Eur J Vasc Endovasc Surg (2019) 58, 284—291

Achieving Consensus to Define Curricular Content for Simulation Based Education in Vascular Surgery: A Europe Wide Needs Assessment Initiative

Leizl J. Nayahangan [a,*], Isabelle Van Herzeele [b], Lars Konge [a], Igor Koncar [c], Enrico Cieri [d], Armando Mansilha [e], Sebastian Debus [f], Jonas P. Eiberg [a,g]

[a] Copenhagen Academy for Medical Education and Simulation, The University of Copenhagen and the Capital Region of Denmark, Copenhagen, Denmark
[b] Department of Thoracic and Vascular Surgery, Ghent University Hospital, Ghent, Belgium
[c] Clinic for Vascular and Endovascular Surgery, Serbian Clinical Centre, Belgrade, Serbia
[d] Vascular and Endovascular Surgery Unit, University of Perugia, Perugia, Italy
[e] Departamento de Cirurgia e Fisiologia da Faculdade de Medicina da Universidade do Porto (FMUP), Porto, Portugal
[f] University Heart Centre, Department of Vascular Medicine, Vascular Surgery — Endovascular Interventions — Angiology, German Aortic Centre Hamburg, Hamburg, Germany
[g] Department of Vascular Surgery, Rigshospitalet, Copenhagen, Denmark

WHAT THIS PAPER ADDS

A three round Delphi questionnaire process has led to a European consensus document focusing on technical procedures for simulation based education in vascular surgery and has proposed a roadmap to plan and develop future simulation based training programs for vascular surgeons across Europe.

Objective: To gather consensus among European educators about technical procedures that should be included in a future simulation based curriculum in vascular surgery.

Methods: A three round modified Delphi survey was initiated among 189 key opinion leaders (KOL) from 34 countries across Europe who were identified according to their positions in the European Society for Vascular Surgery, the *European Journal of Vascular and Endovascular Surgery*, and Union Européenne des Médecins Spécialistes Section and Board of Vascular Surgery. The first round was a brainstorming phase to identify technical procedures that a newly qualified vascular surgeon should be able to perform. The answers were analysed qualitatively. The second round investigated how often the identified procedures are performed, the number of vascular surgeons that should be able to perform these procedures, whether the procedures pose a risk to the patients, and whether simulation based education (SBE) is feasible. In the third round, elimination and re-ranking of procedures were performed. Only procedures that gained more than 70% support were included. An international steering group consisting of open and endovascular surgeons and medical educators governed the process.

Results: Response rates in the three rounds were 75% (142/189), 89% (126/142), and 85% (107/126), respectively. In the final prioritised list of 30 technical procedures for SBE, the top five procedures focus on basic open vascular skills, basic endovascular skills, vascular imaging interpretation, femoral endarterectomy, and open peripheral bypass. Twenty-six procedures were eliminated, including peripheral pressure measurement, wound management, open management of complications, major amputations, and highly advanced endovascular skills.

Conclusion: The prioritised list of technical procedures from this ESVS supported project could be used to guide planning and development of future SBE programs to meet the needs of vascular surgeons across Europe.

Keywords: Curriculum, Delphi, Endovascular, Needs assessment, Simulation based education, Vascular surgery
Article history: Received 12 November 2018, Accepted 16 March 2019, Available online 21 June 2019

INTRODUCTION

The current European healthcare system poses several challenges to the delivery of effective vascular surgical education. Vascular surgery has evolved into an independent specialty with highly technical and complex procedures.[1] New training modalities have been introduced to address these tasks and ensure efficient training for vascular surgeons.[2] Today's vascular surgeon in training

* Corresponding author. CAMES Rigshospitalet, Blegdamsvej 9, Copenhagen, Denmark.
E-mail address: leizl.joy.nayahangan@regionh.dk (Leizl J. Nayahangan).
1078-5884/© 2019 European Society for Vascular Surgery. Published by Elsevier B.V. All rights reserved.
https://doi.org/10.1016/j.ejvs.2019.03.022

needs to cope with reduced trainee working hours, shortened residency training time, and a recent surge of endovascular procedures decreasing the number of open procedures available for training.[3,4] It is critical to implement optimal and efficient educational strategies, both inside and outside the operating room to ensure that vascular surgeons are proficient in open and endovascular procedures.[5]

Over the last two decades, medical education has embraced simulation technology for clinical skills training to comply with patient safety concerns, medical and surgical errors, and cost effective patient centred care.[6,7] Development of simulation based education (SBE) does not always follow a structured curriculum, but often relies on commercially available simulators, local interests, or coincidence.[8,9] The development of an efficient curriculum should follow a systematic approach starting with problem identification and a general needs assessment (GNA) to achieve comparable education levels within the participating countries, that is one should identify the procedures that should be taught before defining how to teach them.[9]

The aim of this study was to conduct a European GNA to identify those technical procedures in vascular surgery that should be included in a simulation based curriculum that will address contemporary training needs, and to gather consensus across Europe.

