

Reciprocal Development and Progressive Responsibility: The History of the Mayo Clinic Neurology Residency

Christopher J. Boes, MD; David B. Burkholder, MD; Elizabeth A. Coon, MD; Jeremy K. Cutsforth-Gregory, MD; James P. Klaas, MD; and Lyell K. Jones Jr, MD

From the Department of Neurology, Mayo Clinic, Rochester, MN.

The first Mayo Clinic neurology resident began training approximately 1 century ago. Over the subsequent 100 years, 639 budding specialists in diseases of the nervous system graduated from the Mayo Clinic Neurology Residency in Rochester, Minnesota. The history of the American residency has been thoroughly covered by Ludmerer in his 2014 book *Let Me Heal*,¹ and a history of the Mayo Clinic Otolaryngology Residency Program was published in 2020.² Mulder discussed education in the Mayo Clinic Department of Neurology as part of an overview of the history of the department in 1971.³ The history of the Mayo Clinic Neurology Residency Program was reviewed in a book by Mulder in 1988, but this was privately printed and not widely available.⁴ Todman summarized some of the contents of this book, but did not delve into the history of the training program.⁵ Using annual section/department reports and numerous other primary sources in the W. Bruce Fye Center for the History of Medicine at Mayo Clinic, this commentary will review the history of the Mayo Clinic Neurology Residency in detail. It will focus on the training program in Rochester, MN, while noting that neurology residencies were started at Mayo Clinic in Florida and Mayo Clinic in Arizona in the 2000s. Reciprocal development and progressive responsibility were essential components of the residency from the start.

THE FOUNDING OF THE MAYO CLINIC NEUROLOGY RESIDENCY

Interns and residents at Mayo Clinic in the late 1800s/early 1900s could not receive formal degrees, as the institution had no academic affiliation.⁶ Walter Shelden moved from the

teaching staff of the University of Minnesota Medical School to Mayo Clinic in 1913 to become its first neurology *consultant* (Mayo Clinic's term for *faculty member*).⁴ In 1914, the University of Minnesota inaugurated graduate work in various fields of clinical medicine and surgery. Physicians could receive master's or PhD degrees in surgery, internal medicine, and other clinical fields.⁷ Henry Woltman, who became Mayo's second neurology consultant in 1917, was a product of this innovative system at the University of Minnesota. He completed medical school at the University of Minnesota in 1913, did 1 year of internship at University Hospital in Minneapolis, MN, and then finished a teaching fellowship in neurology at the University of Minnesota from November 1914 through June 1917.⁸ His fellowship was under the jurisdiction of the University of Minnesota Graduate School, not its medical school. Woltman stated that he was "among the first group of 11 vertebrates used in this experiment,"⁹ and it worked out well for him. Woltman received a Doctor of Science degree in neurology for his thesis on the central nervous system changes in pernicious anemia.¹⁰ Later this was changed to a PhD degree in neurology.¹¹ Earning a master's or PhD degree in a clinical specialty as evidence of being a qualified specialist did not prevail in America in the long run, as specialty board certification won out as a proof of competence.⁷

The Mayo Foundation for Medical Education and Research (Mayo Foundation), incorporated in 1915 from an endowment from William J. and Charles H. Mayo, was a graduate education link between Mayo Clinic and the University of Minnesota with the main purpose of elevating the standard for training medical

specialists.⁶ Applicants to the 3-year Mayo Foundation fellowships needed to have graduated from college and medical school and completed 1 year of internship. A thesis was required for those pursuing master's or PhD degrees. Neurology was not one of the “fellowships” offered in Rochester, MN, in 1915 through the Mayo Foundation—University of Minnesota affiliation (the word *fellow* used then equates to our present-day term *resident*).⁶

The Mayo Clinic Neurology Residency was initiated when John (Jack) B. Doyle began his training in Rochester on August 1, 1919 (Figure 1). Doyle had graduated from Rush Medical College in 1917, completed internship in Cincinnati, Ohio, and served in the US Army. While in the military in 1918, he completed a 3-month assignment at Mayo Clinic for special medical instruction.¹² After discharge in 1919, Doyle returned to Mayo Clinic, where his major was internal medicine and minor was neurology.¹³ The October 1, 1919, *Bulletin of the University of Minnesota* clarified that the neurology residency in Rochester was grouped under internal medicine, along with dermatology and general medicine.¹⁴ Shelden and Woltman were listed as supervising “practical work in neurology and psychiatry.”¹⁴ Doyle excelled clinically in the Mayo training program.¹³ He changed his major from medicine to neurology and became a first assistant in neurology on October 1, 1921.^{12,15} The term *first assistant* could refer to a junior faculty member (in the early years of the neurology section) or a senior resident (by the late 1940s).^{4,16-19} Doyle received a Master of Science degree in neurology in December 1923 for a thesis on glossopharyngeal neuralgia, and he was named a Mayo Clinic consultant in the section of neurology in January 1925.^{12,15,20,21} The label “section” (or later “sections” when there were more faculty members) was used instead of department until 1966 when the neurology sections officially became a department.²² Doyle worked at Mayo Clinic until 1931, leaving during the Depression to work in California.⁴

Doyle had a phenomenal memory and repeatedly amazed his colleagues by his uncanny references to articles with exact page and date.²³ Luman Daniels, one of his residents, commented that he could “still hear

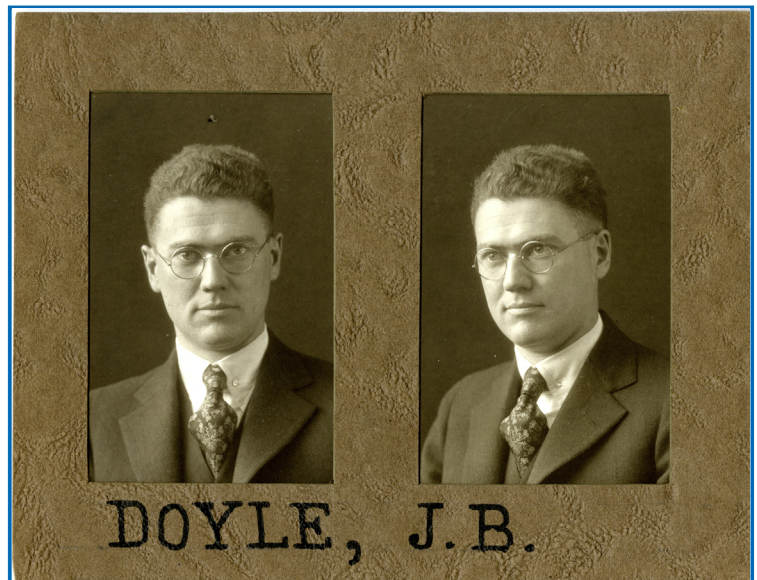


FIGURE 1. Dr John (Jack) Benedict Doyle in 1919. By permission of the Mayo Foundation for Medical Education and Research. All rights reserved. Courtesy of the W. Bruce Fye Center for the History of Medicine, Mayo Clinic, Rochester, MN.

