAT) before completing their training to confirm their competency in performing EUS. Furthermore, all trainees are assessed using The EUS and ERCP Skills Assessment Tool (TEESAT) before completing their training to confirm their competency in performing EUS [9]. Complications associated with the need for EUS and EUS-FNA procedures encompass biliary peritonitis, hemorrhage, perforation, pancreatitis, and infection. This definition aligns with the guidelines provided by the American Society of Gastrointestinal Endoscopy (ASGE) and ESGE [10].

Statistics

The measurement data were assessed for normality, and normally distributed data were presented as mean ± standard deviation (M ± SD). The independent sample t-test was utilized to compare between the two groups. For non-normally distributed data, quartiles (P50 [P25, P75]) were used for characterization, and the Mann-Whitney U test was employed for group comparisons. Categorical data were expressed as frequency and percentage (%), and intergroup comparisons were conducted using the χ^2 test. Factors exhibiting significant differences ($P<0.05$) in univariate analysis were incorporated into a multivariate logistic regression model. All statistical analyses were performed using Stata/MP 16.0 with a significance level (α) set at 0.05.

Results

Questionnaire collecting and grouping method

A total of 65 online questionnaires were distributed, with 100% (65) valid responses received. The respondents, all gastroenterologists, hailed from 39 cities across 18 provinces or municipalities. Their ages ranged from 24 to 53 years, with 27 men and 38 women among them. Trainees were stratified into two groups based on the median number of EUS procedures conducted within a year post-return to their respective hospitals: those with fewer EUS cases (< 30 cases) and those with more EUS cases (≥ 30 cases).

Analysis of the pre-training situation of the two groups

This section of the questionnaire primarily delved into the personal attributes of the trainees, and the departmental conditions and hospital environments from which they came, and hospital environments. Its aim was to probe the impact of both internal and external factors from the pre-training hospitals on the trainees' post-training performance in EUS. No statistically significant differences were observed between the two groups of trainees concerning sex, age, individual annual endoscopy volume, individual annual gastroenteroscopy volume, individual annual Endoscopic Retrograde Cholangio-Pancreatography (ERCP) and EUS volume, theoretical learning and training in EUS, and the number of linear echoendoscopes in the department ($P>0.05$).

In contrast to individual factors, the developmental status of hospitals and departments may wield a more substantial influence on trainees' post-training EUS performance. Notably, all trainees in the group with more EUS cases hailed from Grade IIIA hospitals. Among trainees in the group with fewer EUS cases, 21 were from Grade IIIA hospitals, 6 from Grade IIIB hospitals, and 5 from Grade IIA hospitals. A statistical difference was evident between the two groups ($P=0.001$). Furthermore, the group with more EUS cases had a higher number of available beds ($P=0.015$).

At the departmental level, the group with more EUS cases exhibited significantly higher counts in terms of beds, annual endoscopy volume, number of endosonographers, and annual EUS volume compared to the group with fewer EUS cases ($P<0.05$). Moreover, EUS procedures commenced earlier in the group with more EUS cases ($P=0.003$) (refer to Table 1).

The logistic regression model unveiled that the odds ratios (OR) with 95% confidence intervals (CIs) for pre-training factors such as the number of hospital beds, department beds, number of endosonographers, and duration of EUS implementation hovered around 1, suggesting that these factors did not independently influence the division between the two groups. Conversely, both the annual endoscopy volume and annual EUS volume in the department exhibited ORs with 95% CIs exceeding 1, indicating their independent influences between the two groups (refer to Fig. 1).

Analysis of the training situation of the two groups

The questionnaire findings revealed that both groups of trainees successfully completed our center's six-month training program (refer to Table 2), which encompassed approximately three months of immersive observation and hands-on training in EUS and associated techniques. The training curriculum also entailed fundamental theoretical instruction on EUS, perioperative patient management for those undergoing EUS interventional therapy,

