—Original Article—

A core curriculum for basic EUS skills: An international consensus using the Delphi methodology

John Gásdal Karstensen[1,2,*], Leizl Joy Nayahangan[3,*], Lars Konge[2,3], Peter Vilmann[2,4]; The EUS Delphi Panel[#]

[1]Pancreatitis Centre East, Gastro Unit, Copenhagen University Hospital-Amager and Hvidovre, Hvidovre, Denmark; [2]Department of Clinical Medicine, University of Copenhagen, Copenhagen, Denmark; [3]Copenhagen Academy for Medical Education and Simulation, Centre for Human Resources and Education, The Capital Region of Denmark, Copenhagen, Denmark; [4]Division of Endoscopy, Gastro Unit, Herlev and Gentofte Hospital, Denmark

ABSTRACT

Background and Objectives: During recent years, the demand for EUS has increased. However, standardized training programs and assessments of clinical quality measures are lacking. We therefore aimed to establish a basic curriculum for EUS fellows that includes a prioritized list of interpretational capabilities and technical skills. **Materials and Methods:** International key-opinion leaders were invited to participate in a Delphi process. An electronic three-round iterative survey was performed to attain consensus on skills that 70% of the participants found either very important or essential for a newly graduated endosonographer. **Results:** Of 125 invited experts, 77 participated in the survey. Initially, 1,088 skills were suggested, resulting in a core curriculum containing 29 interpretational skills and 12 technical skills. The top-five interpretation skills included abilities to discern between normal anatomy and pathology, to identify the entire pancreas and ampullary region, to identify solid versus fluid-filled structures, to detect bile duct and gallstones, and to identify a pancreatic mass of 5 mm or larger. For technical skills, ability to insert the endoscope from the mouth to the second part of duodenum, to obtain FNA adequately and safely, to navigate the scope tip to follow anatomical landmark structures, to achieve endoscopic position of each of the four stations, and to perform passage of the scope past a hiatal hernia were given the highest ranking. **Conclusions:** After a structured Delphi process involving 77 international experts, a consensus was reached for a basic curriculum for EUS fellows to be included during training.

Key words: education, EUS, training

INTRODUCTION

EUS has become a fundamental part of endoscopic patient care for a variety of gastrointestinal and

Access this article online	
Quick Response Code:	Website: www.eusjournal.com
	DOI: 10.4103/EUS-D-21-00125

How to cite this article: Karstensen JG, Nayahangan LJ, Konge L, Vilmann P, The EUS Delphi Panel. A core curriculum for basic EUS skills: An international consensus using the Delphi methodology. Endosc Ultrasound 2022;11:122-32.

*John Gásdal Karstensen and Leizl Joy Nayahangan contributed equally to this work.

[#]The EUS Delphi Panel shares co-authorship of the article and the members are listed at the end of this article.

Address for correspondence

Dr. John Gásdal Karstensen, Pancreatitis Centre East, Gastro Unit, Copenhagen University Hospital- Amager and Hvidovre, Hvidovre, Denmark. E-mail: john.gasdal.karstensen@regionh.dk

Received: 2021-05-11; **Accepted:** 2021-11-30; **Published online:** 2022-04-23

pulmonary indications.[1] The range of EUS procedures is expanding, leading to an increasing demand for skilled clinicians as well as the need to develop and implement extensive training programs to cater to this need and ensure competency.[2-4] Prior to supervised practice on patients, training in EUS has been recommended by recent guidelines.[5,6] In past years, the development and implementation of training programs have mainly been unstandardized and based on local initiatives. It is imperative that the selection of interpretational and technical skills to include in a training curriculum should align to current needs.

Studies and guidelines have suggested a minimum number of cases during EUS fellowship to achieve suggested performance targets (*e.g.,* diagnostic rate of adequate sampling of solid lesions >85% or incidence of acute pancreatitis <2% after EUS-FNA) during 1st year of independent practice, and in addition, competence measures have been proposed and validated.[7-10] Furthermore, both the American Society for Gastrointestinal Endoscopy (ASGE) and the European Society of Gastrointestinal Endoscopy (ESGE) have suggested a set of performance measures established to monitor and assess the quality of EUS.[1,11] However, the requirements for EUS operators during individual practice may differ between medical specialties and the quality indicators for the experienced endosonographer may not reflect mandatory skills needed by a newly qualified specialist in EUS. More importantly, while it is clinically important for instance to reach a sensitivity of 90% for EUS-FNA in solid lesions or document EUS landmarks in >90%, the road to reaching such performance targets is paved with several procedural skills. To reach the performance targets outlined in the guidelines, these specific skills need to be identified for training and assessment during EUS fellowships.

To establish an adequate and focused training curriculum for an EUS fellowship, we wanted to achieve expert consensus on what basic skills should be prioritized and warranted. While we believe that a systematically gathered curriculum for basic interpretational and technical skills is needed, communicative skills and knowledge about *e.g.*, indications, as prioritized in many guidelines, were intentionally not included. With the identification of an interpretational and technical skillsets, focused learning programs may be developed, validated and compared optimizing the learning curve during EUS fellowships. The aim of this study was to create a prioritized list of interpretational capabilities and technical skills to establish a basic curriculum for EUS fellows.

MATERIALS AND METHODS

The study was designed as a Delphi study aiming at a prioritized skill set for basic EUS operators to incorporate into an EUS training curriculum.[12] The Delphi method is a widely used structured process to gather information from a defined group of experts and arrive at a consensus regarding a certain topic.[13,14] This method uses iterative survey rounds sent anonymously to an expert panel, where responses from previous rounds are re-evaluated until a group decision is made. In this study, we followed a three-round Delphi process [Figure 1] using electronic survey questionnaires (SurveyMonkey, San Mateo, CA, USA).