Jack Doyle’s hearty laughter during his morning confabs with Pop [Walter Shelden].”²⁴ Shelden once told Doyle that he “must have a weak spot somewhere but I’ve never been able to find it.”²⁴ John Doyle was certified by the America Board of Psychiatry and Neurology (ABPN) in 1935, 1 year after it came into existence.¹²

RECIPROCAL DEVELOPMENT

John Doyle commented that his residency training was imbued with the spirit of “reciprocal development.”¹⁶ The residents and faculty members learned from each other. Harry Lee Parker, who started his Mayo Clinic residency 3 months after Doyle and became a neurology faculty member with him in 1925, commented further on the concept of reciprocal development:

For fifteen years, I had taught postgraduate students at the Mayo Clinic. It was a labor of love since these young men are carefully selected as being of high intelligence and of a previous faultless career. They absorbed information with an unparalleled gusto, and could ask and answer questions in neurology that were controversial topics. They could

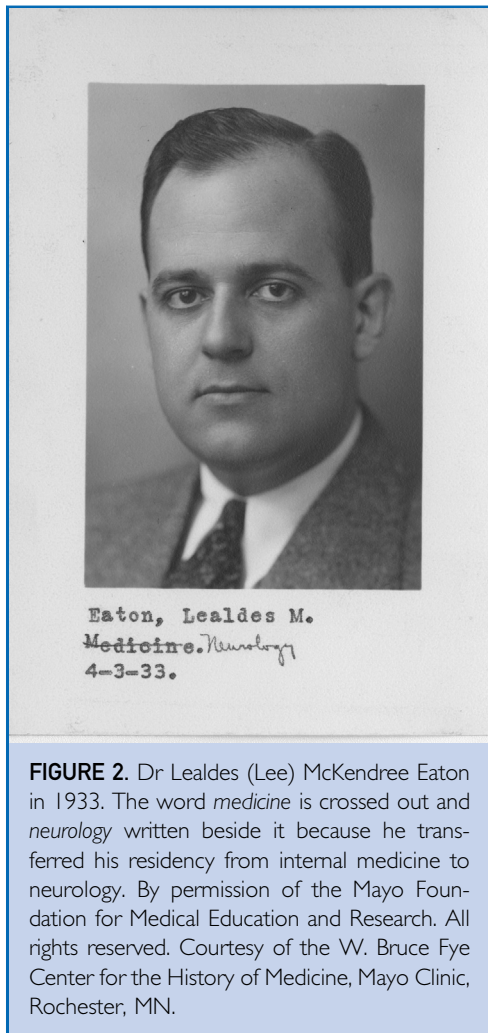


FIGURE 2. Dr Lealdes (Lee) McKendree Eaton in 1933. The word *medicine* is crossed out and *neurology* written beside it because he transferred his residency from internal medicine to neurology. By permission of the Mayo Foundation for Medical Education and Research. All rights reserved. Courtesy of the W. Bruce Fye Center for the History of Medicine, Mayo Clinic, Rochester, MN.

go further and discuss modernities of which I was ignorant.²⁵

Alexander MacLean, who was on the Mayo staff from 1937 to 1952, wrote about reciprocal development in 1950 when he advised residents that “we would like you to feel perfectly free to ask questions, to seek instruction and to criticize our opinions and judgments....It is only through this free interchange of ideas that we will continue to learn together.”²⁶ The book *Medical Neurosciences*, authored by Mayo Clinic neurologists in 1978, again referred to reciprocal development in its dedication to “the students of the Mayo Medical School and the residents in the Department of Neurology who have provided the stimulus for this venture by teaching us as we have taught them.”²⁷ This dedication

appears essentially unchanged in the 2017 sixth edition of the book, highlighting the importance of the concept of reciprocal development in the current Mayo Clinic Neurology Residency Program.²⁸

RESIDENCY PROGRAM AIMS

In 1924, Walter Sheldon stated that the aims of the neurology section consisted of “increasing and perfecting our work of educating fellows, of developing specialists in neurology and above all of educating ourselves.”²⁹ Henry Woltman stated plainly in 1950 that the purpose of the Mayo Clinic Neurology Residency Program was to “enable a physician to take better care of the sick.”³⁰ Mayo Clinic neurologist Jack Whisnant further clarified in 1973 that “it is our goal to train clinical neurologists and to provide special training for about a third of the trainees so that they can be qualified academic neurologists.”³¹ The principal aim of the residency program now is to train future leaders in clinical neurology, neurological education, and neuroscience research.

RESIDENCY RECRUITMENT AND THE INFLUENCE OF THE NATIONAL INSTITUTE OF NEUROLOGICAL DISEASES AND BLINDNESS

Lee Eaton was interviewed for a residency position at Mayo Clinic in the summer of 1932. He was granted an internal medicine position in 1933 and switched to the neurology residency in 1934.³² Eaton’s 1933 photo gives evidence of this, with “medicine” crossed out and “neurology” written beside it (Figure 2). Recruitment from the internal medical residency was a common source of neurology residents at Mayo Clinic in the 1930s and 1940s.^{4,33}

Recruiting to the neurology residency could be challenging at times. Henry Woltman noted in 1947:

At present neurosurgery and psychiatry are in the ascendency, and fewer fellows seem to be applying for training in neurology. This is probably a national trend and temporary, since medical neurologic diseases are very common and must be treated. The formation of a national and “not so exclusive” American Academy of Neurology and greater

emphasis on the treatment of neurologic disorders will doubtless attract men to this field of work.³⁴

A 1947 *Journal of the American Medical Association* article on hospital service in the United States supported Woltman's observations.³⁵ The number of neurology residency positions increased from 73 in 1941 to 128 in 1947. In the same time period, the number of neurosurgery residency slots increased from 36 to 127 and the number of psychiatry positions increased from 424 to 841.³⁵ The American Academy of Neurology (AAN) was established in 1948 partly to provide a home for those neurologists trained after World War II who had difficulty meeting the publication and research thesis requirements of the exclusive American Neurological Association.³⁶

The National Institute of Neurological Diseases and Blindness (NINDB), established in 1950, spurred the growth of neurology residencies in the United States.³⁷ The first NINDB grants were for research, but graduate medical education was also supported to the sum of \$191 million for more than 10,000 trainees from 1952 to 1974.³⁸ Mayo Clinic received training grants for the neurology residency and the electroencephalography (EEG)/electromyography (EMG) neurophysiology training program in 1957.³⁹ The neurology grant ended on June 30, 1977, and the neurophysiology grant finished 1 year later.^{40,41} Mayo neurologist Joe Brown, who was responsible for administration of the neurology training grant and sat on the training grant committee of the NINDB, stated in 1958:

We had available this year a larger number of better qualified first assistants as a result of the increased number of trainees in neurology. This partly reflects increased interest in the field and is partly the effect of the NINDB training grant.⁴²

By 1967, Mayo Clinic neurologist Frank Howard was able to state that the neurology residency program was approved for 30 residents (10 per year) and that the program "had no difficulty in filling these residencies but hope to improve on the quality of the residents selected...we continue to attract some residents from internal medicine."⁴³

The residency match began in the fall of 1980 for neurology positions that started in

