Supplemental Guide: Neuromuscular Medicine

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Milestones Supplemental Guide

This document provides additional guidance and examples for the Neuromuscular Medicine Milestones. This is not designed to indicate any specific requirements for each level, but to provide insight into the thinking of the Milestone Work Group.

Included in this document is the intent of each Milestone and examples of what a Clinical Competency Committee (CCC) might expect to be observed/assessed at each level. Also included are suggested assessment models and tools for each subcompetency, references, and other useful information.

Review this guide with the CCC and faculty members. As the program develops a shared mental model of the Milestones, consider creating an individualized guide (Supplemental Guide Template available) with institution/program-specific examples, assessment tools used by the program, and curricular components.

Additional tools and references, including the Milestones Guidebook, Clinical Competency Committee Guidebook, and Milestones Guidebook for Residents and Fellows, are available on the Resources page of the Milestones section of the ACGME website.

Patient Care 1: History **Overall Intent:** To develop skills of history taking that focuses specifically on all portions of history relevant to neuromuscular disorders	
Milestones	**Examples**
Level 1 *Obtains a relevant and organized history that identifies a neuromuscular condition, including review of medical records and family history*	● Reviews records for previous genetic testing in a patient who presents with foot drop and pes cavus ● Obtains family history including early cataracts and early cardiac death in a patient with suspected myotonic dystrophy type 1
Level 2 *Obtains a relevant and organized history, incorporating subtle verbal and non-verbal cues, and includes functional assessment*	● Asks about frequency of falls in a patient with foot drop and pes cavus ● Raises concerns for possible swallowing difficulties in a patient with myotonic dystrophy type 1 with progressive weight loss
Level 3 *Consistently obtains a history sufficient to evaluate, diagnose, and treat neuromuscular disorders, including collateral information and systemic manifestations*	● Asks about recent electrocardiogram (EKG) and cardiology visit, last eye exam, and any gastrointestinal symptoms in a standardized fashion with all patients with myotonic dystrophy type 1 ● Asks about morning headaches and orthopnea in a patient with amyotrophic lateral sclerosis (ALS)
Level 4 *Consistently obtains a history that includes patient-reported outcomes and identifies a neuromuscular condition within a complicated medical history*	● Identifies myotonic dystrophy as a potential diagnosis in a patient presenting with diffuse pain and irritable bowel syndrome
Level 5 *Serves as a role model to other learners for history taking regarding neuromuscular diagnosis and management*	● Develops a standardized checklist for review of systems specific to different neuromuscular disorders
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback
Curriculum Mapping	●
Notes or Resources	● Amato AA, Russell JA. Approach to patients with neuromuscular disease. In: Amato AA, Russell JA. *Neuromuscular Disorders*. 2nd ed. McGraw-Hill Education; 2016:2-21. ISBN:978-0071752503. ● McDonald CM. Clinical approach to the diagnostic evaluation of hereditary and acquired neuromuscular diseases. *Phys Med Rehabil Clin N Am*. 2012 Aug;23(3):495-563. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3482409/. 2021.

Patient Care 2: Neuromuscular Examination **Overall Intent:** To develop examination skills that focus on all aspects of the neuromuscular examination	
Milestones	**Examples**
Level 1 *Performs a relevant general, neurologic, and neuromuscular exam*	● Accurately assesses distribution of weakness in patient with ALS ● Distinguishes between upper and lower motor neuron signs ● Performs accurate anti-gravity strength testing ● Does a thorough cranial nerve exam in a patient with progressive weakness and loss of reflexes
Level 2 *Performs a relevant general, neurologic, and neuromuscular exam, accurately incorporating additional appropriate maneuvers*	● Accurately performs percussion myotonia testing in appropriate muscles ● Checks for Tinel's sign or atrophy of the thenar eminence in a patient with hand numbness concerning for carpal tunnel syndrome
Level 3 *Consistently performs an examination sufficient to evaluate and narrow the diagnostic evaluation for common neuromuscular disorders*	● Consistently assesses for muscle fatigability in a patient with myasthenia gravis ● Accurately assesses the strength of cranial/bulbar muscles
Level 4 *Consistently performs a nuanced examination that identifies subtle findings and patterns sufficient to evaluate and narrow the diagnostic evaluation for uncommon neuromuscular disorders*	● Performs a detailed sensory exam in a patient with a wrist drop to help distinguish a radial neuropathy versus multifocal motor neuropathy ● Looks for facilitation of reflexes post-exercise in a patient with proximal lower extremity muscle weakness ● Uses outcome measures such as the manual muscle test in a patient with myasthenia gravis
Level 5 *Serves as a role model to other learners for performing an examination regarding neuromuscular diagnoses and management*	● Instructs the residents on nuances of the neuromuscular exam ● Uses neuromuscular outcome measures to assess response to therapy
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback
Curriculum Mapping	●
Notes or Resources	● Amato AA, Russell JA. Approach to patients with neuromuscular disease. In: Amato AA, Russell JA. *Neuromuscular Disorders*. 2nd ed. McGraw-Hill Education; 2016:2-21. ISBN:978-0071752503. ● McDonald CM. Clinical approach to the diagnostic evaluation of hereditary and acquired neuromuscular diseases. *Phys Med Rehabil Clin N Am*. 2012 Aug;23(3):495-563. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3482409/. 2021.

Patient Care 3: Management and Treatment **Overall Intent:** To acquire the skills required to manage and treat neuromuscular disorders	
Milestones	**Examples**
Level 1 *Identifies treatment options for neuromuscular disorders*	● Identifies intravenous immunoglobulin and plasma exchange as a treatment option for patients in myasthenic crisis or Guillain-Barré syndrome ● Identifies steroids as a treatment option for myasthenia gravis and chronic inflammatory demyelinating polyneuropathy
Identifies symptoms and complications associated with neuromuscular disorders (pain, joint contractures, fatigue, mood disorders, etc.)	● Identifies fatigue as one of the symptoms of ALS ● Identifies symptoms of mood disorders in patients with chronic neuromuscular disorders
Describes assistive technologies and their indications	● Describes ankle foot orthosis as a helpful measure to improve gait in patients with foot drop ● Describes a walker and motorized chair as a helpful measure for a neuromuscular weakness affecting mobility
Level 2 *Discusses risks and benefits and monitoring plan of treatment options with patients' and patient's families*	● Initiates management for neuromuscular emergencies and triages patients to appropriate level of care ● Discusses treatment options with patient and family members, including immunomodulating and immunosuppressants' risk and benefits
Employs first-line interventions for symptoms and complications associated with neuromuscular disorders	● Uses neuropathic pain medications to treat pain from polyneuropathy
Recognizes the indications for basic orthotics and mobility aids for patients with neuromuscular disorders	● Recognizes when a neuromuscular condition includes weakness or sensory loss in feet, that a walker, safety/grab bars in the bathroom, and/or a shower chair may be of help
Level 3 *Monitors treatment, and recognizes and manages complications of immunomodulating/ immunosuppressive and genetic therapies*	● Regularly orders labs to monitor treatment of spinal muscular atrophy patients on nusinersen ● Orders meningococcal vaccination for myasthenia gravis patients starting eculizumab ● Orders basic blood work to monitor complete blood count and metabolic panel for patients on immunosuppressant therapies ● Follows liver panel labs for patients on riluzole

