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European training requirements in neurological surgery: A new outcomes-based 3 stage UEMS curriculum

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ABSTRACT

Introduction: Post-graduate training in medical education has seen a seismic shift from time-based to competency-based training. We describe a competency-based European Training Requirement (ETR) in neurological surgery that is applicable across all European centres.

Research question: To develop the ETR in Neurological Surgery using a competency-based approach.

Material and methods: The competency-based approach ETR in neurosurgery was developed in accordance with the European Union of Medical Specialists (UEMS) Training Requirements guidelines. The UEMS ETR template, based upon the UEMS Charter on Post-graduate Training was utilized. Consultation took place with Council and Board members of the European Association of Neurosurgical Societies (EANS), the Young Neurosurgeons forum of the EANS and members of the UEMS.

Results: We describe a competency-based curriculum comprising 3 stages of training. Five entrustable professional activities, outpatient care, inpatient care, emergency on call, operative competencies and team working are described. The curriculum emphasizes the importance of high levels of professionalism, early consultation with other specialists where relevant and the importance of reflective practice. Outcomes must be reviewed at annual performance reviews. Evidence of competency should be multifaceted and include work-based assessments, logbook data, multisource feedback, patient feedback and examination performance. Required competencies for certification/licensing are provided. Approval for the ETR was provided by the UEMS.

Discussion and conclusion: A competency-based ETR was developed and approved by UEMS. This provides a suitable framework for the development of national curricula that train neurosurgeons to an internationally recognized level of capability.

1. Background

Europe is a diverse continent with a population of nearly 750 million living in over 40 countries. Healthcare in Europe is provided by a wide range of systems run at national levels with a state-run system being the prevailing model. Specialist training in neurosurgery varies across the continent. In many countries, entry into a specialist training programme is a competitive process that follows award of a medical degree. In other countries, foundation (internship) and basic surgical experience is first required, providing a platform for further learning. The duration of training varies and there is no unifying curriculum. The requirements for certification, or licensing, differ from one country to another and there are variations in the levels of operative experience between trainees (Stienen et al., 2020). Different methods of assessment, including in-training assessment of knowledge, skills and behaviours, examination assessment of applied knowledge, assessment of clinical skills and

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logbook experience, are utilized. In this curriculum we describe an outcome-based, rather than time-based, curriculum. We outline a 3-stage training model. We define wider, necessary generic professionalism skills, key conditions, index cases and emergency competencies. We describe advisory requirements for "certification". This includes the full attainment of **Entrustable Professional Activities** related to inpatient care, outpatient care, emergency on-call neurosurgery, elective operative neurosurgery and multidisciplinary team working. We discuss the need for continuing professional development, continuing medical education and the acquisition of special interest skills.

1.1. Scope – to serve the population

Neurosurgical conditions afflict any member of the population at any age. Emergency or urgent presentation is common. Both elective and emergency neurosurgical conditions can cause mortality and severe morbidity. The disease burden upon society caused by urgent neurosurgical pathology is therefore substantial. Suboptimal treatment increases the risk of poor outcome and should be averted by effective training, continuing professional development and collaborative team working. Training must enable newly appointed specialists to be competent at treating most patients (adult and children) presenting with emergency or urgent conditions during an unselected on-call duty, in a timely fashion. It is important the newly certified specialist recognises when to seek assistance and support from colleagues for both emergency and planned operative cases. We encourage early collaboration with other specialties. We recognise that trainees in some countries will not have opportunities to undertake some aspects of this curriculum due to well established pathways of care and in some cases legal requirements. The curriculum aims to harmonise training standards but accepts compromises will be required for some trainees and training programmes.

Most branches of neurosurgery also comprise the management of patients with conditions that require planned (elective) surgical treatment. It is common practice for a specialist to develop expertise in the management of patients with elective neurosurgical conditions in an area of subspecialty interest: this experience should commence during training and continue during specialist practice. Acknowledging that trainees acquire and apply knowledge at different rates, certification or licensing should target demonstration of competence rather than simply be a measure of time in training. A neurosurgeon has responsibility not only for the diagnosis and treatment of patients with neurosurgical conditions, but also for the communications with patients, families, carers and colleagues. Professional attributes, including ethical practice, are a prerequisite for the provision of safe care and are as necessary to practice as advanced operative skills. Since optimal treatments change in the face of rigorous scientific evaluation, a specialist must participate in continuing medical education and professional development to deliver evidence-based practice. Key elements of neurosurgical practice involve multi-disciplinary working with other medical and surgical specialties. Trainees should understand the skills and knowledge which can be brought to patient care for example in the management of craniofacial trauma working with oral and maxillofacial surgery.

2. Training requirements for trainees

2.1. Selection into neurosurgery

Selection into neurosurgery varies across the continent. Appointment to a training programme may be made via a local, regional or national process. The selection process should be open to all eligible persons. It must be fair and multifaceted, with objective assessment of:

1. A structured curriculum vitae application form
2. Motivation and understanding of the specialty
3. Applied clinical knowledge and technical skills
4. Communication skills
5. Situational judgement skills evaluating judgement under pressure, problem solving and professional integrity

2.2. 3-Stage training programme

Once appointed to a training programme, training should be conducted in 3 stages. Given that outcomes are based upon competency, the duration of training is not specified. An indicative period of training is 5–8 years: we recognise that in some countries there is pressure to shorten specialist medical training. Learning should include:

