Education Research: Neurology Resident EEG Education

A Survey of US Neurology Residency Program Directors

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Abstract

Objective

To better understand the EEG education provided to adult neurology residents by surveying program directors of adult neurology residency programs in the United States.

Methods

An online survey focused on characteristics of neurology residency programs and their EEG teaching systems was distributed to the 161 adult neurology residency program directors listed in the Accreditation Council for Graduate Medical Education website at the time of the study.

Results

Forty-seven (29%) out of the 161 program directors completed the survey. Most of the participating programs (89%) were academic. The mean number of 1-month EEG rotations required to graduate was 1.7 (range 0–4, median 1.75). EEG rotations involved the inpatient and outpatient setting in 91% and 70% of programs, respectively. The average number of EEGs read during a typical EEG rotation varied from more than 40, in about one-third of programs, to 0–10, in about 14% of programs. There was significant variability in the requirements for successful completion of EEG rotations, and most program directors (64%) reported not utilizing objective measures to assess EEG milestones. The most commonly used educational methods were didactics throughout the year (95%) and EEG teaching during EEG rotations (93%). The most commonly reported barriers to EEG education were insufficient EEG exposure (32%) and ineffective didactics (11%); possible solutions are summarized.

Conclusion

Our study identified a lack of consistency in teaching and evaluating residents during residency and presented EEG education barriers alongside possible solutions. We encourage program directors across the country to re-evaluate their EEG teaching systems in order to optimize EEG education.

Glossary

AAN = American Academy of Neurology; ACGME = Accreditation Council for Graduate Medical Education; AES = American Epilepsy Society; ICU = intensive care unit; PGY = postgraduate year; RITE = Residency In-service Training Examination.

In accordance with the Accreditation Council for Graduate Medical Education (ACGME) neurology milestones project, adult neurology residents, by graduation, should be able to “interpret common EEG abnormalities, recognize normal EEG variants, and create a report.”¹ This milestone is of utmost importance as EEGs are often read by general neurologists.^{2–4} Nonetheless, published literature has shown that a significant portion of graduating neurology residents do not feel confident interpreting EEGs independently.^{5,6} In this context, we sought to better understand the EEG education provided to residents as well as possible educational barriers by surveying program directors of adult neurology residency programs in the United States.

Methods

We evaluated multiple aspects of EEG education during adult neurology residency training utilizing an online survey directed at program directors. The survey consisted of 18 questions that focused on characteristics of neurology residency programs and their respective EEG teaching systems (e-survey available from Dryad: doi.org/10.5061/dryad.wdbrv15mm). The survey was conducted electronically via SurveyMonkey, and links to the survey were emailed to program directors or program coordinators of all 161 adult neurology residency programs listed on the ACGME website at the time of the study. Their contact information was obtained from both the ACGME website and the online American Academy of Neurology (AAN) member directory. In addition to the first email inviting program directors to participate in this research project, 4 weekly reminders were sent to nonrespondent centers. This study was approved by the Baylor College of Medicine institutional review board and was performed in April to May 2020. No financial compensation was offered to respondents. All data are available upon request.

Results

Survey Results

Forty-seven (29%) out of the 161 program directors of adult neurology residency programs completed the survey. Forty-two programs were purely academic, 3 community, and the remaining 2 mixed. The mean number of residents in each center varied significantly (range 10–49).

EEG Rotation Characteristics

The mean number of 1-month EEG rotations required to graduate was 1.7 (range 0–4, median 1.75). EEG rotations

were typically completed by residents in their second year of residency (postgraduate year [PGY] 2), in 50% of programs, and PGY3s, in 41% of programs. PGY1s and PGY4s typically rotated through EEG in 2% and 7% of programs, respectively. EEG rotations involved the inpatient setting (including epilepsy monitoring unit) in 91% of programs and outpatient setting in 70% of programs. The average number of EEGs read during a typical EEG rotation was more than 40 in about one-third of programs. In the other two-thirds, responses included 0–10 (14%), 11–20 (20%), 21–30 (20%), and 31–40 (11%).

