

Roadmap for a competency-based educational curriculum in epileptology: report of the Epilepsy Education Task Force of the International League Against Epilepsy

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ABSTRACT – Teaching competency in the diagnosis and clinical management of epilepsy is of utmost importance for the ILAE. To achieve this mission, the Task Force for Epilepsy Education (EpiEd) developed a competency-based curriculum for epileptology, covering the spectrum of skills and knowledge for best medical practice. The curriculum encompasses seven domains, 42 competencies, and 124 learning objectives, divided into three levels: entry (Level 1), proficiency (Level 2), and advanced proficiency (Level 3). A survey of the currently existing ILAE-endorsed teaching activities identified a significant gap in education of basic knowledge of epileptology (Level 1). To bridge this gap, a web-based educational tool is being developed. A virtual campus will be constructed around the curriculum, integrating the various educational activities of the ILAE. This paper describes the development of the curriculum and future tasks necessary to achieve the educational goal of the ILAE.

Key words: epilepsy, teaching competency, diagnosis, clinical management, curriculum, web-based, ILAE, Task Force for Epilepsy Education (EpiEd)

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Teaching competency in the diagnosis and clinical management of epilepsy is of utmost importance for the ILAE, as the foremost international organization for all professional stakeholders involved in the care of people with epilepsy (PwE). ILAE congresses, regional and national conferences, and symposia, as well as the broad spectrum of topic-oriented teaching and training courses, bear testimony to the ILAE's long track record in epilepsy education. However, the ILAE has not yet developed a common educational curriculum or a competency-based teaching program for healthcare professionals managing PwE. Moving to an "outcome" or "competency-based" approach for the organization of educational materials will allow for a more systematic and strategy approach to developing educational offerings for the ILAE. Furthermore, it will make it possible for ILAE to create formal programs for a variety of learner levels, which can be undertaken in a step-wise, self-paced fashion to achieve educational objectives at various levels. The ILAE Epilepsy Education (EpiEd) Task Force was founded in 2014 to achieve this goal and pave the way towards a web-based, 21st century virtual campus and teaching academy.

Specific objectives and target audience

The ILAE's stated mission is to ensure that healthcare professionals, patients and their care providers, governments, and the public world-wide have the educational and research resources that are essential in understanding, diagnosing, and treating epilepsy. Accordingly, the educational agenda is paramount in the League's activities. Such an agenda is by necessity vast and multifaceted. It is comprised of multiple levels of expertise aimed at different types of professionals in epilepsy and requires a staged approach. One of the ILAE's primary aims is to support all national actions that will ensure PwE access to clinical practitioners with knowledge in epilepsy for optimal diagnosis and care, ideally epilepsy specialists. Acquiring a full set of competencies in the field of epileptology entails a long educational process, targeting adult and child clinical specialists caring for PwE. On the other hand, many PwE live in countries where access to epilepsy specialists is not always possible or may take several months (Wilmshurst *et al.*, 2014). Because seizures are one of the commonest neurological presentations in all clinical settings (WHO, 2017), a common body of knowledge should be made available for all clinical practitioners and hospital-based adult neurology or child neurology units, but also for nurses, allied health professionals, and caregivers working in remote areas. These healthcare professionals are the ones who usually provide care at the time of first presentation with

epilepsy, and they are expected to initiate appropriate investigations and treatment.

On the other hand, many epilepsies are difficult to control and clinically complex, or are the expression of rare brain disorders, requiring interdisciplinary approaches and highly skilled clinicians. In these situations, highly trained specialists are expected to guide specialized care in a cost-effective manner. Such specialized care involves, for example: expertise in ordering and interpreting investigations, such as video-EEG (Jayakar *et al.*, 2016; Schomer and Lopes da Silva, 2016; Tatum *et al.*, 2018), neuroimaging, and metabolic and genetic testing; mastering the know-how of complex drug interactions and treatment choices; identifying and managing common comorbidities (Kerr *et al.*, 2011; Mula *et al.*, 2017); providing counselling regarding life-style issues relevant to epilepsy; identifying early candidates for pre-surgical evaluation; and providing surgical and post-surgical care.

After extensive consultation with its constituency and with educational experts, the ILAE decided to systematically address the educational pathways required for the optimum management of PwE. Accordingly, the ILAE will develop a comprehensive portfolio of educational activities. Learning portfolios can be thought of as "a collection of evidence that learning has taken place" (Snadden and Thomas, 1998). Such portfolios address specific competencies, constituting an assessment-based curriculum and certificate in epilepsy. According to the Institute for Credentialing Excellence (Institute for Credentialing Excellence, Defining Features of Quality Certification and Assessment-Based Certificate Programs 2010, <http://www.credentialingexcellence.org>), an assessment-based certificate program can be defined as a non-degree granting program that:

- provides instruction and training to aid participants in acquiring specific knowledge, skills, and/or competencies associated with intended learning outcomes;
- evaluates participants' achievement of the intended learning outcomes;
- awards a certificate only to those participants who meet the performance, proficiency or passing standard for the assessment(s) (hence the term, "assessment-based certificate program").

