Clinical Neurophysiology Practice 7 (2022) 120–126

Contents lists available at ScienceDirect

Clinical Neurophysiology Practice

journal homepage: www.elsevier.com/locate/cnp

Review article

# Training and education practice in the Europe, Middle East and Africa, Latin America and Asia Oceania chapters, IFCN; an international survey

Jonathan Cole[a,*], Anita Kamondi[b,c], Paulo Teixeira Kimaid[d], Nortina Shahrizaila[e,1],
on behalf of the Europe, Middle East and Africa, Latin America and Asia-Oceania Chapters of the International Federation of Clinical Neurophysiology[e,1]

[a] Clinical Neurophysiology, University Hospitals Dorset, (Poole), and University of Bournemouth, Poole, United Kingdom
[b] Department of Neurology, Semmelweis University, Budapest, Hungary
[c] Department of Neurology, National Institute of Mental Health, Neurology and Neurosurgery, Budapest, Hungary
[d] CENEC-Neurofisiologia Clínica, Campinas, SP, Brazil
[e] Neurology Unit, Department of Medicine, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia

ARTICLE INFO

*Article history:*
Received 17 March 2021
Received in revised form 2 February 2022
Accepted 12 February 2022
Available online 22 March 2022

*Keywords:*
Clinical neurophysiology
Training
Education
Survey
IFCN chapters

ABSTRACT

This paper presents results from the first survey of training and education undertaken by the Europe-Middle East-Africa (EMEAC), the Latin America (LAC) and the Asia-Oceania (AOC) Chapters of the International Federation of Clinical Neurophysiology (IFCN). The survey was conducted initially by the EMEAC in 2012 and updated in 2016, 2019, and 2020. It had the following categories: status of specialty and training in member country (21 questions), competency and accreditation (12 questions), practice and concerns (23 questions). An abbreviated version of the survey was conducted by the LAC and AOC in 2018–2019.

Clinical neurophysiology (CN) was a single specialty in a minority of member societies' countries: 8/33 EMEAC, 2/12 AOC and 2/10 LAC. In others it was usually a subspecialty of neurology. Training periods in CN were split fairly evenly between 1, 2, 3, 4 and 5 years in EMEAC, while neurology takes 4 to 5 years. In the AOC, neurology training was for 3 to 4 years and CN for up to 2 years. In LAC a majority of countries trained for 2 to 3 years in both neurology and CN. An exit exam was performed in 16/30 EMEAC respondents, 8/12 in the AOC and 3/10 in the LAC.

Competence was considered to require a wide range of numbers of tests performed under supervision, from <250 to >750 in EMEAC and AOC, with the EMEAC tending to require more. The main concerns were in recruitment and workload in EMEAC, training in AOC and the need for more recognition of the specialty in some countries within the LAC.

This survey, the first across the three chapters, revealed considerable differences in training durations and numbers of tests performed for competence between national societies.



**Contents**



* Corresponding author at: University Hospitals, Dorset, Longfleet Road, Poole BH15 2JB, United Kingdom.
*E-mail address:* jonathan.cole@uhd.nhs.uk (J. Cole).

[1] For the Members of IFCN Chapter committees, see the Appendix.

https://doi.org/10.1016/j.cnp.2022.02.004
2467-981X/

## 1. Introduction

The International Federation of Clinical Neurophysiology (IFCN) is an organisation that represents national professional societies in clinical neurophysiology (CN). The IFCN has sixty-one societies from 58 countries, organised into four chapters: North America (NAC); Latin-America (LAC); Europe, Middle East and Africa (EMEAC) and Asia-Oceania (AOC) (https://www.ifcn.info).

Societies and structures of the chapters vary (Supplementary file 1); the majority of countries have a single national society for CN. The NAC has two nations, USA and Canada, and three main societies. The LAC has ten countries and 11 societies (Colombia has two societies); the AOC has 13 countries and 12 societies (Australia and New Zealand have one common society), whereas the EMEAC has 35 societies for its 34 countries (Egypt has two societies). Collectively, more than 20,000 members are represented. It makes sense that given the diversity of the IFCN member societies, there will be differences in the practice and training of CN.

A survey on training and practice in CN was first commenced in Europe in 2012 following discussions at the 2009 General Assembly of the European Congress of Clinical Neurophysiology (ECCN). This survey was later updated in 2016, 2019 and 2020. The results of this survey were presented at the inaugural IFCN Special Interest Group (SIG) in Education workshop convened at the 3rd International Congress of Clinical Neurophysiology (ICCN) in Washington in 2018. In connection with this, the EMEAC survey was pre-circulated (by J. Cole) which drew interest from the Latin-America chapter who conducted a similar survey (by P. Kimaid) and presented their findings at that time. Following these presentations, the AOC sought permission to also conduct the survey amongst its members (by N. Shahrizaila).