EEG Education: Resident Evaluation

In terms of requirements for successful completion of EEG rotations, program directors' answers varied significantly and ranged from completion of rotation to oral examination and evaluation and interpretation of 30 EEGs. More than half of program directors (55%) reported that 81%–100% of their residents met EEG level 4 milestones¹ by graduation. Roughly a quarter (27%) of program directors reported that 61%–80% met level 4 milestones and 18% of program directors reported fewer than 61% of residents meeting level 4 milestones. Most programs (64%) reported not utilizing objective measures to assess EEG milestones. In those programs where objective measures were used, these varied significantly and included EEG tests/quizzes, oral examinations, Residency In-service Training Examination (RITE), Self-Assessment Examination, American Epilepsy Society (AES) examination, direct assessment from faculty, evaluation of EEGs logged by residents, and number of EEGs read during the rotation.

EEG Education: Teaching Methods, Barriers, and Solutions

The 2 educational methods utilized most frequently by residency programs were (1) didactics given by attending, fellows, or residents throughout the year and (2) teaching EEG during EEG rotations by fellows or attendings. These methods were utilized by 95% and 93% of programs, respectively. Additional educational methods comprised teaching during epilepsy clinic (66%), bedside teaching during inpatient rounds (52%), and didactics given by attendings, fellows, or residents that are concentrated in a 1-to-2 months protected course directed at residents (30%). Other methods were reported by 16% of program directors and included overnight EEG reading on senior night float and utilizing online EEG teaching platforms.

Almost half of program directors (41%) reported an absence of any barriers to teaching EEG to residents. Insufficient EEG exposure and ineffective didactics were reported by 32% and 11% of program directors, respectively. Other barriers listed

Table Possible Solutions to Most Commonly Reported Barriers to EEG Education During Adult Neurology Residency (Number of Respondents = 25)

Increase exposure	1. Increase length/number of rotations
	2. Create rotation devoted exclusively to EEG, without clinical duties
	3. Implement EMU rotation
Optimize teaching and learning	1. Increase supervision/oversight
	2. Increase reading time with faculty
	3. Increase responsibility/accountability to read EEGs during rotation
	4. Utilize online modules to supplement education
	5. Utilize case-based teaching—online and/or in-person
	6. Encourage independent reading throughout residency
	7. Ensure that faculty has time to read EEGs and teach
	8. Implement regular EEG conferences
	9. Increase EEG emphasis on inpatient services
Optimize measures of learning and evaluation	1. Require minimum numbers of EEGs read during rotation
	2. Implement tests/quizzes, written and/or oral, online, and/or in-person

Abbreviation: EMU = epilepsy monitoring unit.

include excessive inpatient workload and necessity for more residents, low/absent resident interest, and insufficient time to teach from faculty standpoint. Possible solutions to these barriers, submitted by roughly half of program directors, are summarized in the table. Survey results are summarized in e-table 2 available from Dryad (doi.org/10.5061/dryad.wdbrv15mm).

Discussion

Our study evaluated EEG education practices in roughly 30% of American adult neurology residency programs, most of which were purely academic. On average, the mean number of 1-month EEG rotations required to graduate was 1.7 (median 1.75, range 0–4) and most programs had EEG rotations completed by PGY2s and PGY3s. EEG rotations were noted to take place both in inpatient and outpatient settings: in 91% and 70% of programs, respectively.

The time devoted to EEG during residency training seems to have remained grossly unchanged over time. Survey data from 1999 to 2000 involving more than 100 adult neurology program directors showed that the mean number of EEG months

required to graduate was 2 (range 0 to 4).⁷ A similar survey study, conducted in 2007 and also involving more than 100 adult neurology program directors, showed that the typical length of EEG and epilepsy unit rotations was 1.5 (range 0–4) and 0.5 (range 0–3), respectively.⁸

Our survey data also highlighted the lack of consistency in evaluation of residents during their EEG rotations. Almost two-thirds of program directors reported not using objective measures to assess for ACGME-recommended EEG milestones.¹ Even in programs that utilized objective measures, there was significant variability in criteria measured.