Table 1 Comparison of pre-training indicators between the two groups

		The fewer EUS cases group	The more EUS cases group	Total	*p*-value
		***N*=32**	***N*=33**	***N*=65**	
Age		39±4	39±4	39±4	0.748
Number of hospital beds		1200 (1000–2000)	1800 (1300–2150)	1500 (1137–2000)	0.015
Number of departmental beds		60(52–83)	84 (62–106)	70(57–104)	0.033
Annual endoscopy volume of department (cases)		20,000 (10000–22500)	35,000 (25000–55000)	25,000 (15000–40000)	<0.001
Individual annual endoscopy volume (cases)		2000 (1000–2750)	2000 (1500–3000)	2000 (1000–3000)	0.202
Number of endosonographers in the department		2 (1–4)	4 (3–5)	3 (2–4)	<0.001
Annual EUS volume of department (cases)		49 (0-190)	400 (300–500)	300 (34–500)	<0.001
Number of linear echoendoscopes in the department		1 (0–2)	1 (1–1)	1 (1–2)	0.365
Duration of EUS implementation in the department (years)		3 (1–10)	9(5–12)	7 (2–10)	0.003
Sex	Female	18 (56)	20 (61)	38 (59)	0.722
	Male	14 (44)	13 (39)	27 (41)	
The level of hospital	Grade IIIB	6 (19)	0 (0)	6 (9)	0.001
	Grade IIIA	21 (66)	33 (100)	54 (83)	
	Grade II	5 (15)	0 (0)	5 (8)	
Individual annual gastroscope volume (cases)	0	1 (3)	0 (0)	1 (1)	0.591
	>0 & <500	1 (3)	0 (0)	1 (1)	
	≥500 & <1000	2 (6)	3 (9)	5 (8)	
	≥1000 & <5000	11 (34)	9 (27)	20 (31)	
	≥5000	17 (54)	21 (64)	38 (59)	
Individual annual colonoscopy volume (cases)	0	1 (3)	0 (0)	1 (1)	0.776
	>0 & <100	1 (3)	2 (6)	3 (5)	
	≥100 & <500	5 (16)	4 (12)	9 (14)	
	≥500 & <2000	12 (37)	11 (33)	23 (35)	
	≥2000	13 (41)	16 (49)	29 (45)	
Self-study of EUS related theoretical knowledge	NO	5 (16)	7 (21)	12 (18)	0.562
	Yes	27 (85)	26 (79)	53 (82)	
Participate in short-term EUS training courses	NO	26 (81)	24 (73)	50 (77)	0.415
	Yes	6 (19)	9 (27)	15 (23)	
Individual annual ERCP volume (cases)	0	26 (82)	28 (85)	54 (83)	0.819
	>0 & <50	2 (6)	3 (9)	5 (7)	
	≥50 & <200	2 (6)	1 (3)	3 (5)	
	≥200 & <1000	2 (6)	1 (3)	3 (5)	
Individual annual EUS volume (cases)	0	31 (97)	25 (76)	56 (86)	0.054
	>0 & <20	1 (3)	1 (3)	2 (3)	
	≥20 & <50	0 (0)	2 (6)	2 (3)	
	≥50	0 (0)	5 (15)	5 (8)	

computer simulation training, Rapid On-Site Evaluation (ROSE) training, as well as participation in biliary and pancreatic Multidisciplinary Team (MDT) discussions concerning the appropriate use of EUS in diagnosis and therapy, among other components.

Implemented via the "apprenticeship model," our training program aimed to equip trainees with the proficiency to independently perform EUS. Results indicated that trainees from both groups were capable of executing EUS procedures upon completion of their training, with some even proficient in EUS-FNA. Trainees in the group with fewer EUS cases completed a median of 10 (interquartile range: 5–23) EUS procedures, while those in the group with more EUS cases completed a median of 20 (interquartile range: 10–50) EUS scans during the training period. It should be noted that, to ensure patient safety and reduce anesthesia duration, our center requires trainees to undergo a step-by-step training program in gastric, duodenal bulb, and descending duodenal scanning before they are allowed to independently perform a complete "three-station" EUS scan. In other words, trainees have already received extensive hands-on mentoring and procedural training before performing a full EUS scan. Additionally, trainees must pass an assessment by

