

# Education Research: Multiple sclerosis and neuroimmunology fellowship training status in the United States

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## Abstract

### Objective

To investigate the current status of postgraduate training in neuroimmunology and multiple sclerosis (NI/MS) in the United States.

### Methods

We developed a questionnaire to collect information on fellowship training focus, duration of training, number of fellows, funding application process, rotations, visa sponsorship, and an open-ended question about challenges facing training in NI/MS. We identified target programs and sent the questionnaires electronically to fellowship program directors.

### Results

We identified and sent the questionnaire to 69 NI/MS fellowship programs. We successfully obtained data from 64 programs. Most programs were small, matriculating 1–2 fellows per year, and incorporated both NI and MS training into the curriculum. Most programs were flexible in their duration, typically lasting 1–2 years, and offered opportunities for research during training. Only 56% reported the ability to sponsor nonimmigrant visas. Most institutions reported having some internal funding, although the availability of these funds varied from year to year. Several program directors identified funding availability and the current absence of national subspecialty certification as major challenges facing NI/MS training.

### Conclusion

Our study is the first to describe the current status of NI/MS training in the United States. We found many similarities across programs. We anticipate that these data will serve as a first step towards developing a standard NI/MS curriculum and help identify areas where shared resources could enhance trainee education despite differences in training environments. We identified funding availability, certification status, and nonimmigrant visa sponsorship as potential barriers to future growth in the field.

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## Glossary

AAN = American Academy of Neurology; IMG = international medical graduate; MS = multiple sclerosis; NI = neuroimmunology.

The current scope of postgraduate medical training in neuroimmunology (NI) and multiple sclerosis (MS) in the United States is mostly unknown. Over the last decade, more than 9 different immunomodulatory medications were Food and Drug Administration–approved for treating MS, and dozens more are advancing through the therapeutic pipeline.<sup>1</sup> As these new medications come with specialized monitoring and safety considerations, the need for specialists intimately familiar with each has become clear.<sup>1</sup> Over the same period, new neuroimmunologic diagnoses have been increasingly recognized, including neuromyelitis optica spectrum disorders, anti-MOG diseases, and numerous unique autoimmune encephalitides including anti–glial fibrillary acid protein and anti-IgLONS.<sup>1–4</sup> The increasing utilization of biologic drugs for systemic autoimmune conditions and checkpoint inhibitors for cancers has also created a new set of neuroimmunologic illnesses due to medication side effects.<sup>5,6</sup> The widening diagnostic palette and complexity of treatment options combined with increasing need for multidisciplinary care underscore the need for comprehensive, standardized NI/MS fellowship training.<sup>7</sup>

Because existing programs may vary widely in their curricula and resources, we investigated the current status of NI/MS fellowship training in the United States.

## Methods

We performed a web search to identify current NI/MS training programs in the United States using the terms “neuroimmunology fellowship,” “neuroimmunology training,” “autoimmune fellowship,” “autoimmune training,” “multiple sclerosis fellowship,” and “multiple sclerosis training.” We also sent emails via the American Academy of Neurology (AAN) Synapse listservs for MS and autoimmune neurology, requesting that fellowship directors self-identify. In addition, we utilized partial fellowship directories compiled by the AAN and the Consortium for MS Centers. When no training program was readily identified at major academic centers but was known to exist by the authors, the research team contacted the NI/MS faculty at those institutions to confirm the status of NI/MS training. Through these methods, we identified a comprehensive list of fellowship directors (appendix e-1, [links.lww.com/WNL/B53](https://links.lww.com/WNL/B53)) and developed a questionnaire (appendix e-2, [links.lww.com/WNL/B54](https://links.lww.com/WNL/B54)) to collect information on fellowship focus (MS, NI, or both); training focus (research, clinical, or combined); duration of training; annual number of trainees; funding; timeline for application/acceptance; call responsibilities; required and elective rotations; and the availability of nonimmigrant visa sponsorship for international medical graduates (IMGs). We emailed the survey to each

program director and sent individualized reminders to complete it. The current status of postgraduate NI/MS training in the United States was extrapolated using aggregate data.