This study presents findings collated from all three Chapter surveys. The aim is to facilitate discussions on the best practice and education of trainees in CN and identify concerns of clinical neurophysiologists about their present work and the future.

## 2. Methods

The original survey was commissioned by the EMEAC in 2012 and repeated in 2016 (Supplementary file 2). It was updated in 2019, and 2020 (by A. Kamondi) taking into account changes in current practice i.e. adding new procedures where indicated. The original survey was long and was collapsed to give the results in the paper. Subsequent surveys used those data sets to ask if there had been any changes in the intervening period. An abbreviated version of the survey was used by the AOC in 2019 and the LAC in 2018, the latter with Spanish translation (Supplementary files 3 and 4). The survey was sent to the representatives from each member society, with reminders when necessary. The main mode of communication was through email, although in the LAC, phone calls, phone messaging system as well as in-person interviews were also adopted. In its most comprehensive form, the survey had the following categories:

- Status of specialty and training in member country (21 questions)
- Competency and accreditation (12 questions)
- Practice and concerns (23 questions)

## 3. Results

Results were collated by the author/s from each chapter (EMEAC: JC and AK; AOC: NS and LAC: PK). The EMEAC sampled thirty-three member societies, the AOC 12 (representing 13 countries with Australia and New Zealand represented by one society) and LAC 11 (representing 10 countries). In the EMEAC, the findings incorporate any updated information from member countries following dissemination of the latest version of the survey in 2020. The main difference in EMEAC survey results from 2012 to 2022 is considered in 3.1.1.

From the total number of questions posed in the surveys by the three chapters, not all questions received a response. The results are presented based on the number of respondents to each question in the survey. In certain categories, data were only available for the EMEAC, which conducted a more comprehensive survey.

### 3.1. Status of specialty and training in member society

#### 3.1.1. Monospecialty vs subspecialty

In the EMEAC, CN was seen as a separate specialty in 10/33 member societies that completed the questionnaire in 2012 though this number had reduced to 8/33 by 2021 (CN has lost monospecialty status in Italy and Denmark). All countries where CN was monospecialty within EMEAC were in Europe. In Europe when not a monospecialty, it was a subspecialty of neurology, in other regions of the EMEA chapter it was also aligned with physical and/or rheumatological medicine or not formally recognised.

In the AOC, 2/13 also considered CN a monospecialty (i.e. Japan and the Philippines). In other AOC countries, CN was always a part of neurology.

In the LAC, it was a monospecialty in 2/10 countries, part of neurology or physical medicine in 5/10 and not recognised in a further 3/10.

### 3.1.2. Training of clinical neurophysiologists

In the EMEAC, the training periods before certification were as follows: one year in 5/28, two years in 7/28, three years in 5/28, four years in 6/28, and five years in 5/28. 17/30 had national training schemes. Where CN was a mono-specialty, 8/11 required neurology for a year and where it was part of neurology, neurology training was four to five years (17/21). Training was board-certified in 19/32. General internal medicine training was required in 11/24 and for eight this was for one year.

In the AOC, CN training ranged from three months to two years as a subspecialty of neurology. The lengths of neurology training were three years (8/11), four years (2/11) and two years (1/11). In eight countries, training was done at a local centre and in four at certified national training centres.

The LAC had specialty training for two to three years, either in neurology, medicine, or physical medicine. Where CN was a subspecialty, training was for two to three years and was part of neurology in four countries, paediatric neurology in four countries, physical medicine in four countries and neurosurgery in 2/10 countries. In the three countries where CN was not recognised, training was for a year or less.

### 3.1.3. Training of technicians

The focus of the questionnaire was on medically qualified trainees, but some information on health care scientists or technicians was gained. Within the EMEAC, 20/28 member societies trained in CN, though 11/28 trained as nurses first (11/28). The training duration was <2 years in 15/27, with the remainder lasting between two and four years. Exit was via a national training programme in 8/27, an exam through a national body in 11/27 or through an exam by a university in 8/27. Once qualified, 6/27 had statutory regulation.

In the AOC, technicians trained in CN alone in 7/12 member societies, as nurses first in 3/12 and a mixture of both in 2/12. Durations of training were less than two years in 5/12 and for two to four years in 4/12. They had exit exams in 6/11, of which three were run locally and three by the national society.

There was no formal training program for technicians or technologists in LAC. Instead they are trained informally for a short period (weeks or months) by the physician they work with.

## 3.2. Competency, accreditation, and governance

### 3.2.1. Competency assessments

Amongst EMEAC societies, 16/30 had an exit exam, with 14/15 using a multiple-choice questionnaire (MCQ) and 11/15 using assessment of practical skills. Exit exams were administered by a university in 10/16, a medical college in 2/16, and their own society in 4/16. In those without an exit exam, competency was judged by a practical exam in 10/13, with a logbook also used in 7/13. Competency was then assessed by the trainee's own consultant in 8/13.