Employs second-line interventions for symptoms and complications associated with neuromuscular disorders and coordinates care with other health care practitioners	● Considers botulinum toxin injection for sialorrhea in ALS patients with no response to oral medications, recognizing the risk of exacerbating weakness in nearby muscles ● Informs the primary care physician about medications to avoid in patients with myasthenia gravis ● Informs primary care physician/cardiologist on avoiding statin use in a patient with necrotizing autoimmune myopathy associated with prior statin use
Prescribes basic orthotics and mobility aids for patients with neuromuscular disorders	● Prescribes ankle-foot-orthoses for patients with foot drop ● Performs face to face evals to document medical necessity for motorized power chairs ● Prescribes home based therapy assessment for evaluating for grab bars, home modifications for increased safety
Level 4 *Considers clinical trials for patient management*	● Refers patients with neuromuscular disorder for clinical trials
Independently adapts interventions for symptoms and complications associated with neuromuscular disorders based on patient response	● Adjusts dose of prednisone in patients with myasthenia gravis independently ● Adds additional immunosuppressant medications for a patient with myasthenia gravis not able to be tapered off steroid monotherapy
Integrates recommendations for patient needs for a full range of assistive technologies based on impairments, considering barriers, contraindications, comorbidities, and input from other professionals	● Discusses recommendations for adaptive devices and equipment with physical therapist(s), occupational therapist(s) and physical medicine and rehabilitation colleagues; can order equipment ● Discusses with pulmonologist the indications for specific respiratory devices, including bilevel positive airway pressure (BiPAP) treatment, Trilogy, cough assist, spirometry, or tracheostomy, used to support neuromuscular respiratory failure
Level 5 *Applies sophisticated knowledge of treatment subtleties and controversies*	● Uses evidence to select one treatment over another for a patient with myasthenia gravis ● Discusses clinical trial data with a patient about medications to inform therapeutic decision making
Demonstrates sophisticated knowledge and serves as resource for orthotics, mobility aids, and rehabilitation for neuromuscular disorders	● Develops knowledge of available local companies and resources of durable medical equipment, ALS chapter equipment loan closet, Muscular Dystrophy Association (MDA) local chapter loan closet, orthotics companies
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback ● Self-assessment exams
Curriculum Mapping	●

Notes or Resources	● American Academy of Neurology (AAN). Practice Advisory: Thymectomy for Myasthenia Gravis (Practice Parameter Updated). https://www.aan.com/Guidelines/home/GuidelineDetail/993. 2021. ● Finkel RS, Mercuri E, Meyer OH, et al. Diagnosis and management of spinal muscular atrophy: Part 2: Pulmonary and acute care; medications; supplementals and immunizations; other organ systems; and ethics. *Neuromuscul Disord*. 2018;28(3):197-207. https://www.sciencedirect.com/science/article/pii/S0960896617312907?via%3Dihub. 2021. ● Mercuri E, Finkel RS, Mutoni F, et al. Diagnosis and management of spinal muscular atrophy: Part 1: Recommendations for diagnosis, rehabilitation, orthopedic and nutritional care. *Neuromuscul Disord*. 2018;28(2):103-115. https://www.sciencedirect.com/science/article/pii/S0960896617312841?via%3Dihub. 2021. ● Myotonic Dystrophy Foundation. Consensus-based Care Recommendations for Children with Myotonic Dystrophy Type 1. https://www.myotonic.org/sites/default/files/pages/program/MDF_2018_CareConsiderationsChildhoodDM1.pdf. 2021. ● Myotonic Dystrophy Foundation. Myotonic Dystrophy: Toolkits & Publications. https://www.myotonic.org/toolkits-publications. 2021.

Patient Care 4: Nerve Conduction Studies **Overall Intent:** To acquire the skills required to perform and interpret nerve conduction studies	
Milestones	**Examples**
Level 1 *Applies knowledge of peripheral nerve anatomy in the performance of nerve conduction studies* *Formulates basic nerve conduction studies plan for specific, common clinical presentations*	● Applies principles of electrical safety to the performance of nerve conduction studies ● Understands proper patient positioning, electrode placement, and stimulation sites ● Knows the appropriate timing of nerve conduction studies; allows for Wallerian degeneration to complete ● Chooses to perform sensitive comparative studies in a patient with clinical symptoms suggestive of carpal tunnel syndrome
Level 2 *Performs and interprets common motor and sensory nerve conduction studies, and late response studies (e.g., F-waves, H-reflexes)* *Identifies technical artifacts in the interpretation of nerve conduction studies*	● Ensures supramaximal response during nerve conduction studies, while monitoring patient comfort ● Recognizes low motor amplitudes with preserved sensory amplitudes in root disease ● Recognizes prolonged/absent F waves as being common in early acute inflammatory demyelinating polyradiculopathy ● Troubleshoots 60 Hz artifact due to nearby electrical generators
Level 3 *Performs and interprets neuromuscular junction testing (e.g., repetitive stimulation study)* *Recognizes common anatomical variants in the interpretation of nerve conduction studies*	● Modifies the study to accommodate unique patient factors or tolerance ● Identifies a Martin Gruber anastomosis in a patient with an ulnar “conduction block” in the forearm, but no clinical weakness ● Attempts to elicit post-exercise facilitation in a patient with diffusely low compound muscle action potential ● Identifies movement artifact in patients undergoing repetitive nerve stimulation
Level 4 *Performs and interprets uncommon motor and sensory nerve conduction studies, including cranial nerve testing (e.g., blink reflex, facial nerve)* *Recognizes performance quality and inconsistencies of nerve conduction studies*	● Accurately localizes focal demyelination with inching studies ● Localizes lesions of the facial nerve, trigeminal nerve, mid-pontine, and medullary lesions by performing blink responses ● Participates in electrodiagnostic quality assurance practices
Level 5 *Performs and interprets special nerve conduction studies procedures (e.g., near nerve testing, phrenic nerve testing)*	● Accurately performs phrenic nerve conductions

Recognizes uncommon anatomical variants in the interpretation of nerve conduction studies	● Identifies a Riche-Cannieu anastomosis in a patient with a low median motor response and normal thenar strength/bulk
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback ● Practical examinations ● Review of patient reports
Curriculum Mapping	●
Notes or Resources	● Preston D, Shapiro B. Electromyography and Neuromuscular Disorders: Clinical-Electrophysiologic-Ultrasound Correlations. 4th ed. Philadelphia, PA: Elsevier; 2021. ISBN:978-0323661805.

Patient Care 5: Electromyography (EMG) **Overall Intent:** To acquire the skills required to perform and interpret needle electromyography	
Milestones	**Examples**
Level 1 *Applies knowledge of nerve and muscle anatomy in the study design and performance of EMG (e.g., muscle localization)*	● Demonstrates knowledge of needle insertion sites based on their relation to anatomical landmarks ● Avoids blood vessels and other structures during needle electrode placement ● Formulates a strategy of muscles to sample based on the reason for referral
Explains the procedure to patients' and patient's families	● Uses simple language to counsel patients on what to expect during the procedure
Describes nerve physiology and instrumentation involved in electromyography	● Recognizes different EMG needle sizes and when to use each
Level 2 *Performs EMG of commonly sampled muscles*	● Performs needle examination of the deltoid ● Elicits and accurately identifies various spontaneous discharges ● Alters filters, sweep speed, and gain appropriately ● Selects muscles representative of each cervical myotome on needle EMG in a patient with symptoms suggestive of cervical radiculopathy
Monitors patient comfort during the procedure	● Recognizes endplate spikes and moves the needle electrode to another location ● Uses isometric muscle contraction to obtain volitional motor units
Distinguishes normal from abnormal electrodiagnostic findings with guidance and recognizes artifacts	● Distinguishes fibrillation potentials from normal motor unit action potentials
Level 3 *Performs EMG of uncommonly sampled muscles*	● Chooses an appropriate number of muscles to sample to answer adequately localize the pathology
Modifies the procedure for challenging or high-risk patients	● Understands the high-risk muscles for patients on therapeutic anticoagulation and modifies the testing protocol if necessary ● Understands the high risk of EMG study in the setting of local infection/open wounds/nearby recent surgical site/lymphedema
Independently interprets abnormal electrodiagnostic findings and troubleshoots artifacts	● Accurately prepares written electrodiagnostic reports at the conclusion of a technically complex study

Level 4 *Performs EMG of cranial nerve innervated muscles (e.g., tongue)* *Proactively organizes and efficiently completes procedure to optimize diagnostic yield in challenging or high-risk patients* *Interprets uncommon EMG findings and patterns of unique disorders and modifies the study accordingly*	● Examines the mentalis, frontalis and genioglossus in a patient suspected of having motor neuron disease ● Prioritizes muscle selection in a pediatric patient or patient with pain ● Examines weak muscles first on EMG ● Uses noxious stimulation to activate voluntary motor units in an obtunded patient ● Differentiates myokymia from myotonia and complex repetitive discharges
Level 5 *Performs and interprets special EMG procedures (e.g., single fiber EMG, quantitative EMG studies)* *Performs and interprets EMG of rarely sampled muscles (e.g., diaphragm)*	● Interprets and obtains adequate number of muscle pairs during single-fiber study ● Verifies the quality of the single fiber EMG recordings ● Uses quantitative motor unit analysis ● Performs laryngeal, anal sphincter, and/or diaphragmatic EMG
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback ● Practical examinations ● Review of patient reports
Curriculum Mapping	●
Notes or Resources	● Aminoff MJ. *Aminoff's Electrodiagnosis in Clinical Neurology*. 6th ed. Elsevier Saunders; 2014. ISBN:978-1455703081. ● Preston D, Shapiro B. Electromyography and Neuromuscular Disorders: Clinical-Electrophysiologic-Ultrasound Correlations. 4th ed. Philadelphia, PA: Elsevier; 2021. ISBN:978-0323661805.

