A structured Endoscopic Ultrasound training program in Germany improves knowledge and competence

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Introduction

Indications for Endoscopic Ultrasound (EUS) have increased strongly in the latter years and EUS is now widely available. EUS has a proven clinical impact on daily patient management [1]. Systematic training is required to acquire EUS competence, including a sufficient level of skill and knowledge. So far EUS is largely learned by observation and self-teaching assisted by the use of textbooks, video or e-learning cases. ASGE (American Society for Gastrointestinal Endoscopy) guidelines recommend a minimum of 225 supervised procedures, including 50 cases of Fine-Needle Aspiration (FNA) to gain a sufficient skill level [2,3]. For diagnosing pancreaticobiliary diseases, which has been regarded particularly difficult, expert opinion suggest a number of 120 to 150 cases of pancreatic findings to reach interpretative competence [4,5]. EFSUMB (European Federation of Societies for Ultrasound in Medicine and Biology) guidelines on interventional ultrasound are in agreement with the need of at least 50 EUS-guided sampling procedures to attain basic expertise for this method [6]. However, stud-
ies have reported a large amount of variation in learning curves [7,8]. A specific caseload alone does not ensure competence [8]. The extent of theoretical learning and the minimum number of procedures required to ensure sufficient expertise are not widely defined and may be specified too low in the national recommendations.

Training in EUS poses a special challenge due to the difficult technical approach with radial and linear endoscopes. The mixture of endoscopy and ultrasound as a difficult imaging technique as well as the complexity of instrument handling to generate adequate visualization raise the necessity to gain appropriate competence and to design structured training programs [9]. Until now, limited evidence is available on how to organize training and how to evaluate competence with objective methods as training performance measurements have not yet been standardized.

In 2007 we developed and implemented a structured EUS training program that consists of a basic module and an advanced module each lasting one and a half days. The training program includes a precise content of theoretical teaching, interactive video sessions, observation of live demonstrations and hands-on experience. Practical training follows a theoretical introduction to the specific method and includes the use of various phantom models consisting of computer-based simulators (Simbionix, Israel), a pancreaticobiliary training model (Ikuma, Olympus), EUS meets VOXEL-MAN training DVD as well as EUS-guided sampling models and animal-based simulators. Practical training is done with expert supervision in groups of maximal four to five trainees. In addition, a syllabus covering all theoretical topics is available to enable self-directed learning. The program execution is in line with the previously developed endoscopic training concept called “GATE-gastroenterological education – training endoscopy” [10,11]. The training program is approved by DGVS (German Society of Gastroenterology) and DEGUM (German Society of Ultrasound in Medicine).

The aim of our study was to assess the impact of a structured EUS training program on the perceived curricular relevance of the four training components (theoretical teaching, video sessions, live demonstration, hands-on experience), the self-rated improvement in competence by participants and the improvement of knowledge overall und in comparison between beginners and advanced learners.

**Material and methods**

**Subjects**

In a prospective study design, evaluation was conducted during four training courses at three centers in Munich, Berlin and Lübeck (Germany). All centers provide training courses according to the training guidelines approved by the national societies DGVS and DEGUM. Course directors belong to the experts in gastrointestinal endoscopy and require an experience of at least 2,000 EUS examinations. A total of 64 trainees, who independently registered for the courses and took part in the whole training program, were enrolled in the study. Participants consecutively attended the basic and advanced module resulting in a three-day structured training program. Each training program followed the same curriculum containing ten hours of theoretical teaching and 11 hours of practical exercises via simulator-based training (four hours), video sessions (four hours) and live demonstrations (three hours).

**Item scoring**

All 64 trainees completed a structured questionnaire at the beginning and end of the course. We created a unique ID for each trainee to pseudonymize data collected in the questionnaires. The questionnaires were completed inside the lecture hall under supervision of the course directors. At baseline, six items were documented to evaluate trainees’ characteristics and initial experience.

To evaluate the curricular relevance of the four training components (theoretical teaching, video sessions, live demonstrations and hands-on experience) participants were asked to assess the appropriateness of the extent of the four components during the training program as “too little”, “adequate” or “too much”. Furthermore, in the post-test questionnaire acceptance of the training program was judged using four items on a 5-point Likert scale (1=completely disagree, 5=completely agree). The four items included statements on motivation during the training program, improvement of diagnostic competence, improvement of basic knowledge and relevance for practical experience. Evaluation of each item was subdivided according to the four different components of the training program.