In the AOC societies, there was an exit exam in 8/11: this was an MCQ in four, assessment of practical skills in 2 and a viva in 2. In three countries, there was no exam, so competency was judged by a logbook and practical evaluation. Assessments were made by the university or the trainee's own centre in two, a medical college in two and by the professional society in five countries.

In the LAC, 3/10 countries had an exam with MCQ and practical evaluation, and these were run by the national society in one, and university or council in two countries. There was no formal exam in the remaining countries.

The numbers of tests trainees were expected to do themselves are given in Figs. 1 and 2 for the EMEAC and AOC. In the LAC there is no mandated minimum number of tests. These show that both within and between chapters the numbers of tests required for competence in independent practice varies widely, from <250 to >750 in both EEG and EMG.

### 3.2.2. Continuing medical education and revalidation

Within the EMEAC there was no formal requirement for continuing education in 10/16, while in those who do have it, it was run by the society in 4/16 and a medical college in 2/16. Revalidation was not required in 16/25, while in 5/25 it was every three years or more through their national body. Some form of departmental accreditation was present in 9/31.

In the AOC, continuing medical education was required in 11/12 and this was run by the university or centre in 1/9, by a medical

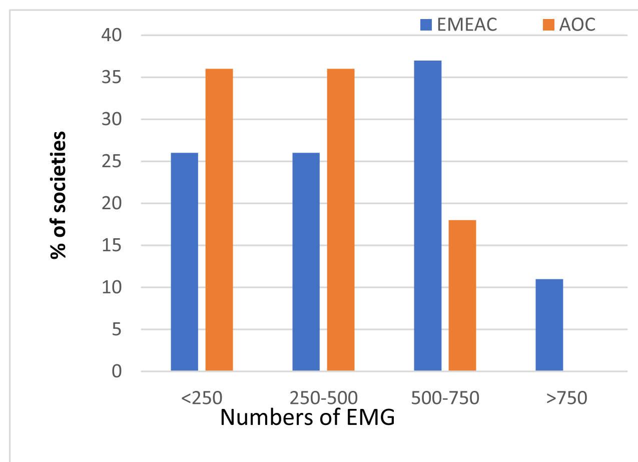


**Fig. 1.** EMG numbers for competency assessment in EMEAC and AOC. EMG: electromyography; EMEAC: Europe, Middle East and Africa Chapter; AOC: Asian-Oceanian Chapter.

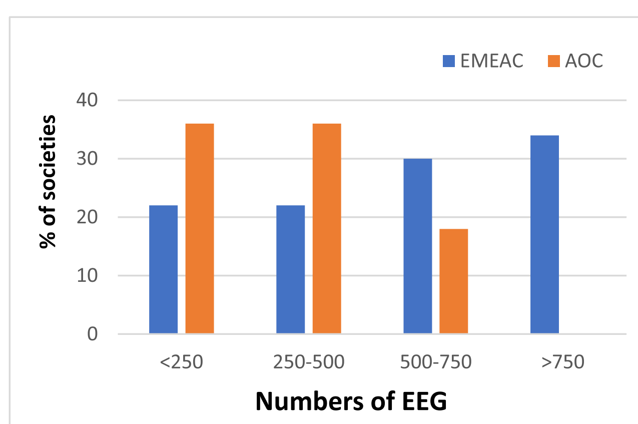


**Fig. 2.** EEG numbers for competency assessment in EMEAC and AOC. EEG: electroencephalography; EMEAC: Europe, Middle East and Africa Chapter; AOC: Asian-Oceanian Chapter.

college in 3/9, and by the professional society in 5/9. Revalidation was necessary in 4/12 and institutional accreditation in 8/12.

Within the LAC continuing medical education or revalidation was not mandatory.

### 3.3. Practice

Specific areas of practice within CN were surveyed in the EMEAC and AOC as follows, although not in the LAC.

#### 3.3.1. Access to procedures

The survey also looked at where the types of procedures were performed, whether in peripheral clinics and hospitals, or tertiary centres. We did not ask how they were staffed which could be from the tertiary centres through hub and spoke models of outreach or by independent staff. This may have implications for training and continuing education.

In the EMEAC, electroencephalography (EEG) (30/30) and nerve conduction studies/electromyography (NCS/EMG) (29/29) were available at all peripheral and tertiary centres whereas polysomnography (30/30), intraoperative monitoring (IOM) (29/29), video telemetry (25/33) and transcranial magnetic stimulation (21/30) were mostly available at tertiary centres (Table 1A). Specialised procedures such as threshold tracking (18/28), magnetoencephalography (11/29) and laser evoked potentials (15/19) were also offered by tertiary centres in some member countries.