## Data availability

Qualified investigators may request any data not directly included in this report, including the full questionnaire.

## Results

We identified and sent questionnaires to 69 NI/MS fellowship programs and obtained data from 64 programs (93%). The overall program characteristics are presented in table 1. Most matriculate 1–2 fellows annually, incorporate both MS and NI training, are flexible in duration (typically 1–2 years), and offer opportunities for research. Seven programs enrolled ≥3 fellows annually.

Fellowship funding sources varied. Most institutions reported having some internal funding, although the availability of these funds varied from year to year. Funding was also commonly obtained from nonprofit (e.g., National Multiple Sclerosis Society, AAN) and for-profit entities. External funding sources typically had to be secured by the fellow or institution well before matriculation but after the institution had committed to accepting the fellow.

Most fellowship programs (n = 38 [60%]) reported conducting fellowship interviews about 18 months before matriculation (during postgraduate year 3). Twenty-five programs (40%) reported interviewing on a rolling basis. Interestingly, 47 programs (75%; 1 missing) reported that available positions are usually filled more than 1 year before the starting date. Four (6%) programs reported that fellowship positions often remained unfilled, while the remaining programs (19%) filled their available positions within a year of start date. Only 35 programs reported the ability to sponsor nonimmigrant visas (56%; 2 missing).

All programs confirmed that trainees received clinical exposure to the diagnosis and management of classical demyelinating diseases. Other frequently addressed diagnoses included CNS rheumatologic diseases (62/63), neurologic complications of biologic drugs (e.g., tumor necrosis factor- $\alpha$  inhibitors) (60/63), vasculitis (59/63), paraneoplastic syndromes (57/63), encephalitis (52/63), autoimmune epilepsy (42/63), and peripheral NI (22/63).

The core training environment for NI/MS fellowship programs was the outpatient NI/MS clinic. All programs also

**Table 1** Characteristics of neuroimmunology (NI)/multiple sclerosis (MS) fellowship programs

Training focus	No. (%)
Combined NI/MS training	55 (87.3) <sup>a</sup>
Separate MS and NI in same institution	4 (6.3)
MS	2 (3.2)
NI	2 (3.2)
<b>Duration of training</b>	
Only 1 year (clinical or mixed in research)	20 (31.3)
Flexible duration (1-2 or more years; clinical or mixed in research)	29 (45.3)
At least 2 years (clinical or mixed in research)	15 (23.4)
<b>Maximum number of fellows/year</b>	
1	38 (59.4)
2	19 (29.7)
≥3	7 (10.9)
<b>Total fellows in program</b>	
1	15 (23.4)
2	31 (48.4)
≥3	18 (28.2)
<b>Guaranteed institutional funding (fellows/year)</b>	
1	32 (50)
2	15 (23.4)
None reported	17 (26.6)
<b>Timing of interviews<sup>a</sup></b>	
Postgraduate year 3	38 (60)
At any time (rolling basis)	25 (40)
<b>Call duties</b>	
No call duties	42 (65.6)
Limited hours of phone calls	16 (25)
Overnight phone call	4 (6.3)
Phone and in-house call	2 (3.1)

<sup>a</sup> Data from one program missing.

offered complementary subspecialty rotations (table 2). Elective rotations included public health, clinical trial management, patient-centered medical home, ataxia/movement disorders, behavioral neurology, health system science, relevant neurogenetics, and laboratory medicine.

In response to an open-ended question about challenges facing NI/MS education, program directors identified concerns about funding availability (n = 32) and the current absence of national certification for NI/MS (n = 4). Other identified challenges

included nonstandard curricula, application/interview timelines, and heterogeneity in practice environments. Fellowship programs (appendix e-1, [links.lww.com/WNL/BS3](https://links.lww.com/WNL/BS3)) were geographically clustered, with numerous training opportunities in parts of the country, while other geographic regions had few or no training programs (figure).