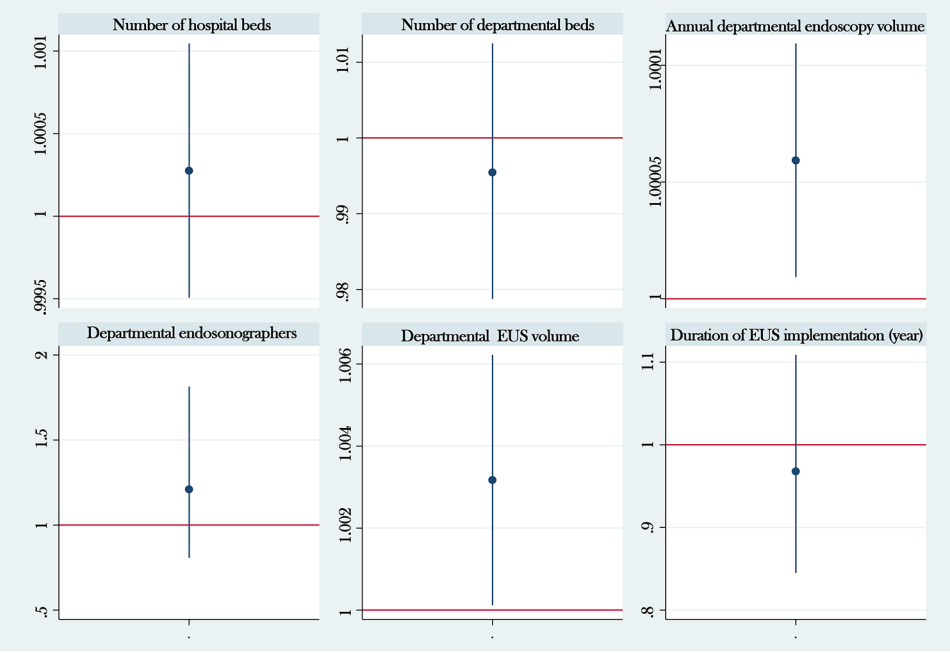

Fig. 1 Multivariate Logistic Regression Analysis Model. The multivariate logistic regression analysis model depicts the odds ratio (OR) values and 95% confidence intervals (CI) for each factor. The OR 95% CI for the number of hospital beds, departmental beds, endosonographers in the department, and duration of EUS implementation were all close to 1, indicating that these factors did not exert independent influence between the two groups. Conversely, the OR 95% CI for the annual endoscopy volume and EUS volume in the department were above 1, signifying that these two factors were independent influencing factors for grouping

Table 2 Comparison of training indicators between the two groups

		The fewer EUS cases group	The more EUS cases group	Total	*p*-value
		N **= 32**	***N*** **= 33**	***N*** **= 65**	
Total training duration (months)		6 ± 2	6 ± 2	6 ± 2	0.913
Duration of EUS training (months)		3 ± 1	3 ± 1	3 ± 1	0.137
Number of participation in EUS theory courses (times)	0	1 (3)	0 (0)	1 (1)	0.070
	< 10	5 (16)	13 (39)	18 (28)	
	≥ 10	26 (81)	20 (61)	46 (71)	
Perioperative management for patients undergoing EUS interventional therapy (cases)	0	9 (28)	10 (30)	19 (29)	0.934
	< 20	15 (47)	16 (49)	31 (48)	
	≥ 20	8 (25)	7 (21)	15 (23)	
Number of EUS procedures (cases)		10(5–23)	20 (10–50)	10 (6–30)	0.135
Number of EUS-FNA procedures (cases)		0(0–2)	1 (0–2)	1 (0–2)	0.461
Participation in computer simulation training	No	20 (62)	21 (64)	41 (63)	0.924
	Yes	12 (38)	12 (36)	24 (37)	
Participation in ROSE training	NO	6 (19)	3 (9)	9 (14)	0.260
	YES	26 (81)	30 (91)	56 (86)	
Number of ROSE	0	7 (22)	3 (9)	10 (15)	0.118
	> 0 & < 10	6 (19)	13 (39)	19 (29)	
	≥ 10	19 (59)	17 (52)	36 (56)	
Number of Participation in MDT discussions	0	6 (19)	3 (9)	9 (14)	0.427
	> 0 & < 10	21 (65)	22 (67)	43 (66)	
	≥ 10	5 (16)	8 (24)	13 (20)	

Table 3 Comparative analysis of post-training indicators between two groups

		The fewer EUS cases group	The more EUS cases group	Total	*p*-value
		N = 32	*N* = 33	*N* = 65	
Number of EUS procedures (cases)		9 (1–20)	50 (50–100)	30 (10–50)	< 0.001
Number of EUS-FNA procedures (cases)		0 (0–1)	5 (0–20)	1 (0–6)	< 0.001
Complete scan rate(%)		75 (0–90)	85 (80–90)	80 (60–90)	0.007
Missed diagnosis or misdiagnosis	0	19 (59)	8 (24)	27 (41)	0.012
	> 0 & ≤2	8 (25)	12 (36)	20 (31)	
	> 2	5 (16)	13 (40)	18 (28)	
EUS procedure-related complications	No	31 (97)	28 (85)	59 (91)	0.094
	Yes	1 (3)	5 (15)	6 (9)	
EUS-FNA/B procedure-related complications	No	32 (100)	31 (94)	63 (97)	0.157
	Yes	0 (0)	2 (6)	2 (3)	
Guidance from colleagues with EUS experience	No	21 (66)	11 (33)	32 (49)	0.009
	Yes	11 (34)	22 (67)	33 (51)	

their mentors to demonstrate their competency in independent EUS operations before they are permitted to perform complete EUS procedures.

