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Title: The Neuromuscular Fellowship Portal and Match

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Abbreviations:

AANEM – American Association of Neuromuscular & Electrodiagnostic Medicine

ACGME - Accreditation Council for Graduate Medical Education

AAN - American Academy of Neurology

CNP – Clinical Neurophysiology

EEG - Electroencephalography

EMG – Electromyography

ERAS - Electronic Residency Application Service

IOM – Intraoperative monitoring

NMM - Neuromuscular Medicine

NRMP - National Resident Matching Program

PGY – Post graduate year

SFMatch – San Francisco Match

ABSTRACT:

For many years, Neuromuscular Medicine programs lacked a standardized means of handling fellowship applications and offering positions. Programs interviewed applicants and made offers as early as the first half of Post Graduate Year 3 (PGY3), a suboptimal timeline for applicants who may have had little prior exposure to neuromuscular or electrodiagnostic medicine. In 2021, the American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) developed the Neuromuscular Fellowship Portal to standardize a later timeline and establish a process for fellowship applications and offers. In its first year, the Neuromuscular Fellowship Portal used a unique one-way match, in which the portal released serial offers to applicants based on rank order lists submitted by programs. Fifty-two Neuromuscular Medicine programs and seven electromyography (EMG)-focused Clinical Neurophysiology programs participated. Sixty-eight positions were filled, a similar number to previous years. A survey of fellowship directors and applicants following this process showed overwhelming support for the standardized timeline and application portal, but all program directors and most applicants favored moving to a traditional match. To maintain the existing application timeline and minimize costs for all parties, the AANEM Neuromuscular Fellowship Portal will host a two-way match, based on existing commercial match algorithms, in 2022. A match will afford a fair and efficient process for all involved. Both Neuromuscular Medicine and EMG-focused Clinical Neurophysiology programs will be encouraged to participate. The process undertaken by the AANEM can stand as an example for other neurologic subspecialties who are interested in standardizing their application timeline.

Background

Fellowship application and offer timelines vary among neurologic subspecialties. Some fellowship programs accept fellowship applications as early as the beginning of the second year of neurology-specific training (PGY3 for adult residents; PGY4 for pediatric residents), and others nearly a

year later in the beginning of the third year of neurology residency (PGY4 for adult residents; PGY5 for pediatric residents).¹ Other neurologic subspecialties have a formal match process, utilizing programs like the National Resident Matching Program® (NRMP®) and the San Francisco Match® (SFMatch®). However, Neuromuscular Medicine fellowships have historically operated on a “first come-first serve” basis. Without centralized oversight there has been a lack of guidance about the application process and the timing of interviews and offers, leading to a system of rolling admissions. Anecdotally, over recent years this system has resulted in neuromuscular interviews and offers moving earlier, with some positions being filled by October of the PGY3 year for adult residents (note that in the remainder of this article, the PGY years are based on adult trainees, and should be increased by one for pediatric neurology applicants). This may be, in part, a consequence of a supply and demand mismatch, with fewer qualified applicants than available positions. Based on data from the Accreditation Council for Graduate Medical Education (ACGME), between 2018 and 2020 a mean of 75 Neuromuscular Medicine fellowship positions were filled each year². The total number of positions available in those years is not available but based on the available positions in the 2021 season approximately 20% of positions go unfilled each application cycle.

When combined with an admissions process lacking structure and oversight, the surplus of Neuromuscular Medicine fellowship positions incentivized programs to interview applicants and offer positions as early as possible. Neuromuscular Medicine programs may have also felt the need to move their application process earlier to compete with subspecialties that established matches with early application cycles, such as vascular neurology and neuro-oncology.

The possibility of unfilled positions also pushed programs to give applicants a narrow time window in which to accept or decline the offer. While potentially beneficial to some programs, this process precluded applicants from exploring a wide range of institutions to find the best program to meet their career goals. Some neurology residency programs postpone outpatient experiences until later in

training, so the early and abbreviated fellowship timeline may have prevented residents from having the breadth of exposure to make informed career decisions.