In the AOC, routine CN investigations available at both peripheral and tertiary centres include EEG (6/10), NCS (4/10), EMG (3/10), single-fibre EMG (2/10) and trimodality evoked potentials (4/10) (Table 1B). Other investigations were available only at tertiary centres such as polysomnography (9/10), IOM (9/10), video telemetry (8/10) and transcranial magnetic stimulation (9/10). The more specialised CN investigations including transcranial direct current stimulation (3/10) and laser evoked potential (1/10) were performed only in a minority of member countries.

**Table 1A**
Availability of clinical neurophysiology tests in peripheral clinics and tertiary centres within EMEA Chapter.

| | Peripheral | Tertiary | Neither |
|---|---|---|---|
| Electroencephalography | | | |
| EEG | 30 | 30 | |
| EEG/polysomnography | 7 | 30 | |
| Video EEG | 3 | 25 | 5 |
| Ambulatory EEG | 9 | 29 | 1 |
| Electrocorticography | | 22 | 8 |
| Intracranial EEG | | 24 | 6 |
| Magnetoencephalography | | 11 | 18 |
| Electromyography and Nerve Conduction Studies | | | |
| EMG/NCS | 29 | 29 | |
| Single fibre EMG | 7 | 28 | |
| macro EMG | 3 | 25 | 5 |
| Quantitative EMG | 10 | 29 | |
| Quant interference EMG | 10 | 30 | |
| High density surface EMG | | 18 | 12 |
| Threshold track | | 18 | 10 |
| Ultrasound | 9 | 13 | 9 |
| Microneurography | | 19 | 11 |
| Evoked Potentials | | | |
| Visual evoked potentials | 21 | 28 | |
| Electroretinograms | 1 | 29 | |
| Brain stem auditory EPs | 18 | 29 | |
| Somatosensory EPs | 21 | 30 | |
| Intraoperative monitoring/spinal | 1 | 29 | |
| Magneto-EPs/spinal | 1 | 28 | 1 |
| Intraoperative monitoring/cranial | | 26 | 4 |
| Transcranial magnetic stim | 8 | 21 | 1 |
| Transcranial direct current stim | | 20 | 18 |
| Thermal thresholds | 3 | 22 | 5 |
| Laser evoked potentials | | 15 | 14 |

**Table 1B**
Availability of clinical neurophysiology tests in peripheral clinics and tertiary centres within AO Chapter.

| | Peripheral | Tertiary | Neither |
|---|---|---|---|
| Electroencephalography | | | |
| EEG | 6 | 10 | |
| EEG/polysomnography | 1 | 10 | |
| Video EEG | 2 | 10 | |
| Ambulatory EEG | 1 | 6 | 4 |
| Electrocorticography | 1 | 6 | 4 |
| Intracranial EEG | 1 | 6 | 4 |
| Magnetoencephalography | | 5 | 5 |
| Electromyography and Nerve Conduction Studies | | | |
| EMG/NCS | 4 | 10 | |
| Single fibre EMG | 2 | 10 | |
| Quantitative EMG | 1 | 8 | 2 |
| Evoked Potentials | | | |
| Visual evoked potentials | 4 | 10 | |
| Electroretinograms | 0 | 4 | 6 |
| Brain stem auditory EPs | 4 | 10 | |
| Somatosensory EPs | 4 | 10 | |
| Intraoperative monitoring/spinal | 1 | 10 | |
| Intraoperative monitoring/cranial | 1 | 9 | 1 |
| Transcranial magnetic stim | 1 | 10 | |
| Transcranial direct current stim | 0 | 3 | 7 |
| Thermal thresholds | 0 | 5 | 5 |
| Laser evoked potentials | 0 | 1 | 9 |

#### 3.3.2. Practice personnel

In the EMEAC, neurologists/clinical neurophysiologists reported all EEGs and no technicians did this, though in Denmark technicians interpreted and reported, while neurophysiologists supervised and signed the final report. In 15/30 countries technicians did NCS but in only 4/30 did they also report them, while in two countries technicians did needle EMG but did not report them. Technicians in 13/30 countries did IOM.

In the AOC, neurologists reported EEGs in 11/12 member societies and the technician and neurologist provided a joint report in 1/12. Both the technician and neurologist performed NCS together in 7/12 but only the neurologists reported them. EMG was also only performed and reported by neurologists. IOM was performed by both neurologists and technicians in 6/12, neurologists alone (2/12), technicians alone (3/12) and surgeon (1/12). IOM reports were done by neurologists (6/12), technicians (1/12), both (4/12) and surgeon (1/12).