The ILAE curriculum development must be guided by strategies based on adult learning principles and reflecting active learning approaches. The process should address the specific educational needs of healthcare professionals in a global environment with different socio-cultural contexts and access to educational activities (Taylor and Hamdy, 2013). Based on the theory of andragogy, defined as the art and science of adult learning, it is necessary to acknowledge the specific features of adult learners in contrast to

children or adolescents, for whom the learning principles are defined as pedagogy (Knowles, 1984a). Adult learning activities have to focus on specific aspects of learner self-perception with autonomy in the learning process and the learner's experience of perceived and unperceived gaps, either by self-assessment or discussion with peers. The learning should have practical relevance, and be goal-oriented and outcome-based, and the learner's readiness and motivation for learning should be fostered by actively performing specific tasks (Kolb, 1984).

Curriculum design is a step-wise process, which traditionally begins with the identification of a "problem" or learning gap. This is followed by formal assessment of learner needs (survey, stakeholder interviews, expert input, etc.), the development of learning objectives, choice of educational design, assessment of learning, and then program evaluation (Kern, 1998). It is contemplated that this curriculum will eventually address the epilepsy educational needs of a wide range of professionals dealing with PwE. For example, it would cover the educational competencies required for allied healthcare workers such as nurses, general practitioners, pediatricians, and adult and child neurologists, and would also encompass advanced training and in-depth courses on specific topics for epileptologists.

Development of the ILAE curriculum for epileptology (2016 ILAE EpiEd survey)

As a first step, EpiEd developed a catalogue of competencies, covering the spectrum of skills and knowledge for best medical practice, irrespective of economic, social or cultural background in a given patient (Mula *et al.*, 2017; Carrizosa *et al.*, 2018; Murray *et al.*, 2018). In 2016, EpiEd launched a worldwide online survey addressing their entire constituency to approve the catalogue. In this survey, respondents were asked to rate each proposed competency as: (1) "extremely important"; (2) "important"; (3) "somewhat important"; (4) "slightly important"; (5) "not at all important"; or (6) "I don't know". In addition, opinions were gathered regarding the importance of developing such a curriculum. The survey was answered by 742 people within an eight-week period covering all six ILAE world regions and the broad spectrum of professional backgrounds. The survey revealed that 94.45% of people would support the creation of a curriculum, 92.11% would apply this curriculum in their own practice, and 73.83% would take or recommend taking an ILAE exam on the competencies addressed by the curriculum, leading to an assessment-based certificate in epileptology. The first milestone reached in our long endeavor to build an international teaching academy was that

the ILAE community contributed to, and endorsed a list of competencies in epileptology. This catalogue of competencies was our blueprint for developing the common body of knowledge for the education of healthcare professionals in epileptology. All content was designed to cover these competencies and was targeted to an appropriate level of professional background and experience.

The second step was to assign learning objectives to each domain of competencies, to organize them according to levels of proficiency, and to arrange them in a logical order of implementation. We conceptualized three levels of professional expertise in epileptology, *i.e.* Level 1 or "entry level", Level 2 or "proficiency level", and Level 3 or "advanced proficiency level"; these are described in further detail below. Our didactic methods and the granularity of learning content and educational tools should adapt to these three levels.

With the assistance of educational experts, the EpiEd task force developed a curriculum for the three levels of expertise, encompassing seven domains, 42 competencies, and 124 learning objectives (*table 1*). The entire ILAE curriculum is presented in *appendix 1* as well as on the ILAE's educational website (www.ilae.org).

Didactic methods and educational tools: a patient-centered approach

Following the process described above, it was concluded that when delivering the ILAE curriculum, it should follow a patient-centered educational approach (Barrows, 1983; Dave Davis and McMahan, 2018), which addresses adult learning styles and needs (Knowles, 1984b; Christianson *et al.*, 2007; Taylor and Hamdy, 2013; Palis and Quiros, 2014). Accordingly, the ILAE will implement a comprehensive, web-based learning environment encompassing all the instructional elements required for successful adult learning, hereby addressing motivation, knowledge gain, improvement in skills, and adaptation of professional behavior. This problem-based approach would start with the issues any physician first encounters when examining a new patient presenting with seizures. Recognition of the most important clinical features would be mandatory at this stage for two reasons. First, because it translates directly into decisions to order the most appropriate diagnostic tests. Secondly, because it leads to immediate decisions about initial treatment, without necessarily waiting for the results of the clinical investigations, which may require additional time and resources.

Furthermore, the evaluation of learning content and workflow actively involves the learner, enhances the learning process, and provides information about

Table 1. Learning domains in epileptology.