Both neurology residents and program directors find the current application timeline problematic.^{1,3} In 2019, the American Academy of Neurology (AAN) issued a position statement endorsing a standardized fellowship timeline across subspecialties.⁴ This statement recommended no communication between fellowship programs and applicants until March 1 of the PGY3 year and no offers made before August 1 of the PGY4 year. The position statement was distributed to neurologic and subspecialty organizations for comment. While many of these organizations endorsed the position statement, the American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) initially did not, citing lack of a defined process for enforcing the timeline.⁵

Two ACGME-accredited subspecialty fellowships were influenced by the AANEM statement. The Neuromuscular Medicine (NMM) fellowship encompasses comprehensive training in neuromuscular disorders and electrodiagnostic (EMG) testing. Residents in neurology and physiatry (physical medicine and rehabilitation) are eligible to apply, though some NMM fellowships accept only neurology fellows. The actions taken by the AANEM in preparation for the 2020-2021 application cycle were primarily designed to address variability in the NMM fellowship application process. However, the Clinical Neurophysiology (CNP) fellowship has significant overlap with the NMM fellowship. The CNP fellowship allows for electrodiagnostic training in EMG, electroencephalography (EEG), intraoperative monitoring (IOM), and clinical training in the care of associated disorders. The content and structure of CNP fellowship programs varies widely, but some programs are EMG-focused and may draw from the same applicant pool as NMM fellowships.

Benefits of a Standardized Application Timeline

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A later timeline affords several advantages to the fellowship applicants. First, applicants from both neurology and physiatry residencies will have ample time to explore a broader range of subspecialties, including neuromuscular and electrodiagnostic medicine, providing confidence that their chosen fellowship speciality was the best option. Second, a later timeline allows residents the ability to produce a stronger application by participating in neuromuscular-specific scholarly experiences, such as research activities, meeting attendance, and quality improvement projects, allowing them to solicit informed letters of recommendation from neuromuscular faculty. Third, a standardized interval between submitting the application, interviewing, and receiving offers allows applicants to explore every program in which they are interested, rather than feeling pressured to accept the first position offered.

The new timeline may also benefit fellowship programs. Programs will not feel pressured to offer interviews earlier than their peer programs or feel compelled to make offers before interviewing all candidates. As outlined above, the quality of applications may improve as residents have more time to demonstrate their interest in the field. Finally, because both neurology and physiatry residents will have more clinical experiences in neuromuscular medicine and electrodiagnosis before applying for fellowship, the number of applicants may increase. This would then both reduce the number of unfilled positions and help address the projected workforce deficits in neuromuscular care.⁶

The 2021 Fellowship Application Cycle

To address these concerns, in 2020 the AANEM formed a Neuromuscular Fellowship Committee composed of program directors of Neuromuscular Medicine and Clinical Neurophysiology fellowships and neurology residency programs, key AANEM staff members, and a PGY4 neurology resident who had recently completed the fellowship application process. The committee included some of the authors of this article. This group conceived and developed the idea of the Neuromuscular Medicine Fellowship Portal, a centralized application and offer hub hosted on the AANEM website, and determined a uniform

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timeline for its use.⁷ The inaugural process described here was designed for a fellowship start date of July 1, 2022. In exchange for agreeing to abide by this process, fellowship programs were invited to post informational listings in a centralized location on the AANEM site. This public-facing site (no login required) was made available on January 1, 2021. Applicants then electronically submitted their application materials, including personal statements, CVs, and optional program-specific letters of interest to programs of their choice. Letters of recommendation were submitted directly by their writers. On March 1, programs were able to access the applications and begin to schedule interviews. Fellowship offers were issued on June 1. Of note, the Committee agreed with the AAN recommendation for a uniform offer date but felt that August 1 of PGY4 year was later than necessary. Rather, they recommended June 1 of PGY3 year, based on the observation that a three-month window between interview offers and a match was standard in some fellowship fields outside of neurology.

The AANEM Portal utilized a one-sided match in which programs ranked applicants, but applicants did not rank programs. On June 1, 2021, the portal automatically released offers to the top candidates on every program's rank list based on the number of positions for which they were recruiting. For instance, if a program had two available positions, the top two candidates on their list received an automatically generated email offer from that program. Thus, some applicants received multiple simultaneous offers on June 1, while others did not receive any. Applicants were given up to 48 hours to accept or decline each offer. If an applicant accepted another program's offer, declined an offer within 48 hours, or did not respond within 48 hours, the portal would automatically issue an offer to the next applicant on the program's rank list.