#### 3.3.3. Recruitment of posts and concerns

In the EMEAC, training posts were not always filled in 16/28 and consultant posts in 11/28 of countries. This was exacerbated by the fact that in 6/30 nations, medical students had no exposure to the specialty, while in 14/28 there were no academic or scientific jobs in the specialty. The main perceived threats to the specialty were workload (13/17) followed by staffing (6/17), equipment (2/17) and skill mix (4/17).

In the AOC, where there were training positions in CN (4/12), these were always filled and when CN is a monospecialty (2/12), consultant positions were also always filled.

#### 3.3.4. Remuneration methods

Within the EMEAC, tests were paid by block contracts in 9/29, national tariff in 10/29 and local tariff in 9/29. Finance was through a national scheme in 19/30, private in 2/30, work insurance in 1/30 and in 8/30 a mixture of these.

In the AOC, there was a national tariff in 6/11, a local tariff in 2/11, block contracts in 1/11 and a mixture in 2/11. Payment was either through a national service in 3/11 and a mix of private insurance and national tariff in 8/11.

### 3.3.5. Waiting times

Within the EMEAC, the waiting time for routine NCS/EMG was 4 to 8 weeks in 18/28 and 8 to 16 weeks in the remainder. Routine EEG waits were less than 6 weeks in 12/28, 6 to 18 weeks in 10/28 and longer than 18 weeks in 6/28.

In the AOC, routine NCS/EMG waiting time was less than 2 weeks in 4/11 member societies, 2 to 4 weeks in 4/11, up to 8 weeks in 2/11 and up to a year in 1/11. Waits for routine EEG were less than 2 weeks in 7/11 and more than 4 weeks in 4/11.

## 4. Discussion

The EMEAC executive committee initiated this survey over a decade ago which was conducted then by one of the present authors (JC). The survey has since been presented at international meetings, drawing interest from the AO and LA chapters. Both chapters have since conducted an abbreviated version of the original survey in their member societies.

### 4.1. Status of specialty and training

Monospecialty status was present in a minority of countries in each chapter. CN was usually a sub-specialty of neurology, though in the LAC, it could be associated with paediatrics or physical medicine. Whilst the lack of monospecialty status had little impact in the AOC or LAC, there was concern within the EMEAC that the loss of monospecialty status might threaten CN status as an independent medical specialty within the Union of European Medical Specialties (UEMS). Then it would become important for an independent voice of the specialty to be maintained. In this, EMEAC may become crucial, collaborating with our colleagues in the Clinical Neurophysiology Panel of the European Academy of Neurology. This may be particularly important when considering a curriculum since the UEMS Clinical Neurophysiology Curriculum, naturally, is particularly concerned with monospecialty status. Though not part of the present paper, the present initiative has also led to the development of a group working on an advisory curriculum through the EMEAC, and with the approval from the General Assembly of the EMEAC at the Budapest meeting in 2017.

Although one might have expected training for those with monospecialty status to be shorter than subspecialty status (the latter taking longer with another specialty), this was not entirely evident from the current survey. There was a wide spread of training durations from less than one year to four to five years but these did not correlate with monospecialty or subspecialty status. However, we did not enquire on the intensity of training and these results suggest wide variations amongst the member societies in time spent in training and gaining experience before being considered competent for independent practice.

In some countries such as the United Kingdom, Australia and New Zealand, an online search provided evidence of a formal CN curriculum. The existence of similar curricula in other countries, although not queried, was not apparent from the current survey. One of the key limitations in delivering an optimum level of CN training and service may be the lack of human resource. A survey by the World Federation of Neurology reported the number of neurologists per 100,000 population ranges from 0.04 (Burkina Faso) to 13.37 (Georgia) (Steck et al. 2013). In the low-and-middle-income countries (LMICs), training more neurologists to provide general neurology service will take precedence and thus, ensuring adequate CN training within general neurology training will remain a challenge. Societies from such countries may need to develop training programs of shorter durations to address the demands from their healthcare service.

However, this wide diversity in training may raise questions on the integrity of the specialty. For instance, someone with five years training in neurology and two in CN, will have little resemblance in their knowledge and skills to someone with five years training in CN but only one in neurology. The routes to become a specialist in CN also differ. Although, the majority will come from a background in general neurology, in some countries, trainees from other backgrounds such as physical medicine, neurosurgery or internal medicine can also pursue CN specialty. In this regard, CN differs from other specialties where there are clearer career pathways to follow.

CN also encompasses a broad area of study and as such, no one clinical neurophysiologist can be considered an expert in all its areas. Furthermore, there may be non-clinical neurophysiologists who might choose to pursue specific areas of CN close to their areas of expertise. For instance, a neurologist with an interest in neuromuscular disorders may pursue CN training in NCS and EMG but not in other CN procedures such as EEG. This makes the specialty less defined and, in some instances, can result in CN training being under the supervision of colleagues with more resources but may not value the specialty as a whole.