## Discussion

NI is one of the fastest-growing neurologic subspecialties, yet in the absence of standardized fellowship training, there is the potential for high variability in the quality of education that trainees receive. Other neurologic specialties previously experienced a similar phenomenon, and over the last 2 decades many have opted to standardize their programs under the governance of a regulating body (table 3). Others implemented a match system for recruiting new fellows. As the NI community considers whether to pursue either of these avenues, it was critical to first evaluate the current state of subspecialty education and achieve consensus about core competencies for neuroimmunologists.

Most training programs incorporate a variety of CNS neuroimmune conditions, including non-MS demyelinating diseases, paraneoplastic syndromes, and autoimmune encephalitides, in contrast to some previously held assumptions.<sup>8</sup> Exposure to peripheral neuroimmunologic conditions and autoimmune movement disorders was less common, likely because these conditions fall under the purview of other neurologic subspecialties. Graduates of NI/MS training programs should therefore be expected to have expertise in diagnosing and managing most CNS neuroimmune conditions. Discrepancies in the size of training institutions' NI/MS programs, available clinical expertise, and patient referral bases may affect trainees' familiarity with rare, non-MS diagnoses. Opportunities exist for collaboration to ensure that all trainees are exposed to the breadth of central neuroimmunologic diagnoses.

The majority of training programs incorporate subspecialty rotations in complementary disciplines (table 2). Such cross-disciplinary exposure is an essential component of comprehensive neuroimmunologic care and allows the NI/MS trainee to become skilled in symptom management, develop a knowledge base about treatment modalities, and make effective referrals. Neuro-ophthalmologic exposure improves fellows' physical examination skills and enhances their ability to diagnose and manage visual concerns. Neuroradiology exposure helps fellows select and interpret relevant imaging studies. Neurorehabilitation rotations allow fellows to develop skill in managing spasticity and to become familiar with ambulatory assistive devices. Training in neuropsychology helps ensure that future NI/MS specialists effectively identify and address mood disturbances, a common phenomenon among patients with neuroimmune diseases.<sup>9</sup> A third of NI/MS programs also reported incorporating formal teaching in basic immunology into their curricula. This training expands trainees' understanding of the mechanisms of action underlying current

**Table 2** Variety of diseases encountered and additional rotations during training

Required	Availability, n (%)	Elective	Availability, n (%)
Neuro-ophthalmology	36 (56)	Neuro-ophthalmology	34 (53)
Neuroradiology	31 (48)	Neuroradiology	33 (52)
Neurorehabilitation	26 (41)	Neurorehabilitation	36 (56)
Basic immunology	22 (34)	Basic immunology	33 (52)
Neurourology	20 (31)	Neurourology	30 (47)
Statistics	18 (28)	Statistics	30 (47)
Rheumatology	14 (22)	Rheumatology	28 (44)
Neuropsychology	13 (20)	Neuropsychology	37 (58)
Infectious disease	10 (16)	Infectious disease	27 (42)
Neurophysiology	2 (3)	Neurophysiology	15 (23)
Neuropathology	1 (1.5)	Neuropathology	31 (48)
Neuro-oncology	1 (1.5)	Neuro-oncology	15 (23)
		Other	13 (20)

Some programs have specific required rotations that are also available as electives.

immunotherapies, provides the necessary foundation for understanding the limitations of current neuroimmunologic testing, and ensures efficient practice in utilizing panels of autoimmune antibodies.

NI/MS fellowships are not formally accredited by a governing body. This may make enrollment challenging for applicants who require nonimmigrant visa support, as only 56% of programs reported sponsoring nonimmigrant visas. This may discourage some IMGs from pursuing NI/MS as a career choice.