International panel of experts as Delphi participants

The panel consisted of international EUS experts, which the senior author (PV) knows and has collaborated with for up to 30 years. Moreover, most of these participants have contributed to numerous academic papers within the field of EUS. In order to arrive at a consensus document of EUS skills based on a collaborative effort of international experts, all participant who responded to initial rounds were invited to subsequent survey rounds. The participants complete each round blinded to one another's responses for that round.

Facilitation of the Delphi process

A steering group was formed to facilitate the Delphi process including identification and invitation of the participants [Supplementary Material 1], formulation and piloting of the questionnaires, data gathering and organization between rounds, and data analysis. The group consisted of LJN (nurse, senior researcher in medical education), JGK (MD, associate professor of endoscopy), LK (MD, professor of medical education), and PV (MD, professor of endoscopy).

Round 1

This was the brainstorm stage, where all participants were asked to list "*EUS procedural skills that a newly qualified specialist in endosonography should be able to perform.*" The participants individually constructed a list of skills considered mandatory for an EUS operator during individual practice. Specifically, procedural skills are defined as the psychomotor domains that are involved

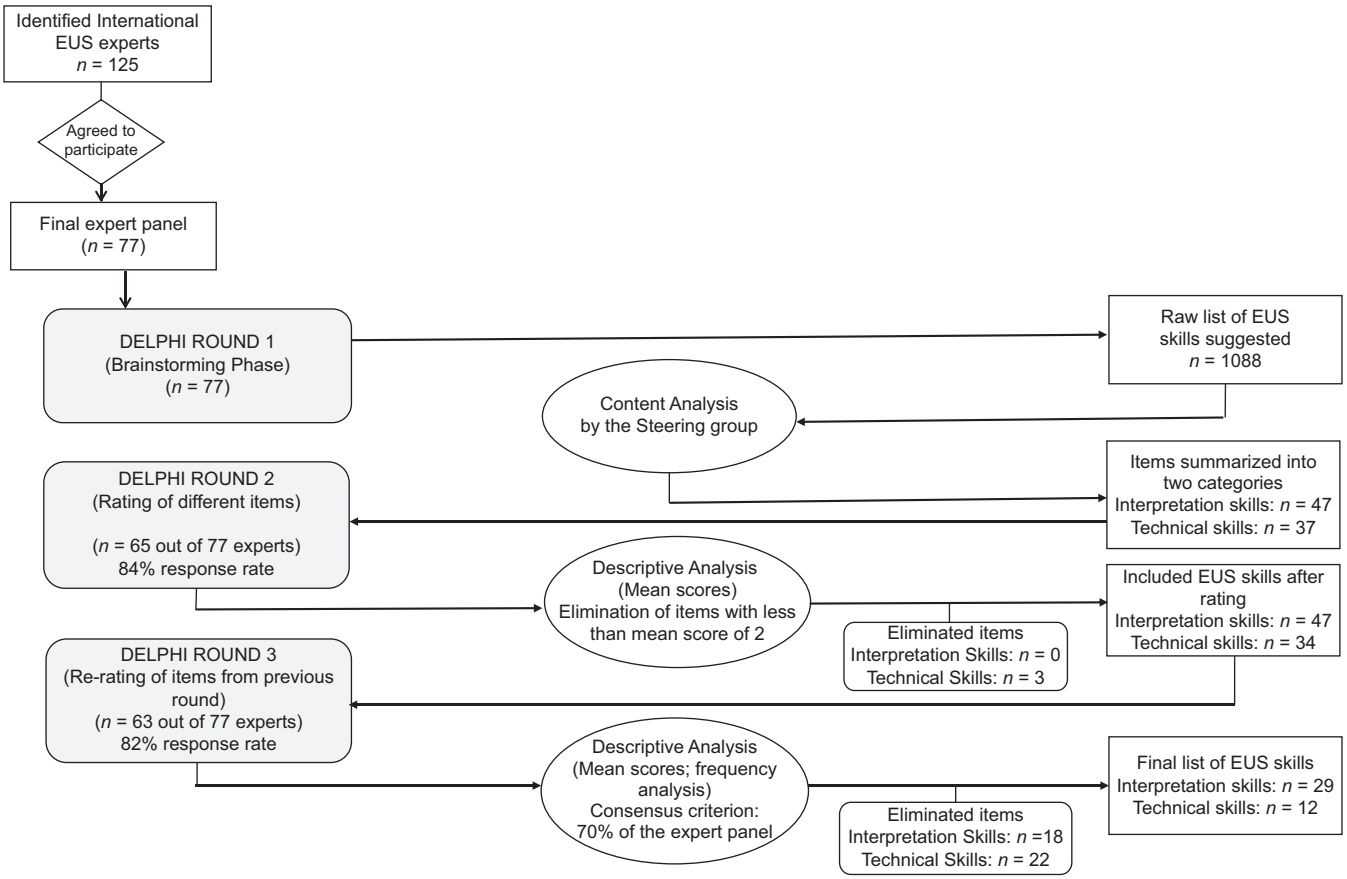

Figure 1. Flowchart of the Delphi process

when performing an EUS procedure. To avoid any bias, the list was completed by free hand and there was no limitation to number of suggested skills. The participants were given 2 weeks to complete the survey with a 1-week extension. When all answers were received and registered, the steering group made a qualitative assessment of the data by removing duplicates or synonyms and excluded items such as communicative abilities and skills related to knowledge such as relation between basic anatomical structures and EUS indications. The included items were organized and grouped into two categories based on the responses: Interpretation skills and technical skills. The lists of selected items were sent as an electronic survey to the participants in the second Delphi round.

Round 2

The suggestions from Round 1, organized into interpretational and technical skills, were sent to the participants to review and re-evaluate. They were asked to rate the statements according to importance. Specifically, we aimed to explore the importance of each item to include in an EUS training curriculum for residents in endosonography. The rating scale was from 1 = not important, 2 = somewhat important, 3 = moderately important, 4 = very important, and 5 = essential. The participants were asked to use the complete scale. A comment box was provided to allow the participants to expand on their choice of rating, as well as provide further comments or suggestions. The participants were given 2 weeks to complete the survey with a 1-week extension. The steering group gathered the responses and analyzed the data for the third round. Statements or items with a mean score lower than two were eliminated.