Patient Care 6: Anterior Horn Cell Disorders **Overall Intent:** To diagnose and manage anterior horn cell disorders and their complications	
Milestones	**Examples**
Level 1 *Recognizes signs and symptoms that should prompt consideration of anterior horn cell disorders*	● Considers anterior horn cell disorders in a patient who presents with single limb weakness ● Recognizes hyperreflexia in a patient with foot drop as concerning for ALS
Recognizes when electrodiagnostic and serologic testing is indicated	● Considers spinal muscular atrophy genetic testing for a baby with hypotonia and normal intellectual development ● Considers electrodiagnostic testing in a patient with weakness and atrophy
Recognizes common anterior horn cell disorders and complications	● Recognizes morning headaches and non-restful sleep as signs of neuromuscular respiratory weakness ● Recognizes coughing or clearing throat as early signs of dysphagia due to neuromuscular weakness
Level 2 *Diagnoses anterior horn cell disorders*	● Diagnoses a patient with generalized weakness, hyperreflexia and fasciculations with probable ALS ● Uses signs of lower motor neuron dysfunction in a floppy infant to diagnose probable spinal muscular atrophy
Incorporates results of electrodiagnostic and serologic testing in context of clinical presentation	● Diagnoses a patient with spinal-bulbar muscular atrophy (Kennedy's disease) based on clinical exam, EMG findings, and genetic results ● Diagnoses of ALS in a patient with slurred speech, tongue atrophy, and widespread denervation on EMG
Manages anterior horn cell disorders and complications, with direct supervision	● Monitors respiratory function in a patient with ALS ● Monitors weight loss to assist with discussions of non-oral enteral feeding options
Level 3 *Distinguishes anterior horn cell disorders from mimics*	● Identifies multifocal motor neuropathy in a patient presenting muscle atrophy fasciculations and positive conduction block on nerve conduction studies ● Identifies spastic dysarthria versus flaccid to distinguish between ALS and myasthenia gravis ● Recognizes subtle ocular weakness as a sign more consistent with myasthenia gravis than ALS in a patient presenting with bulbar weakness
Orders and incorporates additional testing, including routine genetic testing, to distinguish	● Orders serum ganglioside-monosialic acid (GM1) antibody testing to distinguish limb onset ALS versus multifocal motor neuropathy

anterior horn cell disorder from mimics and co-existing disease	● Orders acetylcholine receptor (AChR) and musk antibody tests to distinguish myasthenia gravis from motor neuron disease in patients with dysarthria ● Samples bulbar and thoracic muscles to help distinguish structural spine disease from ALS
Manages anterior horn cell disorders and complications, with indirect supervision	● Manages pseudo-bulbar affect and offers appropriate treatment ● Refers patients to pulmonologist and orthopedics specialist appropriately ● Manages secretions in ALS patients
Level 4 *Diagnoses atypical anterior horn cell disorders, including within the context of other neurodegenerative conditions*	● Diagnoses spinal-bulbar muscular atrophy based on genetic testing in a patient with a gynecomastia and lower motor neuron signs ● Diagnoses ALS in a patient with frontotemporal dementia and Parkinson's disease
Continuously evaluates accuracy of anterior horn cell diagnosis	● Pursues further genetic testing in a patient with suspected spinal muscular atrophy who has negative standard spinal muscular atrophy testing ● Recognizes that decremental response on repetitive nerve stimulation can be seen in motor neuron diseases and considers repeat EMG as it progresses ● Orders serum copper level in patients with lower motor neuron syndrome and history of bariatric surgery
Independently manages common anterior horn cell disorders and complications with the interdisciplinary team, as needed	● Obtains speech therapy, physical therapy, and occupational therapy for activities of daily living and communication needs ● Obtains consult for a patient needing tube feeding ● Prescribes non-invasive ventilation in a patient with reduced vital capacity
Level 5 *Engages in scholarly activity (e.g., teaching, research) in anterior horn cell disorders*	● Gives journal club on spinal muscular atrophy treatment trials and ALS treatment trials ● Gives up-to-date presentations on most recent advances in motor neuron disease theories, management, and treatments under investigation
Independently manages atypical anterior horn cell disorders and complications with the interdisciplinary team	● Independently and effectively leads multidisciplinary team, including occupation and physical therapists, respiratory therapists, nurses, social workers, pulmonologist, and orthopedic specialists, caring for patient
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback ● Self-assessment exams
Curriculum Mapping	●

Notes or Resources	● AAN. Update: The Care of the Patient with Amyotrophic Lateral Sclerosis: Multidisciplinary Care, Symptom Management, and Cognitive/Behavioral Impairment. https://www.aan.com/Guidelines/home/GuidelineDetail/371. 2021. ● Cure SMA. Mission and Values. https://www.curesma.org/mission-and-values/?gclid=CjwKCAjwvMqDBhB8EiwA2iSmPIldR9YmtYvyBiun3tNNG3nVa9y-hOa6D7OjJn2jiDEIOtXk6Uj3sRoCKgIQAvD_BwE. 2021. ● Miller RG, Jackson CE, Kasarskis EJ, et al. Practice parameter updated: The care of the patient with amyotrophic lateral sclerosis: Drug, nutritional, and respiratory therapies (an evidence-based review): Report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*. 2009;73(15):1218-1226. https://n.neurology.org/content/73/15/1218. 2021. ● Miller RG, Jackson CE, Kasarskis EJ, et al. Practice parameter update: The care of the patient with amyotrophic lateral sclerosis: Multidisciplinary care, symptom management, and cognitive/behavioral impairment (an evidence-based review): Report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*. 2009;73(15):1227-1233. https://n.neurology.org/content/73/15/1227.long. 2021.

Patient Care 7: Root, Plexus, and Nerve Disorders **Overall Intent:** To acquire the skills required for diagnosis and management of root, plexus, and nerve disorders	
Milestones	**Examples**
Level 1 *Recognizes common presentations of nerve root, plexus, and peripheral nerve disorders*	● Considers carpal tunnel syndrome and ulnar neuropathy at the elbow in a patient presenting with hand pain and numbness ● Recognizes that numbness in hands before shins in indicative of a non-length dependent neuropathy ● Recognizes clinical patterns that differentiate length dependent neuropathy versus brachial plexopathy versus radiculopathy
Recognizes when electrodiagnostic, serologic and genetic testing is indicated	● Uses electrodiagnostic testing to localize a peripheral nervous system disease ● Recognizes the need for genetic testing in a neuropathy patient with positive family history and pes cavus on examination
Recognizes common peripheral nerve disorder emergencies (e.g., Guillain Barre Syndrome)	● Includes Guillain-Barré syndrome in the differential diagnosis of a rapidly progressive ascending paralysis ● Recognizes the need for hospitalization of patient with Guillain-Barré syndrome to monitor respiratory function
Level 2 *Diagnoses common nerve root, plexus, and peripheral nerve disorders*	● Localizes common entrapment neuropathies ● Diagnoses diabetic length-dependent neuropathy and diabetic amyotrophy
Incorporates results of electrodiagnostic, serologic and genetic testing in context of clinical presentation	● Incorporates EMG findings in determining localization of a nerve lesion ● Incorporates Charcot-Marie-Tooth testing in determining etiology of a suspected genetic neuropathy ● Correctly attributes mildly slowed conduction velocity to axon loss in a patient with clinical length-dependent neuropathy
Manages patients with common nerve root, plexus, and peripheral nerve disorders (e.g., Guillain Barre Syndrome) under direct supervision	● Checks negative inspiratory force and vital capacity on patient with Guillain-Barré syndrome ● Manages neuropathic pain of a peripheral neuropathy ● Manages orthotics, wrist splints, and arm slings for neuropathies
Level 3 *Diagnoses uncommon nerve root, plexus, and peripheral nerve disorders*	● Diagnoses mononeuritis multiplex ● Diagnoses sensory neuronopathy/ganglionopathy ● Diagnoses lower trunk plexopathy following sternotomy ● Diagnoses lumbosacral plexopathy