MATERIALS AND METHODS

The Delphi method

The needs assessment process incorporated a three round modified Delphi method to harness expert opinion and achieve consensus across Europe regarding technical procedures that should be included and prioritised in a simulation based curriculum (Fig. 1). The Delphi method is a rigorous and systematic strategy to collect information and refine judgment from a group of experts[10] and has been used in different settings,[11,12] including previous national needs assessment processes to define curricular content.[8,13]

The steering group

A needs assessment steering group managed and facilitated all processes including identification of key opinion leaders (KOL), number of Delphi rounds, consensus criteria, development of questionnaires, data collection, and data analysis. The group consisted of six multiprofessional members from different countries covering open and endovascular surgery as well as medical education (JE, IK, IVH, EC, LK, LJN).

The Delphi panel of KOLs

The end product of the Delphi process should be a prioritised list of procedures that will function as a roadmap for future development of SBE in Europe. Therefore, it was decided to select KOLs according to their roles in the European Society for Vascular Surgery (ESVS), the *European Journal of Vascular and Endovascular Surgery* (EJVES), and the Union Européenne des Médecins Spécialistes (UEMS) Section and Board of Vascular Surgery (SBVS). Names and email addresses were based on the ESVS master list 2017—2018. To achieve a broader and more representative panel composition, the ESVS Council was asked to nominate two additional national representatives with an interest in education and training (Table 1). Participation was voluntary.

Survey administration and communication

Communication was conducted through personal emails and web based surveys. Authors LJN and JE were responsible for all correspondence and were not blinded to the

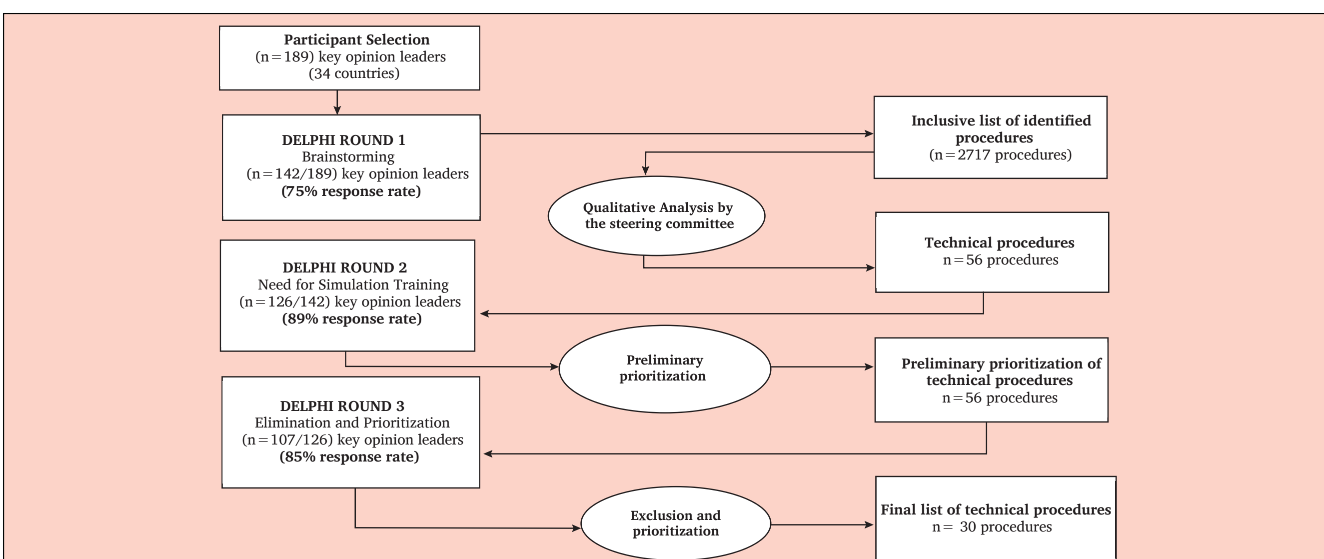

Figure 1. Overview of the needs assessment process using the Delphi method.