Round 3

The statements selected during the second round were ranked according to mean score and subsequently included in the third round, where the participants were asked to re-rate the items a final time using the same scoring system as in round 2. The participants were given 2 weeks to complete the survey with a 5-day extension. Consensus was defined as percent agreement in which a statement is included when 70% of the expert panel rated it as 4 – very important or 5 – essential. The statements that failed to reach 70% were excluded.[14]

Statistics

In Round 1, content summative analysis was performed to organize the data gathered from the brainstorming phase. Duplicates were removed and similar items were combined and rephrased for clarity. Suggestions that did not fit the inclusion criteria were deleted. In Rounds 2 and 3, descriptive analysis was performed to calculate the mean scores, which were arranged in descending order to indicate high ranking. Statistical analyses were performed using IBM SPSS Statistics 25.0 (SPSS 2017, Chicago, IL, USA).

RESULTS

Out of the 125 identified experts in endosonography, a total of 77 (62%) agreed to participate by responding to the questionnaire (first round), representing 25 countries across the world. The median age of the panel was 52 years (range 38–69) and the expert panelist had a median of 19 years (range 2–42) experience in endosonography. Two out of 77 participants were pulmonologists. The demographic characteristics are presented in Table 1.

Table 1. Participants characteristics

	Number
Age (years)	Median: 52 (38-69)
Experience in endosonography (years)	Median: 19 (2-42)
Country (*n*)	
Belgium	1
Brazil	3
Canada	1
China	1
Denmark	7
Ethiopia	1
France	4
Germany	5
Greece	1
Hong Kong	1
India	6
Israel	2
Italy	3
Japan	2
Netherlands	4
Norway	3
Romania	2
Russia	1
Scotland	1
Spain	3
Sweden	2
Switzerland	1
Turkey	1
United Kingdom	1
USA	20

Round 1

The brainstorming phase produced a raw list of 1,088 EUS skills, many of which were duplicate items [Supplementary Material 2]. These were reduced and organized into two categories: Interpretation skills (n = 47 items) and technical skills (n = 37 items). These lists were sent to the expert panel in round 2 to rate each item according to importance.

Round 2

Sixty-five out of 77 experts answered the survey (84%). All 47 interpretation skills had a mean score of >2. Thirty-four out of the 37 technical skills were rated >2 and were included. The three items that were eliminated included the ability to perform angiotherapy, perform EUS-guided gastrojejunostomy, and perform dilatation of duodenal stricture with linear EUS scope. The complete list and ratings scores are presented in Table 2.

Round 3

The response rate in the final round was 82% with 63 out of 77 experts. The final list included EUS skills that were ranked as very important or essential by more than 70% of the experts. There was a broad consensus to include 29 interpretational skills and 12 technical skills in the final list. Eighteen interpretational skills and 25 technical skills did not achieve consensus and were therefore eliminated. The top five interpretation skills include the ability to discern between normal anatomy and pathology (stones, tumors, lymph nodes, metastasis), ability to identify the entire pancreas and ampullary region, ability to identify solid lesions and discriminate them from fluid-filled structures, ability to detect bile duct stone and gallstone, and ability to identify a pancreatic mass of 5 mm or larger. For technical skills, the highest ranked items include the ability to insert the endoscope from the mouth to the second part of duodenum, ability to obtain FNA adequately and safely, ability to navigate the scope tip to follow anatomical landmark structures, ability to achieve endoscopic position of each of the 4 stations for imaging the pancreas and bile duct, and ability to perform passage of the scope past a hiatal hernia. The final list of interpretational and technical skills that are included in the EUS curriculum for residency training is presented in Tables 3 and 4, respectively.

Table 2. List of all EUS skills identified in Round 1, ranked by importance in Round 2

Rank	Interpretation skills	Mean score
1	Able to discern between normal anatomy and pathology (stones, tumors, lymph nodes, metastasis)	4.88
2	Able to identify the entire pancreas and ampullary region	4.86
3	Able to detect bile duct stone and gallstone	4.75
4	Able to identify the entire biliary system (CBD, CHD, cystic duct, and gallbladder)	4.74
5	Able to identify solid versus fluid-filled structures	4.72
6	Able to identify a pancreatic mass of 5 mm or larger	4.68
7	Able to identify the peripancreatic vessels (SMA, SMV, portal vein, aorta, ICV, SA, SV, CA, HA etc)	4.66
8	Able to identify the left lobe liver and major vasculature	4.65
9	Able to determine vascular flow by doppler	4.60
10	Able to identify and avoid structures that should not be routinely entered during FNA/FNB (for instance lung parenchyma and bone)	4.60
11	Able to identify the spleen	4.57
12	Able to identify celiac axis and ganglia	4.52
13	Able to differentiate ultrasound artifacts from normal and abnormal structures	4.51
14	Able to identify the left adrenal gland	4.51
15	Able to recognize which anatomic features that have not been confidently visualized or examined	4.43
16	Able to recognize malignant lymph nodes and the normal presentation of LN	4.43
17	Able to differentiate the normal appearing pancreas from autoimmune pancreatitis and pancreatic mass	4.34
18	Able to accurate interpret the echogenicity of a structure	4.32
19	Able to identify features associated with chronic pancreatitis and understands how to interpret them	4.31
20	Able to evaluate ampullary masses	4.29
21	Able to ascertain the wall layers of luminal organs	4.28
22	Able to perform TN staging of esophageal cancer	4.28
23	Able to stage luminal lesions/cancers (may include miniprobe competency for endoscopic resectors)	4.26
24	Able to interpret the mediastinum with linear scope	4.26
25	Able to detect ascites and pleural effusions	4.26
26	Able to perform TN staging of gastric cancer	4.23
27	Able to discern subepithelial lesions based on wall layer of origin	4.22
28	Able to perform TN staging of pancreatic cancer	4.20
29	Able to differentiate the microcystic serous cyst from other pancreatic cysts	4.11
30	Able to interpret CT images	4.05
31	Able to differentiate echographic appearance and diagnosis of different diseases	3.95
32	Able to recognize pathological anatomy like diverticula. strictures. varices. volvulus etc.	3.95
33	Able to identify the crus of diaphragm	3.91
34	Able to do mediastinal staging	3.85
35	Able to differentiate the splenule from pancreatic endocrine tumor	3.78
36	Able to decide frequency for area of interest	3.66
37	Able to identify both kidneys	3.62
38	Able to interpret the mediastinum with radial scope	3.45
39	Able to interpret the anal canal with radial scope	3.37
40	Able to interpret the perigastric and periduodenal area with radial scope	3.37
41	Able to identify inferior caval vein - judge width/collapse	3.23
42	Able to interpret contrast-enhanced EUS	3.03
43	Able to interpret the anal canal with linear scope	2.92
44	Able to interpret trans-abdominal US	2.83
45	Able to recognize sarcoid characteristics on EUS	2.75
46	Able to interpret elastography	2.65
47	Able to interpret cardiac anatomy	2.48
Rank	**Technical skills**	**Mean**
1	Able to obtain FNA adequately and safely	4.90
2	Able to insert the endoscope from the mouth to the second part of duodenum	4.87
3	Able to navigate the scope tip to follow anatomical landmark structures	4.86
4	Able to achieve endoscopic position of each of the 4 stations for imaging the pancreas and bile duct	4.57
5	Able to perform passage of the scope past a hiatal hernia	4.56
6	Able to operate a modern ultrasound processor used with EUS including documentation (images and films)	4.49