To analyse the self-rated improvement in competence we requested the self-assessment of improvement in EUS skills at the end of the training program in comparison to the beginning. Therefore, we adopted a post-test self-evaluation on a 5-point-Likert scale (1=excellent EUS skills, 5=no EUS skills).

Improvement of theoretical knowledge was investigated by a pre- and post-test questionnaire consisting of 12 multiple choice questions each. Two different types of multiple choice questions were used: nine single-best-answer items (one-out-of-five, A-type) and three Pick-N items (two answers out of six options). Within the Pick-N items the number of options to select was specified. Each question scored a maximum of one point for 100% cor-
rect answers, 0.5 points for 50% to 99% correct answers and zero points for less than 50% correct answers [12]. Topics were taken from the lectures given during the theoretical part of the course. Items were designed pairwise to each topic but had different content. The level of difficulty for each item was assessed as comparable by two experts in endoscopic ultrasound (both >600 EUS-examinations).

To assess changes in the state of knowledge between beginners and advanced learners results of the MC-test for the group of beginners with little experience (<50 examinations, group 1, n = 38) were compared to the group with advanced learners (≥50 examinations, group 2, n = 26).

**Statistical analysis**

Descriptive statistics are provided as median and interquartile range (IQR) for continuous variables, as appropriate. Categorical data are reported as numbers and frequencies in percent. The t-test for paired samples was used to compare the overall score in the MC-test at baseline and after the training. The analyses were performed for the whole cohort as well as after stratification by prior experience (group 1 vs. group 2). The Wilcoxon test for paired samples was used to determine the statistical significance of the differences in self-rated EUS competency at baseline and after the training. p<0.05 was considered to be statistically significant. For statistical analysis IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp. (2011) was used.

**Results**

**Characteristics of trainees**

Baseline characteristics of the 64 participants are shown in Table I: all except one of the trainees were working in hospitals, 71% of them as senior physicians; 38 (59%) of the participants had only marginal experience with fewer than 50 EUS examinations; 63 % performed fewer than 25 EUS-guided sampling procedures and 29 trainees (47%) had even no experience in EUS-FNA before attending the course. Both linear and radial scanning echoendoscopes were available for 55% of the participants in their departments whereas only in five cases equipment was complemented with EUS miniature probes.

**Curricular relevance of the four course components**

Time slices for live demonstrations and hands-on training were considered as “too small” by 19% respectively 28% of the participants, whereas the theoretical part was judged as “too much” by 19% of the trainees. The length of video sessions was considered as “adequate” in 92% of the cases (Table II).

**Table I. Baseline characteristics of all trainees (n=64)**

| Parameter                  | Value                        |
|----------------------------|------------------------------|
| Age (years, m ± SD)       | 42.4±7.1                     |
| Position                  | Frequencies (%)              |
| Senior physician          | 40 (71.5)                    |
| Medical specialist        | 12 (21.5)                    |
| Resident physician        | 4 (7)                        |
| Experience                |                              |
| Number of EUS examinations|                              |
| < 50                      | 38 (59)                      |
| ≥ 50                      | 26 (41)                      |
| Number of EUS-FNAs*       |                              |
| < 25                      | 39 (63)                      |
| ≥ 25                      | 23 (37)                      |
| Equipment (multiple selection possible) |         |
| Linear Probe              | 48 (77)                      |
| Radial Probe              | 44 (70)                      |
| Mini Probe                | 5 (9)                        |

* FNA = Fine Needle Aspiration

**Table II. Acceptance of the extent of the different components used in the training program (n=64)**

| Components              | too little | adequate | too much |
|-------------------------|------------|----------|----------|
| Theoretical lectures    | 0          | 52 (81%) | 12 (19%) |
| Video sessions          | 3 (5%)     | 59 (92%) | 2 (3%)   |
| Live demonstrations     | 12 (19%)   | 51 (80%) | 1 (1%)   |
| Hands-on training       | 18 (28%)   | 42 (66%) | 4 (6%)   |

Overall evaluation on acceptance of the training course received above-average results with median between four and five and IQR between one and two on Likert scale (fig 1). Video sessions obtained the best results with positive agreement in 78-83% of cases (rating four and five on Likert scale). The theoretical part was perceived to have a negative impact on motivation and to be of little relevance for clinical practice by 37.5% and 30% of the participants, respectively (rating one to three on the Likert scale). Remarkably only 61% and 62% respectively, evaluated hands-on training to be suitable to improve diagnostic competency and basic knowledge.