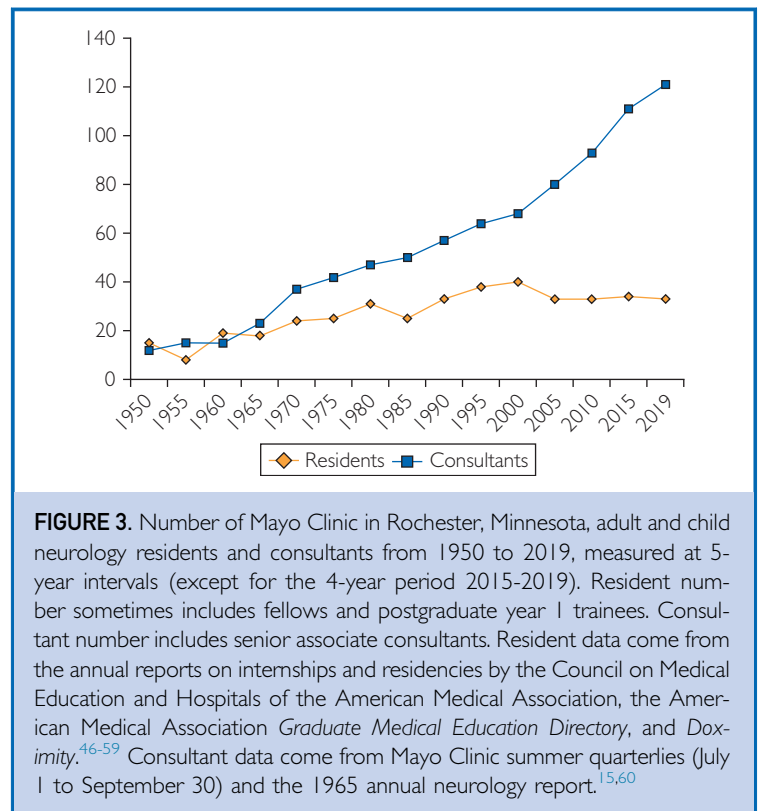


FIGURE 3. Number of Mayo Clinic in Rochester, Minnesota, adult and child neurology residents and consultants from 1950 to 2019, measured at 5-year intervals (except for the 4-year period 2015-2019). Resident number sometimes includes fellows and postgraduate year I trainees. Consultant number includes senior associate consultants. Resident data come from the annual reports on internships and residencies by the Council on Medical Education and Hospitals of the American Medical Association, the American Medical Association *Graduate Medical Education Directory*, and *Doximity*.⁴⁶⁻⁵⁹ Consultant data come from Mayo Clinic summer quarterlies (July 1 to September 30) and the 1965 annual neurology report.^{15,60}

July 1982.⁴⁴ The Mayo neurology recruitment team quickly determined that positive predictors of success in the residency included ranking in the upper 15th percentile of their graduating medical school class and "being psychologically and emotionally well adjusted."⁴⁵

NUMBER OF RESIDENTS

Eleven Mayo neurology residents were appointed in the 1920s, 20 in the 1930s, and 25 in the 1940s.⁴ Figure 3 displays the number of adult and child neurology residents and consultants in Rochester, MN, from 1950 to 2019 at 5-year intervals (except for the terminal 4-year period). The doubling of residents from 1955 to 1960 reflects growth related to the NINDB training grant. The ratio of residents to consultants was nearly 1:1 from 1950 to 1965. By 1970, consultant growth outpaced that of residents, and that trend continued over time. Five hundred seventy-one adult neurology and 68 child neurology trainees graduated from the Mayo Clinic Neurology Residency in Rochester, MN, from 1919 to 2019.

TABLE 1. Mayo Clinic in Rochester, MN, Neurology Residency Conferences and Courses in 2019

Conference	Course
Monday neurology grand rounds	Clinical neurology (PGY-2 and PGY-3)
Tuesday hospital case conference (2 times per month) • Includes monthly morbidity and mortality conference	Neuroanatomy (PGY-2)
Tuesday resident conference (alternates with hospital case conference) • Journal club • Neuroethics • Visiting faculty	Clinical neuroradiology (PGY-2)
Wednesday child neurology conference	Quality improvement (PGY-2)
Wednesday case of the week	Neuroethics (PGY-2)
Thursday resident-led case conference (1 time per month)	Neurointensive care (PGY-2)
Friday neuro-oncology conference • And numerous other recurring subspecialty conferences including behavioral neurology, clinical neurophysiology, cerebrovascular therapeutics, deep brain stimulation, multiple sclerosis, muscle, neuromuscular, peripheral nerve, and surgical epilepsy	Teaching skills course (PGY-3)
Friday clinical conference	Basic neuroscience (PGY-3) Systems-based practice (PGY-3) Neurosimulation course (PGY-2 and PGY-3) Transition to practice course (PGY-3)

PGY-2 = postgraduate year 2; PGY-3 = postgraduate year 3; PGY-4 = postgraduate year 4.

STRUCTURED DIDACTICS

Walter Shelden stated in 1924 that “by daily conferences the educational value of the whole service is given to all while the patients profit by the added suggestions and constructive criticism...[in addition] we avoid the narrowness of isolation.”²⁹ In 1924, there were daily clinical conferences after lunch from 1:30 to 2:30 PM during which 2 to 4 patients were presented to the entire staff and residents. John Doyle recalled that some of the conferences lasted until 4 PM.⁶¹ Fred Moersch, Mayo’s third neurologist, described this conference:

Dr. Shelden might spend an entire conference hour in presenting a patient with tabes dorsalis. He would demonstrate the art of a careful sensory examination and illustrate the phenomena of delayed pain, butterfly sensory changes over the face, and possibly a Charcot joint.... Frequently these meetings became prolonged, much to the dismay of our desk attendants, waiting patients, and our medical colleagues.²³

Opinions were freely exchanged during this conference:

During the early years of our conferences, Jack Doyle and Harry Parker, goaded on by other fellows, especially one by the name of J. Arthur Buchanan, would enliven the meetings with their heated discussions over a clinical finding or a diagnosis. At times I feared that one of the trio might commit mayhem on his tormentors. It was all in fun and on another occasion the battle lines would be drawn in reverse order.²³

The 1924 schedule also included a clinicopathological conference every 2 weeks, a weekly Saturday seminar in which papers were presented by the residents on special topics, and a weekly 5 PM neuroanatomy review by Mayo neuropathologist James Kernohan (of Kernohan’s notch in brain herniation).²⁹

Electroencephalographer Reginald Bickford came to Mayo Clinic in 1946, after which EEG conferences were routinely scheduled.⁶² Criticisms of the residency teaching program

TABLE 3. Lee Eaton's Residency Rotations^{15,30,76}

Quarter/date	Rotation
Jul 1931 to Dec 31, 1932	Intern at Cook County Hospital in Chicago, IL
2nd, 3rd, and 4th quarters of 1933	Mayo internal medicine resident
First 3 quarters of 1934	Assigned to outpatient neurology <ul style="list-style-type: none"> • Transferred residency to neurology in Oct 1, 1934
4th quarter of 1934	University of Minnesota neuroanatomy rotation (supervisor Dr Andrew T. Rasmussen)
1st and 2nd quarters of 1935	Psychiatry at Rochester State Hospital
3rd quarter of 1935	Outpatient neurology <ul style="list-style-type: none"> • Appointed neurology first assistant in Jul 1, 1935
4th quarter of 1935	Neuro-ophthalmology
1st and 2nd quarters of 1936	Neuropathology (supervisor Dr James Kemohan)
3rd quarter of 1936	Outpatient neurology
Oct 1, 1936	Named neurology consultant

teaching conferences in pediatric neurology, neurosurgery, and neuroradiology; and regularly scheduled conferences in basic neurology research, neuropathology, cerebrovascular disease, neuro-oncology, muscle disease, and peripheral nerve disease.⁷¹ There were formal courses in basic neurology, neuroanatomy, and neurophysiology; clinicopathological conferences several times per year; and seminars on neurochemistry, neuropharmacology, and neuroimmunology.⁷¹ Program director Emre Kokmen encouraged the residents in 1988 to “eat, drink, dream and think neurology and nothing else.”⁷² In 1990, Mayo neurologist

Eduardo Benarroch began directing the basic neuroscience course, which he continues to do. [Table 1](#) lists the current conferences and courses. The courses are directed and taught almost exclusively by clinical neurologists and comprise approximately 245 hours of face-to-face didactic or procedural teaching over the 3-year neurology residency.

