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A Survey of Neurophysiology Fellows in the United States

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Abstract

Purpose: Fellowship training in Clinical Neurophysiology (CNP) is often sought following Neurology residency. However, data documenting the reasons for choosing CNP fellowship, and experiences therein, are sparse.

Methods: Current Neurophysiology fellows across the United States participated in a 17-item, Internet-based survey. Data regarding demographics, reasons for choosing fellowship, adequacy of training, and future plans were collected.

Results: Among respondents ($n = 49$), 84% graduated from a US medical school. Personal interest in CNP was the most common reason for choosing the fellowship. Program choice was guided by location and clinical strength of the program. Choosing a program based on clinical strength was likely to result in higher satisfaction scores. Overall, most (87%) were satisfied with their current program giving a satisfaction score of 4 or 5 on a 1–5 Likert scale. Lesser time spent in the epilepsy monitoring unit and EEG was also associated with higher satisfaction scores—these were also the areas that seemed to be most stressed during training. No differences emerged between male and female respondents in their answers to the various survey questions.

Conclusions: The authors encountered a group of academically minded CNP trainees who are satisfied with their choice of fellowship, the current application process, and training received. Most intend to have a future in academic medicine. The CNP areas that seem to need further development in providing a well-rounded fellowship include training in sleep, evoked potentials, and intraoperative monitoring. The findings would be informative to future fellowship trainees and to program officers.

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Z. Haneef and S. Chiang contributed equally. Z. Haneef provided study concept and design, and manuscript preparation. S. Chiang participated in data tabulation, validation, statistical analysis, and manuscript preparation. H. Rutherford participated in acquisition of data and critical revision of manuscript. A. Antony provided study concept and design, manuscript preparation, and critical revision of manuscript.

Keywords

Clinical neurophysiology; Survey; Fellowship; Training; Education

Clinical Neurophysiology (CNP) was established as a Neurology subspecialty by the American Board of Psychiatry and Neurology in 1990, with a subspecialty board established in 1997.¹ The Accreditation Council of Graduate Medical Education (ACGME) lists 99 Neurophysiology programs (95 accredited) in the United States.² Clinical Neurophysiology is one of the major fellowship tracks available to Neurology trainees in the United States. Although data are not available on what proportion of Neurology residents choose a career including CNP, data from the Association of American Medical Colleges (AAMC) for 2015 indicate that there were 2,562 active Neurology/Child Neurology residents and 215 active CNP residents, (8.4%).³ Given that the average Neurology residency is approximately 4 years and the CNP fellowship approximately 1 year; this would indicate that roughly one third of residents may choose additional training in CNP. The CNP encompasses the specialties of EEG and electromyography (EMG), along with intraoperative monitoring, sleep, and evoked potentials. Although fellowship and residency training in other medical and surgical specialties have been analyzed in the past, a systematic survey of CNP fellowships has not been performed to date. Here, we performed a survey of fellows currently in training in various CNP programs in the country to assess factors such as demographics, reason for choosing the fellowship, experience and satisfaction with the current program, and suggestions for change.

METHODS

A single-page, Internet-based survey was designed consisting of 17 multiple choice, Likert scale, ordinal, categorical, and interval scale questions (Fig. 1). Program coordinators whose contact information was available from the ACGME were contacted via e-mail with an invitation to forward a request for the current fellows to complete the online form available. If the e-mail address of a program coordinator was not available, the program director was contacted. To enhance the response rate, a second round of follow-up e-mails was sent to those who had not responded. The survey was sent to the program coordinators and directors of 99 CNP programs in the United States. Of the 95 programs listed with the ACGME and 4 non-ACGME programs, we had responses from 93 programs (93.9%), who forwarded the survey invitation to current fellows. No fellows were contacted directly. Forty-nine fellows responded to the survey between December 2015 and March 2016. Of the 99 programs contacted, we had responses from fellows in 35 programs (35.4%). Although we do not know how many fellows ultimately got the invitation to participate in the survey, going by the AAMC data noted earlier of 215 active CNP fellows, our survey would have sampled 22.8% ($n = 49$) of the current fellows. The study was approved by the institutional review board of the Baylor College of Medicine, Houston, Texas.

Statistical Analysis

Data obtained from the survey were segregated by responses. For numerical responses reported as a range (e.g., weekend work days, salary), the mean was taken. The average item

nonresponse rate was 7.8%. Higher item nonresponse rates (> 10%) were present for fellowship duration; agreement with the match process; percentage of time allocated to epilepsy monitoring unit (EMU) training, research, electives, and vacation; weekend work schedule; and annual salary. Missing values were noted, but imputation was not used. Group differences between men and women and between satisfaction ratings were evaluated using Mann–Whitney *U* test, Kruskal–Wallis test, and Fisher exact test. Statistical significance was evaluated at the $\alpha = 0.05$ level. All statistical analyses were performed using R version 3.1.3.