Recognizes indications for special diagnostic techniques (e.g., nerve biopsy, skin biopsy, ultrasound, quantitative sensory testing) *Manages patients with uncommon nerve root, plexus, and peripheral nerve disorders under indirect supervision*	● Recognizes role of ultrasound in evaluating for nerve hypertrophy ● Uses skin biopsy and quantitative sudomotor axon reflex test to diagnose small fiber neuropathies ● Prescribes intravenous immunoglobulin treatment for a patient newly diagnosed with chronic inflammatory demyelinating polyneuropathy ● Manages weakness and neuropathic pain associated with diabetic amyotrophy
Level 4 *Continuously evaluates the accuracy of the diagnosis of nerve root, plexus, and peripheral nerve disorders* *Relates the results of special diagnostic testing (e.g., nerve biopsy) to the context of the clinical presentation* *Independently manages common nerve root, plexus, and peripheral nerve disorders and complications with the interdisciplinary team as needed*	● Considers additional testing for Polyneuropathy, Organomegaly, Endocrinopathy, Monoclonal protein, Skin change (POEMS) syndrome or a genetic neuropathy in chronic inflammatory demyelinating polyneuropathy patients not responding to treatment ● Correlates amyloid deposition on nerve biopsy with amyloid neuropathy ● Correlates intramural vascular inflammation on nerve biopsy with vasculitic neuropathy ● Manages neuropathy associated with monoclonal gammopathy in collaboration with a hematologist ● Manages weakness and sensory loss, changes in mobility with occupational and physical therapists
Level 5 *Engages in scholarly activity (e.g., teaching, research) on nerve root, plexus, and peripheral nerve disorders* *Independently manages uncommon nerve root, plexus, and peripheral nerve disorders and complications with the interdisciplinary team as needed*	● Publishes a journal manuscript on peripheral nerve disorders ● Participates in ongoing local institutional research on peripheral nerve disorders ● Manages neuropathy due to POEMS syndrome in collaboration with a hematologist ● Manages checkpoint inhibitor induced adverse event of demyelinating neuropathy with the oncologist
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback ● Self-assessment exams
Curriculum Mapping	●
Notes or Resources	● Smith AG. Peripheral nerve and motor neuron disorders. *Continuum*. 2020;26(5). https://www.scribd.com/document/479623220/Vol-26-Peripheral-Nerve-and-Motor-Neuron-Disorders-2020. 2021.

Patient Care 8: Neuromuscular Junction Disorders **Overall Intent:** To diagnose and manage neuromuscular junction disorders and their complications	
Milestones	**Examples**
Level 1 *Diagnoses common neuromuscular junction disorders* *Recognizes when electrodiagnostic and serologic testing are indicated* *Recognizes common neuromuscular junction emergencies (e.g., myasthenic crisis)*	● Diagnoses myasthenia gravis in a patient presenting with fluctuating ptosis and double vision worse at the end of the day ● Considers serologic testing (acetylcholine receptor antibodies) in a patient presenting with ptosis, double vision, and bulbar weakness ● Frequently assess respiratory mechanics in a patient with myasthenia gravis admitted to the hospital with worsening bulbar and generalized weakness leading to difficulty swallowing and keeping the head upright ● Initiates treatment with intravenous immune globulin or plasmapheresis in a myasthenia gravis patient requiring hospitalization for worsening symptoms
Level 2 *Diagnoses uncommon neuromuscular junction disorders* *Incorporates results of electrodiagnostic and serologic testing in context of clinical presentation (e.g., false positives, false negatives)* *Manages common neuromuscular junction emergencies*	● Diagnoses Lambert-Eaton myasthenic syndrome in a patient with small cell cancer who is presenting with proximal limb weakness and constipation ● Considers botulism in a previously well infant who develops low tone ● Recognizes that normal repetitive nerve stimulation cannot exclude a diagnosis of myasthenia gravis in a patient with only ocular symptoms due to low sensitivity ● Recognizes that repetitive nerve stimulation can be false positive in patients with motor neuron disease ● Starts and monitors prednisone treatment in a patient with myasthenia gravis who has achieved incomplete resolution of symptoms on pyridostigmine ● Recognizes that thymectomy is beneficial in patients with AChR antibody positive generalized myasthenia gravis even without thymoma
Level 3 *Diagnoses neuromuscular junction disorders, even when the presentation is atypical* *Recognizes indications for special diagnostic techniques (e.g., single fiber EMG); tracks disease activity with formal scales and patient reported outcome measures (PROMs)*	● Sends low density lipoprotein receptor-related protein 4 (LRP4) antibody test to diagnose myasthenia gravis in a patient with classic fatigable weakness but negative AChR and muscle-specific tyrosine kinase (MuSK) antibodies ● Refers a patient with fluctuating ptosis but negative serologies and normal repetitive nerve stimulation for single-fiber EMG ● Routinely incorporates use of myasthenia gravis -activities of daily living (MG-ADL), 15-item myasthenia gravis quality of life (MGQOL15r), myasthenia gravis composite (MGC),

Manages uncommon neuromuscular junction disorders	or quantitative myasthenia gravis (QMG) surveys/tools to follow disease progression and to help determine management decisions ● Prescribes 3,4-diaminopyridine (DAP) for a patient with Lambert-Eaton myasthenic syndrome and counsels patient on the side effects
Level 4 *Distinguishes worsening of neuromuscular junction disorders from complications of treatment or new disorders* *Recognizes when genetic testing is indicated (e.g., congenital myasthenic syndromes)* *Manages patients with refractory neuromuscular junction disorders*	● Considers steroid myopathy in a patient with myasthenia gravis complaining of fatigue and difficulty walking rather than simply escalating myasthenia gravis treatment ● Considers genetic testing for congenital myasthenic syndromes in a young patient with symptoms of a neuromuscular junction disorder and previously diagnosed as seronegative myasthenia gravis but refractory to immunomodulatory treatments ● Considers additional testing for mitochondrial myopathy in patients with progressive external ophthalmoplegia initially diagnosed as seronegative ocular myasthenia gravis ● Consider diagnosis of oculopharyngeal muscular dystrophy in patients with seronegative myasthenia gravis and bulbar symptoms ● Relying on shared decision making, considers and prescribes options such as eculizumab, rituximab, and enrollment in a clinical trial for a patient with myasthenia gravis who has severe persistent symptoms despite conventional immunomodulatory therapies
Level 5 *Engages in scholarly activity (e.g., teaching, research) in neuromuscular junction disorders* *Manages patient with neuromuscular junction disorders and complex co-morbidities*	● Publishes a manuscript on neuromuscular junction disorders ● Participates in local or multicentric research on neuromuscular junction disorders ● Diagnoses a patient with myasthenia gravis and myositis overlap after treatment with an immune checkpoint inhibitor
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback
Curriculum Mapping	●
Notes or Resources	● Benatar M. A systematic review of diagnostic studies in myasthenia gravis. *Neuromuscular Disorders*. 2006;16(7):459-467. https://www.nmd-journal.com/article/S0960-8966(06)00152-0/fulltext. 2021. ● Gilhus NE, Verschuuren JJ. Myasthenia gravis: Subgroup classification and therapeutic strategies. *Lancet Neurol*ogy. 2015;14(10):1023-1236.