- self-directed learning that is shaped by reflection upon feedback from trainers
- learning from clinical practice under the supervision of trainers
- learning from formal educational programmes (e.g. EANS Training Course; National Training Courses or similar)
- simulation training – useful for technical and non-technical skill acquisition

Trainees should be trained within a structured, accredited Training Programme (see Table 1). Each trainee must achieve competence in adult and paediatric neurosurgery including competence in cranial and spinal surgery. Where possible, trainees should attain competence and skills in peripheral nerve surgery.[1] Trainees should rotate to posts covering all the major specialty interest areas of neurosurgery. Training programmes ideally should encompass training in at least two different neurosurgical centres, although large centres may have sufficient breadth and depth of opportunities to support single centre training. Each trainee must have an Educational Supervisor. This does not need to be the clinical supervisor (clinical supervisors will change every time the trainee rotates to a different placement). The trainee must meet with the Educational Supervisor on a regular basis (at least every 3 months). Meeting content should evaluate clinical and non-clinical (e.g. professionalism) aspects of training in the context of achieving curriculum requirements, provide a forum for reflective learning and set SMART objectives (Specific, Measurable, Achievable, Realistic, Time scale) that are forward thinking. Many tools may be used to evaluate competence, and these should be discussed with the Educational Supervisor. Tools include:

- Logbook evaluation – assessing the volume, complexity and extent of involvement with cases
- Work based assessments (e.g. clinical evaluation exercise; case-based discussion; direct observation of procedural skills; procedural based assessment) – aimed at assessing understanding and application of knowledge and clinical competence
- Multisource feedback (from members of the multidisciplinary team) and/or multiple specialist reports (from those involved in providing clinical supervision) – providing anonymised feedback on clinical, operative and professional development
- Performance in formal examinations
- Feedback from patients
- Reflections – particularly in relation to complaints or untoward events.

2.3. Annual performance review

Trainees must compile a Training Portfolio (electronic preferred) detailing posts held, examinations achieved, publications, presentations

[1] In many European Countries, neurosurgeons are the main providers of peripheral nerve surgery. However, in some countries, orthopaedic and plastic surgeons provide this care on limb nerve injuries and oral & maxillofacial surgery for facial and trigeminal nerve injuries. All neurosurgeons must have a thorough understanding of the principles of peripheral nerve dysfunction, clinical assessment and investigation. Where available we encourage neurosurgical trainees to acquire surgical skills in peripheral nerve surgery.

Table 1
Requirements for trainers and training programmes.

Requirement	Recommendations
Trainers	• The Training Programme Director and Educational Supervisors should have been trained in the delivery of teaching, learning and assessment. • TPDs and Educational Supervisors should have protected time for educational activities and adequate administrative support. • TPDs and Educational Supervisors should be familiar with the contents and requirements of the curriculum and the use of assessment tools. • The TPD has overall responsibility for the placement of trainees to ensure that training opportunities are structured and that training is delivered in the 3 stages described in the curriculum. • The TPD should lead an Annual Performance Review for each trainee. This is usually undertaken in the context of a Panel reviewing the performance of all trainees using assessment tools as described in the curriculum
Education programme	Face to face and virtual learning opportunities should be available throughout training e.g. • Mortality and morbidity meetings • Journal clubs • Educational neuroscience lectures/seminars/ webinars covering a wide selection of the curriculum provided on a regular and sustained basis • Multidisciplinary team meetings in key specialty areas • Delivery of teaching by trainees
Research opportunities	• Trainees should be enabled to develop an understanding of research methodology including assessment of published literature. • Trainees should have opportunities to undertake supervised clinical and/or basic science research. • Trainees should be encouraged to recruit patients into approved clinical trials.
Audit and Quality Improvement	• Trainees should work with trainers to develop audit and quality improvement programmes aiming to improve patient care.
Presentations	• Trainees should be encouraged to present research, audits and quality improvement projects (poster and oral) at national and international meetings.
Courses	• Trainees should attend simulation training throughout the training programme. • Trainees should be encouraged to attend relevant training courses in neurosurgery (e.g. European Training Course), the management of trauma and 'hands-on'' cadaveric courses.
Training Programme Hospital Requirements	• Sufficient volume of adult and paediatric cases to support training in the breadth of the specialty – this may involve trainees rotating between centres to obtain sufficient experience in all key areas. Logbooks should be used to evaluate surgical opportunities for trainees. Indicative logbook numbers are provided in Appendix 1. • Dedicated neurosurgical theatres (24h access) with a microscope in each theatre and availability of commonly used equipment e.g. neuronavigational system, ultrasonic aspirator, stereotactic equipment, endoscopy equipment, instrumentation for spinal fixation procedures. • Neurosurgical intensive care beds. • Availability of allied specialties e.g. Neuroanaesthesia, neurology, neuroradiology with on-site CT and MRI, neuropathology, clinical oncology, paediatrics. Rehabilitation. • Sufficient manpower to provide safe clinical services within the limits of any Working Time directives. • Outpatient clinics with learning opportunities for trainees. • Library with electronic access to key journals • Office space for trainers and trainees • Resources to support clinical and/or basic science research activities • Governance systems responsible for infection control, prescribing, reporting systems (e.g. for 'near misses' and when things go wrong) and medical records. • Transparency in reviews of training conducted by regulatory or advisory bodies.

delivered, courses attended, outcomes from educational tools listed above and evidence of satisfactory progress. The Training Portfolio enables evidence to be assessed at the Annual Performance Review by the Training Programme Director; this assessment may be conducted by a panel chaired by the programme director. The annual assessment will result in one of the following options:

- o Achieving progress and competencies at the expected rate
- o Development of specific competencies required – additional training time not required
- o Development of specific competencies required – additional training time required
- o Inadequate progress – additional training time required
- o Release from training programme
- o Gained all required competencies for completion of the programme

2.4. Stages of training: overview

Stage 1 Development of diagnostic and ward-based clinical skills; learning of basic operative skills and principles. (Indicative duration 1–2 years)

Stage 2 Acquisition of emergency operative skills. Consolidation of clinical skills. Acquisition of technical skills including frequently used cranial and spinal approaches and non-complex elective operations. Acquisition of peripheral nerve surgical skills where available. (Indicative duration 3–5 Years)

Stage 3 Development of transferable microsurgical and special interest skills. (Indicative duration 1–2 years)

2.5. Stage 1 training (indicative duration 1–2 years)

Trainees should attain experience relevant to a career in neurological surgery. The curriculum is not prescriptive concerning specific placements. However, a minimum of 6 months should be spent in neurological surgery. Other placements may include the clinical neurosciences (e.g. neurology, neuroradiology, neuro-intensive care), other surgical specialties and Emergency Medicine. Relevant experience gained in common trunk training can appropriately be counted towards Stage 1 at the discretion of the Training Programme Director.

During Stage 1, trainees will undertake directly or indirectly supervised work in the following five key areas of practice:

1. Inpatient care on a ward – learning the principles of patient care and clinical management
2. Emergency care – who to transfer to a neurosurgical centre, principles of safe transfer, rapid assessment of a patient and formulation of a safe management plan
3. Outpatient clinic – learning diagnostic and clinical skills
4. Multidisciplinary team care – often coordinating care
5. Operating theatre – acquiring generic principles of surgery, basic operative skills and an understanding of surgical anatomy

During Stage 1 trainees will attain experience in the management of key conditions. These are shown in Table 2. The level of knowledge is defined as:

Table 2
Knowledge of key conditions management at the end of Stage 1 of training.

Key conditions (end of Stage 1)	Knowledge level required
Impaired consciousness and seizures	4
Cranial trauma	3
Acute hydrocephalus	3
Acute tumour presentations	2
Spontaneous intracranial haemorrhage	2
CNS infections	2
Spinal trauma	2
Spinal oncology	2
Degenerative spinal disorders and cauda equina syndrome	3
Peripheral nerve	2
Emergency paediatric neurosurgery	1

Table 3
Surgical competency levels at end of Stage 1 of training.

Index procedure (end of Stage 1)	Skill level required
Lumbar puncture and lumbar drain insertion	4
Insertion of ICP monitor	3
Burr hole evacuation of chronic subdural haematoma	2
Insertion of external ventricular drain	2
Craniotomy (opening and closing)	2
Lumbar decompression (approach)	2
Median nerve decompression/ulnar nerve decompression or transposition/sural nerve biopsy/harvesting (where available)	2

- **Level 1 = Knows of**
- **Level 2 = Knows basic concepts**
- **Level 3 = Knows in detail**
- **Level 4 = Knows in detail and can apply knowledge**

Trainees at the end of Stage 1 training must attain experience in surgical procedures. The index procedures with levels of competency are shown in Table 3. The level of operative competency is defined as:

- **Level 1 = Assisted**
- **Level 2 = Perform with direct supervision**
- **Level 3 = Perform with indirect supervision**
- **Level 4 = Competent to perform without supervision, including management of complications that occur during the procedure**

Trainees at the end of Stage 1 should be competent at taking a detailed clinical history, performing a competent examination of a patient, formulating an appropriate differential diagnosis and initial management plan. The trainee should be competent at resuscitation of a patient, including after trauma.

2.6. Stage 2 training (indicative duration 3–5 years)

Trainees will consolidate Stage 1 achievements and further develop their clinical, professional and technical skills. The main focus of Stage 2 training is to develop competence in the management of most acute neurosurgical presentations, in adult and paediatric neurosurgical practice. Training must include management of traumatic brain injury, acute hydrocephalus, neurovascular emergencies, CNS infection, spinal trauma and all other spinal emergencies. Where available, trainees should be exposed to peripheral nerve surgery. Trainees must therefore rotate through most special interest areas. All trainees should undertake a minimum period of 6 months paediatric neurosurgery. Most trainees will need a longer period of paediatric training, including exposure to paediatric emergencies, to develop competence in the management of emergency presentations. In some training programmes, exposure to paediatric neurosurgery and adult neurosurgery can be synchronous. We recognise that in some jurisdictions, access to paediatric neurosurgical and neurovascular training may be limited. Due to the high proportion of emergency work in neurosurgical practice, all trainees must undertake experiential emergency on-call work including "out of hours" work for a substantial proportion of Stage 2 training. Trainees must be supported with appropriate levels of direct and indirect supervision throughout Stage 2 training commensurate with their level of competence. Levels of competence in key conditions (Table 4) and surgical procedures (Table 5) are shown. Trainees should also develop considerable experience in the management of a majority of elective neurosurgical conditions including hydrocephalus, neuro-oncology, skull base and pituitary surgery, pain, epilepsy and functional surgery, peripheral nerve surgery, spinal surgery and paediatric neurosurgery. At the end of Stage 2 training, the trainee should be able to undertake a majority of emergency neurosurgical work with remote supervision. Areas of special interest should develop, and the trainee should be ready to undertake supervised microsurgery on a regular basis.

