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Implementation of a Multifaceted Interactive Electrodiagnostic Medicine Workshop in a PM&R Residency Program

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Abstract

Electrodiagnostic Medicine is a required component of Physical Medicine and Rehabilitation residency education, but limited resources exist to guide curriculum development. Our objective was to create a focused workshop to enhance our residency program's electrodiagnostic curriculum. We created two separate 1.5-day workshops, one basic and one advanced, for all residents. Each workshop included didactic sessions, case discussion, question and answer sessions, demonstrations and hands-on participation with direct supervision and feedback. Pre and post surveys were administered to evaluate the value of the workshops. We also assessed trends in electrodiagnostic self-assessment exam scores. Residents reported clinical electrodiagnostic rotations to be more valuable to their education than prior didactic sessions and independent learning. Self-reported knowledge of electrodiagnostic concepts, resident comfort level in planning, performing, and interpreting studies, and perceived value in independent learning of Electrodiagnostic Medicine improved after implementation of the workshops. There was a 7% improvement in the American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) electrodiagnostic self-assessment exam (SAE) score compared to the previous year and a 15% improvement in the Physical Medicine and Rehabilitation SAE electrodiagnostic subscore compared to the previous five years. All participants recommended similar educational experience for other residents. This successful workshop may serve as a resource for other training programs.

Keywords

Curriculum Development; Resident Feedback; EMG; Neuromuscular

Introduction

Electrodiagnostic Medicine, the use of neurophysiologic techniques to diagnose, evaluate, and treat patients with neuromuscular disorders¹, is a key component of Physical Medicine

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and Rehabilitation (PM&R). As a result, it is also a highly represented area on the board examination (15%) and a major focus of PM&R training.² In fact, PM&R is currently the only residency program with a specific Electrodiagnostic Medicine requirement. The requirements for PM&R training programs specify that residents should demonstrate progressive responsibility in diagnosing, assessing, and managing congenital or acquired myopathies, peripheral neuropathies, motor neuron and motor system diseases, and other neuromuscular diseases.³ It is further stipulated that residents demonstrate competence in the performance, documentation, and interpretation of 200 electrodiagnostic evaluations prior to graduation.³ In addition to these training requirements, the ACGME milestone system has further outlined targets for residents in relation to electrodiagnostic procedures as they progress through training.⁴

Nevertheless, despite the continued emphasis on the importance of Electrodiagnostic Medicine in the field of PM&R and associated program requirements, there has been relatively little guidance regarding specific curriculum development, permitting significant individual program autonomy. In most programs, electrodiagnostics comprise at least 4 of the 36 months of training and also a portion of the regular occurring didactics. Yet, due to several factors, the training experience can differ greatly among programs and even within a single residency.

There are very few published studies regarding Electrodiagnostic and Neuromuscular Medicine education and training for PM&R residents. Previously, the Robert Wood Johnson Medical School PM&R residency program published their experiences creating an educational module instructing PM&R residents in electrodiagnostic evaluation and verifying the acquired competencies through objective evaluation methodology.^{5,6} This module included a combination of hands-on training, lectures, and review of self-assessment exam concepts, with demonstrated improvement in self-assessment exam scores at initial implementation and at follow up.^{5,6} The American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) has also developed education products including Self-Assessment Examinations, but there are no specific guidelines on how to train residents in Electrodiagnostic Medicine.⁷ We are not aware of any additional resources for PM&R programs at this time.

The goal of this project was to better understand the value of the current components of our electrodiagnostic curriculum and to create a focused electrodiagnostic workshop to enhance our residency program's current clinical and didactic training. We used a multifaceted and interactive approach to optimize participant engagement and clinical relevance, and we tracked resident scores on the AANEM Electrodiagnostic self-assessment examination and the electrodiagnostic component of the general PM&R self-assessment examination before and after the workshop. This curriculum may be applicable to other residency programs experiencing similar challenges to training.