### 4.2. Competency and accreditation

The survey also demonstrated marked variations in competency evaluations amongst the three chapters. There were exit exams in approximately half of EMEAC member countries, two-thirds of AOC and a third of LAC. These took the form of MCQs, practical evaluations, logbooks or a combination. The organisation responsible for convening the exams also varied. In the EMEAC and LAC, this was more often the universities whereas in the AOC this was done by the professional societies. Though the survey focussed on trainees in CN, it was also apparent that the requirement for CME and revalidation of tenured consultants in CN also varied widely and, in the LAC, this was not a requirement.

There are inherent problems with an exit exam which could not both assess minimum levels of competence and be widely accepted as a proxy for fitness to practice at a consultant level. In addition, there is now a move away from simple knowledge based exit exams to continuous multiformat assessments. Therefore, any new, supranational form of evaluation in CN would require more than a conventional exam and be supported by evidence of experience and practical skills. Should exams be made available at an international level, this would have to be administered through a board convened from relevant stakeholders including representatives from IFCN member societies and other relevant specialities such as neurology, physical medicine and surgery. There were also concerns that the numbers of tests required to meet competency evaluations cannot be generated in countries with limited access either to patients or procedures. In such scenarios, this might be mitigated by facilitating training abroad for short periods of time.

### 4.3. Practice

In the EMEAC and AOC, the more common CN procedures such as routine NCS, EEG and evoked potentials were available and performed routinely at the majority of the peripheral centres. More specialised procedures such as single-fibre EMG, video and ambulatory EEG, IOM and transcranial stimulation were mainly available at tertiary centres. In the EMEAC, some of the more advanced procedures,which would be considered within the remit of research, were also offered at some tertiary centres. These include threshold-tracking techniques, transcranial direct current stimulation and laser evoked potentials. This reflects the research culture that exists within the CN field and by incorporating training of these novel techniques in some countries, this important and stimulating aspect of the specialty will remain protected. The advanced research procedures, however, were less readily available in the AOC member societies.

Certain procedures such as electrocorticography and intracranial EEG form part of pre-surgical evaluation of epilepsy surgery and as such were only available in centres that also offer this surgery (Vakharia et al. 2018). Electroretinograms were rarely available in CN departments at tertiary centres but likely to be offered by departments of ophthalmology. As previously mentioned, IOM was available at most tertiary centres but how this might impact surgery performed outside of these centres remains unknown from the current survey. There is evidence to suggest that IOM did not result in fewer neurological events in spine surgery but prospective randomized studies are necessary to further clarify (Daniel et al., 1976).

A growing field within CN is neuromuscular ultrasound and there are calls to incorporate this technique into the routine evaluation of peripheral nerves (Walker et al. 2018). It has also become apparent that the number of evoked potentials has declined with the advent of MRI, particularly in the evaluation of central demyelinating disorders (Giovannoni et al. 2016). This raises concerns that the numbers of evoked potentials required for competence may also be reduced and be offset by more modern tests like ultrasound. However, these changes are inevitable and should be viewed as a positive evolution in the practice and training in CN as the specialty must remain dynamic and alter as techniques advance.

CN procedures are performed not just by clinical specialists but also technicians. In the current survey, certain procedures including EEG, NCS and IOM were performed by technicians, presumably to agreed protocols, although they rarely also report them. This raises the possibility that there are CN procedures reported by clinical neurophysiologists, who may or may not have seen patients who have had said procedures. Whilst this may be an effective way to address demands on service and to share workload, such practices may raise issues on practice governance. The current survey also found that the waiting times for routine tests were largely between four to eight weeks for both NCS/EMG and EEG in the EMEAC and were slightly lower in the AOC. These data do not reflect the triaging of more urgent cases where the waiting time might be significantly reduced.

The survey found that recruitment to the specialty was a major concern within the EMEAC where CN positions were not always filled which may, in some part, relate to concerns on workload and threats to training provision. This was not as much of a concern in the AOC where CN is practised within the field of neurology. Positions in CN were not common but always filled.

In the EMEAC survey, some trainees shared the following concerns:

'residents are [so] overworked that their main interest is to complete the required residency tasks as soon as possible. As a result, very few of the residents will choose clinical neurophysiology'.

'difficulties in filling posts due to the reduction in the number of residents. Increases in workload due to the high demand of intra-operative monitoring and a pending reform of all specialities in medicine'.

'pressure to reduce the procedures in the curriculum (e.g. electrocorticography, event related potentials) and the numbers of cases seen in the logbook. Cynically, it was felt that this is so that the ever-increasing number of neurologists seeking consultant posts will be able to credential in clinical neurophysiology quickly. They have trained too many neurologists whilst limiting clinical neurophysiology training posts'.