We suspect the above leads to variations in the resident education experience—for example, the number of EEGs read by residents during EEG rotations among different residency programs. Limited published data demonstrate the educational value of increased EEG review in trainees who interpreted 20 vs 10 EEGs.⁹ Due to institutional variability, it is difficult to compare resident performance across institutions—for example, the percentage of residents meeting level 4 EEG milestones by graduation across various programs. In our study, more than half of program directors (55%) reported that more than 80% of their residents meet level 4 EEG milestones upon graduation. In the literature, the median of residents who meet level 4 EEG milestones was identified as 85%.⁶

Published resident perception data, however, does not align with program director perceptions. In fact, it appears that adult neurology residents are graduating without becoming comfortable reading EEGs independently. According to the last triannual AAN survey, only 37.3% of graduating adult neurology residents felt confident performing or interpreting EEG in an independent fashion.⁵ An additional survey-based study that involved 55 adult neurology residents from different programs asked these residents how confident they were, on a scale of 0%–100%, in terms of their EEG skills. For graduating PGY4s, the median was 67% for interpreting common EEG abnormalities and creating a report and 60% for recognizing normal EEG variants.⁶

As far as weaknesses, our study was limited by inherent aspects of its methodology. The response rate to our survey (29%) lies within the typical response rate linked with academic surveys.¹⁰ The respondents in our study were mainly program directors from academic institutions. We suspect that EEG education experiences in community-based programs may differ due to differences in EEG types (less continuous EEG in intensive care unit [ICU] and epilepsy monitoring unit environments) and program structure (fewer epilepsy and clinical neurophysiology fellows, which in turn may increase resident EEG exposure). Further, we examined PD perspectives only and did not study objective measures of the quality of EEG education such as residency in-service training examination (RITE) and neurology certification scores. Lastly, our survey did not investigate resident exposure

to ICU EEG. Given its significant clinical and educational importance, this specific category within EEG education should be explored in future studies. All these factors need to be accounted for when analyzing our results and caution is needed upon extrapolation of our data to a national level.

Our study revealed intrinsic issues related to EEG education in residency. We identified a lack of consistent and objective measures associated both with teaching and evaluating residents. Moreover, we learned that over half of programs reported barriers to effective EEG education including insufficient EEG exposure and ineffective didactics. While program directors seem to believe most residents are able to read EEGs independently by graduation, graduating residents repeatedly report low levels of confidence in doing so.

Minimal quality standards are necessary to ensure competency in EEG interpretation by residents. However, current practice is largely guided by nonobjective measures. As a result, on a national level, resident EEG education and EEG exposure are varied. Guidelines outlining minimum training requirements for EEG education in residency are clearly needed to standardize the resident experience nationwide. This need was also identified in the realm of electrocardiogram education, leading to many experts advocating for the use of guidelines based on objective measures associated with teaching and assessment.¹¹ The production and implementation of EEG education guidelines may require support from national organizations such as the AAN, AES, and the American Clinical Neurophysiology Society.

In current EEG practice in the United States, general neurologists without any neurophysiology fellowship training often read EEGs.²⁻⁴ This model of practice mandates that all neurologists should be competent in reading EEGs since EEG misinterpretation has significant negative implications to patients and health care systems.^{2,3} Unless this model is switched in a way that neurologists who read EEGs are required to undergo a clinical neurophysiology or epilepsy fellowship after residency, EEG education in residency must be improved. Current milestones assessing resident “EEG competency” may be a poor metric for defining residents who are capable of reading EEGs independently. The milestones lack any guidance on assessing the accuracy and quality of EEG report, for example, which is an essential component of the EEG interpretation process. A level 4 EEG milestone requires ability to identify “common EEG abnormalities” without specifying which abnormalities are included. The first step in ensuring that graduating residents are able to successfully review and interpret an EEG study is to establish specific

learning expectations and rewrite clear and objective evaluation measures.

We encourage program directors across the country to re-evaluate their EEG teaching systems in light of the EEG education barriers presented in this study as well as possible solutions. Increasing EEG exposure, optimizing EEG teaching, and establishing objective measures to teach and evaluate residents are avenues through which EEG education can be improved.

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Disclosure

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Appendix Authors

Name	Location	Contribution
Fábio A. Nascimento, MD	Baylor College of Medicine, Houston, TX	Conceptualized and designed study, analyzed and interpreted data, drafted manuscript
Jay R. Gavvala, MD, MSCI	Baylor College of Medicine, Houston, TX	Conceptualized and designed study, analyzed and interpreted data, reviewed manuscript, supervised study

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