RESULTS

Demographics

Among respondents ($n = 49$), 51.0% were female and 49.0% were male. The mean age was 32.8 (95% confidence interval [CI], 31.9–33.7) years. The majority of respondents (83.7%) graduated from a US medical school, whereas the remainder (16.3%) graduated from a non-US medical school.

Choosing a Fellowship Program

Choice of Fellowship—Participants were asked to rank the 4 most important reasons for choosing to train in CNP (Fig. 2A). The most common primary motivation for entering CNP by far was personal interest (91.7% of respondents). Reimbursement and prestige were cited as the second and third most important motivations for choosing to train in CNP.

Choosing a Program—Location and clinical strength were the most important reasons for choosing the current training program (Fig. 2B), with 52.0% ranking location as the most important reason and 42.0% ranking clinical strength as the most important reason. Research was the most important reason for choosing the current training program for only a minority (4.0%); however, it was the most common secondary reason (38.0%) for choosing the current training program. Work schedule was the least important reason for choosing the current training program, with 54.2% ranking it as the least important reason and only 2.0% ranking it as the most important reason.

Match—Although 75.7% of respondents did not believe that the match was the best means of arranging fellowship positions, 24.3% believed that it was the best means of arranging fellowship positions. Notably, 24.5% of fellows surveyed did not answer this question.

Training Experience

Satisfaction—Most respondents reported being satisfied with their fellowship program when asked to rank satisfaction on a Likert scale of 1 (least satisfaction) to 5 (most satisfaction), with 87.0% ($n = 40$) ranking their satisfaction as 4 (45.7%) or 5 (41.3%). A score of 3 was given by 10.9% ($n = 5$), one respondent gave a satisfaction score of 2, and none reported a score of 1.

Two factors were significantly associated with greater satisfaction (rankings of 5 vs. satisfaction rankings of 4 or lower) and included: (1) choosing the training program based on clinical strength as the primary reason: 61.9% of those who chose the current training

program based primarily on clinical strength reported a satisfaction of 5, whereas only 24.0% with a different primary reason gave a score of 5 ($P = 0.016$) and (2) lesser time allocated to EMU training: respondents scoring 5 reported a median of 18.5% (range, 0%–35%) of time allocated to EMU training, whereas a score of 4 was associated with a median of 30.0% (range, 0%–60%) of time allocated ($P = 0.04$).

In addition, 3 trends were associated with a higher satisfaction, including (1) personal interest as the primary motivation for choosing CNP: 46.3% of fellows citing personal interest as the primary motivator had a score 5, whereas none of the 5 respondents citing another primary motivator had a score 5 ($P = 0.067$); (2) location not being the primary reason for choosing the current clinical program: only 26.1% of fellows choosing the current program based primarily on location had a satisfaction of 5, whereas 56.5% with a different primary reason had a satisfaction of 5 ($P = 0.07$), and (3) more time allocated to EEG training: fellows giving a score of 5 reported a median of 33.0% (range, 5%–50%) of time allocated to EEG training, whereas a score of 4 was associated with a median of 25.0% (range, 5%–75%) time allocated ($P = 0.08$).

Training Duration—Most respondents were training in 1-year fellowship (76.9%). Of the 23.1% with a longer fellowship, 12.8% were in 2-year fellowships with different tracks, 7.7% were in 2-year fellowships with the same track, and 2.6% were in fellowships lasting longer than 2 years.

CNP Areas Stressed During Training—Fellowship programs allocated the largest mean percentage of training time to EEG (29.0%; 95% CI, 24.8%–33.2%), followed by EMU (22.1%; 95% CI, 17.7%–26.5%) and EMG/nerve conduction studies (NCS) (20.7%; 95% CI, 14.9%–26.6%) (Fig. 3). Smaller percentages of time were allocated to clinics (13.6%; 95% CI, 10.9%–16.3%), vacation (9.3%; 95% CI, 5.2%–13.4%), electives (7.9%; 95% CI, 5.8%–9.9%), and research (7.0%; 95% CI, 4.0%–10.0%). Among respondents, 11 reported no elective rotation time and 8 reported no research time, whereas none reported no clinic time.

Adequacy of Training in CNP Areas—The areas that the majority of respondents expected to be adequately trained by the end of their fellowship were EEG (87.8%) and continuous EEG (83.7%) (Fig. 4). Figure 5 shows the correlation of training time with perception of adequate training in EEG, EMG/NCS, and EMU interpretation.