Notably, all training indicators did not conclusively impact the trainees' post-return EUS performance. There were no statistically significant differences observed between the training indicators across both groups of trainees ($p > 0.05$).

Analysis of the post-training situation of the two groups

In this study, all investigated trainees performed EUS procedures within one year of returning to their respective hospitals. The group with fewer EUS cases conducted a median of 9(interquartile range: 1–20) procedures, whereas the group with more EUS cases conducted a median of 50 (interquartile range: 50–100) procedures (refer to Table 3). The number of EUS-FNA procedures was significantly higher in the group with more EUS cases compared to the group with fewer EUS cases ($P < 0.001$).

Furthermore, the complete scanning rate of EUS was notably higher at 85% in the group with more EUS cases compared to 75% in the other group ($P = 0.007$), fulfilling the requirements outlined by the ESGE position statement. While no significant difference was observed between groups concerning the incidence of complications related to both EUS and EUS-FNA/B ($P = 0.094$ and $P = 0.157$, respectively). Our survey results found that in the group with more EUS cases, 76% of trainees experienced missed or misdiagnosed cases within the first year after returning to their home institutions, while in the group with fewer EUS cases, 41% of trainees experienced missed or misdiagnosed cases ($P = 0.012$). This discrepancy may be attributed to the increased EUS volumes and the trainees' primary level of proficiency in EUS procedures. This finding also highlights the considerable challenges encountered by newly trained endosonographers in performing EUS and underscores the need for further refinement of our training program. It is crucial to not only prioritize standardized EUS procedural training but also to place greater emphasis on improving trainees' diagnostic proficiency in EUS.

Moreover, a statistically significant difference was observed in the guidance received from experienced colleagues in the first year after their training period, with 67% of trainees in the group with more EUS cases during the first year post-training receiving guidance compared to 34% in the group with fewer EUS cases ($P = 0.009$).

Discussion

In recent years, the development of EUS in China has made strides, yet a significant gap persists compared to developed countries. The high equipment costs and shortage of endosonographers are recognized as primary impediments to EUS advancement [6]. Notably, the dearth of endosonographers in China considerably lags behind medical demand, making it a focal point in EUS training research to ensure trained endoscopists possess competence in EUS for clinical diagnosis and treatment. Proficiency in EUS entails not only adeptness in maneuvering large probe echoendoscopes but also a comprehensive grasp of intracavitary ultrasound principles and three-dimensional anatomy—an intricate skill set challenging for both novices and seasoned endoscopists alike [11].

To achieve competency in EUS, ESGE training guidelines advocate for 3–12 months of training and completion of a minimum of 250 EUS procedures [10, 12, 13]. Presently, China lacks a standardized EUS training model and predominantly adheres to the classical apprenticeship approach [7]. EUS training methodologies primarily encompass on-site observation of expert procedures, self-study from literature, computer simulation training, animal model training, and hands-on instruction [14, 15, 16, 17]. The survey data from our study reveals that all 65 EUS trainees underwent over 3 months of comprehensive

training at our center, comprising sequential theoretical courses, computer simulation training, practical hands-on sessions, ROSE training, participation in MDT discussions, and EUS-related patient management. Consequently, trainees acquired a foundational understanding of EUS theory and practical skills. During the training period, each trainee was required to perform a minimum of 250 EUS procedures, distributed across key anatomical regions: the stomach (minimum 100 procedures), duodenal bulb (minimum 75 procedures), and descending duodenum (minimum 75 procedures). This step-by-step approach ensured that trainees gained comprehensive exposure to the anatomical variations and technical challenges associated with each region. However, to ensure patient safety and minimize anesthesia duration, trainees typically completed scans at only 1–2 stations per patient during the initial phases of training. As a result, the mean number of complete three-station scans performed by trainees during the training period was lower, but this does not reflect the total number of procedures performed across all regions.