**Self-rated improvement in competence**

In the post-test self-evaluation of improvement in EUS skills on a 5-point-Likert scale median of all trainees improved significantly from four points at the beginning to two points at the end of the training program with an IQR of one (p=0.001). Significant improvement could be verified for the beginners as well as for the advanced learners (Table III). The extent of improvement was comparable for both groups.
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Improvement of theoretical knowledge

For the multiple-choice test, the mean score of all trainees improved significantly from 7.9±1.9 points out of 12 possible points in the pre-test to 8.8±1.9 points in the post-test (p=0.001, Table III).

Changes on state of knowledge between beginners and advanced learners

When the group of beginners (group 1) and the group with advanced learners (group 2) were evaluated separately, significant improvement from 7.6±2.0 to 8.8±1.9 points was achieved in group 1 (p=0.001). Results of group 2 revealed only marginal improvement from 8.4±1.6 to 8.8±1.9 points (p=0.251, table III).

Discussion

In 1990 Miller et al proposed a simple four-layered pyramid for the assessment of competence in medical skills [13,14]. The first two steps relate to theoretical knowledge as a base for practical training. Step three (“shows how”) represents simulator-based learning and step four is the observable performance of learners on real patients. Our training program is in line with this idea and combines theoretical teaching with different elements of practical training in a structured manner with a view to prepare trainees for step four. Previous formal EUS training courses were scarce in Europe. In France a structured training program over a period of four weeks started in 2004, but no data on outcome is reported and it allows training of only a small number of endoscopists per year [15,16]. After starting our training program in 2007 in Munich, in the meantime courses were provided with the same curriculum in several centres throughout Germany, which enabled us to provide the study in a prospective, multicentre approach.

Baseline characteristics show that most participants provided only previous knowledge in EUS, especially 47% had no experience in EUS-FNA. This raises the question if physicians without experience in EUS-FNA should already attend the advanced module of the training program, as it is desirable that trainees participating in this module have adequate basic knowledge in EUS. On the other hand, Cote et al demonstrated that supervised EUS-FNA training initiated at the onset of EUS training for advanced endoscopy fellows was safe and had comparable results to advanced learners [17]. The optimal time to initiate EUS-FNA training is still unclear but advanced endoscopic skills and basic EUS-knowledge should be obligatory preconditions. Finally in our study it enabled numerous trainees to gain first interventional experience in a pre-patient setting under expert supervision.

Results concerning the curricular relevance of the four course components underline the importance of video sessions, which are provided in our training program for each topic discussed in the theoretical part. Sessions should be presented in an interactive manner and should cover representative material for normal anatomy and typical pathologic findings of the discussed organ systems. Around 20% of the participants would like to find more hands-on training or live-demonstrations incorporated in the training curriculum. To compensate the temporal limitation during the training course the DEGUM education program advocate an internship following the course modules to intensify practical experience.

Despite general positive feedback the theoretical part was perceived to have a negative impact on motivation by about one-third of the trainees. This impression is inconsistent with the results of the MC-Test. In the pre-test the trainees achieved only a mean value of 7.9 points out of 12 points which emphasizes the need to improve the theoretical background. Expectedly the advanced learners showed slightly better results than the beginners in
The definite impact of simulator training in EUS teaching is a subjective rather than an objective measurement. Our results concerning practical learning curves during simulator training, which are based on self-evaluation, may pose a limitation of our study. Therefore, guidelines concerning the effects of structured training programs to improve diagnostic competency and basic knowledge are needed to achieve competence has still to be demonstrated in further studies. To date elaborated simulators are missing, who could provide teaching in a structured and reproducible setting (e.g., finding of labelled anatomic landmarks). Our data reveal slightly below average results for the impact of hands-on training to improve diagnostic competency and basic knowledge. This assessment underlines that all so far available simulators are afflicted with some impairments. This limitation may be overcome in the near future due to the development of new simulators. A currently developed computer-based simulator provides demonstration of important anatomical landmarks for upper endoscopic ultrasound (Smedis AG, Switzerland). In 2017 a new animal-based model was introduced to perform EUS-FNA and EUS-interventions in a reproducible setting (LET – Luebeck-EUS-Trainer, Germany). These new simulators are intended to be integrated in the hands-on training and therefore will enable structured evaluation of practical skills in the future.