#	Code	Domain	Specification
1	1.0	Diagnosis	9 competencies and 40 learning objectives
2	2.0	Counselling	10 competencies and 22 learning objectives
3	3.0	Pharmacological Treatment	7 competencies and 18 learning objectives
4	4.0	Epilepsy Surgery	7 competencies and 7 learning objectives
5	5.0	Emergencies	3 competencies and 9 learning objectives
6	6.0	Comorbidities	2 competencies and 8 learning objectives
7	7.0	Biology of Epilepsy	4 competencies

The curriculum encompasses seven learning domains, each consisting of specific competencies and learning objectives, as specified below (see *appendix 1*). Learning domains constitute the framework of the curriculum and contain elements of all teaching levels, *i.e.* Level 1 (entry), Level 2 (proficiency), and Level 3 (advanced proficiency).

efficiency and application (Palis and Quiros, 2014). Considering the various learning styles, flexibility of learning time demanded by adult learners, and a global approach to address multilingualism, implementation of the curriculum within a virtual learning environment is required. Such an eLearning platform allows the application of the aforementioned adult learning principles and activities, such as web-based-training (WBT) in combination with other didactic formats in a blended learning concept combining asynchronous and synchronous, virtual and onsite, and formal and informal activities. According to the different competency levels and the self-directed approach, the virtual learning and confidence assessment concept will incorporate a guided learning path that is not restricted to a predetermined learning program, but also allows for individual interests and needs (Dave Davis and McMahon, 2018).

Level 1 (entry level)

This level is intended for clinicians trained in adult and child neurology, internists, pediatricians, and psychiatrists who manage PwE, but may also be of interest to other professionals involved in providing care to PwE. This level covers the basic principles in clinical epileptology which are needed to manage the most common forms of seizures and types of epilepsy, and to provide first-line drug treatment. A web-based program with variable levels of tutor support will offer a catalogue of cases with disease-specific clinical histories and seizure presentations. Unlimited access and linkage to the “eLearning library” will allow a participant to read relevant (pre-selected) primary literature (e.g. Kwan and Brodie, 2000; Wiebe *et al.*, 2001; Blümcke *et al.*, 2017), definition and classification

schemes (e.g. Kwan *et al.*, 2010; Blümcke *et al.*, 2011; Kerr *et al.*, 2011; Blümcke *et al.*, 2013; LaFrance *et al.*, 2013; Trinka *et al.*, 2015; Wilson *et al.*, 2015; Glauser *et al.*, 2016; Fisher *et al.*, 2014, 2017; Scheffer *et al.*, 2017), educational review papers or textbook chapters (e.g. Engel and Pedley, 2008; Blümcke *et al.*, 2015; Wyllie, 2015; Arzimanoglou *et al.*, 2016; Schomer and Lopes da Silva, 2016), the epilepsy diagnostic manual at www.epilepsydiagnosis.org, and to listen to topic-related webinars or review self-instructing databases of primary diagnostic investigations. The foremost challenge for the participant in Level 1 will be to draw clinically meaningful and reliable conclusions from the cases presented, leading to initial management decisions. The module will also address common errors in clinical decision-making, a mandatory asset of our eLearning program (Gibson, 2008; Kanner, 2008; Schmidt, 2018). In a second learning phase at this level, the participant can request diagnostic investigations considering cost-effectiveness and the learner’s socio-economic setting (Carrizosa *et al.*, 2018). The results of the investigations requested will be presented as an expert report, *i.e.* the participants are not required to perform the investigation, analyze primary data, or prepare a report of the investigation. The results report will inform the learners and help them refine their first diagnostic hypotheses and management decision. The system will evaluate all clinical decisions and management pathways and offer the participants the opportunity to reconsider decision points in order to adapt their professional behavior. This is of particular importance in order to avoid incorrect clinical decisions resulting in suboptimal patient management, e.g. poor choice of first-line treatment, not recognizing adverse treatment effects, unnecessary invasive investigation, or unacceptable delays in referring the patient for a pre-surgical evaluation.

In a third phase, the participant will be provided with follow-up information resulting from their treatment regimen. For example, if a patient did not respond to a correctly chosen and appropriately administered first-line treatment, a choice of second-line treatments will be presented as well as avenues to counsel the patient for referral to advanced diagnostic work-up (see Level 2).

A multiple-choice exam will be offered at the conclusion of Level 1. Herein, the learner has to correctly address a random selection of cases not presented during the teaching course. Any new learners who deem themselves sufficiently experienced and knowledgeable of the learning objectives addressed in the entry level can use the self-assessment tool and proceed directly to take the exam. Passing the exam will allow them to advance to Level 2. Notwithstanding, participation in ILAE-endorsed workshops and symposia is encouraged as an aid to successfully accomplish this level. Successful accomplishment of the first level should empower a participant to understand how and when to diagnose various types of seizures and epilepsy, with their many facets related to clinical presentation, etiology, and management strategy.