OTHER EDUCATIONAL ENDEAVORS

In the 1949 annual neurology section report, a system to increase bedside teaching was described. A faculty member examining a patient in room 294 in the clinic would ask the desk attendants to call out “1000-294.” This announcement let the residents know to come to room 294 to see a patient with an interesting disease or examination finding.⁶³

The neurology section also produced books and handouts on the neurologic history and examination to educate the residents. *Compend of Clinical Examinations at the Mayo Clinic*, first published in 1924, included a short section on how to take a neurologic history.⁷³ Alexander MacLean created a 17-page document that gave detailed instructions on the neurologic examination.²⁶ It was given to all residents when they started the neurology service.¹⁹ In 1956, the members of the Mayo Clinic Neurology and Physiology sections published *Clinical Examinations in Neurology* ([Figure 4](#)).⁷⁴ It was dedicated to Henry Woltman and Fred Moersch upon their

TABLE 4. Mayo Clinic Neurology Residency Rotations in 1967⁴³

Rotation	Duration (mo)
Adult neurology	15
Pediatric neurology	3
“Basic science” <ul style="list-style-type: none"> • EEG • EMG • Neuropathology • Neuroanatomy (with Dr Henry Hollinshead) 	12
Psychiatry <ul style="list-style-type: none"> • Elective but encouraged 	3
Neuro-ophthalmology	2
Neuroradiology	1

EEG = electroencephalography; EMG = electromyography.

TABLE 5. Mayo Clinic Neurology Residency Rotations in 1985⁷¹

Rotation	Duration (mo)
Adult neurology	19 • Inpatient: 14 • Outpatient: 5
Pediatric neurology	3
Neuropathology and neuroradiology	3
EEG/EMG	2
Electives	9

EEG = electroencephalography; EMG = electromyography.

retirements and was meant to facilitate the residents' "mastery of the clinical neurologic examination."^{74,75}

ROTATIONS

The clinical rotations of John Doyle from the 1920s and Lee Eaton from the 1930s are reviewed in [Tables 2](#) and [3](#). There are several noticeable differences in their schedules. Unlike Doyle, Eaton spent a quarter studying neuroanatomy with Dr Andrew T. Rasmussen at the University of Minnesota.^{4,30} From the mid-1920s through the late 1940s, nearly all Mayo neurology trainees spent a quarter with Dr Rasmussen.^{4,77} Rasmussen published *The Principal Nervous Pathways* in 1932, which had exquisite illustrations.⁷⁸ Two of Rasmussen's sons completed neurology training at Mayo Clinic.^{4,79} One of those sons, Theodore, went on to train in neurosurgery at Montreal and describe what was later called *Rasmussen*

encephalitis.⁸⁰ Henry Hollinshead started teaching neuroanatomy to the Mayo residents in the late 1940s.⁸¹

In contrast to Doyle, Eaton was required to complete several months of psychiatry at the Rochester State Hospital.^{4,76} These rotations began in 1930 and ended about a year after Mayo Clinic hired psychiatrist Frank Brace-land in 1946.^{17,81} By 1948, Mayo Clinic faculty members could provide adequate psychiatry training for the residents.⁸¹ The need for a prolonged psychiatry training experience related to the establishment of the ABPN in 1934. Initially, the ABPN required internship, 1 year of neurology training in a special neurology hospital recognized by the American Medical Association (AMA), 1 year of psychiatry, adequate training in neuroanatomy and neuropathology, and then 3 years of practice largely limited to neurology.⁸²⁻⁸⁴ The ABPN and the AMA's Council on Medical Education evaluated and accredited programs into the early 1950s.⁸³ The residency review committee (RRC), composed of ABPN and AMA members (including Mayo neurologist Kendall Corbin in its original roster), next took over the task of approving residency training programs.^{83,85} The RRC met for the first time in 1954,⁸⁵ and thus the original accreditation date of the Mayo neurology residency was listed as August 2, 1954. In 1972, oversight of residency training passed to the Liaison Committee on Graduate Medical Education, with the Accreditation Council for Graduate Medical Education (ACGME) assuming this function

TABLE 6. Mayo Clinic in Rochester, MN, Neurology Residency Rotations in 2019

PGY-2		PGY-3		PGY-4	
Rotation	Duration (mo)	Rotation	Duration (mo)	Rotation	Duration (mo)
Inpatient stroke and general neurology junior	4-5	Clinical neurophysiology	2	Inpatient stroke, general neurology, EN senior	3-4
Night float EN junior	1-1.5	Neuropathology	2	Night float EN senior	1-1.5
NICU junior	0.5	NICU senior	2	Outpatient subspecialty	1
Outpatient neurology education division junior rotation	1	Hospital consult service senior	1	Outpatient neurology education division senior rotation	1
Pediatric neurology	2	Outpatient subspecialty	1	Pediatric neurology	1
MCA or MCF (elective)	0-1	Psychiatry	1	MCA or MCF (elective)	0-1
Electives	2.5-3	Electives	3	Electives	3-4

EN = emergency neurology; MCA = Mayo Clinic in Arizona; MCF = Mayo Clinic in Florida; NICU = neuroscience intensive care unit; PGY-2 = postgraduate year 2; PGY-3 = postgraduate year 3; PGY-4 = postgraduate year 4.

TABLE 7. Mayo Clinic in Rochester, MN, Neurology Residency Program Directors⁹²

Date	Program director
1958-1966	Joe Brown
1966-1968	Jack Whisnant
1968-1974	Frank Howard
1975-1981	Bill Kames
1982-1986	Jasper Daube
1987-1988	Emre Kokmen
1989-1994	Terry Cascino
1994-1995	Charles (Michel) Harper Jr
1996-1998	Jerry Swanson
1998-2005	Robert Brown Jr
2005-2013	Chris Boes
2013-present	Lyell Jones Jr

in 1981. The RRCs for neurology and psychiatry split in 1983.⁸⁴

The 1967 three-year neurology residency curriculum (after internship) is displayed in Table 4. The first 6 months of neurology training were divided evenly between the inpatient and outpatient settings.⁴³ The neurology junior resident was supervised by a first assistant and a consultant. In the second year of neurology training, the resident spent 3 months as a first assistant on the hospital service.⁴³ During the second or third year, the trainee spent 3 to 6 months as a first assistant in the neurology clinic, where the resident was “obliged to discuss each patient with a neurologic consultant and on appropriate occasions, the neurologic consultant [would] re-examine the patient.”⁴³ Pediatric neurology was also completed during the second or third year (half inpatient, half outpatient). Education during the neuropathology and neuroradiology rotations in 1968 was felt to be inadequate.⁶⁶ Frank Howard commented that “it has always seemed ironic to me that we allow our residents considerable responsibility in taking care of live patients but can trust them to do so little on a cadaver.”⁶⁶ The radiologists were busy clinically and did not have enough time to teach.⁶⁶

In 1980, a new rule was established that first assistants in neurology hospitals were allowed at least 1 day off per week.⁶⁹ By 1983, there were 7 hospital services to cover.⁷⁰ The 1985 three-year neurology residency curriculum is displayed in Table 5. The neurology junior resident spent 8 months

in the inpatient setting, whereas the second year of neurology was focused on EMG/EEG and electives.⁷¹ The third year neurology residents spent most of their time as first assistants in the inpatient and outpatient settings. Neuro-ophthalmology was no longer required, having become an elective rotation in 1973.³¹ During their 3 years of neurology training, residents at Mayo Clinic in Rochester currently complete 17 inpatient months and have approximately 11 months of elective time. The 2019 rotations are listed in Table 6.