Table 1. Groups of key opinion leaders.	
ESVS Council	33
ESVS Executive Committee	10
ESVS Academy	7
ESVS Guideline Committee	7
Vascunet	17
EVST Executive Committee	3
EVST Council members	16
ESVS Council nominations	34
UEMS SBVS National Delegates	35
EJVES, Editorial Board	24
EJVES, Past Editors in Chief	3
Total	189

ESVS = European Society for Vascular Surgery; EVST = European Vascular Surgeons in Training; UEMS = European Union of Medical Specialists; SBVS = Section and Board of Vascular Surgery; EJVES = European Journal of Vascular and Endovascular Surgery.

respondents; however, strict confidentiality was maintained throughout the process. Up to four reminder emails per round were sent to non-responders. A minimum response rate of 70% for each round was required before moving on to the next round and the KOL who did not respond were excluded in the subsequent rounds. Consensus was defined at 70% agreement in the final round. The entire process took place between June 2017 and April 2018.

Delphi round 1: brainstorming

Round 1 was a brainstorming phase. An initial email with an invitation to participate was sent to the KOLs introducing them to the study aim, importance of participation, the iterative nature of the Delphi process, and timeline for each round. In the email, the KOLs were given the opportunity to participate by clicking on the survey link. The brainstorming question was an open ended question to "identify technical procedures that a newly certified vascular surgeon should be able to perform." A technical procedure was defined as a procedure with hands on learning components. The collected responses were explored and synthesised by the steering group. Prior to initiating the study, it was decided that procedures suggested by fewer than two persons in the brainstorming phase should not proceed to round 2. Furthermore, non-technical procedures such as knowledge of vascular anatomy, communication skills, and writing prescriptions were not included.

Delphi round 2: exploring the needs for simulation

Round 2 was an online survey to explore the technical procedures from the first round. In this round, the Copenhagen Academy for Medical Education and Simulation (CAMES) Needs Assessment Formula (NAF) was used to evaluate the procedures according to four factors.[8]

Frequency of procedures,
Number of surgeons that should be able to perform the procedure,
Impact of training on patients,
Feasibility for SBE.

The first three factors were answered by the KOLs while the fourth factor (feasibility) was answered by the steering group. This was an essential step with the assumption that not all KOLs have the same knowledge with regards to availability of equipment, implementation logistics, and costs.

Table 2 presents exploration of the first three factors that were rated by the key opinion leaders using a five point Likert scale and the fourth factor, feasibility, as rated by the steering group considering suitability for SBE, associated cost, and availability of equipment.

Table 2. Round 2 exploration of each procedure using the needs assessment formula.
A. Exploration of the first three factors as answered by the key opinion leaders using a 5-point Likert scale (Frequency of procedures, number of doctors and impact on patients)
1. How often is this procedure (or these procedures) performed by vascular surgeons or trainees in your department?
1 Few times a year/never
2 Several times per year
3 Several times per month
4 Several times per week
5 Daily
2. How much do you agree with the following statement: "Every newly qualified vascular surgeon must be able to perform one or more of these procedures."?
1 Strongly disagree
2 Disagree
3 Neither agree nor disagree
4 Agree
5 Strongly agree
3. How much do you agree with the following statement: "The procedure is very uncomfortable and/or risky to the patient if performed by an untrained physician."?
1 Strongly disagree
2 Disagree
3 Neither agree nor disagree
4 Agree
5 Strongly agree
B. Assessment of the fourth factor- feasibility as rated by the steering committee
1. Suitability for simulation based training
1 Safely learned in a clinical environment
2
3 Can be learned in either a clinical or a simulation based environment
4
5 Must be practiced in a simulation based environment
2. Availability of equipment
1 No known simulation equipment for training the procedure
2
3 Equipment is available but not perfect
4
5 Effective and realistic equipment readily available
3. Associated cost
1 Very expensive to practice the procedure in a simulation based environment
2
3 Neither expensive nor cheap to practice in a simulation based environment
4
5 Very cheap to practice the procedure in a simulation based environment

Delphi round 3: elimination and prioritisation

In round 3, the KOL reviewed the preliminary ranking of procedures from round 2. The survey was twofold: first, the KOLs were asked to eliminate procedures that they considered irrelevant for SBE for vascular surgeons in training. For example, basic clinical skills that should be learned during pre-graduate education, skills that are easily and safely learned in clinical practice, or advanced vascular skills irrelevant to newly qualified vascular surgeons. After elimination, the KOLs were asked to prioritise the remaining procedures for SBE.