As EUS belongs to the endoscopic procedures with a long-learning curve former studies have already confirmed the importance of adequate experience to improve accuracy. Fockens et al demonstrated a learning curve for staging of oesophageal carcinoma with acceptable accuracy achieved after 100 examinations [23]. Most studies concentrate on influence of patient-based training on accuracy of EUS-FNA. The learning process of EUS-FNA for solid pancreatic lesions has been investigated in three case series [24-26]. Results have shown significant improvement in sensitivity up to 80% for the cytopathological diagnosis of cancer after 20–30 EUS-FNA [24,25]. At the same time the number of needle passes needed to obtain adequate results decreased, reaching a median of three after 150 EUS-FNA [24,26]. However, little data is available on the impact of structured, pre-patient training courses in EUS education. A recent systematic review of the currently available literature on training and competence assessment in GI endoscopy could include only one EUS – based study dealing with simulator-based training and learning curves [15,18]. Therefore, guidelines for training in EUS are often based on expert opinion [2,3,6,16].

In conclusion the presented study provides some data concerning the effects of structured training programs to gain competence in diagnostic and interventional EUS. The presented study underlines the need for a comprehensive approach with a sensible combination of theoretical and practical components. The most suitable course modules considering the experience of the trainees as well as frequencies of training periods still remain to be determined. Nevertheless, the study provides arguments for the usefulness of structured training programs resulting in a positive acceptance by the participants and significant improvement in knowledge and self-rated competence. To take into account the growing number of therapeutic applications for EUS (e.g., biliary drainage) prospective focus has to be set on a further level of special courses to offer specific training in these interventional techniques [26].
Conclusions

The current study for the first time provides some data on the usefulness of a structured training course in EUS education resulting in a positive acceptance and high self-rated EUS competence by the participants and significant improvements in knowledge. The results may help to better define how to organize pre-patient training and competence assessment in EUS.