PROGRESSIVE RESPONSIBILITY

Having already completed 6 months of neurology and several quarters of internal medicine, John Doyle was given more clinical responsibility in 1921 when he was named a first assistant in neurology.¹³ Allan Bailey, who started his Mayo neurology residency in 1937, commented that “we were given responsibility as we were ready for it.”⁸⁶ A second-year neurology resident working as a first assistant in the hospital service in 1967 managed the service “to a degree commensurate with his experience and capability as determined by the consultant with whom he is working.”⁴³ Frank Howard felt that “this program of graded responsibility as the resident progresses has been highly successful both from the viewpoint of the resident and from the standpoint of assisting with the clinical load.”⁴³ Neurology department chair Jack Whisnant commented in 1973:

Our residents receive increasing responsibilities throughout their period of training so that by the time of completion of training they are capable of independent consultative practice in Neurology. They do receive supervision throughout their training period, even at the point where they have independence in seeing patients. The opportunities for increasing responsibilities are achieved both in [sic] outpatient and inpatient practice of Neurology.³¹

Mayo neurology trainees have always been granted graded, progressive responsibility for patient care with defined oversight as they progress toward independence, which is now a stipulation of the ACGME (Table 6).⁸⁷

EVALUATION

Oral examinations with faculty members from both Mayo Clinic and the University of Minnesota were required for those completing master's degrees in neurology.⁶ Frank Howard commented in 1967 that quizzes were given 4 times per year to all residents (2 oral, 2 written), regardless of whether they were pursuing master's degrees.⁴³

Quarterly letter grades were given to John Doyle by his supervising Mayo Clinic physicians, and this was the mainstay of the Mayo resident evaluation system for many years.¹³ By 1972 in the Mayo Clinic Neurology Residency, B– was considered a bad grade, B average, A good, and A+ excellent.⁸⁸ Inconsistency in grading of residents was discussed in the 1980 annual neurology report.⁶⁹ In 1985, Mayo neurologist Bruce Evans noted that an assessment form was completed by each faculty member with whom a resident had worked and a quarterly grade was derived from these forms.⁸⁹ Any resident receiving 2 consecutive grades of C or lower was placed on probation, and a remediation plan developed.⁸⁹ Oral examinations were still in place in 1985, and multiple-choice in-service examinations had been used since 1972.^{68,89,90} Sometimes, the evaluators were unwilling to be overly critical of the residents.⁸⁹ Evans noted deficiencies in direct observation and evaluation according to consistent standards and proposed amending the evaluations sheets, starting witnessed histories and examinations, and performing chart audits.⁸⁹

PERSONNEL: PROGRAM DIRECTOR

Louis Wilson was head of the Mayo Foundation and all residency programs from 1915 to 1937, followed by Donald Balfour from 1937 to 1947, and Victor Johnson from 1947 to 1966.⁹¹ No one particular faculty member was identified as being in charge of the residency in the Mayo Clinic annual neurology reports through 1957, so likely the Mayo Foundation director worked with the head of neurology to administer the program. Joe Brown was named head of Mayo Clinic neurology education in 1958.⁴² Subsequent program directors are listed in Table 7. Note that the AMA *Directory of Approved Residencies* used the term “program

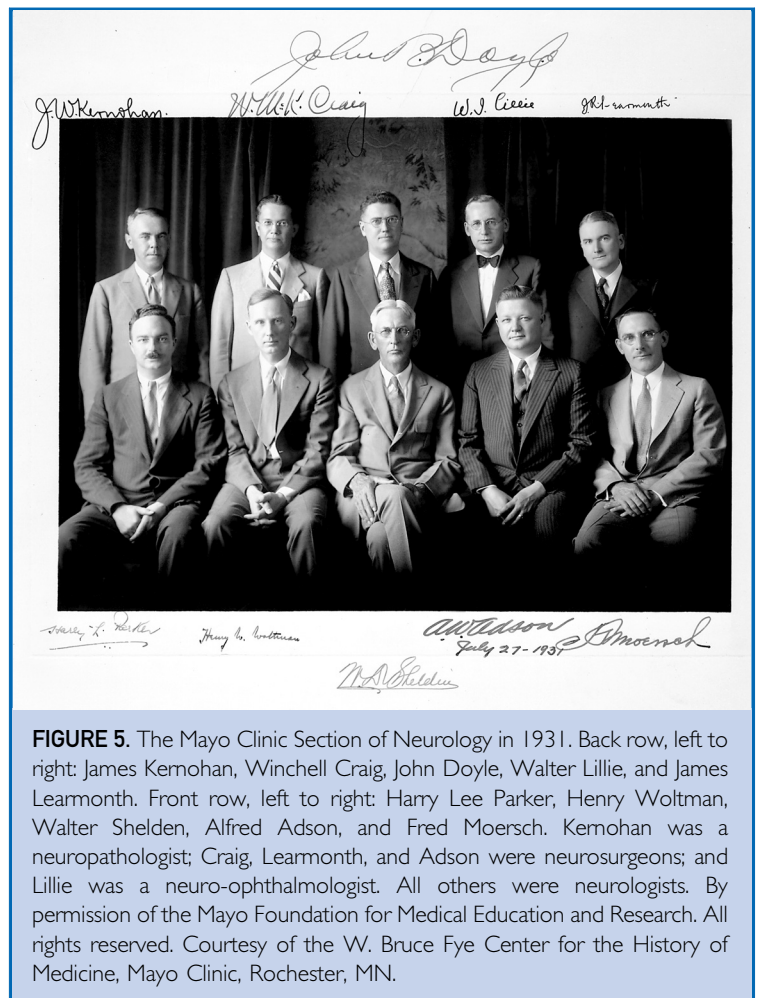


FIGURE 5. The Mayo Clinic Section of Neurology in 1931. Back row, left to right: James Kemohan, Winchell Craig, John Doyle, Walter Lillie, and James Learmonth. Front row, left to right: Harry Lee Parker, Henry Woltman, Walter Shelden, Alfred Adson, and Fred Moersch. Kemohan was a neuropathologist; Craig, Learmonth, and Adson were neurosurgeons; and Lillie was a neuro-ophthalmologist. All others were neurologists. By permission of the Mayo Foundation for Medical Education and Research. All rights reserved. Courtesy of the W. Bruce Fye Center for the History of Medicine, Mayo Clinic, Rochester, MN.

director” for the first time in 1960 (instead of just “chief of service”), and the label was first used in the annual AMA hospital worksheet completed by Joe Brown in 1962.^{46,93}

Brown shared some of the residency administrative duties with Kendall Corbin, who took care of residency recruitment.^{94,95} This distributed approach to program administration continued. While Frank Howard was the program director in 1972, Allan Dale was in charge of resident assessment, and Bill Karnes handled assignments and absences.⁸⁸ Similarly, when Jasper Daube was the program director in 1985, he shared administrative duties with Brian O’Neill (assessment), Don Layton (recruitment), and J.D. Bartleson (assignments and absences).⁹⁶ Lyell Jones Jr, the current neurology residency program director in Rochester, is assisted by Mayo neurologists Scott Eggers (clinical