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Patient Care 9: Myopathies **Overall Intent:** To diagnose and manage muscle disorders and their complications	
Milestones	**Examples**
Level 1 *Recognizes common presentations of myopathies*	● Considers a diagnosis of Duchenne muscular dystrophy in a four-year-old boy who is falling frequently and has trouble getting up from the floor
Recognizes when electrodiagnostic and serologic testing is indicated	● Sends a myositis antibody panel in a middle-aged adult presenting with six weeks of progressive difficulty rising from a chair, reaching above the head, and a rash who has been found to have an elevated creatine phosphokinase ● Orders an EMG to confirm myopathy in a patient presenting with slowly progressive limb-girdle pattern of weakness and an elevated creatine kinase
Prescribes basic orthotics, mobility aids, and therapies (e.g., physical therapy [PT], occupational therapy [OT], speech therapy [ST]) as indicated	● Refers a patient with facioscapulohumeral muscular dystrophy for occupational therapy and prescribes them ankle-foot orthotics
Level 2 *Diagnoses common myopathies*	● Diagnoses Anti-Jo-1 antisynthetase syndrome via serologic testing in a patient presenting with interstitial lung disease and limb weakness ● Considers a diagnosis of inclusion body myositis in a patient with finger flexor weakness but a normal creatine kinase) antibodies, and considers muscle biopsy, to further investigate
Incorporates results of electrodiagnostic and serologic testing in the context of the clinical presentation (e.g., false negatives and false positives); recognizes when genetic testing or muscle biopsy is indicated	● Obtains a muscle biopsy in a patient with persistent weakness and persistently elevated creatine phosphokinase five weeks after stopping a statin
Manages patients with common myopathies; provides collaborative care with relevant medical specialties	● Carefully and accurately assesses muscle strength in a patient with dermatomyositis, working together with the patient's rheumatologist to determine when to initiate prednisone taper ● Provides exercise recommendations, in consultation with a physical therapist if needed, for a patient who has recently been diagnosed with myotonic dystrophy
Level 3 *Diagnoses uncommon myopathies*	● Refers a 30-year-old patient with bilateral foot drop for electrodiagnostic testing and considers a diagnosis of inherited distal myopathy after EMG shows myopathic changes in the distal limb muscles

Interprets genetic testing and/or findings on muscle biopsy in the context of the clinical presentation	● Recognizes the presence of rimmed vacuoles and inflammatory infiltrates on a muscle biopsy may suggest inclusion body myositis rather than polymyositis ● Appreciates that muscle fiber type grouping may indicate a neuropathic etiology of weakness on muscle biopsy ● Sends targeted genetic testing for acid maltase deficiency in a patient presenting with exercise intolerance, second wind phenomenon, and normal strength on confrontational testing ● Sends a panel of genes that commonly cause limb-girdle muscular dystrophies in a 28-year-old patient who was not very athletic in high school and is now having trouble getting off the toilet
Recognizes medical complications of myopathies, including respiratory failure, cardiac disease, and ocular manifestations	● Obtains an electrocardiogram, echocardiography and refers a patient to cardiology who has recently been diagnosed with type 1 myotonic dystrophy
Level 4 *Distinguishes worsening of myopathies from complications of treatment or new disorders*	● Uses a rising creatine kinase level and signs of edema on magnetic resonance imaging (MRI) of the thigh muscles to determine that a patient with immune-mediated necrotizing myositis is becoming weaker due to a flare of the disease rather than the chronic effects of corticosteroid therapy
Discusses the implications of variants of uncertain significance on genetic testing and interprets in the context of the clinical presentation	● Obtains a muscle biopsy to look for the presence of cores after genetic testing in a patient complaining of axial muscle weakness identifies a variant of uncertain significance in the ryanodine receptor 1 gene
Manages patients with uncommon myopathies, including genetic counseling and goals of care for those with inherited myopathies	● Refers a patient to hematology for consideration of autologous stem cell transplant after diagnosing them with monoclonal gammopathy-associated sporadic late onset nemaline myopathy ● Discusses family planning with a young patient with an autosomal dominant form of limb girdle muscular dystrophy and their spouse who are trying to decide whether to have children
Level 5 *Engages in scholarly activity (e.g., teaching, research) on myopathies*	● Publishes a manuscript on myopathies ● Participates in local or multicentric research on myopathies
Manages patients with myopathies and complex co-morbidities	● Coordinates the immunomodulatory treatment of a patient with paraneoplastic dermatomyositis while they are undergoing chemotherapy
Assessment Models or Tools	● Direct observation

	● Medical record (chart) review ● Multisource feedback
Curriculum Mapping	●
Notes or Resources	● Allenbach Y, Mammen AL, Benveniste O, et al. 224th ENMC International Workshop: Clinico-sero-pathological classification of immune-mediated necrotizing myopathies Zandvoort, The Netherlands, 14-16 October 2016. *Neuromuscular Disorders*. 2018:28(1):87-99. https://www.nmd-journal.com/article/S0960-8966(17)31207-5/fulltext. 2021. ● De Bleecker JL, De Paepe B, Aronica E, et al. 205th ENMC International Workshop: Pathology diagnosis of idiopathic inflammatory myopathies Part II 28-30 March 2014, Naarden, The Netherlands. *Neuromuscular Disorders*. 2015;25(3):268-272. https://www.nmd-journal.com/article/S0960-8966(14)00703-2/fulltext. 2021. ● Gloss D, Moxley RT III, Ashwal S, Oskoui M. Practice guideline update summary: Corticosteroid treatment of Duchenne muscular dystrophy. *Neurology*. 2016;86(5):465-472. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4773944/#__ffn_sectitle. 2021. ● Lieqluck T, Milone M. Untangling the complexity of limb-girdle muscular dystrophies. *Muscle Nerve*. 2018;58(2):167-177. https://onlinelibrary.wiley.com/doi/abs/10.1002/mus.26077. 2021. ● Milone M, Lieqluck T. The unfolding spectrum of inherited distal myopathies. *Muscle Nerve*. 2019;59(3):283-294. https://onlinelibrary.wiley.com/doi/abs/10.1002/mus.26332. 2021. ● Narayanaswami P, Weiss M, Selcen D, et al. Evidence-based guideline summary: Diagnosis and treatment of lib-girdle and distal dystrophies. *Neurology*. 2014;83(16):1453-1463. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4206155/#__ffn_sectitle. 2021. ● Rose MR, ENMC IBM Working Group. 188th ENMC International Workshop: Inclusion body myositis, 2-4 December 2011, Naarden, The Netherlands. *Neuromuscular Disorders*. 2013;23(12):1044-1055. https://www.nmd-journal.com/article/S0960-8966(13)00950-4/fulltext. 2021. ● Tawil R, Kissel JT, Heatwole C, et al. Evidence-based guideline summary: Evaluation, diagnosis, and management of facioscapulohumeral muscular dystrophy. *Neurology*. 2015;85(4):357-364. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4520817/#__ffn_sectitle. 2021.