Table 4
Knowledge of key conditions management at the end of Stage 2 of training.

Key condition (end of Stage 2)	Knowledge level required
Impaired consciousness and seizures	4
Cranial trauma	4
Spontaneous intracranial haemorrhage	4
Acute hydrocephalus	4
Intracranial tumours	4
CNS infections	4
Spinal trauma	4
Spinal oncology	4
Degenerative spinal disorders	4
Peripheral nerve	4
Emergency paediatric neurosurgery	4

Table 5
Surgical competency levels at the end of Stage 2 of training.

Index procedure (end of Stage 2)	Indicative skill level required
Advanced adult supratentorial	3
Endoscopic and transsphenoidal	2
Convexity and falcine meningiomas	3
Advanced adult infratentorial	3
Intradural spine	3
Complex spinal fusion	3
Advanced paediatric supratentorial	2
Advanced paediatric infratentorial	2
Non-complex peripheral nerve surgery[a] (where available)	3

[a] At stage 2 non-complex peripheral nerve surgery includes simple peripheral nerve decompression in the extremities and nerve transposition.

During Stage 2 trainees must continue to develop skills enabling them to develop capabilities as listed below. These should be assessed at the Annual Performance Review of trainee progress.

- In-patient care (including ward and intensive care unit management)
- Outpatient care (assessment, diagnosis, investigation and management)
- Emergency on-call neurosurgery (assessment, investigation, operative and non-operative management of cranial, spinal, adult and paediatric cases)
- Elective operating (cranial, spine, peripheral nerve [where available], adult and paediatric cases in a breadth of specialty interest areas)
- Multidisciplinary team working

2.7. Stage 3 training (indicative duration 1–2 years)

Stage 3 of training is designed to enable trainees to develop specialist technical skills of generic and specialty interest area relevance. Trainees

Table 6
Knowledge of key conditions at the end of Stage 3.

Key condition (end of Stage 3)	Knowledge level required
Impaired consciousness and seizures	4
Cranial trauma	4
Spontaneous intracranial haemorrhage	4
Acute hydrocephalus	4
Intracranial tumours	4
CNS infections	4
Spinal trauma	4
Spinal oncology	4
Degenerative spinal disorders	4
Peripheral nerve	4
Emergency paediatric neurosurgery	4

will be provided with experience to acquire transferable microsurgical skills. During Stage 3, Special Interest Training should enable the trainee to develop in-depth experience in specialty interest areas. Ideally a period of 12 months should be provided as a minimum in each of the specialty interest areas undertaken. Key condition requirements (Table 6) and indicative index procedure requirements (Table 7) are shown. Key condition requirements are similar to those required at the end of Stage 2. Trainees should develop their confidence and competence in all areas during Stage 3 and should continue to provide emergency on-call care.

2.8. Special interest training during stage 3

We recognise the following areas of special interest, though accept that there must be flexibility about the specifics of training content at this stage in accordance with trainer skillsets and with evolving clinical practice. During Stage 3, some trainees may learn skills that provide competence in areas not specified in this curriculum. Once practicing as a specialist, the trainee should apply the principles of professionalism when undertaking such surgery. For example, the specialist should work with appropriate audit and clinical governance structures to ensure patient safety is of paramount importance. For some cases this will require team working, including in the operating room, with other specialties.

- Neuro-oncological surgery – e.g. functional imaging, awake craniotomy, intra operative monitoring, use of fluorescent markers, intraventricular tumour surgery, pineal surgery, brainstem tumours, stereotactic radiosurgery.
- Skull-base and pituitary surgery – advanced surgical approaches, endoscopic and microscopic experience, cranial nerve monitoring, repair of CSF fistulae
- Neurovascular surgery – Emergency and elective aneurysm management (surgical and/or interventional radiology skills); AVM management, mechanical thrombectomy, cerebral ischaemia management.
- Pain, epilepsy and functional surgery – microvascular decompression, spinal cord neuromodulation (or stimulation), intrathecal drug delivery systems, rhizotomy, assessment of epilepsy, surgery for epilepsy, management of movement disorders including deep brain stimulation (DBS) and lesioning.
- Peripheral nerve surgery – including management of complex conditions including trauma and tumours.
- Spinal surgery – minimally invasive procedures, spinal navigation, advanced management of spinal trauma, stabilisation of metastatic spine, resection of spinal tumours (bony, extradural, intradural extramedullary and intramedullary), use of spinal monitoring, surgical management of osteoporosis, spinal deformity, ankylosing spondylitis, rheumatoid spine, syringomyelia and hindbrain malformations.
- Paediatric neurosurgery – hydrocephalus, paediatric neuro-oncology, paediatric trauma, spinal dysraphism, spinal deformity, craniofacial disorders.

During Stage 3 trainees must continue to develop skills enabling them to be competent to the level of a Day 1 specialist at the end of training. These Entrustable Professional Activities should be assessed at the Annual Performance Review of trainee progress (see below).