Level 2 (proficiency level)

This next level of patient care covers a broader and deeper spectrum of knowledge and skills in epileptology. The complexity of the very different forms of epilepsy, the diversity of underlying etiologies, and the large number of available investigations that have to be prioritized and selected on the basis of electroclinical indications and cost-effectiveness require specific training beyond that of general neurology or child neurology expertise. Proficiency in video-EEG and MRI interpretation are considered absolute prerequisites for those neurologists and child neurologists practicing clinical epileptology. Similarly, the complexity of available therapeutic strategies and their immediate and long-term consequences require motivation, knowledge, and adaptation of professional behavior to ensure best clinical practice.

The ILAE thus proposes a global patient-centered approach incorporating knowledge and skills to build a comprehensive hypothesis on the pathophysiological and anatomical basis of a given form of epilepsy, to choose appropriate first and second-line AEDs, and to recognize at an early stage the indications for pre-surgical evaluation. This includes the capacity to

inform and counsel the patient and the family on prognosis, risk of SUDEP, vocational orientation, sports, and family life. It will also cover skills and knowledge to deal with special patient groups, embracing women of child bearing age or the elderly with associated comorbidities.

Participants qualified for the second level must have successfully accomplished Level 1 or must show evidence for equivalent knowledge (*i.e.* passed the corresponding exam). The common body of knowledge in general epileptology will be presented to the learner and taught with a comprehensive portfolio of case-oriented eLearning modules covering major epileptic conditions, syndromes, but also rare disorders. The eLearning platform will be blended with tutor-guided, web-based teaching courses, advanced face-to-face workshops (see below), or special teaching courses offered at international congresses. The “virtual library” already introduced for Level 1 will encompass a large body of primary literature, standard textbook chapters, and databases for the analysis and interpretation of primary diagnostic investigations, such as EEG and MRI.

We contemplate developing standardized ILAE examinations in order to assess knowledge of independent components or modules at each level of the curriculum, *i.e.* Level 1 and 2. The examination and certification offered by the ILAE educational program are still under consideration. There are many elements that require careful assessment, including, for example, the minimum requirements for each level, the format of the exam (online, face to face, or both), the requirement for additional clinical training in the case of more advanced modules, and the type of certificate granted. These aspects remain to be determined.

Level 3 (advanced proficiency level)

ILAE’s EpiEd Task Force envisioned also a level of advanced proficiency for epileptologists interested in more advanced or specialized training, *e.g.* epilepsy in neonates; planning of intracranial electrode implantation; interpretation of invasive EEG recordings; post-processing in EEG, MEG and MRI; analysis of genetic investigations; design and management of clinical drug trials; organizing epilepsy surgery centers or epilepsy research programs. These skills will require demonstrated knowledge of Level 2 material, and completion of Level 3 modules typically will require practical clinical training in specialized epilepsy centers.

Appendix 1.

The body of knowledge for epileptology.