Contd...

Table 2. Contd...

Rank		Mean score
7	Able to troubleshoot basic scope functions. including valves and balloon inflation	4.41
8	Able to create an ideal image and how to problem solve when the image is suboptimal	4.41
9	Able to shorten an EUS scope in D2	4.30
10	Able to perform EUS-guided sampling of subepithelial lesions	4.16
11	Able to perform duodenoscopy	4.00
12	Able to perform transferred rotation of the linear transducer	3.83
13	Able to administer proper sedation before and during the procedure	3.70
14	Able to make an FNA slide	3.67
15	Able to perform endoscopic treatment of complications (clips. OVESCO. injection etc)	3.63
16	Able to perform EUS block/neurolysis	3.41
17	Able to perform pancreatic fluid collection drainage and necrosectomy	3.33
18	Able to read the FNA slide sufficiently enough to determine adequacy of aspirate	3.29
19	Able to perform EUS guided drainage	3.22
20	Able to do a complete gastroscopy with linear EUS scope (as surrogate for scope handling)	3.16
21	Able to perform biliary endoscopy	3.16
22	Able to perform anal endosonography and identify of anal anatomy	3.03
23	Able to pass guidewires and stents into otherwise inaccessible biliary and pancreatic ducts	2.95
24	Able to clean/disinfect EUS endoscope correctly according to regulations	2.86
25	Able to perform biliary drainage under supervision	2.79
26	Able to place fiducials	2.73
27	Able to perform miniprobe EUS	2.59
28	Able to handle the albaran-device	2.59
29	Able to perform biliary rendezvous	2.57
30	Able to perform direct gallbladder drainage	2.37
31	Able to perform alcohol ablation (tumor)	2.32
32	Able to perform EUS-PD drainage	2.17
33	Able to perform pancreatic rendezvous	2.16
34	Able to perform EUS-B-FNA with the EBUS endoscope	2.11
35	Able to perform angiotherapy	1.98*
36	Able to perform EUS-guided gastrojejunostomy	1.98*
37	Able to perform dilatation of duodenal stricture with linear EUS scope	1.97*

*Eliminated procedures. CT: Computerized tomography; FNB: Fine needle biopsy; CBD: common bile duct; CHD: common hepatic duct; SMA: superior mesenteric artery; SMV: superior mesenteric vein; ICV: inferior caval vein; SA: splenic artery; SV: splenic vein; CA: celiac artery; HA: hepatic artery; EBUS: endobronchial ultrasound; PD: pancreatic duct; TN: tumor and node; EUS-B: transesophageal use of the EBUS endoscope

DISCUSSION

Seventy-seven EUS experts participated in a three-round modified Delphi process, resulting in the core curriculum for EUS training including 29 interpretational and 12 technical skills, respectively.

The Delphi process that has been applied in this study secures an efficient and quick gathering of information, starting with brainstorming followed by a two round assessment and selection course to ensure consensus.[12] The process is constructed as electronic surveys with anonymous and confidential responding. This ensures independent answering and limits the risk of bias compared to for instance an expert meeting where one or a few dominating figures can have an unproportionate impact on the final result. The steering group had extensive experience with Delphi methodology and before initiation of the study, they defined the specific methodology that has been applied in this study.[12,15,16] The decision about the final threshold of 70% of the participants finding the specific skill very important or essential is a common approach which has been advised or applied in numerous papers.[14]

As several guidelines and papers already defined proper indications for EUS associated procedures, it was agreed to exclude skills related to knowledge and communication.[1,9] That was also emphasized in the letter of invitation to the participants [Supplementary Material 1]. However, during the study, the steering group made the decision to separate the skillset into interpretational and technical categories for didactic reasons.