Patient Care 10: Digital Health **Overall Intent:** To maximize use of technology in the support of care of patients with neuromuscular disorders	
Milestones	**Examples**
Level 1 *Expands use of the electronic health record (EHR) to include and reconcile secondary data sources in patient care activities*	● Reviews outside electronic data links for interim events in a return neuromuscular patient
Initiates and carries out a telehealth visit	● Successfully connects electronically and verifies patient identity at the beginning of the telemedicine visit
Level 2 *Utilizes EHR capabilities and identifies use for digital or remote monitoring data in patient care activities*	● Reviews outside monitoring labs on a patient on azathioprine
Identifies which clinical situations can be managed through a telehealth visit	● Schedules an in-person visit after a telemedicine visit in a patient with myasthenia gravis and increasing fatigue
Level 3 *Utilizes EHR capabilities to manage and monitor patients, including through patient-reported outcomes*	● Prior to clinic visit, has every patient with myotonic dystrophy fill out the excessive daytime sleepiness scale
Demonstrates the ability to perform a neuromuscular history and examination in a telehealth visit	● Assesses response to therapy of a patient with necrotizing myopathy to rise from a seated position with arms crossed
Level 4 *Uses the EHR to communicate complex care plans with patients and other providers*	● Documents an increase in prednisone in a patient with myasthenia gravis and communicates this change with the primary care provider via electronic health record (EHR) or telephone for appropriate monitoring
Uses telehealth visits for complex patient management	● Involves multi-disciplinary providers in a telemedicine visit in a patient with advanced ALS
Level 5 *Leads improvements in the EHR specific for neuromuscular patients*	● Develops templates, flowsheets for outcome measures or dot phrases within the EHR
Innovates and leads in the use of emerging technologies for care of neuromuscular patients	● Works through the EHR with pulmonologists to manage non-invasive ventilation settings in a patient with ALS
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback

Curriculum Mapping	●
Notes or Resources	● Howard IM, Kaufman MS. Telehealth applications for outpatients with neuromuscular or musculoskeletal disorders. *Muscle Nerve*. 2018;58(4):475-485. https://onlinelibrary.wiley.com/doi/abs/10.1002/mus.26115. 2021.

Medical Knowledge 1: Localization **Overall Intent:** To properly correlate symptoms and exam findings to an anatomical region	
Milestones	**Examples**
Level 1 *Localizes neuromuscular lesions to general components* *Describes basic anatomy of the peripheral nervous system*	● Identifies fixed proximal weakness as concerning for a myopathic process ● Recognizes peripheral patterns of sensory loss ● Recognizes upper and lower motor neuron signs ● Outlines the anatomical structure of muscle, motor, and sensory neurons ● Describes the corticospinal motor and spinothalamic and posterior column sensory tracts
Level 2 *Accurately localizes neuromuscular lesions to specific components* *Recognizes localization to the brachial plexus as opposed to radicular or focal peripheral nerve process*	● Differentiates spastic from flaccid dysarthria ● Incorporates provocative maneuvers to aid in localization (e.g., Spurling sign, straight leg raise, Phalen maneuver) ● Identifies a more proximal lesion when a patient sent for ulnar neuropathy identifies numbness in the medial forearm ● Identifies a lumbar or radicular lesion in a patient with foot drop that has weakness in foot inversion and/or hip abduction
Level 3 *Accurately localizes neuromuscular lesions and recognizes pitfalls in localization, as well as potential sources of error* *Recognizes precise localization to elements of the brachial plexus (e.g., cord, trunk) and distinguishes it from radicular or focal peripheral nerve process*	● Understands that joint motion can be accomplished by multiple muscles; weakness of elbow flexion can occur in a radial neuropathy due to the contributions of the brachioradialis and brachialis (dual innervated) ● Recognizes that history is also important to the examination; a stepwise mononeuritis multiplex can eventually become more confluent, mimicking a more benign length dependent polyneuropathy
Level 4 *Efficiently and accurately localizes neuromuscular lesions, including focal and multifocal peripheral nerve lesions and generalized neuromuscular and autonomic disorders* *Recognizes anatomic variants (e.g., prefixed plexus, Riche-Cannieu anastomosis)*	● Recognizes hereditary amyloid neuropathy as a potential localization in a patient with Sicca syndrome, orthostatic hypotension, and incontinence ● Understands the importance of a nerve biopsy in a patient developing constitutional symptoms and multiple mononeuropathies over a one-month period ● Considers a prefixed plexus in a patient with cervical spinal nerve (C)4 root impingement on imaging, but a C5 radiculopathy clinically/electrically
Level 5 *Consistently demonstrates sophisticated and detailed localization of*	● Requests a neuromuscular ultrasound in a patient with symptoms classic for ulnar neuropathy at the elbow, but normal electrodiagnostic testing

neuromuscular lesions by combining clinical, neurophysiologic, imaging and laboratory testing using efficient approaches	
Assessment Models or Tools	● Direct observation ● American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) In-Service Self-Assessment Examination
Curriculum Mapping	●
Notes or Resources	● Alrajeh M, Preston DC. Neuromuscular ultrasound in electrically non-localizable ulnar neuropathy. *Muscle Nerve*. 2018;58(5):655-659. https://onlinelibrary.wiley.com/doi/abs/10.1002/mus.26291. 2021. ● Morrison BM. Neuromuscular diseases. *Semin Neurol*. 2016;36(5):409-418. https://www.thieme-connect.de/products/ejournals/abstract/10.1055/s-0036-1586263. 2021.

Medical Knowledge 2: Formulation **Overall Intent:** To identify neuromuscular patterns based on key symptoms and exam findings and formulate accurate differential diagnoses	
Milestones	**Examples**
Level 1 *Summarizes key elements of history and exam and generates a relevant differential diagnosis* *Correlates under guidance the clinical presentation with basic anatomy but not with pathophysiology of nerve and muscle disorders*	● Identifies significant alcohol use and diabetes as important risk factors for polyneuropathy ● Identifies numbness in feet and length dependent sensory loss extending to the ankles with balance problems as consistent with polyneuropathy ● Correlates under guidance paresthesia in medial hand and digits 4 and 5 with ulnar nerve entrapment ● Correlates under guidance a pattern of proximal arm and leg weakness with myopathy
Level 2 *Synthesizes information to focus and prioritize diagnostic possibilities for neuromuscular disorders* *Correlates under guidance the clinical presentation with basic anatomy and pathophysiology of neuromuscular disorders*	● Prioritizes testing for fasting blood glucose/glycosylated hemoglobin in patients with polyneuropathy ● Prioritizes testing for AChR antibodies in patients with fatigable weakness ● Correlates facial weakness in Bell's palsy with the electrodiagnostic findings to inform severity and prognosis ● Correlates hand numbness in carpal tunnel syndrome with the electrodiagnostic findings to inform severity ● Correlates under guidance ulnar nerve entrapment with symptoms with common site of entrapment at the elbow and anatomy of the elbow (cubital tunnel and ulnar groove) ● Correlates under guidance the extent of axonal loss and reinnervation with prognosis in traumatic nerve injuries
Level 3 *Efficiently synthesizes information to focus and prioritize diagnostic possibilities* *Independently correlates the clinical presentation with detailed anatomy and pathophysiology of neuromuscular disorders*	● Efficiently synthesizes that in a patient with length dependent neuropathy and history of diabetes, most likely diagnosis is diabetic neuropathy and to check recent glucose testing versus a less likely diagnosis of toxic neuropathy ● Prioritizes genetic testing in a patient with bilateral foot drop and strong family history of Charcot-Marie-Tooth disease ● Considers inclusion body myositis in patient with polymyositis not responsive to treatment and marked finger flexor and quadriceps muscle weakness ● Independently correlates progressive sensorimotor polyneuropathy associated with autonomic features with amyloid polyneuropathy ● Independently correlates progressive limb weakness, dry mouth, and facilitation of muscle stretch reflexes with Lambert-Eaton myasthenic syndrome