Current Electrodiagnostic Curriculum

At our program, residents are required to spend 5 months on rotations primarily focused on electrodiagnostics. Residents rotate through the Electrodiagnostic Medicine clinic at one of

two large affiliated academic hospitals during their post-graduate 3 year (PGY-3) and through the Electrodiagnostic Medicine clinic at a Veterans Administration Hospital during their PGY-4 year. Additional time can be spent on electives to gain more experience, but relatively few residents select this option. Anecdotally, there has been moderate variability in experiences secondary to multiple training sites, rotating faculty, rotation timing, and presence or absence of other trainees including Electrodiagnostic Medicine fellows.

In addition to clinical rotations, one month of a repeating 12-month didactic curriculum is also devoted to electrodiagnostics. Residents participate in this curriculum annually throughout all years of training. Limitations of the traditional didactic curriculum include difficulty in securing expert faculty, variability in content, lack of continuity between sessions, and a primarily lecture-based format. For the 2015–2016 academic year, the electrodiagnostic didactic block occurred in February.

Workshop Development

The development of the workshop was a collaboration among residency program leadership, a faculty expert in Electrodiagnostic Medicine, and the chief residents. Program leadership identified Electrodiagnostic Medicine as an area for curriculum improvement and dedicated resources and protected resident time to support this effort. Given the continued value of current educational strategies and general feasibility, the addition of a workshop-based format was selected rather than changing the overall curriculum.

Together, an expert faculty member with sub-specialty board certification in Electrodiagnostic Medicine, Neuromuscular Medicine, and significant clinical experience in electrodiagnostics, and a volunteer chief resident identified educational goals, key content areas, and approaches to optimize learning. A total of five electromyography (EMG) machines were provided by a medical device service provider free of charge for the duration of each workshop. Electrodiagnostic education and the workshops were evaluated with pre- and post-surveys and via review of resident AANEM electrodiagnostic self-assessment examination (SAE) scores and general PM&R SAE electrodiagnostic subscores.

The Workshop

The workshop strived to utilize a wide array of educational strategies to optimize learning in a simulated environment, bridging the gap between the already established electrodiagnostic didactic curriculum and electrodiagnostic clinical practice. It was decided to create two separate 1.5-day workshops, one basic and one advanced, for all residents (PGY2-4). Each workshop lasted a total of 12 hours (over 1.5 days) and included didactic sessions, case discussion, question and answer sessions, EMG demonstrations and hands-on participation with direct supervision and feedback. Approximately 50% of the workshops consisted of hands-on participation or other interactive sessions. The detailed workshop schedules are outlined in Table 1.

The initial workshops were held during the 2015–2016 academic year. The basic workshop was held in February. The advanced workshop took place in April, two months after the

basic workshop. The workshops were held during the week and residents were excused from any conflicting clinical duties.

The basic workshop focused on an introduction or review of basic anatomy, terminology, and instrumentation. It also provided key information regarding nerve conduction studies (NCS) and EMG. The advanced workshop focused on advanced nerve conduction studies, repetitive stimulation and late responses, clinical applications, and details of the electrodiagnostic report. One expert faculty member provided the majority of the sessions. Other facilitators included neuromuscular specialists who discussed myopathies, brachial plexopathy, and demyelinating neuropathy and an expert in the use of electromyography for guidance for botulinum toxin injections.

Residents volunteered to receive electrodiagnostic testing. Volunteer waivers were completed. Senior residents provided immediate one on one supervision and feedback to junior residents during the hands-on sessions. The expert faculty member was available during the hands on session for additional supervision, advanced questions, and teaching as needed.