Many program directors identified lack of predictable funding as a major barrier to NI/MS training. About 3-quarters of the programs reported that institutional funding could be obtained for 1 year of clinical training. Fellows desiring additional research opportunities or a longer fellowship were typically required to secure external funding or earn their salary through clinical productivity. Inconsistencies in the application/interview process were also identified as a barrier. Most programs lacked an application deadline and the window during which applications began to be considered varied widely across institutions. Almost all programs filled more

**Figure** Geographic distribution of neuroimmunology/multiple sclerosis programs

**Table 3** Training pathways for neurologic subspecialties

Subspecialty	Accreditation	Accreditation date	Match
Brain injury medicine	ACGME	2014	NRMP
Clinical neurophysiology	ACGME	1992	No
Epilepsy	ACGME	2011	No
Neuromuscular	ACGME	2008	No
Pain	ACGME	2000	NRMP
Sleep	ACGME	2007	NRMP
Vascular neurology	ACGME	2005	NRMP
Autonomic disorders	UCNS	2007	No
Geriatric neurology	UCNS	2007	No
Neurocritical care	UCNS	2007	SF match
Behavioral neurology and neuropsychiatry	UCNS	2004	No
Headache medicine	UCNS	2005	No
Neuroimaging	UCNS	2007	No
Clinical neuromuscular pathology	UCNS	2007	No
Neural repair and rehabilitation	UCNS	2012	No
Neuro-oncology	UCNS	2007	SF match
Neuro-ophthalmology	AUPO FCC (optional)	2005	No
Neuroimmunology	No certifying body	NA	No
Movement disorders	No certifying body	NA	SF match
Neuroinfectious disease	No certifying body	NA	No

Abbreviations: ACGME = American Council for Graduate Medical Education; AUPO FCC = Association of University Professors of Ophthalmology Fellowship Compliance Committee; NRMP = National Resident Matching Program; SF = San Francisco; UCNS = United Council of Neurologic Specialties.

than a year before matriculation. This trend places both applicants and programs under pressure to make decisions before having access to all available options. Several other neurologic subspecialties have implemented a national match system, but this approach may be impractical for NI/MS due to a relatively small number of candidates and a limited number of programs and positions.

This study provides novel data to establish a consensus definition of NI fellowship training. There was widespread agreement that trainees should be exposed to the full spectrum of neuroimmunologic diagnoses and cross-disciplinary rotations during training. These data lay the groundwork for a standard curriculum and identify areas where shared resources could enhance trainees' education despite differences in training environments. Barriers to growth include a nonstandard application/interview timeline, inconsistent nonimmigrant visa sponsorship, and lack of certification status. NI subspecialty training is at a critical juncture, analogous to that faced by neuro-ophthalmology and other neurologic subspecialties in the early 2000s.<sup>10</sup> There are benefits to clearly defining the subspecialty and identifying a core curriculum for trainees, but

there may also be disadvantages associated with a more rigid training environment. Our data will help shape the continuing evolution of this neurologic subspecialty.

### Study funding

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## Appendix Authors

Name	Location	Contribution
<b>Ahmed Z. Obeidat, MD, PhD</b>	Medical College of Wisconsin	Designed and conceptualized study, helped in questionnaire design and data collection, analyzed the data, interpreted the data, drafted and revised the manuscript for intellectual content
<b>Yasir N. Jassam, MBChB, MRCP (UK)</b>	University of Kansas	Designed and conceptualized study, interpreted the data, revised the manuscript for intellectual content
<b>Le H. Hua, MD</b>	Cleveland Clinic	Participated in study and questionnaire design, interpreted the data, revised the manuscript for intellectual content
<b>Gary Cutter, MS, PhD</b>	University of Alabama	Interpreted the data, revised the manuscript for intellectual content
<b>Corey Ford, MD, PhD</b>	University of New Mexico	Interpreted the data, revised the manuscript for intellectual content
<b>June Halper, MSN, APN-C, MSCN</b>	Consortium of MS Centers	Interpreted the data, revised the manuscript for intellectual content
<b>Robert P. Lisak, MD, FRCP (E)</b>	Wayne State University	Interpreted the data, revised the manuscript for intellectual content
<b>Nancy L. Sicotte, MD</b>	Cedars-Sinai Medical Center	Conceptualized study, interpreted the data, revised the manuscript for intellectual content
<b>Erin E. Longbrake, MD, PhD</b>	Yale University	Designed questionnaire, major role in the acquisition of data, interpreted the data, revised the manuscript for intellectual content

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