Data analysis

Content qualitative analysis was performed to synthesise the procedures that were suggested in round 1. The continuous variable of age is presented as median (range), and categorical data are presented as absolute numbers (%). In round 2, a preliminary prioritisation was achieved based on NAF by adding the mean scores of all four factors. In round 3, only procedures with $\geq$70% agreement were included in the final list. Descriptive analysis (median score) was used to determine the ranking of the procedures as determined by the KOLs. Spearman's rank correlation coefficient was used when comparing ranking of procedures in rounds 2 and 3. Statistical analysis was performed using SPSS version 21 (IBM, Armonk, NY, USA).

RESULTS

Overall, 189 KOLs were identified and invited to participate (Table 1). Several KOLs hold two or more positions within different groups. Only one position was counted. Thirty-four European countries were represented (Fig. 2).

Delphi round 1

Of the 189 KOLs who were invited to participate, 142 (75%) responded to the first brainstorming phase. Among the respondents with a median age of 49 years (range 29—70 years), 38 (27%), six (4%), and 98 (69%) consider themselves as open, endovascular, or both open and endovascular surgeons, respectively. In total, 2717 procedures were suggested and 56 procedures passed on to round 2 after removing duplicates, procedures that did not meet the inclusion criteria and procedures that were suggested by two or fewer KOLs. These were categorised as diagnostic, endovascular, open, and general procedures.

Delphi round 2

The response rate in round 2 was 89% (126 of 142). A preliminary prioritised list was achieved using the CAMES NAF and the top five highest scores were basic open skills, basic endovascular skills, vascular imaging interpretation, carotid thromboendarterectomy, and basic endovascular aortic aneurysm repair (EVAR).

Figure 2. Country distribution and representation.

Delphi round 3

The response rate in round 3 was 85% (107 of 126). Twenty-six procedures were eliminated and a total of 30 procedures were included: two diagnostic procedures, 12 endovascular procedures, 14 open procedures, and two general procedures. The prioritised list is given in Table 3, where basic open skills, basic endovascular skills, and vascular imaging interpretation top the list. Among the eliminated procedures were peripheral pressure measurement, wound management, open management of complications, major amputations, and advanced endovascular skills.

There was a strong correlation between the ranking according to the needs assessment formula after the second round and the order of ranking after the third round ($r_s = 0.89$, $p < .001$).

Table 3. Final prioritised list of procedures for simulation based education.

1	Basic open skills (anastomosis training, instruments, sutures, prosthesis, clamping techniques, patches)
2	Basic endovascular skills (endovascular tools, radiation safety, US access, arteriography)
3	Vascular imaging interpretation [arteriography, computed tomography angiography (CTA), and magnetic resonance angiography (MRA)]
4	Femoral endarterectomy (profundaplasty, patch)
5	Peripheral bypass (infrainguinal, above knee, below knee, crural, intra-operative flow measurement)
5	Open embolectomy of upper and lower limb
6	Carotid thrombo-endarterectomy (CEA)
6	Basic endovascular aneurysm repair (EVAR) and sizing
6	Aortoiliac angioplasty
7	Open abdominal aortic aneurysm (AAA) resection (tube or bifurcated graft)
8	Above knee angioplasty
9	Basic vascular ultrasound [aorta, varicose veins, deep vein thrombosis (DVT), femoropopliteal, bypass, pseudoaneurysms]
9	Open management of ruptured AAA
10	Endovascular closure devices
10	Vascular access surgery, haemodialysis [radiocephalic fistula, brachiocephalic fistula, fistula thrombectomy, bridge graft, distal revascularisation interval ligation (DRIL)]
11	Endovascular management of ruptured AAA [EVAR, resuscitative endovascular balloon occlusion of the aorta (REBOA)]
11	Open management of vascular trauma
11	Endovenous management of varicose veins
11	Open management of varicose veins
12	Basic thoracic endovascular aortic repair (TEVAR) (aneurysm) and sizing
12	Minor amputations (finger, toe, forefoot)
13	Aorto-bifemoral, aorto-bi-iliac, and iliofemoral bypass for occlusive disease
13	Fasciotomy
14	Below knee angioplasty
15	Extra-anatomic lower limb bypass (femorofemoral, axillofemoral, obturator)
16	Open resection of femoral and popliteal aneurysms (medial/posterior approach)
17	Open management of pseudoaneurysms
18	Endovascular management of pseudoaneurysms (thrombin injection, covered stent)
19	Endovascular management of vascular trauma
20	Angioplasty of vascular access for haemodialysis

AAA = abdominal aortic aneurysm; CEA = carotid endarterectomy; CTA = computed tomography angiography; DRIL = distal revascularisation interval ligation; DVT = deep vein thrombosis; EVAR = endovascular aneurysm repair; REBOA = resuscitative endovascular balloon occlusion of the aorta; TEVAR = thoracic endovascular aortic repair; MRA = magnetic resonance angiography; US = ultrasound.