Level 4 *Continuously reconsiders diagnostic possibilities in response to new clinical information* *Demonstrates sophisticated and detailed knowledge of neuromuscular disorders*	● Reconsiders a chronic demyelinating neuropathy not responsive to treatment as possibly being a patient with POEMS syndrome, or Charcot-Marie-Tooth disease ● Reconsiders a patient with a history of bulbar onset weakness now developing hand weakness as being more concerning for ALS ● Considers hereditary neuropathy with liability to pressure palsy in a young patient with history of left common fibular mononeuropathy and new onset of left ulnar mononeuropathy at the elbow ● Suspects, diagnoses, and treats a patient with ALS ● Suspects, diagnoses, and treats a patient with MG
Level 5 *Effectively educates others about neuromuscular diagnostic reasoning* *Discriminates coexisting multiple neurologic and neuromuscular diagnoses*	● Educates residents, multidisciplinary team members, nurses regarding neuromuscular diagnoses ● Presents the diagnostic reasoning of complex neuromuscular cases to colleagues, residents, and the neuromuscular team ● Discriminates coexisting frontotemporal dementia and ALS in the same patient ● Discriminates ALS coexisting with a diabetic neuropathy in a patient ● Discriminates steroid myopathy from polymyositis in a patient undergoing treatment for inflammatory myopathy
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback ● Self-assessment exams
Curriculum Mapping	●
Notes or Resources	● Bönnemann CG, Wang CH, Quijano-Roy S, et al. Diagnostic approach to the congenital muscular dystrophies. *Neuromuscular Disorders*. 2014;24(4):289-311. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5258110/. 2021. ● Keddie S, Lunn MP. POEMS syndrome. *Current Opinion in Neurology*. 2018;31(5):551-558. https://journals.lww.com/co-neurology/Abstract/2018/10000/POEMS_syndrome.7.aspx. 2021. ● London ZN. A structured approach to the diagnosis of peripheral nervous system disorders. *Continuum (Minneap Minn)*. 2020;26(5):1130–1160. https://pubmed.ncbi.nlm.nih.gov/33002996/. 2021. ● Pasnoor M, Dimachkie MM. Approach to muscle and neuromuscular junction disorders. *Continuum (Minneap Minn)*. 2019;25(6):1536-1563. https://journals.lww.com/continuum/Abstract/2019/12000/Approach_to_Muscle_and_Neuromuscular_Junction.4.aspx. 2021.

Medical Knowledge 3: Diagnostic Investigation **Overall Intent:** To order pertinent diagnostic tests supported by the available differential diagnoses, symptoms, and exam findings	
Milestones	**Examples**
Level 1 *Summarizes key elements of history and exam findings and generates a broad differential diagnosis*	● Considers the presence of a proximal myopathy based on prominent symptoms and signs and then produces a list of possible differential diagnoses
Recognizes common indications for serologic and electrodiagnostic testing	● Orders routine screening labs for polyneuropathies and myopathies ● Recognizes the need for AChR Ab testing and repetitive nerve stimulation in a patient with fatigable weakness, diplopia, and eyelid ptosis ● Recognizes the need for limb EMG and nerve conduction study in a patient with progressive dysphagia and brisk reflexes
Level 2 *Identifies the first steps in working up common neuromuscular disorders*	● Identifies fasting glucose tolerance test/hemoglobin A1c, B12, serum immunofixation as high-yield tests in a patient with peripheral neuropathy ● Utilizes nerve conduction study and EMG properly in the work-up of peripheral neuropathy
Sequences laboratory testing, electrodiagnostic testing, imaging, and genetic testing for common neuromuscular disorders	● Orders nerve conduction studies/EMG in a patient with suspected hereditary neuropathy prior to ordering genetic testing
Level 3 *Efficiently synthesizes information to focus and prioritize diagnostic possibilities*	● Recognizes that progressive muscle weakness in a patient with upper and lower motor neuron signs is consistent with motor neuron disease
Integrates the use of nerve and muscle imaging (e.g., ultrasound, magnetic resonance imaging [MRI]) into the diagnostic process; recognizes the indications for nerve and muscle biopsy and genetic testing	● Orders MRI or ultrasound of proximal upper and lower extremity limb in patients with suspicion of multifocal motor neuropathy and lack of conduction block in electrodiagnostic testing ● Orders nerve biopsy in a patient with rapidly progressing multiple mononeuropathies
Level 4 *Continuously reconsiders diagnostic possibilities in response to new clinical information*	● Reconsiders initial diagnosis of ALS in a patient with stable symptoms for an extended period of time
Reconciles conflicting data from diagnostic tests and the clinical presentation; efficiently provides genetic testing suited to the clinical situation (e.g., single gene versus panel testing versus whole exome sequencing)	● Selects additional genetic testing in a patient with hyperCKemia (CK)>10,000 and negative Duchenne Muscular Dystrophy (DMD)/Becker Muscular Dystrophy (BMD) genetic testing

	● Considers inclusion body myositis in a patient with initial biopsy diagnosis of polymyositis that is not responding to immunosuppression and has significant finger flexor and quadriceps weakness ● Considers acid maltase deficiency and orders alpha glucosidase (GAA) genetic testing or blood spot in a patient with progressive neuromuscular respiratory failure and myotonic discharges in paraspinal muscles
Level 5 *Effectively educates others about neuromuscular diagnostic reasoning* *Engages in scholarly activity on diagnostic testing for neuromuscular disorders*	● Presents interesting cases in neuromuscular grand rounds ● Publishes case reports
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback ● Self-assessment exams
Curriculum Mapping	●
Notes or Resources	● Ankala A, da Silva C, Gualandi F, et al. A comprehensive genomic approach for neuromuscular diseases gives a high diagnostic yield. *Annals of Neurology*. 2014;77(2):206-214. https://onlinelibrary.wiley.com/doi/abs/10.1002/ana.24303. 2021. ● Benatar M. A systematic review of diagnostic studies in myasthenia gravis. *Neuromuscular Disorders*. 2006;16(7):459-467. https://www.nmd-journal.com/article/S0960-8966(06)00152-0/fulltext. 2021. ● Biliciler S, Kwan J. Inflammatory myopathies: Utility of antibody testing. *Neurologic Clinics.* 2020;38(3):661-678. https://www.sciencedirect.com/science/article/abs/pii/S0733861920300396?via%3Dihub. 2021. ● Bodofsky EB, Carter GT, England JD. Is electrodiagnostic testing for polyneuropathy overutilized? *Muscle Nerve*. 2016;55(3):301-304. https://onlinelibrary.wiley.com/doi/epdf/10.1002/mus.25464. 2021. ● Cartwright MS, Walker FO. Neuromuscular ultrasound in common entrapment neuropathies. *Muscle Nerve*. 2013;48(5):696-704. https://onlinelibrary.wiley.com/doi/abs/10.1002/mus.23900. 2021. ● England JD, Gronseth GS, Franklin G, et al. Practice parameter: Evaluation of distal symmetric polyneuropathy: Role of autonomic testing, nerve biopsy, and skin biopsy (an evidence-based review). Report of the American Academy of Neurology, American Association of Neuromuscular and Electrodiagnostic Medicine, and American Academy of

	Physical Medicine and Rehabilitation. *Neurology*. 2009;72(2):177-184. https://n.neurology.org/content/72/2/177.long. 2021. ● England JD, Gronseth GS, Franklin G, et al. Practice parameter: Evaluation of distal symmetric polyneuropathy: Role of laboratory and genetic testing (an evidence-based review). Report of the American Academy of Neurology, American Association of Neuromuscular and Electrodiagnostic Medicine, and American Academy of Physical Medicine and Rehabilitation. *Neurology*. 2009;72(2):185-192. https://pubmed.ncbi.nlm.nih.gov/32387049/. 2021. ● London ZN. A structured approach to the diagnosis of peripheral nervous system disorders. *Continuum (Minneap Minn)*. 2020;26(5):1130–1160. https://pubmed.ncbi.nlm.nih.gov/33002996/. 2021. ● Pasnoor M, Dimachkie MM. Approach to muscle and neuromuscular junction disorders. *Continuum (Minneap Minn)*. 2019;25(6):1536-1563. https://journals.lww.com/continuum/Abstract/2019/12000/Approach_to_Muscle_and_Neuromuscular_Junction.4.aspx. 2021. ● Pasnoor M, Dimachkie MM, Farmakidis C, et al. Diagnosis of myasthenia gravis. *Neurologic Clinics*. 2018;36(2):261-274. https://www.sciencedirect.com/science/article/abs/pii/S0733861918300100?via%3Dihub. 2021. ● Rosow LK, Amato AA. The role of electrodiagnostic testing, imaging, and muscle biopsy in the investigation of muscle disease. *Continuum (Minneap Minn).* 2016;22(6):1787-1802. https://journals.lww.com/continuum/Abstract/2016/12000/The_Role_of_Electrodiagnostic_Testing,_Imaging,.6.aspx. 2021. ● Shefner JM, Al-Chalabi A, Baker MR, et al. A proposal for new diagnostic criteria for ALS. *Clinical Neurphysiology*. 2020;131(8):1975-1978. https://pubmed.ncbi.nlm.nih.gov/32387049/. 2021.