Domain	Competency	Learning Objective	Level
1.0 Diagnosis			
	1.1	Demonstrate working knowledge of etiologies for focal and generalized epilepsies in children and adults	
		1.1.1 Describe the major etiologies for epilepsy (<i>i.e.</i> structural, genetic, infectious, metabolic, immune, and neurodegenerative)	Level 1
		1.1.2 Describe the common structural etiologies (<i>e.g.</i> hippocampal sclerosis, tumors, malformations, vascular lesions, traumatic brain injury, <i>etc.</i>)	Level 2
		1.1.3 Describe the common genetic causes of epilepsy (<i>e.g.</i> monogenic or polygenic inheritance, common germline or somatic mutations)	Level 2
		1.1.4 Describe the common infectious causes of epilepsy, including geographical impacts (<i>e.g.</i> bacterial, fungal, viral, parasites)	Level 2
		1.1.5 Describe the common metabolic causes of epilepsy (<i>e.g.</i> inborn errors of metabolism, glucose transport defect, pyridoxine dependent seizures, mitochondrial pathologies)	Level 2
		1.1.6 Describe the common immune causes of epilepsy (<i>e.g.</i> Rasmussen encephalitis, LGI1 antibodies, NMDA antibodies, <i>etc.</i>)	Level 2
		1.1.7 Describe the common neurodegenerative causes of epilepsy (<i>e.g.</i> Alzheimer's disease, Down syndrome, progressive myoclonic epilepsies)	Level 2
	1.2	Demonstrate in whom, when and how genetic testing should be applied	
		1.2.1 Decide on which patients to do genetic testing	Level 2
		1.2.2 Decide what type of genetic testing to conduct	Level 3
		1.2.3 Interpret and apply the results of genetic testing accurately in the clinical context	Level 3
	1.3	Identify and describe seizure semiology using standardized ILAE terminology and classification systems	
		1.3.1 Learn and recognize the seizure semiology and distinguish it from other non-epileptic manifestations	Level 1
		1.3.2 Extract semiology information from patient history	Level 1
		1.3.3 Extract semiology information from video recordings	Level 1
		1.3.4 Interpret semiological signs and symptoms allowing hypotheses on the localization of focal seizures	Level 2
		1.3.5 Interpret semiological signs and symptoms suggesting focal vs. generalized onset	Level 1
		1.3.6 Classify seizures according to the ILAE classification	Level 1
	1.4	Interpret EEG and describe common EEG patterns in children and adults	
		1.4.1 Determine whom should receive EEGs, be familiar with sensitivity and specificity, and how to interpret the report in the clinical context	Level 1
		1.4.2 Demonstrate knowledge on how to conduct EEG recordings, including technical requirements (<i>e.g.</i> mounting electrodes, use filters, amplifiers, electrode arrays, <i>etc.</i>)	Level 2
		1.4.3 Demonstrate knowledge of montages - advantages and disadvantages	Level 2
		1.4.4 Interpret topographic (voltage) maps	Level 2
		1.4.5 Recognize the indications for the different types of provocation methods	Level 2
		1.4.6 Recognize the different types of EEG recordings and methodologies (<i>e.g.</i> invasive, scalp, stereo, video-EEG)	Level 2
		1.4.7 Recognize and describe background activity and sleep patterns in all age groups	Level 2
		1.4.8 Recognize and distinguish artifacts and normal variants from abnormal EEG patterns, and take actions necessary for eliminating artifacts	Level 2
		1.4.9 Recognize and describe interictal abnormalities	Level 2
		1.4.10 Recognize and describe ictal patterns	Level 2
		1.4.11 Recognize and describe ictal and interictal patterns with intracranial recordings	Level 3
		1.4.12 Demonstrate working knowledge of electromagnetic source imaging	Level 3
	1.5	Accurately order and interpret neuroimaging as it pertains to epilepsy	
		1.5.1 Recognize the spectrum of MRI sequences optimized for epilepsy	Level 2
		1.5.2 Decide on whom to do structural neuroimaging	Level 1
		1.5.3 Decide when to conduct neuroimaging and repeat as needed	Level 2
		1.5.4 Decide when to conduct specialized neuroimaging and which type (<i>e.g.</i> functional, metabolic, post-processing, <i>etc.</i>)	Level 2
		1.5.5 Interpret and apply the results of specialized neuroimaging accurately in the clinical context	Level 3
	1.6	Decide which patients should receive lab tests and which types of tests should be ordered	Level 1
	1.7	Accurately diagnose and classify epilepsies and epilepsy syndromes using the most recent ILAE classification	
		1.7.1 Accurately distinguish acute symptomatic seizures from epilepsy	Level 1
		1.7.2 Correctly distinguish between focal and generalized epilepsies and recognize epileptic encephalopathies	Level 1
		1.7.3 Correctly diagnose and classify focal epilepsies	Level 2
		1.7.4 Correctly diagnose and classify generalized epilepsies	Level 1
		1.7.5 Correctly diagnose and classify combined focal and generalized epilepsies including epileptic encephalopathy	Level 2
	1.8	Recognize common non-epileptic paroxysmal events (<i>e.g.</i> PNES, syncope, parasomnia)	
		1.8.1 Describe the epidemiology, psychiatric and experiential risk factors for PNES	Level 1
		1.8.2 Recognize the semiology of PNES and the use of video-EEG procedures and suggestion techniques in the diagnosis of suspected PNES	Level 2
		1.8.3 Describe formulation of diagnosis of PNES at different levels as suggested by the ILAE PNES task force	Level 2
		1.8.4 Recognize the typical semiology and risk profile associated with syncope	Level 1
	1.9	Identify patients at high risk of cardiac death: recognize semiology, risk factors, and initial management of high risk of cardiac death	Level 1