Academics—Among respondents, 85.1% attended/would attend 1 to 2 conferences in the current academic year, and 78.8% reported that their fellowship research would result in a publication (36.2%), abstract (36.2%), or grant (6.4%). Another 12.8% of respondents reported no research conducted during the fellowship.

Weekend Work—The respondents worked an average of 1.6 weekend days per month. There was wide variation with average weekend days worked per month reported as 0 (34.1%), 1 to 2 (36.6%), 3 to 4 (26.8%), or more than 4 (2.4%).

Compensation—The mean gross annual fellowship salary was \$62,683 with a median salary of \$60,500, and 95% of fellows earning between \$53,850 and \$77,225 annually.

Future Plans

The most common future plan among the respondents was to go into academics (50.0%), with lesser interest in group practice (15.2%), private practice (15.2%), or a second fellowship (13.1%). Only a minority planned to enter research (2.2%) or had other plans (4.3%) that included community hospital, military service, and sleep-related work.

Gender-Based Differences

As life choices and experiences are potentially different between men and women, we analyzed the above findings for significant differences based on gender. However, none of the findings proved significant including age ($P = 0.59$); US training versus non-US training ($P = 0.99$); reason for choosing CNP fellowship based on personal interest ($P = 0.99$), reimbursement ($P = 0.72$), prestige ($P = 0.86$), or mentorship ($P = 0.99$); or reason for choosing the particular program based on location ($P = 0.72$), clinical strength ($P = 0.93$), research ($P = 0.99$), or work schedule ($P = 0.99$). No significant differences were identified between men or women for satisfaction with the current program ($P = 0.99$), likelihood of being trained in EEG ($P = 0.67$), continuous EEG ($P = 0.25$), EMU ($P = 0.76$), EMG/NCS ($P = 0.99$), sleep ($P = 0.67$), intraoperative monitoring ($P = 0.76$), evoked potentials ($P = 0.55$), or intracranial EEG ($P = 0.99$). No significant differences were identified in research output ($P = 0.22$), number of conferences attended ($P = 0.99$), weekend hours worked ($P = 0.83$), compensation received ($P = 0.15$), or with future plans ($P = 0.41$).

DISCUSSION

This analysis represents the first systematic survey of CNP fellows in the United States, and the findings would be of interest to those considering a fellowship training in the field and educators and program directors of CNP programs. The study describes several interesting findings.

Demographics

Among 304 Neurology residency positions matched in 2015, the ratio of US medical graduates to non-US medical graduates was 1.7:1.⁴ For CNP programs, we found this ratio to be 5.4:1. Although this could mean that a larger proportion of US graduates among Neurology residents go on to train in CNP, this could also represent a selection bias, as an AAMC survey of residencies in 2014 to 2015³ reported a US:non-US ratio of 1.4:1 among 215 CNP fellows. The male:female ratio in the AAMC study was 1.3:1, while our sample had a male:female ratio of 1:1.

Choice of Fellowship—Although it is not surprising that 90% of the respondents cited personal interest as the most important reason for choosing a CNP fellowship, it is somewhat interesting that 10% chose CNP primarily for other reasons. Citing personal interest in CNP as the primary motivator was associated significantly with higher perceived satisfaction scores. Interestingly, the second most common motivator was financial reimbursement/

lifestyle. This suggests that, at least among this group of fellows, a career in CNP was considered to be an attractive option from a financial/lifestyle viewpoint. Mentorship was not the important motivation to pursue CNP among the respondents, unlike previous studies on other fellowships where it was found to be an important reason for fellowship choice.^{5,6}

Choosing a Program—Location (53%) and clinical strength (43%) were the most important reasons for respondents to choose a particular fellowship program. This is consistent with previous studies that showed location (because of interest in the city or suitability for spouse or significant other)^{6,8} and academic reputation^{6,8,9} as the top reasons for choosing a particular training program. Counterintuitively, we also found that choosing a program based on location was associated with a trend for lower satisfaction with the program. However, this was only a trend that did not reach significance. Although research (4%) was not a major motivator for choosing a particular program, it was the most common secondary factor for choosing a particular program, similar to a previous study among internal medicine fellows.⁷ Work schedule did not factor as a consideration while choosing a program for the overwhelming majority (98%) of the respondents, suggesting that being an “easy” training program does not make it more attractive to applicants nor being a “difficult” program make it less attractive.