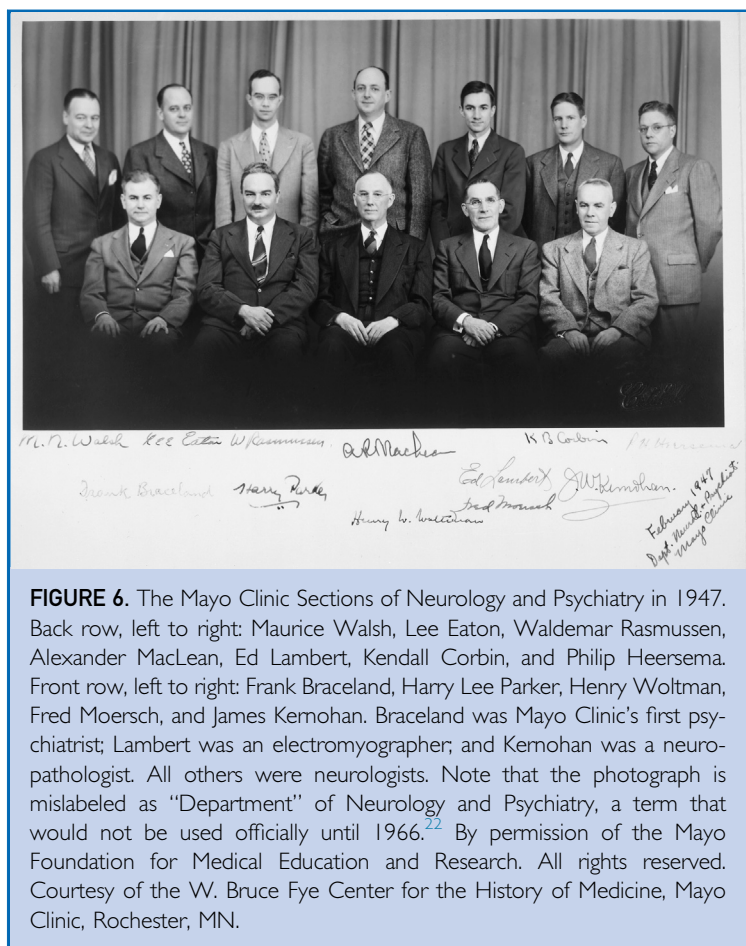


FIGURE 6. The Mayo Clinic Sections of Neurology and Psychiatry in 1947. Back row, left to right: Maurice Walsh, Lee Eaton, Waldemar Rasmussen, Alexander MacLean, Ed Lambert, Kendall Corbin, and Philip Heersema. Front row, left to right: Frank Braceland, Harry Lee Parker, Henry Woltman, Fred Moersch, and James Kemohan. Braceland was Mayo Clinic's first psychiatrist; Lambert was an electromyographer; and Kemohan was a neuropathologist. All others were neurologists. Note that the photograph is mislabeled as "Department" of Neurology and Psychiatry, a term that would not be used officially until 1966.²² By permission of the Mayo Foundation for Medical Education and Research. All rights reserved. Courtesy of the W. Bruce Fye Center for the History of Medicine, Mayo Clinic, Rochester, MN.

competency), Neeraj Kumar (remediation), Elizabeth Coon (curriculum), Jeremy Cutsforth-Gregory (recruitment), and James Klaas (trainee well-being).

Mayo Clinic neurology program directors have been recognized nationally for excellence. Mayo Clinic in Rochester, MN, Neurology Residency Program Directors Chris Boes and Lyell Jones Jr both won Program Director Recognition awards from the AAN, and Jones received the ACGME Parker J. Palmer Courage to Teach Award.^{97,98}

PERSONNEL: PROGRAM COORDINATOR

Isabel Farr was the Mayo Foundation registrar from 1915 to 1951 and likely worked on program coordinator activities with the departmental secretaries.⁹⁹ Program director Frank Howard specifically mentioned the help he received from neurology secretary Marian Dubbels in the 1969 annual neurology

report.⁶⁷ Lea Dacy, Sherry Gustafson, and Deb Bastian served as program coordinators in the 1990s, and Tonya Novak, Laura Disbrow, and Donna Larkin did so in the 2000s. The current residency program coordinators (with their starting years) include Vickie Witt (1995), Linda Schmidt (1996), DeAnna Shones (1998), and Amy Halliday (2018). These coordinators have assisted the program in accomplishing its goals and given wise counsel to numerous residents.

PERSONNEL: FACULTY

According to Mayo neurologist Joe Rushton, famed neurosurgeon and head of the Montreal Neurological Institute Wilder Penfield told John Doyle in 1928 that "if [the neurologic section at Mayo] can be held together, you have the greatest service in the world" (Figure 5).²³ In a 1946 letter, the generally modest and understated Henry Woltman commented that "the Section on Neurology, as it now stands, has been spoken of as the strongest department of organic neurology in the country" (Figure 6).¹⁰⁰ Twenty-eight percent of patients seen in 1947 had neuropsychiatric disorders or normal examinations, but by that time Woltman was head of the sections on neurology and psychiatry, with 2 sections of neurology and 1 of psychiatry.³⁴ Patients with psychiatric disease were preferentially evaluated by the Mayo psychiatrists, but the neurologists continued to see some patients with psychiatric disease because of the demand.³⁴ Mayo neurologist Doug Rooke noted that he "came to [Mayo Clinic] Neurology (1947) at a time that was fortunate...the consulting staff was like no other group I had ever encountered—world authorities without conceit or affectation, a friendly, accessible and thoroughly delightful group."¹⁰¹

A few of the early section members will be highlighted. Mayo Clinic's first neurologist Walter Shelden would often advise the residents that "the patient is the book, study him."⁸ John Doyle commented on his teacher Walter Shelden:

By nature he was adapted to the graduate teaching of medicine. He had an instinctive appreciation of the essential characteristics of clinical entities and had developed a wide knowledge of what he liked to call "the limitations of normal."¹⁶

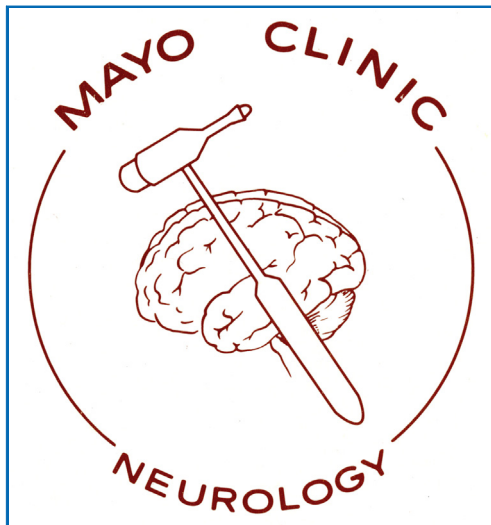


FIGURE 7. Logo of Mayo Clinic Neurology from the 1960s/1970s. By permission of the Mayo Foundation for Medical Education and Research. All rights reserved. Courtesy of the W. Bruce Fye Center for the History of Medicine, Mayo Clinic, Rochester, MN.

Regarding Shelden's feedback style, Woltman reported that "when he suggested I read Gordon Holmes' article on the sensory changes of tabes dorsalis I knew just what he meant—I had missed sensory changes around the nose."⁸ Doug Rooke noted that his teachers Henry Woltman and Fred Moersch were complementary:

Henry—tall, slender, contemplative and reserved—was so quiet and gentle in manner and so unassuming as to seem almost shy. He could move quickly to the heart of any problem but was always aware of the unusual possibilities. Not many diagnoses surprised him, and his inquiring mind was never still....Fred was a squarely-built, down-to-earth, easily accessible, outgoing person. He always seemed available for puzzling problems and always left you with the feeling that you'd figured it out yourself.¹⁰¹

Lee Eaton described Shelden, Woltman, and Moersch as a triumvirate who believed in "guidance without pampering; help without meddling."¹⁰² The 3 took the lead from their bosses, as the same was said about William J. and Charles H. Mayo.^{9,103}



FIGURE 8. Dr. Mary Emily Marshall. By permission of the Mayo Foundation for Medical Education and Research. All rights reserved. Courtesy of the W. Bruce Fye Center for the History of Medicine, Mayo Clinic, Rochester, MN.