Table 3. Final list of interpretation to include in an EUS curriculum for specialist training

Rank	Interpretation skills	Mean score	Rating		Percent agreement (4 and 5 rating)
			4	5	
1	Able to discern between normal anatomy and pathology (stones, tumors, lymph nodes, metastasis)	4.92	7.94	92.06	100.00
2	Able to identify the entire pancreas and ampullary region	4.83	12.70	85.71	98.41
3	Able to identify solid versus fluid-filled structures	4.78	22.22	77.78	100.00
4	Able to detect bile duct stone and gallstone	4.75	11.11	82.54	93.65
5	Able to identify a pancreatic mass of 5 mm or larger	4.65	28.57	68.25	96.83
6	Able to identify and avoid structures that should not be routinely entered during FNA/FNB (for instance lung parenchyma and bone)	4.65	20.6	73.0	93.65
7	Able to differentiate ultrasound artifacts from normal and abnormal structures	4.65	25.4	69.8	95.24
8	Able to determine vascular flow by Doppler	4.62	19.0	71.4	90.48
9	Able to ascertain the wall layers of luminal organs	4.52	30.2	61.9	92.06
10	Able to identify the entire biliary system (CBD, CHD, cystic duct, and gallbladder)	4.44	33.33	57.14	90.48
11	Able to identify the spleen	4.37	31.7	55.6	87.30
12	Able to identify celiac axis and ganglia	4.33	33.3	52.4	85.71
13	Able to accurate interpret the echogenicity of a structure	4.33	36.5	49.2	85.71
14	Able to discern subepithelial lesions based on wall layer of origin	4.33	41.3	47.6	88.89
15	Able to identify the left adrenal gland	4.30	41.3	44.4	85.71
16	Able to differentiate the normal appearing pancreas from autoimmune pancreatitis and pancreatic mass	4.30	41.3	46.0	87.30
17	Able to identify the peripancreatic vessels (SMA, SMV, portal vein, aorta, ICV, SA, SV, CA, HA etc.)	4.29	47.6	41.3	88.89
18	Able to recognize which anatomic features that have not been confidently visualized or examined	4.29	44.4	39.7	84.13
19	Able to detect ascites and pleural effusions	4.25	41.3	42.9	84.13
20	Able to interpret the mediastinum with linear scope	4.22	41.3	42.9	84.13
21	Able to identify the left lobe liver and major vasculature	4.19	44.4	39.7	84.13
22	Able to recognize malignant lymph nodes and the normal presentation of LN	4.19	41.3	38.1	79.37
23	Able to perform TN staging of esophageal cancer	4.19	39.7	41.3	80.95
24	Able to evaluate ampullary masses	4.16	47.6	34.9	82.54
25	Able to differentiate the microcystic serous cyst from other pancreatic cysts	4.13	55.6	30.2	85.71
26	Able to perform TN staging of gastric cancer	4.05	42.9	33.3	76.19
27	Able to perform TN staging of pancreatic cancer	4.05	38.1	34.9	73.02
28	Able to identify features associated with chronic pancreatitis and understands how to interpret them	3.98	44.4	28.6	73.02
29	Able to differentiate echographic appearance and diagnosis of different diseases	3.87	46.0	25.4	71.43

FNB: Fine needle biopsy; CBD: common bile duct; CHD: common hepatic duct; SMA: superior mesenteric artery; SMV: superior mesenteric vein; ICV: inferior caval vein; SA: splenic artery; SV: splenic vein; CA: celiac artery; HA: hepatic artery; EBUS: endobronchial ultrasound; PD: pancreatic duct; TN: tumor and node

Table 4. Final list of technical skills to include in an EUS curriculum for specialist training

Rank	Technical skills	Mean score	Rating		Percent agreement (4 and 5 rating)
			4	5	
1	Able to insert the endoscope from the mouth to the second part of duodenum	4.92	7.9	92.1	100.0
2	Able to obtain FNA adequately and safely	4.86	7.9	88.9	96.8
3	Able to navigate the scope tip to follow anatomical landmark structures	4.86	14.3	85.7	100.0
4	Able to achieve endoscopic position of each of the 4 stations for imaging the pancreas and bile duct	4.63	30.2	68.3	98.4
5	Able to perform passage of the scope past a hiatal hernia	4.57	27.0	66.7	93.7
6	Able to operate a modern ultrasound processor used with EUS including documentation (images and films)	4.48	31.7	58.7	90.5
7	Able to troubleshoot basic scope functions. including valves and balloon inflation	4.48	28.6	60.3	88.9
8	Able to shorten an EUS scope in D2	4.37	49.2	46.0	95.2
9	Able to create an ideal image and how to problem solve when the image is suboptimal	4.33	41.3	46.0	87.3
10	Able to perform EUS-guided sampling of subepithelial lesions	4.13	34.9	42.9	77.8
11	Able to perform transferred rotation of the linear transducer	4.08	44.4	38.1	82.5
12	Able to perform duodenoscopy	3.95	39.7	34.9	74.6

The background and opinion of the expert participants included in the Delphi progress are obviously reflected in the results. The participants are all internationally, well-known experts in endosonography, and academically active. They are also part of the network of the senior author of the steering group and have not been appointed by medical societies, official committees, etc., So, by definition the expert panel was selected by convenience sampling. However, we ended up with a broad, international panel and do not believe that the results are biased by the selection of the Delphi participants. The considerable number of participants contributing to the curriculum will most likely outweigh any distinct opinions within the group. In addition, to promote transparency of the participants, the demography is included in Table 1.

The expert consensus includes 29 interpretational skills and 12 technical skills. Some of the excluded skills call for attention, in particular mediastinal staging, which is mandatory for pulmonologists.[17] The exclusion of this reflects that the vast majority of the participants were gastroenterologists thus, the curriculum is in our opinion only valid for gastrointestinal endosonography. Similarly, the skill in relation to anorectal EUS has all been excluded from the final list. Whether this may reflect a shift in staging of rectal cancers towards MRI or that radiologists or surgeons now perform these procedures with conventional rigid transluminal probes is unknown. Regional differences in the use also play a role for the priorities of the skill set. In general, many skills with radial EUS were suggested by the expert panel. Most of these skills were, however, eliminated during the Delphi process. Most of the skills that reached a consensus and were included, such as the ability to obtain FNA adequately and safely, involved the use of linear echoendoscopes. This change likely reflects a trend toward greater use due to its inherent biopsy, invasive capacity and greater comfort using linear EUS alone for recognizing the anatomy.