Match—Although Neurology residency and the Vascular Neurology (stroke) fellowship have a formal “match” process, CNP, like most other Neurology fellowships, still individually screens and invites candidates for interviews. There is a concern that such a process may be less coordinated and less preferred by candidates and programs. In our survey, however, only a minority (18%) believed that a match was the best means for arranging fellowship positions. It appears that the current selection process seems satisfactory for most respondents. Interestingly, this contrasts with a survey of program directors in Neurology, who were mostly (91%) satisfied with a match system.¹⁰ One possible explanation that was not explored with the current survey was whether the respondents elected to stay on for fellowship in the location where they did residency. For such a subgroup, having a match would not be of benefit.

Satisfaction—The majority of fellows (81%) are very satisfied with their current fellowship program, giving a score of 4 or 5 (out of a maximum of 5) on a Likert scale for overall satisfaction. This is similar to previous studies showing a satisfaction of 75% to 99% among fellows in vascular surgery, otorhinolaryngology, and gynecology–oncology.^{9,11–13} In our study, greater satisfaction was associated with a personal interest in CNP, choosing a program based primarily on clinical strength, and with less time spent in the EMU/more time spent in the EEG. Choosing a program based primarily on location was associated with a trend for lower satisfaction.

CNP Areas Stressed During Training/Adequacy of Training—Reflecting the greater emphasis on EEG and EMU, which when combined accounted for 53.5% of the total training time, compared with EMG/NCS (17% time) or other CNP areas in training programs, most respondents predicted confidence in EEG analysis skills (88%) compared with EMG/NCS (43%) by the end of fellowship (Figs. 3–5). Most respondents did not

believe that their training prepared them adequately for evoked potentials, intraoperative monitoring, or brain mapping. The CNP area where training seemed to be least effective was sleep (10%). These findings suggest areas of training that CNP programs could prioritize for programmatic development.

Work Hours—The outpatient clinic time during CNP fellowship (10%) was approximately similar to the time allocated in a typical Neurology residency (11%).¹⁰ However, dedicated time for research (5%) seemed to be more than that reported during residency (3%).¹⁰

Academics—Most respondents (85%) attended or would expect to attend 1 to 2 conferences in the year of survey. Fellowship-associated research was also expected to result in an output in the majority (79%) of the respondents. A small, but significant, percent (13%) had no research associated with the fellowship, similar to a previous study in gynecology–oncology fellows, which showed that approximately 6% of respondents did not perform research.⁹

Compensation—We did not analyze whether salary was an important consideration for choosing a particular fellowship program. Previous research has suggested that it is a major consideration for only a small proportion of trainees (17%).⁷

Future Plans—About half the respondents (50%) plan to enter academic practice, while a good number (30%) planned to enter private/group practice. This corresponds to previous studies showing that between 30% and 77% of fellowship graduates in different specialties, such as surgical oncology, minimally invasive surgery, dermatology, pediatric emergency medicine, ophthalmology, gynecology–oncology, and palliative care, proceed to academic positions after training.^{9,12,14–18}

Gender-Based Differences—One previous study has systematically examined gender-based differences in surgical fellowship trainees. In that study, although no differences were found in the intellectual appeal or clinical opportunities in the field, significantly more women listed lifestyle as an important factor in choosing their future career.¹⁹ Previous studies have also shown that women were less likely than men to believe that their training experiences were comparable with those of their male colleagues.^{20,21} However, we did not find a difference in responses to the various survey questions between male and female respondents. This suggests that career choices and experiences were broadly similar, at least in this group of self-selected respondents. Specifically, our question on “reimbursement/lifestyle” did not show a significant difference between genders as a reason to choose CNP as a career choice.

Limitations

The survey succeeded in its purpose to gather information. However, some limitations are worth considering. The study design was cross-sectional, and a self-selected group of respondents might have skewed the results. As with any questionnaire survey, accurate interpretation requires accurate reporting. For example, it is unclear if some respondents mistook the question on medical school to mean location of residency graduation rather than

medical school graduation. As answering all questions was not made mandatory, there is some amount of missing data. An inability to include all CNP fellowship programs and all fellows in the United States might have resulted in selection and response biases. Higher nonresponse rates for certain questions might have led to higher response bias for these questions. To enhance responsiveness, the survey was kept purposefully short. This limited detailed subanalysis of the reasons for some of the findings. In particular, a question on the primary and secondary focus of the fellowship (EEG, EMG, sleep or EP, combined) was not posed, which could have provided greater depth in understanding the backdrop of the provided responses. Nevertheless, this is an important first step, and the findings would be of interest to Neurology or CNP programs and to trainees.