2.9. Entrustable professional activities (EPAs)

EPAs describe the daily responsibilities and tasks that a doctor undertakes, EPAs can be simple and related to a particular skill, or more complex representing an integration of multiple advanced skills. Satisfactory completion of the training programme indicates that the trainee is entrusted to undertake all the EPA tasks listed below. The decision to entrust the trainee with the capability and responsibility to undertake EPAs is based on the portfolio review, including logbook review, the use of multiple assessment tools including knowledge tests, observations of clinical and procedural skills, and multiple specialist reports. The EPAs must be delivered with professionalism, encompassing the principles of ethical practice. The five EPAs embedded in the neurosurgical curriculum are:

- ***In-patient care*** (including responsibility for ward and intensive care unit management)
- ***Outpatient care*** (including responsibility for the assessment, diagnosis, investigation, and management of patients)
- ***Emergency on-call neurosurgery*** (including the performance of cranial, spinal, peripheral nerve (where available), adult and paediatric neurological surgery)
- ***Elective operative neurosurgery*** (including advanced technical skills in one or two special interest areas)
- ***Multidisciplinary team working*** (including significant contributions to team decision making and knowing when to seek assistance and advice)

2.10. Logbooks

Trainees must keep a logbook of operative procedures conducted during training. The logbook should be up-dated contemporaneously, validated by the clinical supervisors and reviewed at meetings with the Educational Supervisor and at the Annual Performance Review led by the Training Programme Director. The logbook can be used to monitor accumulation of technical skills according to the Stage of training and to set goals for future development. The logbook should not record personal patient data and should comply with Data Protection Law. The operative procedure and the level of involvement should be recorded. The classification of the operation should include:

- Assisted
- Performed (supervisor scrubbed)
- Performed independently
- Trained (e.g. trained a more junior colleague)

The www.elogbook.org is a well-established, widely used electronic logbook. Tables 8 and 9 (in Appendix 1 and Appendix 2) provide further information for trainees and trainers on logbooks and indicative numbers of cases as published by UEMS and the Intercollegiate Surgical Curriculum Project. These numbers are not obligatory: the key principle to consider is the trainer assessment of competence.

2.11. Professionalism

Professionalism is a key attribute required by the specialist. There are many definitions of professionalism, which are effectively encapsulated as "a set of values, behaviours and relationships that underpins the trust the public has in doctors" (Tweedie et al., 2018). Professionalism encompasses adherence to ethical practice (see below), effective communication skills with patients, family, carers and other health care team

members, reliability, accountability and a commitment to continuing professional developments (Wilkinson et al., 2009). We consider that continuing professional development (CPD) is an important component of training that must continue post certification. We consider that this can be evidenced as undertaking and completing training courses, attending and participating in medical conferences, contributions to audits and contributions to medical research. In providing evidence of professionalism, trainees should demonstrate effective teamwork, management roles and leadership roles commensurate with their stage of training.

We consider that formal assessment of professionalism is required for all trainees. Methods of assessment should be multiple and triangulate. Feedback should include "in the moment" feedback from trainers and colleagues, regular anonymised 360° feedback from multiple members of the healthcare team (e.g. once per annum, selected by the trainee in discussion with the educational supervisor) and feedback from patients. Feedback to the trainee about lapses in professionalism is required to develop professional behaviours. By the end of training, a trainee must display consistent professional behaviours that put the patient first. The trainee should maintain a written reflective portfolio in the event of any complaints, concerns or untoward clinical incidents: this demonstrates the important attribute of personal insight. A reflection should be anonymised as far as possible. Reflections do not need to capture full details of an experience; they should capture learning outcomes and future plans. Discussion with other team members and an educational supervisor can help learning. Reflections following positive experiences can also enhance team performance.

A trainee who does not meet the required professional standards should not be recommended for certification.

2.12. Ethical practice

Trainees should have an applied knowledge of ethical practice. This sphere of practice should develop experientially throughout training. Knowledge should include respecting the key pillars of the principalism model of ethical practice:

- Autonomy: the patient's wishes are paramount
- Non-maleficence: treat with the objective of avoiding harm.
- Beneficience: promote overall benefit to the patient
- Justice: equality of availability of treatments to all patients

Within neurosurgical practice many ethical dilemmas may arise. The application of the above principals will help resolve most dilemmas. However, to manage the full breadth of ethical issues in clinical practice, trainees must have a thorough understanding of the ethical principles governing:

- Capacity
- Consent (of adults and children – including those lacking capacity)
- End of life care (including advanced directives, withholding and withdrawing care)
- Use of human tissue
- Research, experimentation and innovation (including data storage)

3. Fellowship of the Board of European Neurological Surgeons (FEBNS) Examination

The Fellowship of the Board of European Neurological Surgeons (FEBNS) Part 1 examination assesses knowledge and is appropriately undertaken once a trainee has had exposure to a wide range of neurosurgical conditions (usually toward the latter part of Stage 2 training). The oral component (Part 2) of the FEBNS Examination is designed to assess applied knowledge in those who have completed a training programme. Progression through the phases of training differ across Europe. Progression may be dependent upon examination outcome and/or portfolio assessment by the Training Programme Director, evaluating many of the tools used to assess competence. The FEBNS Examination does not constitute a license to practice; it is an evaluation of applied neurosurgical knowledge. Many European Nations conduct national level examinations as a test of applied specialist knowledge.

4. Certification/licensing

The EANS/UEMS Curriculum is provided as a template for the development of national training programmes. The content of the curriculum is given as a safe level for independent specialist practice within a team of neurological surgeons. The National Authority is the responsible body for recognition/certification of medical specialists in Europe. The majority of countries now have a compulsory Board Examination (or equivalent). The FEBNS Examination does not constitute a license to practice neurosurgery in any European country but is a useful tool to evaluate applied neurosurgical knowledge both in countries with, and those without, a Board Examination.