Allan Bailey stated that "it was a great experience to watch a consultant like Lee Eaton ferret out the history of a patient and carry out a careful examination...he used the Socratic method in teaching, hence realizing that it was learning that was important."⁸⁶ Irishman Harry Lee Parker was witty and friendly, delivered memorable lectures, and was an outstanding bedside teacher.^{23,104} Parker "had a love for funny and slightly risqué stories and would laugh heartily as each was told."¹⁹ He was at Mayo Clinic from 1919 to 1934, left to practice neurology in Dublin, and then returned to Mayo Clinic in 1945, where he worked until his death in 1959.¹⁰⁵ He authored the book *Clinical Studies in Neurology*, based on his bedside teaching to Irish medical students at the Richmond Hospital in Dublin.²⁵

The neurology residents voted to give Burt Sandok the first neurology teacher of the year award in 1971.⁶⁸ The following Mayo Clinic



FIGURE 9. Dr Grace Elizabeth (Betty) Clements. By permission of the Mayo Foundation for Medical Education and Research. All rights reserved. Courtesy of the W. Bruce Fye Center for the History of Medicine, Mayo Clinic, Rochester, MN.



FIGURE 10. Dr Frederick Thornton Boulware Jr. By permission of the Mayo Foundation for Medical Education and Research. All rights reserved. Courtesy of the W. Bruce Fye Center for the History of Medicine, Mayo Clinic, Rochester, MN.

in Rochester faculty members were inducted into the hall of fame for winning the neurology teacher of the year award from the Mayo Fellows Association at least 3 times: Allen Aksamit Jr, Eduardo Benarroch, Kelly Flemming, Robert Hermann Jr, Lyell Jones Jr, Donald Klass, Neeraj Kumar, Burt Sandok, and Barbara Westmoreland. Several neurology faculty members have received Mayo Clinic Distinguished Educator awards (the institution's highest educational honor), including Burt Sandok, Eduardo Benarroch, Jasper Daube, Anthony Windebank, Allen Aksamit Jr, Terry Cascino, Robert Brown Jr, and Donn Dexter. Mayo Clinic faculty members have been recognized nationally for teaching excellence by winning the A.B. Baker Award for Lifetime Achievement in Neurologic Education from the AAN, including Burt Sandok, Barbara Westmoreland, Jasper Daube, and Eduardo Benarroch.¹⁰⁶ Daube also won the American Neurological Association Distinguished Neurology Teacher Award.¹⁰⁷

The neurology residents at Mayo Clinic learned not only from the neurologists but also from the nurses. For example, Sister

Theodora Mikolai worked in the spinal puncture room from 1932 to 1960.¹⁰⁸ She assisted the neurology hospital service residents with lumbar punctures, being involved in approximately 40,000 procedures over her 28 years of service.¹⁰⁸ A resident observed that “it was said [in 1949]...that all a fellow had to do was to hold the syringe straight, while Sister Theodore [sic] would guide the patient’s interspace onto the needle.”¹⁹ In 1983, nurse Karen Kuntz was trained by Mayo neurologist Keith Campbell to do spinal taps.⁷⁰ She then trained the residents and medical students on the outpatient spinal tap service.⁷⁰ By 1988, Kuntz had “performed more lumbar punctures than most physicians will in a lifetime.”⁷² As of January 2020, there are 7 lumbar puncture registered nurses working in the Mayo Clinic Department of Neurology in Rochester, MN, who assist in the training of residents to perform this procedure.

SUMMER SCIENTIFIC SESSION

The annual departmental party for faculty members and trainees had its roots in yearly



FIGURE 11. Dr Reno Eugene Backus. By permission of the Mayo Foundation for Medical Education and Research. All rights reserved. Courtesy of the W. Bruce Fye Center for the History of Medicine, Mayo Clinic, Rochester, MN.

gatherings successively hosted by Walter Shelden, Fred Moersch, and Joe Brown.⁴ Proceeds from Moersch’s book *Neurology and Psychiatry*

for Nurses (first published in 1935) paid for an annual neurology picnic at his cottage on Lake Zumbro outside of Rochester.^{4,109} Joe Brown later bought Moersch’s cabin and continued the tradition.⁴ The first “summer scientific session,” named by Mayo neurologist Bob Siekert, was held in 1959 at the Rochester Tennis Club.¹¹⁰ It was possibly paid for by the Lee Eaton Fund, which came from *Clinical Examinations in Neurology* book royalties and later from the 1978 *Medical Neurosciences* book royalties.^{90,110} The “science” was tongue in cheek, as these were social gatherings, during which residents would often show entertaining films that they had produced. In response to an invitation to the 1962 summer scientific session, Henry Woltman said that he hoped to be there and that his wife would attend if the weather permitted.¹¹¹ He added that “she drinks nothing stronger than water whereas I regard it as unexcelled for ablution and necessary for navigation.”¹¹¹

GRADUATION

From October 1926 to April 1927, Henry Woltman went on an extended trip to Europe to visit leading neurologic centers.⁴ In Hamburg he was so impressed with the Trömner reflex hammer that he purchased enough for himself and all section members.¹¹² The hammer became a symbol of Mayo neurology, as well as part of its logo (Figure 7). It became a tradition to present engraved silver Trömner hammers to graduating residents.¹¹³ Eventually the graduates were honored (and given their hammers) during the annual Department of Neurology recognition dinner. The 1983 program listed presentations of the graduating trainees, the Henry Woltman Award (described below), and the neurology trainee research award.¹¹⁴ Retiring staff members were honored, and Arthur Asbury from the University of Pennsylvania was the guest speaker.¹¹⁴

FIRST WOMAN NEUROLOGY RESIDENT

Dr Mary Marshall (Figure 8) started her neuropsychiatry residency at Mayo Clinic in 1937, but her major was always psychiatry, and she practiced psychiatry after finishing her training.^{115,116} The first woman neurology resident at Mayo Clinic to devote herself to the practice of neurology after residency

TABLE 8. Mayo Clinic Department of Neurology Subspecialty Fellowships

Advanced Clinical Neurology
Autoimmune Neurology
Autonomic Disorders
Behavioral Neurology
Clinical Neurophysiology—EEG Track
Clinical Neurophysiology—EMG Track
Deep Brain Stimulation
Epilepsy
Headache
Medical Speech-Language Pathology
Movement Disorders
Multiple Sclerosis
Neurocritical Care
Neuromuscular Disorders—Muscle
Neuromuscular Disorders—Nerve
Neuromuscular Medicine
Neuro-oncology
Vascular Neurology

EEG = electroencephalography; EMG = electromyography.

completion was Dr Betty Clements (Figure 9).¹¹⁷ Clements grew up in a small town in Nebraska, completed undergraduate training at the University of Nebraska, and later became a member of the Women Airforce Service Pilots program.¹¹⁷ While in that program, she flew members of the atomic bomb group around the United States.^{117,118} She subsequently completed medical school at the University of Nebraska and did internship in Phoenix, Arizona. Clements completed her neurology residency at Mayo Clinic from October 1954 through December 1957.¹¹⁷ She was a superior resident, known for her meticulous work, excellent fund of knowledge, and great bedside manner.¹¹⁷ When Clements returned to practice neurology in Phoenix in 1958, she was “the first full-time Neurologist in the Southwest between Dallas and Los Angeles and between Denver and Mexico City.”¹¹⁹ Clements was one of the founders of the Barrow Neurological Institute.¹¹⁹ She died of carcinomatosis at the age of 47.¹¹⁷

FIRST BLACK NEUROLOGY RESIDENT

Dr Frederick T. Boulware Jr (Figure 10) received his medical degree from Meharry Medical College in 1965 and completed internship at Mount Sinai Hospital in New York City.¹²⁰ He began his training in Rochester, MN, in July 1966 as a psychiatry resident but changed to the neurology residency in October 1966. He finished neurology training on December 31, 1969, worked as a Mayo Clinic neurology associate consultant for 6 months, and was named a Mayo Clinic neurology consultant on July 1, 1970.¹²⁰ He resigned at the end of 1971 to work in private practice in Las Vegas, Nevada.⁶⁸ Boulware was an excellent clinical neurologist, and Bill Karnes commented that “we feel his loss, not only as a valuable associate, but as a personal friend.”⁶⁸

OTHER DEPARTMENTAL FIRSTS

After Henry Woltman died in 1964, an award was established in his name to honor the “fellow or resident in the neurological sciences who demonstrates superior ability and performance in the field of clinical neurology in regard to careful observation of clinical phenomena, sympathetic care of patients and initiative in teaching of clinical neurology.”¹²¹ Dr Leonard Carney received the first Henry W.