In this inaugural cycle, there were a total of fifty-nine participating programs. Fifty-two NMM fellowship programs participated; only one did not, citing the large number of internal applicants who wished to remain at the program that year, and uncertainty about the new process. Seven of 28 CNP/EMG programs also chose to participate. There were 93 available NMM fellowship positions for 75 applicants, 68 of whom accepted an offer. Thirty-one programs filled all positions, eight programs filled partially,

and 13 programs did not fill any positions. Forty applicants accepted their first offer, 17 their second or third, and 11 their fourth or higher. The average time an applicant waited to accept an offered position was 11 hours and 55 minutes. The average time an applicant waited to decline an offer was 14 hours and 2 minutes. All offered positions were accepted or declined within 5 days after the match process began, when accounting for the single program that did not participate.

When accounting for the single program that did not participate, the number of positions filled was comparable to the prior three application cycles, which saw a mean of 75 NMM fellowship positions filled each year.

Following the completion of this process, the AANEM conducted a survey of both fellowship directors and applicants in late June 2021. Twenty-two program directors (42.3%) and 38 fellowship applicants (50.7%) responded to the survey, which asked participants to provide their level of agreement to statements using a five-point Likert scale. The majority of program directors and applicants agreed that a standardized timeline was good for all parties involved, and favored a universal portal for submitting and distributing applications (Table 1) Some participants offered suggestions to improve communication between programs and applicants.

Many program directors were dissatisfied with the partial match system. Many indicated that they adjusted the order of their rank lists based on the perceived likelihood of applicants accepting their offers. They noted that an applicant who did not hear from a program on the first day of offers would know that they were not one that program's top choices. This had the potential to damage the relationship between two parties who would be working together in the future. Another troubling feature of the one-way match was that the speed through which a program could move through their rank list depended on how quickly applicants accepted or rejected their offers. If a program made offers to applicants who rejected them right away, that program would be able to move down their rank list immediately. This program would then have access to the remaining pool of applicants before other programs who were still be waiting for

higher-ranked candidates to reject their offers. In the context of these criticisms, all program directors favored moving to a traditional two-way match.

Looking Forward: The 2022 Fellowship Application Cycle

The AANEM Fellowship Committee held a virtual Town Hall with participating fellowship program directors in July 2021 to share the above results, discuss questions and concerns, and identify ways to improve the fellowship application process. Based on the feedback from this event and from the aforementioned survey, the AANEM Fellowship Committee proposed a traditional two-way match process for the 2022 application cycle, replacing the offer-based system used in 2021. Given support from multiple stakeholders, the AANEM supported this proposal.

The 2022 application timeline (for fellowship start date of July 1, 2023) will be similar to the inaugural cycle. Once again, residents may submit materials to the AANEM portal on or after January 1, 2022. Beginning on March 1, programs may review applications, extend interview offers, and interview candidates through the end of May.

The 2022 match process will differ from the inaugural cycle. On May 25, both programs and applicants will enter rank lists into the portal. Like commercially available matching programs, the portal will then use a mathematical algorithm, based on the Gale-Shapley deferred acceptance algorithm, to pair applicants with fellowship positions⁸. The process begins by placing all residents in an applicant pool. The algorithm starts by choosing an applicant and tentatively matching them with their first-choice program; if their first program choice does not have the applicant ranked, the algorithm will move on to their second choice, and so on until a match is made. If there are more tentative matches than available positions at a program, the algorithm will allow the appropriate number of applicants to remain tentatively matched to that program based on their positions on the program rank list and look for new tentative matches for the applicants who were ranked lower, based on their respective rank lists. The process continues until there are no more applicants in the pool, at which time the tentative matches become

finalized. In this way the algorithm will seek to provide satisfactory matches for applicants and programs alike. The match date is set for June 1, 2022, at which time match results will be electronically released to programs and applicants simultaneously. Once the results are released, unmatched applicants will be free to communicate with unfilled fellowship programs. There will be no restrictions on offers made after June 1st.