Our center, with an average of over 15 EUS procedures conducted daily, provides ample opportunities for "hands-on" practice. Following extensive practice, all trainees gained the ability to independently perform EUS procedures. Our survey data also revealed that the majority of trainees did not acquire proficient EUS-FNA skills through our training program. This is because our training is designed for endoscopists with no prior EUS experience, and achieving competency in EUS-FNA is particularly challenging. The primary goal of our training program is to ensure trainees master basic EUS skills. The survey findings revealed that, although trainees were able to independently perform EUS during the training period, many faced challenges in applying their acquired knowledge and skills in real-world clinical settings after returning to their home institutions. Therefore, this study aims to investigate various influencing factors on trainees' post-training EUS performance in their respective hospitals.

To explore the conducive conditions for trainees to undertake EUS post-training, this study examined both personal factors and the external environment across three distinct time frames: before, during, and after the training period. Our findings underscore the substantial influence of hospital and departmental attributes on EUS development. Trainees stationed in larger Grade IIIA hospitals and departments boasting a greater number of beds and higher gastroenteroscopy volumes are more likely to encounter favorable circumstances for EUS advancement. Furthermore, prolonged departmental EUS experience, a higher count of endosonographers, increased annual EUS volumes, and access to guidance from experienced EUS colleagues all emerged as advantageous factors for newly trained endosonographers embarking on EUS practice.

Several factors contribute to these findings. Firstly, larger tertiary hospitals and departments tend to attract a larger outpatient volume and referrals from lower-tier hospitals within the trainee's region, thereby establishing a patient base conducive to EUS procedures. Additionally, the higher endoscopy volume within the department generates greater demand for EUS diagnostics, fostering an environment conducive to EUS development. Secondly, departments with accumulated EUS experience, a sufficient number of endosonographers, and substantial EUS case volumes provide a supportive ecosystem for newly trained endosonographers, offering ample opportunities for EUS operations and sustained technical support.

Moreover, given the higher procedural risk associated with EUS compared to gastroenteroscopy, the guidance and assistance of colleagues with EUS expertise prove invaluable [5, 18]. Lastly, as the adage goes, "a skillful woman can't cook without rice," the acquisition of endoscopic ultrasound equipment at both the hospital and departmental levels serves as a prerequisite for EUS practice.

The survey conducted in this study is subject to certain limitations: (1) The questionnaire method may have resulted in some trainees providing values that are not entirely accurate and potentially influenced by subjective bias. (2) Variations in EUS training modes among different centers, including differences in trainee selection criteria, training duration, and curriculum choices, may exist, potentially affecting the generalizability of our findings. (3) In our training program, there is a lack of detailed documentation regarding the number of procedures performed by trainees at each anatomical station. The adequacy of the training requires further investigation in subsequent studies. (4) The sample size of included trainees was relatively small, which could introduce statistical bias and limit the generalizability of the results.

In conclusion, to enhance the attainment of long-term objectives in EUS training, we propose that EUS training resources should be directed towards trainees from larger tertiary hospitals. Departments can foster favorable conditions for newly trained endosonographers by augmenting the number of beds, seeking guidance from external experts, nurturing additional endosonographers, and amplifying the volume of both endoscopy and EUS procedures.

Abbreviations

EUS	Endoscopic ultrasonography
EUS-FNA	Endoscopic ultrasound-guided fine needle aspiration
CEH-EUS	Contrast-enhanced endoscopic ultrasonography
EUS-EG	Endoscopic ultrasonography elastography
EUS-FNA/B	Endoscopic ultrasound-guided fine needle aspiration or biopsy
ESGE	European society of gastrointestinal endoscopy
ASGE	American society of gastrointestinal endoscopy
ERCP	Endoscopic retrograde cholangio-pancreatography
OR	Odds ratios
CIs	Confidence intervals

ROSE	Rapid on-site evaluation
MDT	Multidisciplinary team

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-025-07208-5.

Supplementary Material 1

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Author contributions
Shen Yonghua, Wang Lei and Lv Ying conceived and designed the study. Zhang Song and Shen Shanshan conducted the study. Zhang Song and Shen Congqiang analyzed the data and wrote the paper. All authors read and approved the final manuscript.

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Data availability
The data 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 protocols were approved by the Medical Ethics Committee of Nanjing Drum Tower Hospital (2024-702-01). Informed consent was obtained from all participants in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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