During recent years several papers have proposed sets of quality indicators for EUS.[1,11,18] A certain number of procedures during fellowships is often defined hoping that this will enable the endosonographer to fulfill quality indicators.[6] For instance, the British Society of Gastroenterology recommends a minimum of 250 supervised cases including 150 pancreaticobiliary indications (75 pancreatic cancers), 80 luminal indications (10 anorectal EUS), 10 subepithelial lesions, and 75 EUS-guided FNA (45 celiac pancreatic).[8] These minimum numbers are recommended even though learning curves alter significantly among trainees.[19] Recently, a push has been made by the ASGE to standardize the assessment of the procedures in order to individualize the number of procedures per fellow and furthermore, a recent prospective study by Wani *et al.* demonstrated how the majority of fellows enrolled in competency-based programs in EUS and ERCP met the quality targets during their index year of independent practice.[7,10] The curriculum developed from this study does not answer the important shift from volume or time-based training to competency-based training.[20] As several EUS quality indicators have become widely accepted, we hope this curriculum will facilitate a more efficient training program with steeper learning curves during EUS fellowship, ultimately securing that newly graduated endosonographers fulfill these quality indicators.[1] Furthermore, the interpretational and technical skills ranked at the top of our lists [Tables 3 and 4] do not conflict with the quality indicators suggested by the ASGE and ESGE. The skill included in our curriculum are mandatory to reach the performance measures.[11,18]

The advances of artificial intelligence (AI) have already impacted luminal endoscopy for both upper and lower gastrointestinal indications.[21,22] In EUS, convolutional neural network models have proven beneficial for differentiating autoimmune pancreatitis from pancreatic carcinomas and other benign lesions.[23] AI may also become an inevitable part of endoscopic training.[24,25] Recently, Zhang *et al.* published a study describing how a deep-learning system was able to recognize the standard positions for pancreas examinations with EUS – a technique that potentially may lead to enhanced real-time monitoring during EUS procedures and serve as an important training tool.[26]

There are several limitations in relation to this study. The results of the survey are solely dependent of the participants selected for the Delphi process – the importance of for instance mediastinal staging, anorectal EUS, and biliary interventions may differ between pulmonologists, and lower gastrointestinal and hepatobiliary endoscopists. Furthermore, the link to a clinically relevant outcome such as sensitivity of biliary stone detection or EUS-FNA has yet to be established. The next steps would be to develop and implement training programs on these procedural and interpretational skills including assessment of competence both in simulation and the clinical environment.

CONCLUSIONS

In conclusion, after a structured Delphi process including 77 international experts, a consensus was reached for a basic curriculum for EUS fellows that may be included during fellowship training in order to be defined as sufficiently competent. The important interpretational capabilities and technical skills included in the curriculum may be further evaluated during an implementation phase and finally integrated in future studies to assess the correlation with quality indicators after graduation.