DISCUSSION

One hundred and eighty-nine KOLs from 34 European countries were invited to participate in a three round Delphi process, resulting in a list of 30 technical procedures that should be included in a simulation based curriculum.

Practice in vascular surgery varies internationally, being an independent specialty in the majority of European countries but a subspecialty in some. The Delphi process is an efficient and time saving strategy to gather expert opinion across Europe and to achieve international consensus. Additionally, the online format makes it possible to reduce any influence of dominant individuals who could monopolise and influence decision making.[10]

KOLs were actively engaged in the process with high response rates in all rounds. In Delphi studies, it is important to include participants who will not only contribute, but also ultimately act on the results.[8,14] Given the support of the KOLs as well as their leadership roles, the present authors are confident that the results of this work can facilitate structured development of surgical education by implementing SBE as an essential part of education across Europe.

A comparable number of open ($n = 14$) and endovascular procedures ($n = 12$) were prioritised, a trend that is likely to continue with the ongoing "endo-shift" and derivative open skills, emphasizing the need for more structured programs in open aortic surgery as well as directing trainees with interest in open surgical skills to train in higher volume centres.[15] To achieve (and maintain) competence in these procedures, the focus should be on development and implementation of evidence based SBE.

Basic vascular skills within different categories (open, endovascular, and vascular imaging interpretation) were the top three ranked procedures, indicating that these, relatively easy to master, skills are frequently used and are essential for every newly qualified specialised vascular surgeon. These "basic" skills should be included in future simulation based training programs.[16]

Basic open vascular skills, including construction of a vascular anastomosis, ranked number one in the final list, which is in line with national surveys performed in Denmark and the United States.[13,17] Vascular anastomosis is a fundamental component of open vascular surgery and should be mastered by every vascular surgeon. Different models are available for anastomotic training, from very basic plastic models[18] to high fidelity simulators with pulsatile flow,[19] as well as animal models.[20] Structured practice on these different models has already been shown to significantly improve knowledge and technical competence,[16,18–21] but has apparently still not gained broad, structured implementation.

Basic endovascular skills, including radiation safety and ultrasound guided access, were the second most important skill to train in a simulation based environment. Endovascular techniques involve manipulating a wire within a three dimensional field under two dimensional guidance on a fluoroscopy screen. These skills take time to master and simulation based training is now being adapted to practice the hand-eye-foot coordination, the use of the various endovascular tools, sequence of steps, and decision making in endovascular procedures.[22] The acquisition of endovascular skills and transferability to real life have been demonstrated; however, integration of training in a safe environment into the daily workload remains challenging.[23] Exposure to radiation has also drawn increasing concerns, with recommendations for practical radiation protection training to achieve key competencies[24] including refresher courses.[25]

The literature on how to teach and learn the interpretation of vascular imaging, which ranks third on the list, is sparse. Future curricula, in collaboration with other specialties, should focus on basic knowledge, interpretation, and use of imaging technology.

Procedures that were eliminated by the KOLs include peripheral pressure measurement, wound management, open management of complications, major amputations, and advanced endovascular skills. Reasons for elimination could be the wide variation in healthcare delivery practices, as well as only a few vascular surgeons being required to master the most advanced procedures.

The high correlation between procedure ranking in rounds 2 and 3 increases the credibility of the NAF used in round 2. Two procedures were significantly prioritised up in the third round by the KOL: basic vascular ultrasound and open management of vascular trauma (Fig. 3). Basic vascular US is a fundamental procedure that vascular surgeons should master; however, it ranked number 39 out of 56 procedures in the second round. The low ranking may be explained by the fact that US examinations are often carried out by radiologists or vascular technologists, which was not considered when answering questions regarding frequency and number of doctors. Furthermore, SBE for US skills in vascular diseases has been difficult to establish. Nevertheless, it was included and prioritised up in the final round by the KOLs.

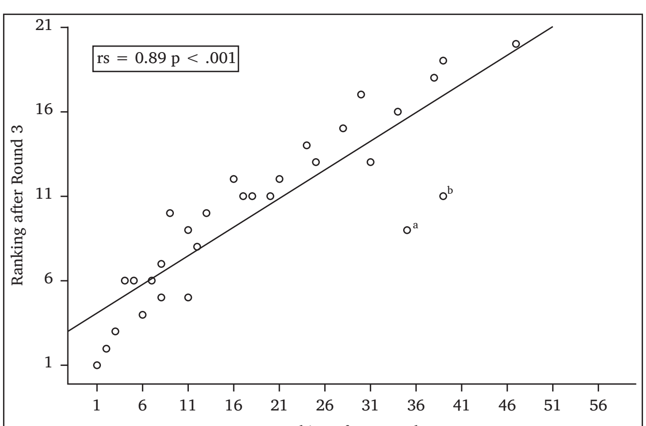

Figure 3. Correlation between the order of ranking of procedures after round 2 and the ranking of procedures after round 3. Procedures up-prioritized from round 2 to round 3 were [a]basic vascular ultrasound (final rank no. 9) and [b]open management of vascular trauma (final rank no.11).