In the LAC, although there was no formal data on individual country practice from the current survey, there were reports of a low representation of basic EEG or EMG in certain countries (Sámano et al. 2018). This was likely due to the lack of formal training programs and qualified experts in these countries, the high cost of studying abroad and attending international meetings. However, an interesting phenomenon was observed in the LAC. In recent years, there has been an expansion in the practice of IOM even in countries without strong support for EEG and EMG. This may reflect the monetary gains from performing these procedures, making it an attractive field to pursue. Another important observation was the establishment of special interest groups (SIGs). This was initiated by those with interest in IOM but has since led to the creation of two other SIGs, in Continuous EEG Monitoring SIG and EMG and Neuromuscular Ultrasound SIG. The developments of these SIGs suggest that there is local desire for education and training especially when there are clear pathways within specific areas of CN.

## 5. Future directions

The main rationale for the present work was to compare education and training amongst the different IFCN member societies. In some countries there are external pressures to reduce training costs and streamline training, which will threaten this area of expertise and the overall health of the specialty. It is hoped that by using international standards of comparison, national societies are better able to mitigate such pressures whilst also finding ways of improving their own training and practice in CN.

Once differences are revealed between societies and countries, then ways to improve and harmonise training require consideration. In the EMEAC, the executive committee has considered the establishment of supranational training centres and offer short-term training scholarships to facilitate training abroad. Similar longer-term fellowships are also offered by the IFCN, providing trainees with the opportunity to train at other centres. There may be merit in supporting the establishment of international training centres amongst existing IFCN member societies and diverting funds to support training at these centres.

The LAC reported success in developing IOM, partly due to a local SIG, which has led to other specialist areas of CN also becoming more popular. This shows the importance of clinical neurophysiologists coming together with an enthusiasm to develop the specialty to improve patient care. A similar effort could also be developed on a larger scale within the IFCN member societies. One way this could be achieved is through the development of an international CN training curriculum, which is one of the specific aims of the IFCN strategic plan. With this curriculum, the specialty's techniques can be divided into modules, either major, e.g. EEG, or EMG, or specialised, e.g. uroneurophysiology or intracranial recording. Each module could have an agreed level of competence which has to be obtained regardless of one's background. In this way it is hoped that those of us within the specialty can define the recommended levels of expertise and competence ourselves. In some CN techniques, such as transcranial magnetic stimulation and neuromuscular ultrasound, international consensus on training guidelines already exist and these could be adopted (Fried et al. 2021; Tawfik et al., 2019). This also allows for excellence within CN to be maintained and member societies to use the curriculum to safeguard themselves from any threat to training and education, or from those trying to practice within it without adequate experience.

At most international meetings, including those endorsed by the IFCN, the official language is English. Whilst this is the accepted international language for science and medicine, many clinical neurophysiologists find its exclusive use a barrier. In developing any international training modules, one should be mindful that these might require adapting, particularly in facilitating its delivery in the local language. Engaging the relevant stakeholders within the IFCN member societies when developing educational activities could achieve this.

## 6. Study limitations

The current study had several limitations. The survey was sent to representatives of the national member societies of the EMEAC, AOC and LAC and performed by a relatively few people, and at times engagement by societies was sub-optimal. It is hoped that publication and dissemination of the present data might kindle a discussion as to how valuable such surveys might be and whether, in future, more complete ones might be performed. The responses may not represent practice in regions within these countries that may be not as well served in CN training and practice. The current survey also did not include the CN training and practice within the North American chapter, which comprises of the USA and Canada. However, there does exist literature to suggest that the practice and training of CN there is more comprehensive in comparison to many of the countries surveyed here (Juul et al. 2020; Karakis et al. 2021; Haneef et al. 2017).

Despite these limitations, we were still able to obtain preliminary data on some of the IFCN member countries, which demonstrated wide variations. It is hoped that this will stimulate more formal work comparing practice and training between and within chapters, including further refining the survey. These tasks could be performed under the remit of the newly established IFCN Education Committee.

## 7. Conclusions

To our knowledge, this survey represents the first international collation of education and training in CN across national societies and between chapters. It revealed wide variations in training durations and training numbers for competence, and draws attention to the concerns of our members going forward, which have focussed on adequate training resources, on workload, training and recognition. The survey makes no judgement on best practice but may be useful for member societies in developing education in CN when faced with external pressures to reduce training duration or depth.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgement

We are grateful to all national society representatives who responded to our survey.

## Appendix A

Members of IFCN Chapter committees.

*Europe, Middle East and Africa Chapter:* Jonathan Cole, Hatice Tankisi, Antonio Martins da Silva, Anita Kamondi and Antonin Gechev, (present), Luis Garcia-Larrea, Walter Paulus, Anders Fuglsang-Frederiksen and Mamede de Carvalho, (during iterations of survey).