Workshop Evaluation

Before and after each workshop, a resident feedback questionnaire was administered to all participating residents (Supplementary Digital Content). The basic workshop pre-survey included questions regarding residents' current clinical electrodiagnostic experience, interest in incorporating electrodiagnostics into their career, and the value of their electrodiagnostic educational experiences to date. There were 11 additional five-point Likert scale questions focused on current level of knowledge and comfort in performing various aspects of Electrodiagnostic Medicine. These same 11 questions were administered in the basic workshop post-survey in addition to 6 questions related to the value of the workshop. Similarly, the pre- and post-advanced workshop surveys consisted of 9 five-point Likert scale questions focused on current level of knowledge and comfort in performing various aspects of Electrodiagnostic Medicine. The post-advanced workshop survey also included 6 questions related to the value of the session. In addition, we evaluated recent AANEM electrodiagnostic self-assessment examination scores and general PM&R self-assessment examination electrodiagnostic subscores for any relevant trends.

Results

All PGY-2 through PGY-4 residents (N=21) were asked to attend both the basic and advanced workshop. Most residents attended the workshop with the exception of a few who were on away-electives or vacation (N of attendees: 18 for the basic and 16 for the advanced workshop). All attendees completed the pre-survey, and most attendees completed the post-survey for each workshop (response rate of post-surveys: 83% for the basic workshop and 94% for the advanced workshop). On average, residents had participated in 1.8 months (range 0–5 months) of clinical electrodiagnostic rotations prior to participation in the workshop. Almost half of residents (44%) did not do any clinical rotation in electrodiagnostics prior to the workshop. Before the workshop, of the 12 respondents who

had completed some independent study, only 58.3% found independent study to be of some value, valuable, or very valuable (Likert mean [SD] score; 3.0 [1.2]). Similarly, residents attending previous electrodiagnostic lectures did not find them very valuable (Likert mean [SD] score; 2.1 [0.5]). Very few residents (16.7%) had attended any supplemental EMG courses outside of the residency curriculum. In contrast, 90.0% of residents who had participated in prior clinical rotations in Electrodiagnostic Medicine found them to be of some value, valuable, or very valuable to their overall education (Likert mean [SD] score; 3.9 [1.0]). Residents demonstrated significant interest in electrodiagnostic medicine with 53.3% hoping to eventually incorporate electromyography into their clinical practice.

Results from the basic workshop surveys are presented in Table 2. Before the basic workshop, resident self-assessment of knowledge of NCS and EMG was low (Likert mean [SD] score; 2.0 [0.7]). Similarly, residents initially reported relative discomfort with planning, performing, and interpreting NCS/EMG independently (Likert mean [SD] scores; 1.9 [0.5], 1.9 [0.5], and 1.8 [0.5] respectively). Resident-reported level of knowledge of basic EMG waveforms was highlighted as an area needing significant improvement (Likert mean [SD] score; 1.8 [0.5]). After the basic workshop, residents reported improvements in level of knowledge and level of comfort for all areas assessed. Resident knowledge of basic EMG waveforms had the most improvement (Likert mean [SD] score; 2.7 [0.5]).

Results from the advanced workshop surveys are presented in Table 3. This workshop took place two months after the previous one and addressed advanced Electrodiagnostic Medicine topics. Residents reported improvement in level of knowledge for all areas assessed including techniques (e.g., F waves and H reflexes), electrodiagnostic approach to neuromuscular diseases (ALS, myopathies, neuromuscular junction transmission disorders), as well as comfort in planning, performing, and interpreting electrodiagnostic studies. There was a 7% improvement in the mean AANEM electrodiagnostic SAE compared to the previous year. There was also a 15% improvement in the mean general PM&R SAE electrodiagnostic subscore compared to the mean subscore from the previous five years.

Overall, residents found the basic and advanced workshops to be valuable (Likert mean [SD] score; 4.8 [0.5] and 3.9 [0.9], respectively) and 100% of residents would recommend similar workshops for other residents (Tables 2 and 3). For the basic workshop, the lecture component was felt to be the most valuable component (Likert mean [SD] score; 4.8 [0.5]), whereas for the advanced workshop the question and answer component (Likert mean [SD] score; 4.4 [0.6]) was the most valuable (Tables 2 and 3). In the survey administered post the advanced workshop, 91.7% of the residents participating in independent study found it to be of some value, valuable, or very valuable to their learning (Likert mean [SD] score; 3.5 [1.1]).