CONCLUSION

In conclusion, in this first survey among CNP fellows, we find a group of trainees with an academic interest who express considerable satisfaction with their choice of fellowship and express satisfaction with the current application process and training. Most of the trainees intend to have a future in academic medicine. Clinical Neurophysiology areas that seem to need further development in providing a well-rounded fellowship include training in sleep, evoked potentials, and intraoperative monitoring. Training gaps should be addressed in training and post-training education. Program location and perceived clinical strength of the program considerably influence applicants' selection of CNP fellowship programs. However, a choice of program based on location could potentially be associated with lower satisfaction, whereas a choice based on clinical strength was associated with a higher satisfaction. The information revealed in this survey can inform trainees contemplating a CNP fellowship and also help program directors in choosing the right candidates and in the continued development of their program.

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Survey questions:

Full name*:	E-mail*:	Age:	Gender: Male ▾								
Medical School:	☒ US ☐ non-US										
Why did you choose to train in clinical neurophysiology? <i>Please rank (1 being the most important)</i>	1 ▾ Personal interest 2 ▾ Reimbursement/lifestyle 3 ▾ Academic prestige 4 ▾ Mentorship										
How long is your fellowship?	☐ 1 year ☐ 2 years (different tracks) ☐ 2 years (same track) ☐ >2 years										
Do you feel that the match is the best means of arranging fellowship positions?	☐ Yes ☐ No										
Please specify the % of time allocated in the following during your fellowship <i>(should total 100%)</i>	<table border="0"> <tr> <td>EEG <input type="text"/> %</td> <td>Clinics <input type="text"/> %</td> </tr> <tr> <td>EMG <input type="text"/> %</td> <td>Electives <input type="text"/> %</td> </tr> <tr> <td>EMU <input type="text"/> %</td> <td>Vacation <input type="text"/> %</td> </tr> <tr> <td>Research <input type="text"/> %</td> <td>Total= <input type="text"/> %</td> </tr> </table>			EEG <input type="text"/> %	Clinics <input type="text"/> %	EMG <input type="text"/> %	Electives <input type="text"/> %	EMU <input type="text"/> %	Vacation <input type="text"/> %	Research <input type="text"/> %	Total= <input type="text"/> %
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What was the main reason for choosing the current training program? <i>Please rank (1 being most important):</i>	1 ▾ Location 2 ▾ Research 3 ▾ Clinical strength 4 ▾ Work Schedule										
In a scale from 1 to 5, how satisfied are you with your fellowship program?	☐ 1 (least satisfied) ☐ 2 ☐ 3 ☐ 4 ☐ 5 (most satisfied)										
Your research during this fellowship will result in :	☐ Abstract ☐ Publication ☐ Grant ☐ None of the above ☐ I did not do research										
How many conferences did you attend (or will attend) this academic year.:	☐ 0 ☐ 1-2 ☐ 3-4 ☐ >4										
How many weekend days on average do you work in a month?	<input type="text"/> days										
What is your gross annual fellowship salary? <i>(enter actual or approximate amount in dollars)</i>	\$ <input type="text"/>										
What is your immediate plan after you complete this fellowship?	☐ Academic practice ☐ Research ☐ Private hospital ☐ Group practice ☐ Another fellowship ☐ Other (please specify) <input type="text"/>										
Please select the areas you think you are (or expect to be) adequately trained at the end of your current fellowship. <i>(select all that apply)</i>	<table border="0"> <tr> <td>☐ EEG</td> <td>☐ Sleep</td> </tr> <tr> <td>☐ Continuous EEG</td> <td>☐ Evoked potentials</td> </tr> <tr> <td>☐ EMU management</td> <td>☐ Intraoperative monitoring</td> </tr> <tr> <td>☐ EMG/NCS</td> <td>☐ Cortical stimulation/ brain mapping</td> </tr> </table>			☐ EEG	☐ Sleep	☐ Continuous EEG	☐ Evoked potentials	☐ EMU management	☐ Intraoperative monitoring	☐ EMG/NCS	☐ Cortical stimulation/ brain mapping
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☐ EMU management	☐ Intraoperative monitoring										
☐ EMG/NCS	☐ Cortical stimulation/ brain mapping										

FIG. 1.
Survey questionnaire completed by the respondents.

FIG. 2.

Motivating factors to train in Clinical Neurophysiology (**A**) and reasons for choosing current training program (**B**).

FIG. 3. Training time for Clinical Neurophysiology areas allocated by training programs (median percentage).

FIG. 4.
Proportion of respondents reporting adequate training in Clinical Neurophysiology areas.

FIG. 5. Percentage of respondents' perception of adequate training for EEG, epilepsy monitoring unit (EMU), and electromyography (EMG) and corresponding training time allocated by training programs.