Availability of simulation equipment in vascular surgery

Several procedures that were included in the consensus can be taught, practiced, and mastered using simulation based equipment. Low cost models, advanced open simulators with lifelike pulsatile flow, animal models, and human cadavers are being used for training open procedures such as open abdominal aortic aneurysm (AAA) repair or carotid endarterectomy.[19,26] Endovascular procedures can be trained using a variety of models and simulators: glass models, advanced virtual reality simulators, anaesthetised pigs and sheep, as well as cadavers.[22,27–30] Acquisition of a simulator is only one small step to offer simulation based training, it is crucial to set clear objectives, use efficient educational strategies, and have dedicated, experienced surgeons to provide formative feedback.[31]

Applications of the needs assessment: educational strategies and design

A GNA is the initial step when developing an educational curriculum. The generated list of procedures may serve as a guide to develop and plan SBE according to targeted local needs. Several training programs in vascular surgery already exist. A GNA performed in Denmark identified open and endovascular AAA repair among the top 10 procedures.[13] Based on this, a five day intensive simulation based training for open and endovascular AAA repair was developed. The involvement of key local leaders in the GNA increased the viability of the course, with departments allowing protected time for trainees to attend.

Another innovative evidence based training program is PROSPECT (Proficiency Based Stepwise Endovascular Curricular Training Program), which was developed in Belgium to train cognitive, technical, and non-technical basic endovascular skills to treat non-complex symptomatic iliac and superficial femoral artery atherosclerotic disease and is now mandatory for surgical trainees.[32] In a randomised controlled trial, trainees who completed PROSPECT outperformed those who had access to e-learning or traditional training alone.[33] It is hoped that evidence based training programs as outlined in these studies will encourage educational leaders to actively promote and integrate SBE into the vascular training curricula. Other examples include the Vascular Surgical curriculum[34] in the UK, which has integrated SBE and the national ASPIRE program, allowing trainees to access simulation during residency training.[35]

Regular access to training, ideally close to the workplace, is a major problem that trainees face today. The key obstacles are insufficient resources and funding, creating disparity across regions.[36] Strategic, evidence based measures are required to ensure that trainees have access to these new training opportunities.[37] Cost effective strategies in medical education have gained increased focus in recent years. Endovascular simulation based training was found to be less expensive compared with training in a real angiosuite.[38]

The ESVS Academy is responsible for education and training activities within the ESVS. For all workshops and courses, the Academy appoints conveners and guarantees scientific educational content.[39] Some workshops are supported by industry, supplying devices and simulation equipment, or through unrestricted educational grants to the ESVS. All activities must be delivered without commercial bias and without connection to any brands. The prioritised list from this ESVS supported study will guide the further development of the ESVS Academy's educational program as well as supporting the needs for passing the UEMS European vascular examination.

Limitations of the study

An inherent limitation of the study is the inclusion of KOLs based on their roles in ESVS, EJVES, and UEMS, and not on their nationalities. Although 34 countries had at least one representative, the selection process did not guarantee equal representation between countries (Fig. 2). Junior doctors [European Vascular Surgeons in Training (EVST) executive committee ($n = 3$) and the EVST council members ($n = 16$)] were underrepresented (10%) and may have different views compared with senior consultants. In future Delphi processes, it would be beneficial to include more trainees especially those in their last year of specialty training (e.g. senior registrars). The involvement of the steering committee to explore feasibility in round two may have influenced the results. Nevertheless, feasibility only weighs 25% of the formula, which limited the impact of the committee. Ultimately, the KOLs decided on the inclusion and prioritisation of procedures in the final round.

Lastly, this GNA focused only on technical skills and not on non-technical skills such as communication and human factors, which are equally important. The list of procedures is based on current needs and may change over time. This process should be repeated periodically.

In conclusion, the Delphi method was used to perform a GNA to identify and prioritise technical vascular procedures that should be integrated into a simulation based curriculum. A prioritised list of technical procedures has emerged from this ESVS supported project, which should be used to guide development of future simulation based training programs for vascular surgeons across Europe.