Benefits of a Match Utilizing the AANEM Portal

By expanding the functionality of the Neuromuscular Fellowship Portal, Neuromuscular Medicine will be the only neurologic subspecialty to utilize a match without employing a commercially available application or matching programs. Some neurologic subspecialties, for example, utilize the Electronic Residency Application Service (ERAS®) and the NRMP. (**Table 2**) The AANEM Fellowship Committee together with the AANEM decided against these resources as they are inflexible regarding timelines for application submission and matching. For instance, in the primary timeline offered by ERAS, applications are submitted and reviewed as early as November of the PGY3 year. Asking residents to choose a subspecialty and apply in the first half of their PGY3 year obviates one of the primary benefits of changing the timeline that existed prior to the 2021 application season and did not fit with the proposed dates issued by the AAN. Additionally, there is at least one financial benefit to applicants and programs. ERAS, the NRMP, and the SFMatch charge applicants at least \$100 and fellowship programs at least \$250 to use their services, whereas the AANEM Neuromuscular Fellowship Portal will continue to be free to participants. The most obvious concern about the AANEM running the match, rather than utilizing an established program, is that the software will be newly developed. This requires a leap of faith by all parties that the code will be bug-free, and the algorithm will be implemented as promised. The AANEM will also need to take responsibility for identifying and enforcing match violations by programs or applicants.

There are benefits of continuing the timeline from the 2021 cycle, and additional benefits to implementing a two-way match. It ensures that all parties will abide by the chosen timeline. Programs will not be able to view application materials before March 1 and will not be able to make offers before June 1. Every program and applicant will learn the match results on the same day and at the same time. This will directly address a key area for improvement about the one-way match system used in 2021, in which the offer process was protracted over several stressful days. During the design of the one-way match system, it was assumed by the committee that applicants would make decisions quickly as the uniform timeline provided them 3 months to decide which programs were most desired. However, many applicants held offers for the full 48 hours, which prevented some unfilled programs from releasing offers to other available candidates before the applicant pool was depleted. One of the greatest benefits of a two-way match is that it rewards applicants and programs for submitting rank-order lists that most accurately reflect their true preferences; there is no incentive to adjust based on predictions about how other parties are likely to rank. Finally, a match is enforceable. Both programs and applicants will be asked to certify that they agree to accept the results of the match and not to offer or accept positions outside of the system. Programs violating a match agreement can be barred from using the portal and match services in the future.

A traditional two-way match has potential drawbacks. Applicants may feel pressured to interview at more programs to avoid the perceived risk of going unmatched. This carries both financial and time costs for applicants and programs, especially if in-person interviews resume in coming years. The need to arrange for service coverage for residents who are missing more workdays to attend interviews could be a challenge for residency programs. And while there are clear advantages to giving applicants the opportunity to explore a larger pool of options, fellowship programs who are used to recruiting internal candidates may have to work harder to convince residents to stay at their home institutions.

The Challenge of Integrating Clinical Neurophysiology Fellowships

In a recent survey of the 93 ACGME-accredited CNP programs, 48% of responding programs were EEG-focused (CNP/EEG), 26% were EMG-focused (CNP/EMG), 22% were split equally between EEG and EMG, and the few remaining programs focused on IOM or autonomic studies.⁹

Many NMM and CNP/EMG fellowships offer a mix of training in EMG and clinical neuromuscular medicine, and interested applicants may ultimately apply to NMM, CNP/EMG or a mix of programs. Thus, CNP/EMG fellowships may benefit from using the AANEM Portal. As a parallel undertaking, the field of Epilepsy is posed to use a fellowship match through the NRMP in 2023, and CNP/EEG fellowships are likely to join Epilepsy for this match. Unfortunately, traditional CNP programs that offer an evenly mixed EEG/EMG experience may be left without a clear direction regarding which application and match process to use. One possible future direction would be to work towards a centralized multi-specialty or all-speciality fellowship application and match.

Conclusions

Neuromuscular Medicine is at the forefront of the movement to optimize the fellowship application process to benefit trainees and programs. Other neurologic subspecialties are now looking to us to lead in this area. This will surely be an iterative process. Feedback gained from every application cycle will help refine the application and match systems to maximize the benefits to our trainees, programs, and the field of neuromuscular medicine.