2.0 Counseling		
2.1	Understand and address the culturally-appropriate aspects and consequences of the diagnosis of epilepsy, including stigma	Level 1
2.2	Provide guidance on specific issues related to epilepsy 2.2.1 Provide guidance on social issues including school integration, work, legal, and related aspects 2.2.2 Provide guidance regarding lifestyle matters, such as driving, sports, alcohol, stress, sleep, drug use, and non-adherence 2.2.3 Provide guidance regarding safety issues related to seizures	Level 1 Level 1 Level 1
2.3	Communicate information about the causes and consequences of the specific type of epilepsy and its treatments 2.3.1 Communicate to patients and families, as appropriate, about the epidemiology of epilepsy 2.3.2 Educate patients and family about the disease specifics (e.g. prognosis, self-limiting, risk factors, etc.) 2.3.3 Educate caregivers about the clinical condition and its management 2.3.4 Educate workplace or school stakeholders concerning the patient's needs 2.3.5 Provide information to patients regarding potential adverse effects of antiepileptic drugs 2.3.6 Counsel patients and family regarding the risks and benefits of epilepsy surgery	Level 1 Level 2 Level 2 Level 3 Level 1 Level 3
2.4	Counsel patients about medication taper and discontinuation 2.4.1 Advise patients in remission 2.4.2 Advise patients with uncontrolled seizures	Level 2 Level 2
2.5	Recognize when to refer patients for higher level of care (e.g. prolonged video-EEG recording, pre-surgical evaluation, uncontrolled epilepsy, lesional epilepsy, epileptic encephalopathy, psychiatric comorbidity, genetic counseling, etc.)	Level 1
2.6	Counsel women of childbearing age about the implications and management of epilepsy 2.6.1 Provide guidance regarding contraception 2.6.2 Provide guidance regarding pregnancy, including teratogenicity of the various antiepileptic drugs 2.6.3 Provide guidance regarding post-partum and child care 2.6.4 Provide guidance regarding antiepileptic drugs and hormonal interactions	Level 2 Level 2 Level 2 Level 2
2.7	Provide information and explain to a patient the concept of sudden unexpected death in epilepsy patients (SUDEP) and advise on the associated risks	Level 1
2.8	Provide counseling on issues specific to the elderly with epilepsy 2.8.1 Identify and provide counseling on issues related to comorbidities 2.8.2 Identify and provide counseling on issues related to drug interactions	Level 2 Level 2
2.9	Provide counseling specific to children with epilepsy and their parents, according to the epilepsy types (e.g. lifestyle, cognitive function and prognosis)	Level 1
2.10	Provide counseling and information in relation to PNES to patients and families 2.10.1 Understand and address the culturally appropriate aspects and consequences of the diagnosis of PNES 2.10.2 Communicate information about the causes and consequences of PNES and the potential of psychological treatment 2.10.3 Counsel patients about tapering inappropriate antiepileptic drugs and the role of other medications (anxiolytics, antidepressants) in PNES	Level 1 Level 2 Level 2
3.0 Pharmacological Treatment		
3.1	Demonstrate up-to-date knowledge about the range of pharmacological treatments for epilepsy 3.1.1 Identify the spectrum of action for antiepileptic drugs 3.1.2 Demonstrate knowledge of pharmacokinetics and pharmacodynamics 3.1.3 Demonstrate knowledge regarding the adverse effects of antiepileptic drugs 3.1.4 Demonstrate knowledge of appropriate monitoring of AES serum levels 3.1.5 Demonstrate knowledge about drug interactions (e.g. enzyme induction, etc.) for AED/AED and AED/concomitant medication (e.g. oral contraceptives, treatment of TB, HIV, etc.) 3.1.6 Demonstrate knowledge about treatment of psychiatric and cognitive comorbidities in children and adults	Level 1 Level 1 Level 1 Level 2 Level 2 Level 3
3.2	Recommend appropriate therapy based on epilepsy presentation 3.2.1 Recommend appropriate therapy according to seizure type 3.2.2 Recommend appropriate therapy according to epilepsy syndrome 3.2.3 Recommend individualized titrations of optimal dosing for patients including starting and discontinuing medication 3.2.4 Communicate information regarding the antiepileptic drug regimen 3.2.5 Recommend second-and third-line treatments as necessary	Level 1 Level 2 Level 1 Level 1 Level 2
3.3	Demonstrate up-to-date knowledge about special aspects of pharmacological treatment 3.3.1 Define treatment strategies considering issues specific to pre-menopausal women 3.3.2 Define treatment strategies considering issues specific to neonates and very young children 3.3.3 Define treatment strategies considering issues specific to the elderly 3.3.4 Define treatment strategies considering issues specific to sexual function and dysfunction 3.3.5 Define treatment strategies considering genetic markers 3.3.6 Define treatment strategies for infectious causes of epilepsy and seizures 3.3.7 Define treatment strategies for immune-mediated causes of epilepsy and seizures	Level 2 Level 3 Level 2 Level 2 Level 3 Level 1 Level 2
3.4	Demonstrate knowledge about the risks and opportunities associated with drug discontinuation and methodologies for individualized implementation	Level 2
3.5	Identify patients who are drug resistant according to the current ILAE definition	Level 1
3.6	Demonstrate knowledge of indications, limitations and risks for ketogenic diets	Level 3
3.7	Demonstrate knowledge of indications, limitations and risks for vagal nerve stimulation and other neuromodulation techniques	Level 3
4.0 Epilepsy Surgery		
4.1	Demonstrate working knowledge of indications for pre-surgical evaluation	Level 1
4.2	Describe the importance of early surgical intervention regarding neuro-developmental, cognitive, behavioral and social integration aspects	Level 2