Discussion

Electrodiagnostic Medicine is a key component of PM&R residency training with specific ACGME-mandated clinical competencies.²⁻⁴ However, there is little guidance regarding specific electrodiagnostic curriculum elements or instructional approach. To our knowledge, there are only two studies from a single PM&R residency program that have examined

educational strategies in either Electrodiagnostic Medicine or Neuromuscular Medicine curriculum for PM&R residents.^{5,6} We present here the development of a workshop designed to enhance an existing Electrodiagnostic Medicine curriculum for PM&R residents. The workshop used a combination of teaching strategies to maximize clinically relevant learning. The curriculum encouraged independent study and brought together expert mentorship, peer teaching, lectures, case-based learning, question and answer sessions, demonstration, and hands-on experience into the safety of a classroom-based learning environment where residents could hone their Electrodiagnostic Medicine knowledge and skills. This framework can be used by other PM&R residency programs to help address potential limitations in current Electrodiagnostic Medicine education and fulfill ACGME requirements.

Overall the program was well-received with 100% of participants recommending a similar workshop for other residents. All assessed components of the workshops were found to be of value. Lectures were rated to be most valuable within the basic workshop whereas question and answer sessions were rated to be most valuable within the advanced workshop. This likely reflects the goals of each workshop and the educational stage of the learners (PGY-2 through PGY-4 residents attended both workshops, which took place 2 months apart).

The goal of the basic workshop was to introduce and train residents on how to perform and interpret basic electrodiagnostic studies. Since 44.4% of the attendees at this workshop had not yet had a clinical rotation in Electrodiagnostic Medicine, the lecture format was more conducive towards laying the initial foundation in electrodiagnostic concepts. Residents could then build upon this knowledge base as they progressed to the advanced workshop where interactive question and answer formats were preferred. Though a similar number of attendees had not yet had an electrodiagnostic clinical rotation at the time of the advanced workshop, prior knowledge from the basic workshop allowed them to more fully participate in the interactive components of the advanced workshop, despite covering higher level concepts.

Still, based on Likert means, residents felt the basic workshop was more valuable compared to the advanced workshop. This finding may be a reflection of the lack of prior training and exposure to Electrodiagnostic Medicine in a substantial portion of the residents rather than a reflection of the quality of workshop. In addition, the basic workshop is likely more applicable to common clinical scenarios whereas the more advanced techniques are typically used for less common diagnoses, are encountered less routinely and may be perceived to be of less interest to learners with little prior exposure to Electrodiagnostic Medicine.

Another notable trend was the increased value that residents placed on the independent study of electrodiagnostic material following completion of the advanced workshop compared to their attitudes pre basic workshop. By providing residents with the tools to understand electrodiagnostic concepts during the workshops, subsequent independent textbook learning was likely easier, particularly for residents without prior clinical exposure to this field. Additionally, the workshop may have piqued earlier interest in Electrodiagnostic Medicine amongst junior residents who had not yet had clinical experience in this area. Earlier exposure to Electrodiagnostic Medicine is also advantageous for residents who may wish to

pursue advanced training in the field, as Electrodiagnostic Medicine and Neuromuscular Disease fellowships often start recruiting potential fellows during PGY-3.

In addition to being well-received, the workshop was successful in improving resident knowledge and comfort with electrodiagnostics. All post-workshop Likert scores for the learning objectives increased. Similarly, in both the basic and advanced workshops, the mean Likert scores for the level of comfort in planning, performing, and interpreting EMG/NCS increased. Our program also had a notable improvement in mean AANEM electrodiagnostic SAE scores and PM&R SAE electrodiagnostic subscores. Of note, there was no change to the electrodiagnostic didactic curriculum with the exception of the above described workshops.