The key considerations for a training programme director to support specialist certification are:

- Completion of a structured training programme in neurosurgery
- Competence in the management of key neurosurgical conditions
- Competence in the operative management of emergency neurosurgical conditions (brain and spine) in children and adults
- Competence in the following Entrustable Professional Activities:
  - Outpatient neurosurgical care
  - Inpatient neurosurgical care (including elective)
  - On-call neurosurgical care
  - Elective operating (including one or two specialty interest areas)
  - Multidisciplinary team working
- Demonstration of ability to consistently undertake ethical practice
- Demonstration of professional attributes that indicate the trainee is committed to continued professional development
- Demonstration of professional attributes that indicate the trainee seeks help and support from more experienced colleagues, and colleagues in other specialties when faced with challenging cases
- Evidence of material contributions to quality improvement
- Understanding and application of the principles of research
- Evidence of participation in management and/or leadership activity relevant to the specialty e.g. rota administration, membership of working party, trainee representative, project lead

Due to variation in the content of individual training programmes, it is not possible to specify required competencies throughout each year of training. The key condition competencies and level of index procedures required at the end of each stage of training are shown in Tables 2-7 above. The requirements of trainers and a training programme are shown in Table 1. Table 8 provides a granular overview of the requirements for competencies at the completion of training. We recognise that all trainees will not achieve all competencies in all conditions. Training Programme Directors should be aware that Table 8 is indicative and does not comprise essential requirements for completion of training (unlike Tables 2-7). Grouping of operations into those with similar transferable skills is useful when assessing competence (see Appendix 2, Table 9).

5. Training requirements for trainers and training institutions

The delivery of high-quality training requires competent trainers with time allocations in their work schedule to provide training opportunities for trainees at all stages of the training programme. The trainers must work with departmental colleagues to ensure that a comprehensive educational programme is provided and that opportunities exist to enable trainees to undertake quality improvement projects, audit and research.

Table 7
Surgical competency levels at the end of Stage 3 of training.

Index procedure (end of Stage 3)	Indicative skill level required[a]
Advanced adult supratentorial	4
Endoscopic and transsphenoidal	2 (4 if pituitary specialty interest)
Convexity and falcine meningiomas	4
Advanced adult infratentorial	4
Intradural spine (extramedullary)	4
Complex spinal fusion	3 (4 if spine special interest)
Advanced paediatric supratentorial	2 (3 if paediatric special interest)
Advanced paediatric infratentorial	2 (3 if paediatric special interest)
Non-complex peripheral nerve surgery (where available)	3 (4 if special interest[b])

[a] Special interest experience can be attained in high-volume training centres supported by national and international specialty courses and meetings.
[b] Non-complex peripheral nerve surgery at Stage 3 includes neurolysis, schwannoma enucleation, nerve sutures.

The Training Programme must have sufficient volume and breadth of cases (across a single or multiple institutions) to enable trainees to achieve the Entrustable Professional Activities defined in the curriculum. The Programme must have access to sufficient clinical and educational resources to fully support the trainees. Table 7 summarises the requirements for training.

Consultations

The curriculum has been reviewed by all Board Members and Section Chairs of the EANS and the UEMS Neurosurgery Section. Feedback from these groups has been of immense value. We recognise the important role for working with others, particularly at the interface between neurosurgery and other surgical specialties including otolaryngology, maxillofacial surgery, ophthalmology, orthopaedics and plastic surgery. The Young Neurosurgeons Committee have also provided valuable input to support the development of the curriculum. We accept responsibility for any errors in the curriculum.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Peter Whitfield: Chairman of the SAC in Neurosurgery in UK and Ireland (2017-20) and led the re-write of the Intercollegiate Surgical Curriculum Project (ISCP) neurosurgery curriculum with immense support from Simon Thomson (Consultant Neurosurgeon). This work paved the foundations for the development of the ETR.

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As Chair of the Specialists Advisory Committee in Neurosurgery in the UK (2017–2020) Peter Whitfield was responsible for the development and writing of the UK and Ireland Curriculum for the Intercollegiate Surgical Curriculum Project (ISCP). Peter recognises the support and guidance provided by the Joint Committee on Surgical Training and the immense efforts of Mr Simon Thomson during this work. The EANS/UEMS Curriculum in Neurosurgery is broadly aligned with the approach taken to training in the British Isles. Professor Whitfield is also Chairman of the Fellowship of the European Board of Neurological Surgeons Examination.

Appendix 1. (Table 8)

Controversy exists about the value of logbook numbers as a measure of competency. We recognise that competence requires the confidence and capability to undertake a procedure, assess and manage anatomical or pathological variation, and safely manage complications. In this table we provide an **indicative** table of expected levels of **competency** by special interest area. If a trainee has undertaken special interest training in Stage 3 of training, the level of expected competency is greater. Due to variation in the delivery of healthcare across Europe, no trainee is expected to achieve maximal levels of competency in all skills. Some trainees may develop experience and competence in operations not included in this list. We recognise that trainees and trainers commonly utilise logbook numbers as a surrogate measure of competence. In this competency-based curriculum, the capabilities of the trainee are more important that the absolute numbers. We have listed UEMS "target" numbers for many operations in this table. These provide an ***indicative*** parameter for the evaluation of experience: increased operative experience often correlates with the ability of the surgeon to manage both straight-forward and complex variations of the same operation. The higher numbers of more straight forward procedures are a surrogate measure of trainee exposure to sufficient operative caseload to support training. The numbers are not obligatory.

The = symbol is used in Table 8 where the operation may contribute to the target numbers of a similar type of procedure included in the table.