*Latin America Chapter:* Armando Tello Valdez, Gustavo Eduardo Ramos Burbano, Jorge Eduardo Gutierrez Godoi, Maria Magdalena Penela, Monica Beatriz Perassolo, Valia Rodriguez.

*Asian-Oceanian Chapter:* Liying Cui, Charungthai Dejthevaporn, Sung-Tsang Hsieh, Ryusuke Kakigi, Byung-Jo Kim, Yew-Long Lo, Atcharayam Nalini, Karl Ng, Raymond Rosales, Ahmad Yanuar Safri, Nortina Shahrizaila, Shozo Tobimatsu, Winnie Wong.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cnp.2022.02.004.

## References

Daniel, J.W., Botelho, R.V., Milano, J.B., Dantas, F.R., Onishi, F.J., Neto, E.R., Bertolini, E.F., Borgheresi, M.A.D., Joaquim, A.F., 1976. Intraoperative neurophysiological monitoring in spine surgery: A systematic review and meta-analysis. Spine (Phila Pa 2018 (43), 1154–1160.

Fried, P.J., Santarnecchi, E., Antal, A., Bartres-Faz, D., Bestmann, S., Carpenter, L.L., Celnik, P., Edwards, D., Farzan, F., Fecteau, S., George, M.S., He, B., Kim, Y.-H., Leocani, L., Lisanby, S.H., Loo, C., Luber, B., Nitsche, M.A., Paulus, W., Rossi, S., Rossini, P.M., Rothwell, J., Sack, A.T., Thut, G., Ugawa, Y., Ziemann, U., Hallett, M., Pascual-Leone, A., 2021. Training in the practice of noninvasive brain stimulation: Recommendations from an IFCN committee. Clin Neurophysiol. 132 (3), 819–837.

Giovannoni, G., Butzkueven, H., Dhib-Jalbut, S., Hobart, J., Kobelt, G., Pepper, G., Sormani, M.P., Thalheim, C., Traboulsee, A., Vollmer, T., 2016. Brain health: time matters in multiple sclerosis. Mult Scler Relat Disord. 9 (Suppl 1), S5–S48.

Haneef, Z., Chiang, S., Rutherford, H.C., Antony, A.R., 2017. A survey of neurophysiology fellows in the United States. J Clin Neurophysiol. 34 (2), 179–186.

Juul, D., Levin, K.H., Gutmann, L., Faulkner, L.R., 2020. Subspecialization in clinical neurophysiology: Development and current status. Neurology. 95 (15), 686–692.

Karakis, I., Liu, L., Bensalem-Owen, M., LaRoche, S.M., Lopez, J.R., Schmitt, S.E., Britton, J.W., Nuwer, M.R., Lee, L.H., Rubin, D.I., Laughlin, R.S., Sinha, S.R., 2021. Clinical Neurophysiology Fellowship Program Directors Survey on a Standardized Fellowship Match Process: A Call for Action. J Clin Neurophysiol.. https://doi.org/10.1097/WNP.0000000000000852.

Sámano, A.G., Ochoa Mena, J.D., Padilla, S.P., Acevedo, G.R., Orenday Barraza, J.M., San-Juan, D., 2018. Clinical neurophysiology training in a developing country: Institutional resources and profiles. J Clin Neurophysiol. 35 (3), 242–245.

Steck, A., Struhal, W., Sergay, S.M., Grisold, W., 2013. Education Committee World Federation of Neurology. The global perspective on neurology training: the World Federation of Neurology survey. J Neurol Sci. 334 (1-2), 30–47.

Tawfik, E.A., Cartwright, M.S., Grimm, A., Boon, A.J., Kerasnoudis, A., Preston, D.C., Wilder-Smith, E., Axer, H., Hobson-Webb, L.D., Alfen, N., Crump, N., Shahrizaila, N., Inkpen, P., Mandeville, R., Sakamuri, S., Shook, S.J., Shin, S., Walker, F.O., 2019. Guidelines for neuromuscular ultrasound training. Muscle Nerve. 60 (4), 361–366.

Vakharia, V.N., Duncan, J.S., Witt, J.-A., Elger, C.E., Staba, R., Engel, J., 2018. Getting the best outcomes from epilepsy surgery. Ann Neurol. 83 (4), 676–690.

Walker, F.O., Cartwright, M.S., Alter, K.E., Visser, L.H., Hobson-Webb, L.D., Padua, L., Strakowski, J.A., Preston, D.C., Boon, A.J., Axer, H., van Alfen, N., Tawfik, E.A., Wilder-Smith, E., Yoon, J.S., Kim, B.-J., Breiner, A., Bland, J.D.P., Grimm, A., Zaidman, C.M., 2018. Indications for neuromuscular ultrasound: Expert opinion and review of the literature. Clin Neurophysiol. 129 (12), 2658–2679.