Supplementary materials

Supplementary information is linked to the online version of the paper on the *Endoscopic Ultrasound* website.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Domagk D, Oppong KW, Aabakken L, *et al.* Performance measures for ERCP and endoscopic ultrasound: A European Society of Gastrointestinal Endoscopy (ESGE) Quality Improvement Initiative. *Endoscopy* 2018;50:1116-27.
2. Costache MI, Iordache S, Karstensen JG, *et al.* Endoscopic ultrasound-guided fine needle aspiration: From the past to the future. *Endosc Ultrasound* 2013;2:77-85.
3. DeWitt JM, Arain M, Chang KJ, *et al.* Interventional endoscopic ultrasound – Current status and future directions. *Clin Gastroenterol Hepatol* 2021;19:24-40.
4. Cho CM. Training in endoscopy: Endoscopic ultrasound. *Clin Endosc* 2017;50:340-4.
5. Vilmann P, Frost Clementsen P, Colella S, *et al.* Combined endobronchial and esophageal endosonography for the diagnosis and staging of lung cancer: European Society of Gastrointestinal Endoscopy (ESGE) Guideline, in cooperation with the European Respiratory Society (ERS) and the European Society of Thoracic Surgeons (ESTS). *Eur J Cardiothorac Surg* 2015;48:1-15.
6. Jenssen C, Hocke M, Fusaroli P, *et al.* EFSUMB Guidelines on Interventional Ultrasound (INVUS), Part IV – EUS-guided Interventions: General aspects and EUS-guided sampling (Long Version). *Ultraschall Med* 2016;37:E33-76.
7. Wani S, Keswani RN, Han S, *et al.* Competence in endoscopic ultrasound and endoscopic retrograde cholangiopancreatography, from training through independent practice. *Gastroenterology* 2018;155:1483-94.e7.
8. Meenan J, Harris K, Oppong K, *et al.* Service provision and training for endoscopic ultrasound in the UK. *Frontline Gastroenterol* 2011;2:188-94.
9. Teoh AY, Dhir V, Kida M, *et al.* Consensus guidelines on the optimal management in interventional EUS procedures: Results from the Asian EUS group RAND/UCLA expert panel. *Gut* 2018;67:1209-28.
10. Wani S, Keswani RN, Petersen B, *et al.* Training in EUS and ERCP: Standardizing methods to assess competence. *Gastrointest Endosc* 2018;87:1371-82.
11. Wani S, Wallace MB, Cohen J, *et al.* Quality indicators for EUS. *Gastrointest Endosc* 2015;81:67-80.
12. Nayahangan LJ, Van Herzeele I, Konge L, *et al.* Achieving consensus to define curricular content for simulation based education in vascular surgery: A Europe wide needs assessment initiative. *Eur J Vasc Endovasc Surg* 2019;58:284-91.
13. Milholland AV, Wheeler SG, Heieck JJ. Medical assessment by a Delphi group opinion technic. *N Engl J Med* 1973;288:1272-5.
14. Diamond IR, Grant RC, Feldman BM, *et al.* Defining consensus: A systematic review recommends methodologic criteria for reporting of Delphi studies. *J Clin Epidemiol* 2014;67:401-9.
15. Karstensen JG, Ebigbo A, Aabakken L, *et al.* Nonvariceal upper gastrointestinal hemorrhage: European Society of Gastrointestinal Endoscopy (ESGE) Cascade Guideline. *Endosc Int Open* 2018;6:E1256-63.
16. Nayahangan LJ, Stefanidis D, Kern DE, *et al.* How to identify and prioritize procedures suitable for simulation-based training: Experiences from general needs assessments using a modified Delphi method and a needs assessment formula. *Med Teach* 2018;40:676-83.
17. Konge L, Colella S, Vilmann P, *et al.* How to learn and to perform endoscopic ultrasound and endobronchial ultrasound for lung cancer staging: A structured guide and review. *Endosc Ultrasound* 2015;4:4-9.
18. Domagk D, Oppong KW, Aabakken L, *et al.* Performance measures for endoscopic retrograde cholangiopancreatography and endoscopic ultrasound: A European Society of Gastrointestinal Endoscopy (ESGE) Quality Improvement Initiative. *United European Gastroenterol J* 2018;6:1448-60.
19. Wani S, Keswani R, Hall M, *et al.* A prospective multicenter study evaluating learning curves and competence in endoscopic ultrasound and endoscopic retrograde cholangiopancreatography among advanced endoscopy trainees: The rapid assessment of trainee endoscopy skills study. *Clin Gastroenterol Hepatol* 2017;15:1758-67.e11.
20. Carraccio C, Englander R, Van Melle E, *et al.* Advancing competency-based medical education: A charter for clinician-educators. *Acad Med* 2016;91:645-9.
21. Mori Y, Kudo SE, Mohmed HE, *et al.* Artificial intelligence and upper gastrointestinal endoscopy: Current status and future perspective. *Dig Endosc* 2019;31:378-88.
22. Ahmad OF, Soares AS, Mazomenos E, *et al.* Artificial intelligence and computer-aided diagnosis in colonoscopy: Current evidence and future directions. *Lancet Gastroenterol Hepatol* 2019;4:71-80.
23. Marya NB, Powers PD, Chari ST, *et al.* Utilisation of artificial intelligence for the development of an EUS-convolutional neural network model trained to enhance the diagnosis of autoimmune pancreatitis. *Gut* 2021;70:1335-44.
24. Hassan C, Spadaccini M, Iannone A, *et al.* Performance of artificial intelligence in colonoscopy for adenoma and polyp detection: A systematic review and meta-analysis. *Gastrointest Endosc* 2021;93:77-85.e6.
25. Vilmann AS, Norsk D, Svendsen MB, *et al.* Computerized feedback during colonoscopy training leads to improved performance: A randomized trial. *Gastrointest Endosc* 2018;88:869-76.
26. Zhang J, Zhu L, Yao L, *et al.* Deep learning-based pancreas segmentation and station recognition system in EUS: Development and validation of a useful training tool (with video). *Gastrointest Endosc* 2020;92:874-85.e3.

[#] Members of The EUS Delphi Panel are listed below

Adrian Saftoiu[1,2]: [1]University of Medicine and Pharmacy, Craiova, Romania; [2]Ponderas Academic Hospital Bucharest, Romania

Aleksei Epshtein: First City Hospital Named after Volosevich E. E, Arkhangelsk, Russia

Anand Sahai: University of Montréal Hospital Center, Montréal, Canada

Andrew Y. Wang: Division of Gastroenterology and Hepatology, University of Virginia, Charlottesville, Virginia, USA

Anthony Y. Teoh: Department of Surgery, Prince of Wales Hospital, The Chinese University of Hong Kong, China

Eike Burmester: Medizinische Klinik I-Endoskopie Sana Kliniken Lübeck, Lübeck, Germany

Can Gonen: Department of Gastroenterology, School of Medicine, Acibadem Mehmet Ali Aydinlar University, Istanbul, Turkey

Christoph F Dietrich: Department Allgemeine Innere Medizin, Kliniken Hirslanden, Beau Site, Salem und Permanence, Bern, Switzerland

Christian Jenssen[1,2]: [1]Krankenhaus Märkisch-Oderland, Department of Internal Medicine, Strausberg, Germany; [2]Brandenburg Institute for Clinical Ultrasound at Medical University Brandenburg "Theodor Fontane," Neuruppin, Germany

Enrique Vazquez-Sequeiros: University Hospital Ramon Y Cajal, Madrid, Spain

Erik H. F. M. van der Heijden: Interventional Pulmonology - Department of Pulmonary Diseases, Radboud University Medical Center, Nijmegen, The Netherlands

Erwan Loïc Bories: Clinique Axium, Hopital privé de Provence, Aix En Provence, France

Erwin Santo: Department of Gastroenterology, Tel Aviv Sourasky Medical Center, Tel Aviv, Israel

Evangelos Kalaitzakis: Department of Gastroenterology, University Hospital of Heraklion, University of Crete, Heraklion, Greece

Everson L. A. Artifon: Department of Surgery University of Sao Paulo, Sao Paulo, Brazil

Fauze Maluf-Filho: Department of Gastroenterology, Instituto do Câncer do Estado de São Paulo-ICESP, University of São Paulo, São Paulo, Brazil

Girish Mishra: Department of Gastroenterology, Wake Forest School of Medicine, Winston-Salem, North Carolina, USA

Harry R. Aslanian: Yale Gastrointestinal Cancers Program, Smilow Cancer Hospital Yale University, Connecticut, USA