CONFLICT OF INTEREST

None.

FUNDING

The study was supported with €1000 from the ESVS to cover transport and accommodation for the steering group meeting.

REFERENCES

1 Mitchell EL, Arora S, Moneta GL. Ensuring vascular surgical training is on the right track. *J Vasc Surg* 2011;**53**:517–25.
2 Goldstone J, Wong V. New training paradigms and program requirements. *Semin Vasc Surg* 2006;**19**:168–71.
3 Reznick RK, MacRae H. Teaching surgical skills–changes in the wind. *N Engl J Med* 2006;**355**:2664–9.
4 Joels CS, Langan 3rd EM, Cull DL, Kalbaugh CA, Taylor SM. Effects of increased vascular surgical specialization on general surgery trainees, practicing surgeons, and the provision of vascular surgical care. *J Am Coll Surg* 2009;**208**:692–7.
5 Bismuth J, Donovan MA, O'Malley MK, El Sayed HF, Naoum JJ, Peden EK, et al. Incorporating simulation in vascular surgery education. *J Vasc Surg* 2010;**52**:1072–80.
6 McGaghie WC, Issenberg SB, Cohen ER, Barsuk JH, Wayne DB. Does simulation-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. *Acad Med* 2011;**86**:706–11.
7 Khamis NN, Satava RM, Alnassar SA, Kern DE. A stepwise model for simulation-based curriculum development for clinical skills, a modification of the six-step approach. *Surg Endosc* 2016;**30**:279–87.
8 Nayahangan LJ, Stefanidis D, Kern DE, Konge L. 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.
9 Thomas PA, Kern DE, Hughes MT, Chen BY. *Curriculum Development for Medical Education: a Six-step Approach*. 3rd ed. ed. Baltimore, Maryland: JHU Press; 2015.
10 Dalkey N. *The Delphi method: an experimental study of group opinion*. Santa Monica, CA: RAND Corporation; 1969 [18 October 2018]. Available from: https://www.rand.org/pubs/research_memoranda/RM5888.html.
11 Strøm M, Lönn L, Bech B, Schroeder T, Konge L, Aho P, et al. Assessment of competence in EVAR procedures: a novel rating scale developed by the Delphi technique. *Eur J Vasc Endovasc Surg* 2017;**54**:34–41.
12 Behrendt CA, Bertges D, Eldrup N, Beck AW, Mani K, Venermo M, et al. International consortium of vascular registries consensus recommendations for peripheral revascularisation registry data collection. *Eur J Vasc Endovasc Surg* 2018;**56**:217–37.
13 Nayahangan LJ, Konge L, Schroeder T, Paltved C, Lindorff-Larsen K, Nielsen B, et al. A national needs assessment to identify technical procedures in vascular surgery for simulation based training. *Eur J Vasc Endovasc Surg* 2017;**53**:591–9.
14 Goodman CM. The Delphi technique: a critique. *J Adv Nurs* 1987;**12**:729–34.
15 Jenkins MP, Boyle JR, Rudarakanchana N. How can we ensure vascular surgical trainees become competent in open aortic surgery in the future training environment? *Eur J Vasc Endovasc Surg* 2019;**57**:617–8.
16 Robinson 3rd WP, Schanzer A, Cutler BS, Baril DT, Larkin AC, Eslami MH, et al. A randomized comparison of a 3-week and 6-week vascular surgery simulation course on junior surgical residents' performance of an end-to-side anastomosis. *J Vasc Surg* 2012;**56**:1771–80.
17 Duran C, Bismuth J, Mitchell E. A nationwide survey of vascular surgery trainees reveals trends in operative experience, confidence, and attitudes about simulation. *J Vasc Surg* 2013;**58**:524–8.
18 Bath J, Lawrence P, Chandra A, O'Connell J, Uijtdehaage S, Jimenez JC, et al. Standardization is superior to traditional methods of teaching open vascular simulation. *J Vasc Surg* 2011;**53**:229–34.
19 Eckstein HH, Schmidli J, Schumacher H, Gurke L, Klemm K, Duschek N, et al. Rationale, scope, and 20-year experience of vascular surgical training with lifelike pulsatile flow models. *J Vasc Surg* 2013;**57**:1422–8.

20 Heelan Gladden AA, Conzen KD, Benge MJ, Gralla J, Kennealey PT. A vascular anastomosis simulation can provide a safe and effective environment for resident skills development. *J Surg Educ* 2018;**75**:1367−73.