4.3	Demonstrate working knowledge of advanced techniques for pre-surgical evaluation	
	4.3.1 Recommend and interpret video-EEG monitoring as appropriate (including when it is indicated to repeat the monitoring)	Level 3
	4.3.2 Recommend functional neuroimaging as appropriate	Level 3
	4.3.3 Recommend and interpret results of neuropsychological testing, taking into account epilepsy-related factors and other factors such as mood	Level 3
4.3.4 Demonstrate working knowledge on planning implantation of intracranial electrodes	Level 3	
4.4	Demonstrate working knowledge of etiologies amenable to surgical treatment and their prognoses in all age groups	Level 2
4.5	Demonstrate ability to integrate information from multi-modal work-up and estimate risks and benefits of surgical therapy	Level 3
4.6	Demonstrate working knowledge of post-surgical follow-up	
	4.6.1 Demonstrate knowledge about the risks and benefits associated with drug management after epilepsy surgery	Level 3
	4.6.2 Demonstrate working knowledge of post-surgical neurological and psychiatric complications	Level 3
	4.6.3 Identify situations which require consideration of repeated surgery	Level 3
4.6.4 Identify situations which require rehabilitation following surgery	Level 3	
4.7	Demonstrate the value and need for multidisciplinary teamwork	Level 3
5.0 Emergencies		
5.1	Demonstrate the ability to implement emergency treatment plans for children and adults in and outside the hospital setting	
	5.1.1 Articulate the conditions or elements that constitute an emergency	Level 1
	5.1.2 Appropriately manage or advise regarding prolonged or sequential seizures	Level 1
	5.1.3 Appropriately manage or advise regarding injuries	Level 1
	5.1.4 Appropriately manage or advise regarding drug intoxication or adverse reactions	Level 1
5.1.5 Appropriately manage or advise regarding psychiatric emergencies (<i>e.g.</i> psychosis, self-harm, agitation, suicidal ideation, <i>etc.</i>)	Level 1	
5.2	Demonstrate the ability to diagnose status epilepticus in children and adults	
	5.2.1 Appropriately diagnose all types of convulsive status epilepticus (including differential diagnosis)	Level 1
5.2.2 Appropriately diagnose all types of nonconvulsive status epilepticus including EEG interpretations (including differential diagnosis)	Level 2	
5.3	Demonstrate the ability to manage status epilepticus in children and adults	
	5.3.1 Appropriately manage all types of convulsive status epilepticus including EEG monitoring of treatment effect	Level 2
5.3.2 Appropriately manage all types of nonconvulsive status epilepticus including EEG monitoring of treatment effect	Level 2	
6.0 Comorbidities		
6.1	Demonstrate the ability to diagnose and manage cognitive and psychiatric comorbidities	
	6.1.1 Recognize psychiatric comorbidities, such as depression, anxiety, attention deficit and hyperactivity disorder, psychosis and autism spectrum disorders	Level 2
	6.1.2 Appropriately manage or advise regarding psychiatric comorbidities	Level 2
	6.1.3 Adjust anti-seizure treatment as required for psychiatric comorbidities	Level 2
	6.1.4 Demonstrate the ability to recognize and manage the special needs of persons with epilepsy and intellectual disability	Level 3
6.1.5 Manage cognitive changes in epilepsy and the cognitive effects of AEDs	Level 2	
6.2	Demonstrate the ability to diagnose and manage somatic comorbidities	
	6.2.1 Diagnose somatic comorbidities, such as those related to epilepsy treatment, causes of epilepsy, or common associated conditions	Level 2
	6.2.2 Appropriately manage and advise regarding somatic comorbidities	Level 2
6.2.3 Adjust anti-seizure treatment as required by common somatic comorbidities	Level 2	
7.0 Biology of Epilepsy		
7.1	Demonstrate working knowledge of ictogenesis	Level 3
7.2	Demonstrate working knowledge of epileptogenesis	Level 3
7.3	Demonstrate awareness of animal models for focal and generalized epilepsies	Level 3
7.4	Demonstrate knowledge of bidirectional relationship between epilepsy and psychiatric comorbidities	Level 3

The curriculum encompasses seven knowledge domains, 42 competencies, and 124 learning objectives. The codes help to clarify which competency and learning objective (LO) belongs to which learning domain; for example, domain 1, competency 1.1, and learning objective 1.1.1 corresponds to Diagnosis, and so forth. LOs for Level 1 were selected by their primacy and precede any other LO from the same competency. Please note that competencies not further specified were considered also a LO. Importantly, all LOs can serve any of the three teaching levels (see text for further information), *e.g.* Level 1 (“entry level”), Level 2 (“proficiency level”), Level 3 (“advanced proficiency level”). The granularity of information and knowledge must be adjusted to the teaching level and specified in each teaching activity.

Proposal for the endorsement of educational activities and recommendations for an outcome-based eLearning approach

The spectrum of educational activities addressing the various knowledge domains and skills in epileptology is broad. In past decades, many face-to-face workshops, summer schools or web-based teaching programs have been launched to cover many of these aspects. Through an international survey, EpiEd compiled a catalogue of currently available teaching activities endorsed by the ILAE and advertised through

the ILAE website (see *appendix 2*). This survey showed that currently available activities do not cover the entire breadth of the curriculum. In addition, the target audience is not always specified according to the different teaching levels, *i.e.* entry level, proficiency or advanced proficiency levels. It is envisaged, therefore, that the goal will be to harmonize ILAE’s future portfolio of web-based courses and face-to-face teaching with the ILAE curriculum, and that, increasingly, courses will clearly specify the learning objectives to be addressed therein. Similarly, standard educational methods should be increasingly adopted by ILAE-endorsed courses; these include student engagement using any of the many adult learning methods,

Appendix 2.