James Scheiman[1,2]: [1]Division of Gastroenterology and Hepatology, University of Virginia, Virginia, USA; [2]Michigan Medicine, Ann Arbor MI, USA

Jan-Werner Poley: Department of Gastroenterology and Hepatology, Maastricht University Medical Centre, Maastricht, The Netherlands

Jeanin van Hooft: Department of Gastroenterology and Hepatology, Leiden University Medical Center, Leiden, The Netherlands

John M. DeWitt: Indiana University Health Medical Center, Indianapolis, USA

Julio Iglesias-Garcia: Department of Gastroenterology and Hepatology, University Hospital of Santiago de Compostela, Spain

Khanh Do-Cong Pham: Department of Medicine, Haukeland University Hospital, Bergen, Norway

Lars Aabakken[1,2]: [1]Oslo University Hospital, Rikshospitalet, Norway; [2]Faculty of Medicine, University of Oslo, Norway

Lene Brink: Division of Endoscopy, Gastro Unit, Herlev and Gentofte Hospital, Denmark

Leonardo Sosa Valencia : Strasbourg Institute of Image-Guided Surgery (IHU), Strasbourg, France

Linda S. Lee: Brigham and Women's Hospital and Harvard Medical School, USA

Manoop S. Bhutani: Department of Gastroenterology, Hepatology and Nutrition, UT MD Anderson Cancer Center, Houston, TX, USA

Manuel Perez-Miranda: Gastroenterology Department, Hospital Universitario Rio Hortega, Valladolid, Spain

Maor Lahav: Sheba Medical Center, Tel Aviv Medical School, Tel Aviv, Israel

Maria Chiara Petrone: Pancreato-Biliary Endoscopy and Endosonography Division, San Raffaele Scientific Institute, Vita Salute San Raffaele University, Milan, Italy

Mariana Jinga: University of Medicine and Pharmacy Carol Davila, Bucharest, Romania

Mark Topazian[1,2,3]: [1]Mayo Clinic, Rochester, MN, USA; [2]Tikur Anbessa Hospital, Addis Ababa, Ethiopia [3]St. Paul's Hospital Millennium Medical Center, Addis Ababa, Ethiopia

Michael B. Kimmey: University of Washington, Washington, USA

Michael Bau Mortensen[1,2]: [1]Department of Surgery, Upper GI and HPB Section, Odense University Hospital, Denmark; [2]Odense Pancreas Center, Odense PIPAC Center, Denmark

Michael Hareskov Larsen: Upper GI surgery, Odense University Hospital, Denmark

Michael Hocke: Helios Hospital Meiningen, Meiningen, Germany

Michael Levy: Mayo Clinic, Rochester, Minnesota, USA

Mohammad Al-Haddad: Indiana University School of Medicine, Indiana, USA

Laurent Palazzo: Endoscopy Dept Trocadéro Clinic Paris, France

Maxime Palazzo: European Hospital of Marseille, Digestive Disease Department

Paolo Giorgio Arcidiacono: Pancreatico/Biliary Endoscopy and Endosonography Division, Vita Salute San Raffaele University, San Raffaele Scientific Institute, Milan, Italy

Paul Fockens[1,2]: [1]Amsterdam University Medical Centers location University of Amsterdam, Department of Gastroenterology and Hepatology, Meibergdreef 9, Amsterdam, the Netherlands; [2]Amsterdam Gastroenterology, Endocrinology & Metabolism, Amsterdam, the Netherlands

Paul Frost Clementsen: Copenhagen Academy for Medical Education and Simulation (CAMES), Denmark

Pierre H. Deprez: Cliniques universitaires St Luc, Université Catholique de Louvain, Brussels, Belgium

Pietro Fusaroli: University of Bologna, Hospital of Imola, Italy

Pramod Garg: All India Institute of Medical Sciences, New Delhi, India

Rabindra Watson: Karsh Division of Gastroenterology Cedars-Sinai Medical Center, Santa Monica, USA

Rajesh N. Keswani: Northwestern Medicine, Chicago, IL, USA

Riadh Sadik: Sahlgrenska University Hospital, Gothenburg

Roald Flesland Havre[1,2]: [1]Department of Medicine, Haukeland University Hospital, Bergen, Norway; [2]Department of Clinical Medicine, University of Bergen, Norway

Serta Kilincalp: Department of Gastroenterology, University of Gothenburg, Sweden

Shou-jiang Tang: University of Mississippi Medical Center, Jackson, MS, USA

Siyu Sun: Department of Gastroenterology, Shengjing Hospital of China Medical University, Shenyang, Liaoning Province, China

Stephan Hollerbach: Department of Gastroenterology/ Endoscopy, AKH Celle, Academic Teaching Hospital, Germany

Stephen P Pereira: Institute for Liver and Digestive Health, University College London, London, UK

Sundeep Lakhtakia: Asian Institute of Gastroenterology, Hyderabad, Telangana, India

Surinder Rana: Department of Gastroenterology, Postgraduate Institute of Medical Education and Research , Chandigarh, India

Saad Haque: Medstar Medical Group, Maryland, USA

Takao Itoi: Department of Gastroenterology and Hepatology, Tokyo Medical University, Tokyo, Japan

Timothy Woodward: Mayo Clinic, Gastroenterology and Hepatology, Jacksonville, USA

Todd Baron: University of North Carolina at Chapel Hill, USA

Uzma D. Siddiqui: University of Chicago, Center for Endoscopic Research and Therapeutics, USA

Vanessa M Shami: University of Virginia, Virginia, USA

Vijay Sharma: Regional institute of health medicine and research, Jaipur, Rajasthan, India

Vikram Bhatia: Institute of Liver and Biliary Sciences, New Delhi, India

Vinay Dhir: Institute of Digestive and Liver Care, SL Raheja Hospital, Mumbai, Maharashtra, India

Vitor Nunes Arantes: Endoscopy Unit, Federal University of Minas Gerais, Belo Horizonte, Brazil