Many factors contributed to the success of this workshop curriculum. First, we received signification support from our residency leadership and were able to allot dedicated and protected time for residents to attend the workshop without competing clinical duties. Second, we secured electrodiagnostic equipment for the workshops to allow for hands-on practice and technical skills development. Third, and most importantly, was the availability of expert clinical educators to provide the didactic sessions, oversee the hands-on training session, offer guidance on technical skills, and answer questions within the safety of a classroom learning environment.

This curriculum adds to the existing literature on electrodiagnostic education for PM&R residents by demonstrating that two 1.5-day workshops dedicated to teaching basic then advanced EMG skills using a multifaceted educational approach were able to improve resident understanding of electrodiagnostics as well as improved self-assessment scores. This workshop differs from previously published work by condensing sessions into two short workshops and including technical skill practice opportunities in the safety of a classroom with expert oversight.

Limitations and Future Directions

Our study has several limitations. To start, these results represent the experiences of a workshop curriculum at a single teaching institution and therefore may not be generalizable to all training programs. Moreover, the sample size was small, a few residents did not complete the post-workshop surveys, and the pre and post data could not be linked to specific individuals, prohibiting statistical testing. Finally, subjective resident self-assessment was used as the primary metric. A larger study across multiple institutions using validated objective measurement tools such as the EMG direct observation tool (EMG-DOT) would allow for further analysis of significance.⁸ Tailoring elements of the basic and advanced workshops to specific learning/PGY levels may also be helpful moving forward.

This course required significant faculty commitment, taking time away from clinical responsibilities for workshop development and instruction. For our workshop, a single faculty member led this effort. The advantage of this approach was the extreme cohesiveness of the workshop curriculum, allowing for excellent continuity of instruction. However, this approach may not always be feasible within the constraints of concurrent clinical, research,

and administrative duties of faculty members. Therefore, distributing the instructional responsibility to multiple faculty or senior residents should be considered for future workshops and for other institutions considering a similar workshop. For instance, Luz et al. demonstrated that training resident volunteers to be peer instructors or “table trainers” is a successful strategy in implementing a hands-on musculoskeletal ultrasound curriculum.⁹ Incorporating senior residents as workshop instructors has the added advantage of honing resident teaching skills in preparation for their transition to attending roles. Therefore, this approach may be a valuable addition to the workshop curriculum moving forward.

Finally, the workshop required a significant amount of time and clinical resources. Specifically, each workshop ran for 1.5 days with 5 EMG machines supplied for each session. Though residents found the hands-on experience with the EMG machines to be valuable, the lecture component of the basic workshop was even more important. We were fortunate to have several EMG machines available for the workshop free of charge through a medical service provider, allowing groups as small as 3 residents to work with each EMG machine. However, for institutions that may not have access to a similar service, it may be reasonable to reduce the amount of EMG machine time for the basic workshop to allow more flexibility with workshop scheduling and less burden on the program.

Moving forward, our residency program has incorporated this Electrodiagnostic Medicine Workshop as an annual component of resident didactics. In addition, given the enthusiasm of the resident class and their interest in furthering their training in this field, program leadership decided to cover participation of PGY-4 (senior) residents in an additional 4-day inter-departmental advanced EMG CME course that is offered to attending physicians at our University as a new required component of the didactic curriculum moving forward. During the workshop, it became apparent that additional lectures dedicated to Neuromuscular Medicine could be synergized with the Electrodiagnostic Medicine Workshop. To this point, supplemental neuromuscular teaching sessions that include short lectures and interviews with patients who have a variety of neuromuscular disorders have since been added to resident didactic sessions throughout the year to build upon the electrodiagnostic clinical skills covered in the workshops. Finally, this learning approach can be extrapolated to other procedural skills required as part of PM&R residency training such as ultrasound, musculoskeletal injections, and chemodenervation. To date, our residency program has successfully used this model to guide a one day baclofen pump management workshop.