Woltman Award for Excellence in Clinical Neurology in 1966, and it has been awarded yearly since then.

Mayo Medical School opened in 1972, and the first neuroscience course was run by Mayo neurologists Jerry Chutkow, Burt Sandok, Jasper Daube, Thomas Reagan, and Jim Melling from October 1972 through December 1972.³¹ It was decided to have residents help teach the course, and in 1976 Mayo neurology residents James Albers and John J. Kelly Jr became the first of many to do so.⁹⁰

CHILD NEUROLOGY RESIDENCY

In 1959, J. Gordon Millichap accepted a job as a pediatric neurologist in Rochester, with the goal of establishing a pediatric neurology residency program at Mayo Clinic.⁹⁴ He received NINDB funding to do so, and the first child neurology resident was Reno Backus (Figure 11). Backus completed 2 years of general pediatrics from 1958 to 1960 and 3 years of pediatric neurology from 1960 to 1963, all at Mayo Clinic.¹²² Millichap left in 1963, to be replaced by Manuel Gomez in 1964.¹²³ In 1968, the ABPN started issuing certificates in neurology with special competence in child neurology in addition to those in general neurology.^{83,84} In 1985, the child neurology residency at Mayo Clinic included 10 months of adult neurology, 12 months of child neurology, 3 months of neuropathology and neuroradiology, 2 months of EEG and EMG, and 9 months of electives.⁷¹ Currently, the ACGME requires 12 months of adult neurology and 12 months of clinical child neurology.

NEUROLOGY RESIDENCIES AT MAYO CLINIC IN FLORIDA AND MAYO CLINIC IN ARIZONA

In the 1990s, Mayo Clinic in Rochester, MN, neurology residents were required to rotate at both Mayo Clinic in Florida and Mayo Clinic in Arizona in 2-month or 3-month blocks during the postgraduate year 2 (PGY-2) and postgraduate year 4 (PGY-4) years of training. Those clinical experiences became electives later when Mayo Clinic in Florida and Mayo Clinic in Arizona established their own neurology residencies. The postgraduate year 1 (PGY-1) neurology class began at Mayo Clinic in Florida in 2001 (program director Frank Rubino, assisted by David Capobianco) and the PGY-1 class began at Mayo

Clinic in Arizona in 2004 (program director David Dodick).^{124,125}

David Capobianco was awarded the Program Director Recognition Award from the AAN in 2011 when he directed the adult neurology residency at Mayo Clinic in Florida.⁹⁷ Several neurology faculty members at Mayo Clinic in Florida and Mayo Clinic in Arizona have received Mayo Clinic Distinguished Educator awards, including Frank Rubino, David Capobianco, Devon Rubin, Ben Eidelman, Dave Freeman, Jon Carter, Joe Sirven, David Dodick, Bart Demaerschalk, and Joe Draskowski.

NEUROLOGY SUBSPECIALTY FELLOWSHIPS

There was considerable growth in the neurologic subspecialties in the late 20th and early 21st centuries.¹²⁶⁻¹²⁸ The Mayo Clinic Department of Neurology received NINDB training grants in neurophysiology (EEG and EMG) in the 1950s and cerebrovascular disease in the 1960s.^{4,22} Neurophysiology-EMG trainees divided their time between clinical EMG and basic laboratory research until 1977 when a 1-year clinical EMG fellowship was established.⁴⁰ By 1979, there were 4 EEG fellows and 2 EMG fellows each year.⁴⁴ Burt Sandok stated in 1983 that “in order to meet the competition of the next decade, we at Mayo will need to move briskly and pointedly toward greater subspecialization.”⁷⁰ The first peripheral nerve fellowship started in 1985, and over the years several other subspecialty fellowships were started. Table 8 lists the current neurology fellowships administered by the Mayo Clinic Department of Neurology in Rochester, MN. In 1983, it was noted that more than 50% of graduating residents completed additional fellowship training.⁷⁰ In the past 7 years, 97% of Mayo Clinic in Rochester, MN, Neurology Residency graduates went on to complete at least 1 subspecialty fellowship (Lyell Jones Jr, MD, written personal communication, June 11, 2020).

ASSESSMENT OF THE MAYO CLINIC NEUROLOGY RESIDENCY

The AAN started offering an in-service training examination in 1972. In 1976, the Mayo neurology residents scored in the 74th percentile overall.⁹⁰ This rose to the 77th percentile

in 1978 and dropped to the 66th percentile in 1979.^{41,44} Averaged over the years 2014 to 2019, the Mayo Clinic adult neurology residents in Rochester, MN, scored in the 99th percentile overall as a group on the resident in-service training examination (Lyell Jones Jr, MD, written personal communication, February 8, 2020). In the mid-1970s, approximately 90% of Mayo neurology residents passed the ABPN examination on their initial attempts, which was felt to be a very high pass rate.³¹ The overall board pass rate of the adult neurology residents at Mayo Clinic in Rochester, MN, from 2014 to 2019 was 96%, above the national average of 88% (Lyell Jones Jr, MD, written personal communication, February 8, 2020). In 2011, Mayo Clinic was number 2 on a list of programs producing the highest number of graduates remaining in academic neurology.¹²⁹ In 1983, 38% of graduating residents accepted academic appointments after residency completion.⁷⁰ In the past 7 years, 70% of Mayo Clinic in Rochester, MN, Neurology Residency graduates entered academic practice after completing all training (Lyell Jones Jr, MD, written personal communication, June 11, 2020).

Mayo neurologist Clark Millikan commented in 1961 that the training program was held in high regard “by leading neurologic educators throughout the United States.”¹³⁰ The institutional (nondepartmental) Mayo Clinic Residency Committee stated in 1972 that the “Neurology Residency Program here was one of the best educational programs in the institution and in the country.”¹³¹ The online physician social networking site *Doximity* and *U.S. News & World Report* partnered to create an annual survey-based ranking of all US residency programs, including neurology. In the 2019 *U.S. News & World Report/Doximity* adult neurology residency reputational rankings, Mayo Clinic in Rochester was number 3, Mayo Clinic in Florida was number 11, and Mayo Clinic in Arizona was number 14.⁴⁷ In the 2019 child neurology residency reputational rankings, Mayo Clinic in Rochester was number 13 and Mayo Clinic in Florida was number 47.⁴⁷

CONCLUSION

Reciprocal development has been a consistent theme of the Mayo Clinic Neurology

Residency Program since its founding in 1919, to the equal benefit of 639 resident graduates and numerous faculty members. The focus on didactics goes back to the beginning of the program, and the division of residency program administrative duties dates to the 1950s. Progressive responsibility was an early key principle that has remained important to this day. Several leaders of neurology and neurology education, at Mayo Clinic and elsewhere, were products of this visionary residency program.

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Correspondence: Address to Christopher J. Boes, MD, Department of Neurology, Mayo Clinic, 200 First St SW, Rochester, MN 55905 (boes.christopher@mayo.edu; Twitter: @ChrisBoesMD).

ORCID

Christopher J. Boes:  <https://orcid.org/0000-0002-7768-0994>; Elizabeth A. Coon:  <https://orcid.org/0000-0003-1206-0222>

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