Conflict of interest: none

References

1. Fusaroli P, Kypraios D, Eloubeidi MA, Caletti G. Levels of evidence in endoscopic ultrasonography: a systematic review. Dig Dis Sci 2021;57:602-609.
2. ASGE Standards of Practice Committee, Faulx AL, Lightdale JR, et al. Guidelines for privileging, credentialing, and proctoring to perform GI endoscopy. Gastrointest Endosc 2017;85:273-281.
3. Eisen GM, Dominitz JA, Faigel DO, et al; American Society for Gastrointestinal Endoscopy. Guidelines for credentialing and granting privileges for endoscopic ultrasound. Gastrointest Endosc 2001;54:811-814.4. Hoffman BJ, Wallace MB, Eloubeidi MA, et al. 3892 How many supervised procedures does it take to become competent in EUS? Results of a multicenter three year study. Gastrointest Endosc 2000;51:AB139.
4. Boyce HW. Training in endoscopic ultrasonography. Gastrointest Endosc 1996;43:S12-S15.
5. Jessen C, Hocke M, Fusaroli P, et al. EFSUMB guidelines on interventional ultrasound (INVUS), Part IV. EUS-guided interventions: general aspects and EUS-guided sampling. Ultraschall Med 2016;37:E33-E76.
6. Wani S, Keswani R, Hall M, et al. A prospective multicenter study evaluating learning curves and competence in endoscopic ultrasound and endoscopic retrograde cholangioipancreateography among advanced endoscopy trainees: the rapid assessment of trainee endoscopy skills study. Clin Gastroenterol Hepatol 2017;15:1758-1767.e11.
7. Wani S, Hall M, Keswani RN, et al. Variation in aptitude of trainees in endoscopic ultrasonography, based on cumulative sum analysis. Clin Gastroenterol Hepatol 2015;13:1318-1325.e2.
8. Rösch T. State of the art lecture: endoscopic ultrasonography: training and competence. Endoscopy 2006;38(Suppl 1):S69-S72.
9. Götzheimer M, Rösch T, Geisenhof S, et al. Effectiveness of a novel endoscopy training concept. Endoscopy 2011;43:802-807.
10. Götzheimer M, Rösch T, Schmitt W, et al. Trainingskurse in der praktischen Endoskopieausbildung: Erfahrungen mit GATE, einem überregionalen Kurzkonzept der DGVS. Z Gastroenterol 2009;47:1010-1014.
11. Bauer D, Holzer M, Kopp V, Fischer MR. Pick-N multiple choice-exams: a comparison of scoring algorithms. Adv Health Sci Educ Theory Pract 2011;16:211-221.
12. Miller GE. The Assessment of Clinical Skills/Competence/Performance. Acad Med 1990;65:S63-S67.
13. Konge L, Colella S, Vilmann P, Clementsen PF. 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.
14. Barther M, Gasm M, Bostriere C, et al; Club Francais d’Echoendoscopie Digestive. EUS training in a live pig model: does it improve echo endoscope hands-on and trainee competence? Endoscopy 2007;39:535-539.
15. Polkowski M, Langhi A, Weynand B, et al; European Society of Gastrointestinal Endoscopy (ESGE). Learning, techniques, and complications of endoscopic ultrasound (EUS)-guided sampling in gastroenterology: European Society of Gastrointestinal Endoscopy (ESGE) technical guideline. Endoscopy 2012;44:190-206.
16. Cote GA, Hovis CE, Kohlmeier C, et al. Training in EUS-guided Fine Needle Aspiration: safety and diagnostic yield of attending supervised, trainee-directed FNA from onset of training. Diagn Ther Endos 2011;2011:378540.
17. Ekkelkamp VE, Koch AD, de Man RA, Kuipers EJ. Training and competence assessment in GI endoscopy: a systematic review. Gut 2016;65:607-615.
18. Cohen J, Cohen SA, Vora KC, et al. Multicenter, randomized, controlled trial of virtual-reality simulator training in acquisition of competency in colonoscopy. Gastrointest Endosc 2006;64:361–368.
19. Matsuda K, Haws RH, Sahai AV, Tajiri H. The role of simulators, models, phantoms. Where’s the evidence? Endoscopy 2006;38(Suppl 1):S61-S64.
20. Baron TH, DeSimio TM. New ex-vivo porcine model for endoscopic ultrasound-guided training in transmural puncture and drainage of pancreatic cysts and fluid collections (with videos). Endosc Ultrasound 2015;4:34-39.
21. Burmester E, Leinweber T, Hacker S, Tiede U, Hütteroth TH, Höhne KH. EUS Meets Voxel-Man: three-dimensional anatomic animation of linear-array endoscopic ultrasound images. Endoscopy 2004;36:726-730.
22. Fockens P, Van den Brande JH, van Dullemen HM, van Lanschot JJ, Tytgat GN. Endosonographic T-staging of esophageal carcinoma: a learning curve. Gastrointest Endosc 1996;44:58-62.
23. Harewood GC, Wiersema LM, Halling AC, Keeney GL, Salamao DR, Wiersema MJ. Influence of EUS training and pathology interpretation on accuracy of EUS-guided fine needle aspiration of pancreatic masses. Gastrointest Endosc 2002;55:669-673.
24. Mertz H, Gautam S. The learning curve for malignant biliary obstruction. Endosc Ultrasound 2005;61:700-708.
25. Fockens P, Van den Brande JH, van Dullemen HM, van Lanschot JJ, Tytgat GN. Endosonographic T-staging of esophageal carcinoma: a learning curve. Gastrointest Endosc 1996;44:58-62.
26. Guo J, Giovannini M, Sahai AV, et al. A multi-institutional consensus on how to perform EUS-guided biliary drainage for malignant biliary obstruction. Endosc Ultrasound 2018;7:356-365.