Conclusion

Electrodiagnostic Medicine is a vital part of PM&R resident training and an ACGME requirement. The authors present a multifaceted electrodiagnostic workshop combining expert mentoring, peer teaching, lectures, case based learning, question and answer sessions, and hands-on experience to enhance the traditional electrodiagnostic curriculum for PM&R residents. This workshop successfully improved resident knowledge of NCS and EMG concepts, increased resident comfort level in planning, performing, and interpreting studies, enhanced the perceived value in independent learning of Electrodiagnostic Medicine, and increased AANEM self-assessment scores.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1a

Basic Workshop

Required Reading	Workshop Outline	Techniques
Physical Medicine and Rehabilitation Board Review; Sara Cuccurullo, MD, Editor; Demos Medical; 3rd ed., pp 341–392. Electromyography and Neuromuscular Disorders; David Preston, MD and Barbara Shapiro, MD, PhD, Editors; Elsevier; 3rd ed., pp 1–35; 97–371;448–528.	<ul style="list-style-type: none"> • Day 1 <ul style="list-style-type: none"> – <u>Lectures</u> <ul style="list-style-type: none"> ◆ Anatomy and terminology ◆ Introduction to electrodiagnostic equipment ◆ Basic Nerve Conduction Studies (NCS) ◆ Clinical-Electrophysiologic Correlations: overview and common patterns – <u>Hands-on practice</u> – <u>Case studies</u> <ul style="list-style-type: none"> ◆ Common upper extremity neuropathies ◆ Common lower extremity neuropathies – <u>Self Assessment Exam (SAE) Practice Questions</u> • Day 2 <ul style="list-style-type: none"> – <u>Lectures</u> <ul style="list-style-type: none"> ◆ Principles of needle EMG ◆ Spontaneous Activity ◆ Motor Unit Action Potentials ◆ Clinical-Electrophysiologic Correlations: overview and common patterns – <u>Waveform videos and Hands-on practice</u> – <u>Case studies</u> <ul style="list-style-type: none"> ◆ Radiculopathies ◆ Plexopathies ◆ Polyneuropathies 	<ul style="list-style-type: none"> • Median nerve sensory and motor response • Ulnar sensory and motor response • Radial sensory response • Tibial motor response • Fibular motor response • Superficial fibular sensory response • Sural sensory response • Basic needle EMG techniques

Table 1b

Advanced Workshop

Required Reading	Workshop Outline	Techniques
Physical Medicine and Rehabilitation Board Review; Sara Cuccurullo, MD, Editor; Demos Medical; 3rd ed., pp 392–433. Electromyography and Neuromuscular Disorders; David Preston, MD and Barbara Shapiro, MD, PhD, Editors; Elsevier; 3rd ed., pp 36–70;384–447;529–562.	<ul style="list-style-type: none"> • Day 1 <ul style="list-style-type: none"> – <u>Lectures</u> <ul style="list-style-type: none"> ◆ Advanced Nerve Conduction Studies (NCS) ◆ Anomalous Innervations ◆ Repetitive Nerve Stimulation ◆ Late responses (H-reflex, F-waves) – <u>Hands-on practice</u> – <u>Case studies</u> <ul style="list-style-type: none"> ◆ Motor Neuron Disease ◆ Neuromuscular junction disorders ◆ Myopathies ◆ Polyneuropathies • Day 2 <ul style="list-style-type: none"> – <u>Lectures</u> <ul style="list-style-type: none"> ◆ The electrodiagnostic report ◆ Common sources of error/artifacts in electrodiagnostics ◆ Expert clinical pearls ◆ Surface anatomy for EMG-guided botox injections – <u>Self Assessment Exam (SAE) Practice Questions</u> 	<ul style="list-style-type: none"> • Saphenous sensory response • Lateral antebrachial cutaneous (LAC) and medial antebrachial cutaneous (MAC) nerves • Radial motor response • Repetitive Nerve Stimulation • H-Reflex • F waves • EMG-guided botox injections