21 Sigounas VY, Callas PW, Nicholas C, Adams JE, Bertges DJ, Stanley AC, et al. Evaluation of simulation-based training model on vascular anastomotic skills for surgical residents. *Simul Healthc* 2012;**7**:334−8.

22 Aggarwal R, Black SA, Hance JR, Darzi A, Cheshire NJW. Virtual reality simulation training can improve inexperienced surgeons' endovascular skills. *Eur J Vasc Endovasc Surg* 2006;**31**:588−93.

23 Stefanidis D, Sevdalis N, Paige J, Zevin B, Aggarwal R, Grantcharov T, et al. Simulation in surgery: what's needed next? *Ann Surg* 2015;**261**:846−53.

24 Doyen B, Maurel B, Cole J, Maertens H, Mastracci T, Van Herzeele I, et al. Defining the key competencies in radiation protection for endovascular procedures: a multispecialty Delphi consensus study. *Eur J Vasc Endovasc Surg* 2018;**55**:281−7.

25 Hertault A, Maurel B, Midulla M, Bordier C, Desponds L, Kilani MS, et al. Editor's choice−minimizing radiation exposure during endovascular procedures: basic knowledge, literature review, and reporting standards. *Eur J Vasc Endovasc Surg* 2015;**50**:21−36.

26 Fletcher B, De La Ree J, Drougas J. Development of a pulsatile, tissue-based, versatile vascular surgery simulation laboratory for resident training. *J Vasc Surg Cases Innov Tech* 2017;**3**:209−13.

27 Desender L, Rancic Z, Aggarwal R, Duchateau J, Glenck M, Lachat M, et al. Patient-specific rehearsal prior to EVAR: a pilot study. *Eur J Vasc Endovasc Surg* 2013;**45**:639−47.

28 Dawson DL, Meyer J, Lee ES, Pevec WC. Training with simulation improves residents' endovascular procedure skills. *J Vasc Surg* 2007;**45**:149−54.

29 See KW, Chui KH, Chan WH, Wong KC, Chan YC. Evidence for endovascular simulation training: a systematic review. *Eur J Vasc Endovasc Surg* 2016;**51**:441−51.

30 Desender LM, Van Herzeele I, Lachat ML, Rancic Z, Duchateau J, Rudarakanchana N, et al. Patient-specific rehearsal before EVAR: influence on technical and nontechnical operative performance. A randomized controlled trial. *Ann Surg* 2016;**264**:703−9.

31 Robinson WP, Baril DT, Taha O, Schanzer A, Larkin AC, Bismuth J, et al. Simulation-based training to teach open abdominal aortic aneurysm repair to surgical residents requires dedicated faculty instruction. *J Vasc Surg* 2013;**58**:247−53. e1-2.

32 Maertens H, Aggarwal R, Desender L, Vermassen F, Van Herzeele I. Development of a proficiency-based StePwise endovascular curricular training (PROSPECT) program. *J Surg Educ* 2016;**73**:51−60.

33 Maertens H, Aggarwal R, Moreels N, Vermassen F, Van Herzeele I. A proficiency based stepwise endovascular curricular training (PROSPECT) program enhances operative performance in real life: a randomised controlled trial. *Eur J Vasc Endovasc Surg* 2017;**54**:387−96.

34 The Intercollegiate Surgical Curriculum. *Educating the surgeons of the future*. 2014 [15 January 2019]. Available from: https://www.iscp.ac.uk/static/public/syllabus/syllabus_vasc_2016.pdf.

35 Vascular Society of Great Britian and Ireland. *ASPIRE training program [15 january 2019]*. Available from: https://www.vascularsociety.org.uk/search/?q=aspire.

36 Robertson V, Davies R. Provision of simulation-based training (SBT) within UK vascular surgery training programmes. *The Surgeon* 2018 [Article in Press, Corrected Proof], https://www.sciencedirect.com/science/article/abs/pii/S1479666X18301173#!.

37 Bjerrum F, Thomsen ASS, Nayahangan LJ, Konge L. Surgical simulation: current practices and future perspectives for technical skills training. *Med Teach* 2018;**40**:668−75.

38 Maertens H, Vermassen F, Aggarwal R, Doyen B, Desender L, Van Herzeele I, et al. Endovascular training using a simulation based curriculum is less expensive than training in the hybrid angiosuite. *Eur J Vasc Endovasc Surg* 2018;**56**:583−90.

39 Eiberg J, van Herzeele I, Vila R, Wahlgreen C, Schrimpf C, Pedrajas FG, et al. From European Training Committee to ESVS Academy: the start of a new paradigm in ESVS education. *Eur J Vasc Endovasc Surg* 2018;**56**:157−8.