* In some European countries peripheral nerve procedures are no longer regularly performed by neurosurgeons.

Levels of Operative Competency.

- o Level 1 = Observed
- o Level 2 = Perform with direct supervision
- o Level 3 = Perform with indirect supervision
- o Level 4 = Competent to perform without supervision, including management of complications that occur during the procedure

Table 8
Levels of competency for neurosurgical operations at Stage 3 with competencies for those with special interest training and UEMS indicative numbers.

Specialty Area	Operative Skill	Level of competency expected by end of stage 3 for all trainees	Level of additional competency expected if included within special interest Stage 3 training	UEMS Section of Neurosurgery target numbers (where available) (European Training Requirements, 2021)
Surgery for Cranial Trauma	Intraparenchymal ICP monitor/EVD	4		30
	Burr hole evacuation of CSDH	4		20
	Elevation of depressed fracture	4		8
	Craniotomy for EDH, SDH, contusions	4		20
	Decompressive craniectomy	4		
	Cranioplasty	4		10
	Combined craniofacial repair of fronto-orbito-maxillary injuries	2	3	
	Craniofacial repair of CSF leak	2	3	
Surgery for CSF Disorders	Insertion of EVD/ventricular access device	4		20
	Insertion of VP shunt	4		30
	Insertion of LP shunt	4		
	Revision of VP shunt	4		15
	Revision of LP shunt	4		
	Third ventriculostomy	2	4	5
	Foramen magnum decompression	4		4
	Syringostomy/syringo-pleural shunt	2	3	
	Endoscopic treatment of complex hydrocephalus	2	3	
Neuro oncological Surgery	Image guided biopsy (framebased and/or frameless) of supratentorial tumour	4		20
	Image guided biopsy of brainstem/cerebellar tumour	2	3	
	Supratentorial craniotomy for intra-axial tumour (e.g. glioma)	4		40
	Supratentorial craniotomy for extra-axial tumour (e.g.convexity, parasagittal, parafalcine, sphenoid wing, anterior fossa meningioma)	4		12
	Midline infratentorial craniotomy/craniectomy for intra-axial tumour (e.g. metastasis)	4		6
	Retrosigmoid infratentorial craniotomy/craniectomy for extra-axial tumour (i.e. VS)	2	3	10
	Craniotomy for intrinsic tumour of insula	2	3	
	Craniotomy for intraventricular tumour excision (lateral, 3rd and 4th ventricle) – e.g. colloid cyst, meningioma, ependymoma. Transcortical, transcallosal and telovelar approaches	2	3	
	Craniotomy for pineal region tumour excision (e.g. supracerebellar-infratentorial and occipital trans-tentorial approaches)	1	3	
	Awake craniotomy	2	4	
	Endoscopic biopsy of intraventricular lesion	2	3	
	Endoscopic resection of intraventricular lesion	2	3	
	Stereotactic radiosurgery	1	4	
Skull Base and Pituitary Surgery	Endoscopic resection of pituitary tumour	2	3	
	Microsurgical resection of pituitary tumour	2	3	10
	Retrosigmoid infratentorial craniotomy/craniectomy for extra-axial tumour (i.e. vestibular schwannoma)	2	3	
	Translabyrinthine excision of vestibular schwannoma	1	2	=
	Extended pterional approach and resection of tumour of skull base	2	3	
	Pre-sigmoid approach to tumour of skull base	1	2	
	Far lateral approach to tumour of skull base	1	3	
	Craniotomy for suprasellar/cliniodal/parasellar lesion (microsurgical and endoscope assisted)	2	3	5
	Trans-facial approach to skull base tumour	1	2	
	Frontobasal approaches to the anterior fossa and orbito-ethmoidal complex	2	3	
Neurovascular Surgery	Craniotomy and evacuation of supratentorial ICH	4		12
	Craniotomy and evacuation of infratentorial ICH	4		=
	Craniotomy to clip anterior circulation aneurysm	1	3	5
	Craniotomy to clip posterior circulation aneurysm	1	2	
	Endovascular treatment of aneurysm	1	3	
	Decompressive craniectomy for cerebral infarction	4		
	Craniotomy for excision of supratentorial AVM	1	3	2
	Craniotomy for excision of infratentorial AVM	1	2	=
	Craniotomy to obliterate DAVF	1	2	
	Craniotomy excision of cavernoma	2	3	5
	Revascularisation (e.g. aneurysm, ischaemia)	1	2	
Pain, Epilepsy and Functional surgery	Removal of infected or malfunctioning implant	4		
	Stereotactic electrode placement	2	4	
	Stereotactic lesioning	2	3	
	Insertion of neuromodulation implant	2	4	5
	Insertion of pharmacological pump delivery system	3	4	20
	Vagal nerve stimulator	2	4	5

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Table 8 (*continued*)