Table 2

Basic Workshop

	Likert Score (range 0–5) Mean (SD)	
	Pre (N=18)	Post (N=15)
What is your current overall knowledge of NCS/EMG?	2.0 (0.7)	2.7 (0.7)
What is your current level of knowledge of basic NCS/EMG terminology?	2.2 (1.0)	3.0 (0.4)
What is your current knowledge of basic NCS/EMG anatomic landmarks?	2.3 (0.9)	2.8 (0.8)
What is your current level of knowledge of CMAPs and SNAPs?	2.3 (0.9)	2.9 (0.5)
What is your current level of knowledge of basic EMG waveforms?	1.8 (0.5)	2.7 (0.5)
What is your current level of knowledge of upper extremity neuropathies?	2.4 (0.7)	2.7 (0.7)
What is your current level of knowledge of lower extremity neuropathies?	2.2 (0.4)	2.7 (0.5)
What is your current level of knowledge of radiculopathies and plexopathies?	2.3 (0.6)	2.7 (0.5)
What is your current level of comfort in planning a NCS/EMG study independently?	1.9 (0.5)	2.3 (0.7)
What is your current level of comfort in performing a NCS/EMG study independently?	1.9 (0.5)	2.3 (0.7)
What is your current level of comfort in interpreting a NCS/EMG study independently?	1.8 (0.5)	2.5 (0.9)
How valuable do you feel the lecture component of this workshop has been to your learning?		4.8 (0.5)
How valuable do you feel the hands on NCS/EMG component of this workshop has been to your learning?		4.7 (0.5)
How valuable do you feel the case based learning component of this workshop has been to your learning?		4.7 (0.5)
How valuable do you feel the question and answer component of this workshop has been to your learning?		4.6 (0.7)
How valuable do you feel the overall Basic EMG Workshop has been to your learning?		4.8 (0.5)
	Number (%)	
Would you recommend a similar workshop for other residents?	Yes	15 (100)
	No	0 (0)

Table 3

Advanced Workshop

	Likert Score (range 0–5) Mean (SD)	
	Pre (N=16)	Post (N=15)
What is your current level of knowledge of NCS/EMGs?	2.2 (0.7)	2.6 (0.7)
What is your current level of knowledge of the electrodiagnostic approach to ALS?	2.1 (0.6)	2.3 (0.7)
What is your current level of knowledge of the electrodiagnostic approach to myopathies?	2.1 (0.6)	2.6 (0.8)
What is your current level of knowledge of the electrodiagnostic approach to NMJ disorders?	2.0 (0.5)	2.6 (0.8)
What is your current level of knowledge of the use and interpretation of F-waves and the H-reflex?	1.9 (0.5)	2.6 (0.8)
What is your current level of knowledge of the use of EMG guidance for Botulinum toxin injection?	2.5 (0.8)	2.8 (0.5)
What is your current level of comfort in planning a NCS/EMG study, independently?	2.3 (0.8)	2.8 (0.9)
What is your current level of comfort in performing a NCS/EMG study, independently?	2.2 (0.7)	2.5 (1.1)
What is your current level of comfort in interpreting a NCS/EMG study, independently?	2.3 (0.7)	2.6 (1.0)
How valuable do you feel the lecture component of this workshop has been to your learning?		4.3 (0.8)
How valuable do you feel the hands on NCS/EMG component of this workshop have been to your learning?		3.8 (0.5)
How valuable do you feel the case based learning component of this workshop has been to your learning?		4.4 (0.6)
How valuable do you feel the question and answer component of this workshop has been to your learning?		4.5 (0.7)
How valuable do you feel the overall Advanced – EMG workshop has been to your learning?		3.9 (0.9)
	Number (%)	
Would you recommend a similar workshop for other residents?	Yes	15 (100)
	No	0 (0)