Survey of currently available teaching activities (2017 ILAE EpiEd survey).

In 2017, EpiEd assessed the available ILAE-endorsed teaching activities worldwide in order to identify existing teaching gaps and establish a list of competencies. A list of endorsed and supported courses, workshops, and summer schools was retrieved from ILAE websites. Course directors as well as current chairs of ILAE commissions and task forces were asked to review the course content and match teaching deliverables with the list of competencies. Our survey results helped to create an asset-map of 21 recognized teaching activities (and two web-based MRI activities in preparation; see T22-23):

We suggest classifying these teaching activities into the following categories:

ILAE teaching activities endorsed for level 1

- T1: VIREPA EEG in the diagnosis & management of epilepsy - basic (web-based)
- T2: ILAE sponsored Latin American Summer School in Epileptology (Brazil)
- T3: Primary Care Course on Epilepsy (Uruguay)
- T4: ILAE-sponsored East European course on Epilepsy (Romania, Bulgaria)
- T5: PET (Pediatric Epilepsy Training) Courses (UK)

ILAE teaching activities endorsed for level 2

- T6: ILAE-sponsored Baltic Sea Summer School on Epilepsy (Estonia)
- T7: ILAE-sponsored San Servolo Summer School (Italy)

ILAE courses endorsed for level 2 (web-based)

- T8: VIREPA EEG in the diagnosis & management of epilepsy -advanced
- T9: VIREPA EEG in the diagnosis & management of epilepsy -pediatric
- T10: VIREPA epilepsy & sleep

ILAE courses endorsed for level 2 (face-to-face)

- T11: ILAE course on neuropathology in epilepsy (Germany, USA, Brazil, China)
- T12: ILAE course on neuropsychology in epilepsy (France)
- T13: ILAE course on EEG in the first years of life (UK)
- T14: ILAE-sponsored Dianalund Summer School on EEG & Epilepsy (Denmark)
- T15: ILAE-sponsored SEEG workshop (Canada, China, Italy, France)
- T16: ILAE-sponsored Video-EEG Course on Pediatric Epilepsy (Spain)
- T17: ILAE course on neuroimaging and epilepsy (Canada)
- T18: ILAE-sponsored Epilepsy Surgery Course (EPODES) (Czech Republic)
- T19: ILAE-endorsed course, EPIPED on Treatment of Pediatric Epilepsy (Spain, France)
- T20: ILAE-endorsed Residential International Course on Drug Resistant Epilepsies (Italy)

Fellowship programs (level 2)

- T21: ILAE-sponsored fellowships (Latin American Academy of Epilepsy)

ILAE courses (in preparation)

- T22: VIREPA MRI reading in epileptology-basic level 1
- T23: VIREPA MRI reading in epileptology-advanced level 2

With the exception of T3-4, all courses are given in English. Most courses are eligible for an audience defined by our curriculum as Level 2 (with experience in epileptology). Course hours and registration fees vary considerably. CME credits and final exams are provided by only a few courses. Measurements to reliably test the efficacy and teaching benefit of each course have not yet been established.

The survey disclosed a considerable gap in availability of teaching activities and in accessibility of basic knowledge in epileptology at a regional level. This informed the decision to focus our initial efforts on building an educational curriculum addressing basic knowledge in epileptology (referred to as "Level 1" in the current report), using web-based teaching methods.

such as “think, pair, share”, “make a vote”, “flipped classroom” and/or “breaking out into smaller groups for a project”. Case or project presentations by the students are also highly recommended as a successful engagement method.

Systematic implementation of post-course evaluation of achievements will be another educational milestone to be introduced into ILAE-endorsed teaching activities incrementally. Various national and international guidelines are already available and provide standards for the development and implementation of learning activities for healthcare professionals in continuing professional development (CDP) to guarantee high-quality approaches (Taylor and Hamdy, 2013). Our previous activities for the planning process can be described as a “learning planning cycle” which includes five steps:

- defining the learning objectives;
- assessing and validating the learning gaps;
- defining the learning outcomes;
- defining the educational format, content, and outcome measures;
- and evaluating the achieved outcomes.

The results of the evaluation phase will help define the planning of further educational activities (Moore et al., 2009).

ILAE’s Task Force for Epilepsy Education will continue to work and to reiterate this “learning cycle” in order to offer all our constituency, in all parts of the world, a comprehensive portfolio of the 21st century, state-of-the-art and competency-based teaching program. □

Disclosures.

None of the authors have any conflict of interest to declare.

Disclaimer: The ILAE’s assessment-based certificate teaching program is not intended to compete with or replace any medical board accreditation processes established in any country for the professional healthcare management of PwE.

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Supplementary appendix.

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