Specialty Area	Operative Skill	Level of competency expected by end of stage 3 for all trainees	Level of additional competency expected if included within special interest Stage 3 training	UEMS Section of Neurosurgery target numbers (where available) (European Training Requirements, 2021)
	Lesionectomy for the treatment of epilepsy	1	4	=
	Amygdalohippocampectomy for epilepsy	1	2/3	=
	Other open epilepsy surgery (e.g. hemispherotomy, callosotomy)	1	2/3	=
	Microvascular decompression of trigeminal/facial nerve	3	3/4	5
	Percutaneous trigeminal rhizotomy	2	3	10
	Spinal cord stimulator	2	4	20
	DREZ lesion	1	3	=
	Cordotomy	1	2	
	DBS for pain/spasticity	1	3	=
Surgery for Infection	Burr home image guided aspiration of abscess	4		10
	Craniotomy excision/marsupialisation of abscess: consideration of dental origin (OMFS consult)	4		=
	Craniectomy for subdural empyema	4		=
Peripheral Nerve Surgery*	Decompression of median nerve	4		45
	Decompression of ulnar nerve	4		=
	Resection of peripheral nerve tumour	2	3	
	Brachial plexus surgery (compression/trauma)	1	3	
	Nerve suture	3	3	
Spinal Surgery	Posterior decompression of lumbar spine	4		70
	Posterior decompression of cervical spine (e.g. foraminotomy, laminectomy, laminoplasty)	4		
	Posterior decompression of thoracic spine	4		
	Anterior cervical discectomy + fusion/arthroplasty	4		25
	Lumbar discectomy	4		=
	Revision lumbar discectomy/decompression	4		
	Thoracic discectomy (range of approaches)	1	3	5
	Drainage of spinal epidural abscess	4		
	Open biopsy of vertebral body/disc	3	4	
	External immobilisation of unstable spine (e.g. application of traction or halo)	4		
	Atlanto-axial stabilisation	1	2	
	Stabilisation of cervical spine (trauma)	2	4	10
	Stabilisation of cervical spine (e.g. tumour/infection)	2	4	=
	Stabilisation of thoracic spine (trauma)	2	4	
	Stabilisation of thoracic spine (e.g. tumour/infection)	2	4	
	Stabilisation of lumbar spine (trauma)	2	4	20
	Stabilisation of lumbar spine (e.g. degenerative/tumour/infection)	2	4	=
	Thoraco-lumbar deformity correction	2	3	
	Resection of intradural extramedullary tumour (e.g. meningioma, neurofibroma, schwannoma)	3	4	5
	Resection of intradural intramedullary lesion (e.g. ependymoma, haemangioblastoma, cavernoma)	2	3	3
	Intra-operative spinal cord monitoring (e.g for intramedullary lesion resection)	1	3	
	Surgery for spinal dysraphism	2	3	
	Use of endoscope in spine surgery	1	3	
Paediatric Neurosurgery	Insertion of ICP monitor	4		5
	Craniotomy for traumatic intracranial haematoma	4		
	Elevation of depressed skull fracture (work with OMFS in craniofacial fractures)	4		
	Tapping of CSF reservoir	4		
	Insertion of EVD/ventricular access device	4		10
	Insertion of VP shunt	4		10
	Revision of VP shunt	4		=
	Endoscopic third ventriculostomy	2	4	
	Endoscopic treatment of complex hydrocephalus	2	3	
	Endoscopic fenestration of arachnoid cyst	2	3	
	Open fenestration of arachnoid cyst	2	3	
	Supratentorial craniotomy for tumour	2	3	5
	Midline infratentorial craniotomy for tumour	2	3	=
	Intraventricular tumour excision	2	3	
	Craniotomy/endoscopic approach for pineal region tumour excision	1	2	
	Craniotomy for spontaneous intracranial haematoma	3	4	
	Craniotomy for vascular lesion (e.g. AVM, cavernoma	1	2	
	Untethering of spinal cord	2	3	5
	Dorsal rhizotomy (e.g. for spasticity)	1	3	
	Baclofen pump insertion	2	3	
	Closure of myelomeningocoele	2	4	
	Instrumented stabilisation of spine	1	3	
	Intradural spinal tumour resection	1	3	
	Surgical management of craniosynostosis	1	2	

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Table 8 (*continued*)

Specialty Area	Operative Skill	Level of competency expected by end of stage 3 for all trainees	Level of additional competency expected if included within special interest Stage 3 training	UEMS Section of Neurosurgery target numbers (where available) (European Training Requirements, 2021)
	Vagal nerve stimulator	2	4	
	Epilepsy surgery	1	2/3	
	Revascularisation surgery for ischaemia (e.g. Moya Moya)	1	2	

Appendix 2. Table 9. Grouping of operative competencies

Neurosurgical training includes the learning of operative skills acquired during a wide range of operations. To facilitate assessment of transferable operative skill acquisition, the UK Specialist Advisory Committee in Neurosurgery developed a grouping of operative experiences to facilitate evaluation of high-fidelity operative capabilities. This is adapted in Table 9 to help TPDs and Trainees benchmark progress.

Table 9

Procedure Group	Indicative number by certification	Operative performance Level
Advanced adult supratentorial e.g. aneurysm, AVM, cavernoma, supratentorial skull base meningioma, craniotomy for craniopharyngioma, colloid cyst, amygdalohippocampectomy, hemispherectomy	10	4
Endoscopic and transsphenoidal	10	3 (4 if special interest training)
Supratentorial meningiomas	10	4
Advanced adult infratentorial e.g. microvascular decompression, intrinsic posterior fossa tumour resection, extrinsic posterior fossa tumour	10	4
Intradural spine (e.g. intradural extramedullary tumour resection, intradural intramedullary tumour resection, foramen magnum decompression with durotomy)	5	4
Complex Spinal Fusion (e.g. any posterior spinal fixation, corpectomy and fusion procedures, NB ACD + F not included)	10	3 (4 if special interest training)
Advanced paediatric supratentorial (e.g. tumour resection, AVM resection)	1	2 (3 if special interest training)
Advanced paediatric infratentorial (e.g. tumour resection, AVM resection)	1	2 (3 if special interest training)

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