References

1. London ZN, Khan J, Cahill C, Schuyler E, Wold J, Southerland AM. 2017 Program Directory Survey: Feedback from your adult neurology residency leadership. *Neurology*. 2018; 9 (15): e1448–e1454.
2. ACGME Data Retrieval System. ACGME website. <https://www.google.com/url?q=https://apps.acgme.org/ads/Public/Request/PublicDataRequest&a=D&source=docs&ust=1637021824466000&usg=AOvVaw2Z5btdpQTLxQsVIDbvcJOU>. Accessed November 15, 2021.
3. Mahajan A, Cahill C, Scharf E, et al. Neurology residency training in 2017: A survey of preparation, perspectives, and plans. *Neurology*. 2019; 92 (2): 76-83.
4. American Academy of Neurology Position Statement: Fellowship Application Timing. American Academy of Neurology Web site. <https://aanfiles.blob.core.windows.net/aanfiles/6b18e1cb-3af2-4714-8f76-44e0b42f7ff9/AAN%20Fellowship%20Application%20Timing%20Position%20Statement.pdf>. Updated February 2020. Accessed November 7, 2021.
5. Neuromuscular Medicine & Clinical Neurophysiology Fellowship Timing & Response to the American Academy of Neurology Position Statement. AANEM Web site. <https://www.aanem.org/getmedia/a5bd9bb2-8c37-422b-8df0-c7421bcc9757/AANEM-Position-Statement-Response-to-AAN-5-28-2020.pdf>. Updated May 2020. Accessed November 7, 2021.
6. Rose L, McKim D, Leasa D, et al. Trends in incidence, prevalence, and mortality of neuromuscular disease in Ontario, Canada: A population-based retrospective cohort study (2003-2014). *PLoS One*. 2019; 14 (3): e0210574.
7. Neuromuscular Medicine Fellowship Portal. AANEM Web site. <https://www.aanem.org/Careers/Fellowships/Neuromuscular-Medicine-Fellowship-Portal>. Accessed November 7, 2021.
8. Gale D and Shapley LS. College Admissions and the Stability of Marriage. *Am Math Mon*. 1962; 69 (1): 9-15.
9. Karakis I, Liu L, Bensalem-Owen M, et al. Clinical Neurophysiology Fellowship Program Directors Survey on a Standardized Fellowship Match Process: A Call for Action. *J Clin Neurophysiol*. Apr 14, 2021, Online ahead of print.

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Table 1. Program director and fellowship applicant survey following the 2021 application cycle.

Questions	Program director percent (number)	Applicant percent (number)
I think that this standardized timeline is beneficial for the field of neuromuscular medicine.	Yes: 77% (17/22)	Yes: 89% (34/38)
I think that this standardized timeline is beneficial for applicants.	Yes: 91% (20/22)	Yes: 95% (36/38)
I am in favor of a universal portal for submitting and distributing fellowship applications.	Yes: 82% (18/22)	Yes: 97% (37/38)
The Neuromuscular portal was easy to use.	Yes: 82% (18/22)	Yes: 95% (36/38)
Did you adjust the order of your rank list based on the perceived likelihood of applicants accepting your offer?	Yes: 64% (14/22)	Not asked
Overall, the process would have been fairer if it was a traditional match.	Yes: 100% (22/22)	Yes: 58% (22/38)
Did you apply to or interview at more programs than you would have if interviews had been in person?	Not asked	Yes: 66% (25/38)
What would be your preferred format for interviews?	Not asked	In person: 38% (14/38)

		Virtual: 18% (7/38) Hybrid: 45% (17/38)
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Table 2. Fellowship application characteristics by neurologic subspecialty

Specialty	Applications Submitted	Offers	Organization that administers offers	Match start year
Neurocritical care	January PGY3	August PGY4	SF Match	2009
Sleep	July PGY4	December PGY4	NRMP	2011
Movement disorders	March PGY3	September PGY4	SF Match	2012
Vascular neurology	December PGY3	May PGY3	NRMP	2014
Neuro-oncology	November PGY3	June PGY3	SF Match	2016
Neuromuscular	March PGY3	June PGY3	AANEM	Planned for 2022
Headache	March PGY3	August PGY4	--	Planned for 2022
Epilepsy	August/September PGY3	Rolling	--	Planned for 2023
Clinical Neurophysiology	August/September PGY3	Rolling	--	Planned for 2022 (EMG) and 2023 (EEG)
Cognitive neurology	Variable	Rolling	--	--
Neuroimmunology	Variable	Rolling	--	--
Neuro-ophthalmology	Variable	Rolling	--	--