Medical Knowledge 4: Muscular and Nerve Pathology **Overall Intent:** To recognize and correlate histologic changes in muscle and nerve to clinical features	
Milestones	**Examples**
Level 1 *Demonstrates ability to identify specific stains and differentiate tissue types, as well as knowledge of normal and abnormal histopathology of peripheral nerve and skeletal muscle*	● Identifies hematoxylin and eosin and trichrome stains ● Differentiates between muscle and nerve histology
Level 2 *Demonstrates knowledge of tissue fixation and utility of specific stains, and recognizes common pathologic findings and technical artifacts in nerve and muscle biopsy preparations*	● Recognizes freeze artifact and can differentiate from muscle pathology ● Identifies ragged red fibers on trichrome stain and anticipates correlative need for evaluating cytochrome c oxidase and succinate dehydrogenase staining ● Recognizes muscle fiber type grouping
Level 3 *Demonstrates advanced knowledge of abnormal histopathology of peripheral nerve and skeletal muscle, and correlates the nerve and muscle biopsy findings with the clinical presentation*	● Recognizes nemaline rods on a trichrome stain ● Recognizes basophilia in muscle tissue as a sign of early regeneration ● Distinguishes demyelination and remyelination on teased nerve fibers ● Recognizes that evidence of central core abnormalities on muscle tissue could correlate to the clinical presentation of head drop ● Recognizes that the presence of inflammatory cell invasion in the vascular wall and in nerve fibers can be associated with clinical symptoms of painful wrist drop or foot drop in a vasculitic neuropathy
Level 4 *Recognizes uncommon pathologic findings in nerve and muscle preparations*	● Recognizes muscle fiber types in adenosine triphosphatase stains
Level 5 *Independently interprets nerve and muscle biopsy specimens and generates a report*	● Gives a detailed description of all stains needed to identify an inflammatory myopathy including when electron microscopy and major histocompatibility complex 1 (MHC1) staining is needed and writes the report
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback
Curriculum Mapping	●
Notes or Resources	● Amato AA, Russell JA. *Neuromuscular Disorders*. 2nd ed. McGraw-Hill Education; 2016:2-21. ISBN:978-0071752503. ● Dubowitz V, Sewry CA, Oldfors A. *Muscle Biopsy: A Practical Approach*. 5th ed. Elsevier; 2020. ISBN:978-0702074714.

Systems-Based Practice 1: Patient Safety and Quality Improvement (QI) **Overall Intent:** To engage in the analysis and management of patient safety events, including relevant communication with patients, families, and health care professionals; to conduct a QI project	
Milestones	**Examples**
Level 1 *Demonstrates knowledge of commonly reported patient safety events* *Demonstrates knowledge of how to report patient safety events* *Demonstrates knowledge of basic quality improvement methodologies and metrics*	● Has basic knowledge about the definition of patient safety events, reporting pathways, and QI strategies ● Understands the safety protocol after an inadvertent needle stick of a physician during a procedure ● Demonstrates the ability to use two patient identifiers to confirm correct patient and confirms correct location prior to performing an invasive procedure ● Demonstrates knowledge of root cause analysis
Level 2 *Identifies system factors that lead to patient safety events* *Reports patient safety events through institutional reporting systems* *Describes local quality improvement initiatives*	● Identifies and reports a medication error caused by inadequate hand-off ● Identifies the lack of a list of medications to avoid for patients with myasthenia as a potential safety event ● Describes initiatives to improve EMG reports for reporting consistencies and quality ● Describes the use of PROMs in neuromuscular patient as a potential measure of quality
Level 3 *Participates in analysis of patient safety events* *Participates in disclosure of patient safety events to patients and patient's families* *Participates in local quality improvement initiatives*	● Participates in a root cause analysis for a medication error and attends a family meeting to disclose ● Participates in a QI project in the ALS clinic to ensure all patients undergo pulmonary function testing
Level 4 *Conducts analysis of patient safety events and offers error prevention strategies* *Discloses patient safety events to patients and patient's families*	● Collaborates in the analysis of a medication error to improve the hand-off process ● Discloses a medication error to patients/families

Demonstrates the skills required to identify, develop, implement, and analyze a quality improvement project	● Designs a QI project that will allow for urgent referrals to be seen in a timely fashion
Level 5 *Actively engages teams and processes to modify systems to prevent patient safety events* *Role models or mentors others in the disclosure of patient safety events* *Creates, implements, and assesses quality improvement initiatives at the institutional or community level*	● Engages appropriate stakeholders to improve awareness of medications that exacerbate neuromuscular junction disorders ● Works with the EHR team to create a function to warn providers when prescribing a dangerous drug to a patient with myasthenia gravis ● Leads a simulation for more junior residents in error disclosure ● Analyzes and publishes the findings of a quality improvement (QI) project to optimize communications between internal medicine and neuromuscular medicine
Assessment Models or Tools	● Chart audit ● Direct observation ● Documentation of QI or patient safety project ● E-module multiple choice tests ● Multisource feedback ● Portfolio ● Simulation
Curriculum Mapping	●
Notes or Resources	● Institute of Healthcare Improvement. http://www.ihi.org/Pages/default.aspx. 2021.

Systems-Based Practice 2: System Navigation for Patient-Centered Care **Overall Intent:** To effectively navigate the health care system, including the interdisciplinary team and other care providers	
Milestones	**Examples**
Level 1 *Demonstrates knowledge of care coordination* *Performs safe and effective transitions of care/hand-offs in routine clinical situations*	● Identifies the members of the interprofessional team ● Lists the essential components of an effective sign-out and care transition, including sharing information necessary for successful transitions
Level 2 *Coordinates care of patients in routine clinical situations effectively using the roles of the interprofessional team members* *Performs safe and effective transitions of care/hand-offs in complex clinical situations*	● Contacts social worker and pharmacist to get assistance for obtaining neuromuscular medications begun in the hospital ● Provides anticipatory guidance to night float team about a patient with new onset Guillain-Barre syndrome with fluctuating blood pressure
Level 3 *Coordinates care of patients in complex clinical situations, effectively using the roles of the interprofessional team members* *Supervises transitions of care/hand-offs by other team members*	● Coordinates care of a patient with myotonic dystrophy with other health care professionals ● Participates in risk evaluation and mitigation strategies program, coordinates meningococcal vaccination with primary care doctor, and contacts infusion pharmacists to arrange for eculizumab treatment for a patient with myasthenia gravis ● Supervises residents when patients are transitioned from intensive care unit (ICU) to a step-down unit
Level 4 *Role models effective coordination of patient-centered care among different disciplines and specialties* *Role models safe and effective transitions of care/hand-offs within and across health care delivery systems, including outpatient settings*	● Participates in a multidisciplinary family meeting for a patient diagnosed with ALS while in the ICU ● Coordinates with primary care and local neurologist for continuity of care of a patient with newly diagnosed myasthenia gravis
Level 5 *Demonstrates skills in developing and implementing new inter-professional care models* *Improves quality of transitions of care within and across health care delivery systems to optimize patient outcomes*	● Designs a transitional clinic from pediatric to adult care for patients with hereditary neuropathies or myopathies ● Helps develop a telemedicine multidisciplinary clinic for patients with neuromuscular disorders such as ALS
Assessment Models or Tools	● Direct observation

	● Medical record (chart) audit ● Multisource feedback ● Simulation
Curriculum Mapping	●
Notes or Resources	● Centers for Disease Control and Prevention (CDC). Population Health Training. https://www.cdc.gov/pophealthtraining/whatis.html. 2021. ● Skochelak SE, Hawkins RE, Lawson LE, Starr SR, Borkan JM, Gonzalo JD. *AMA Education Consortium: Health Systems Science.* 1st ed. Philadelphia, PA: Elsevier; 2016. https://commerce.ama-assn.org/store/ui/catalog/productDetail?product_id=prod2780003. 2021.

Systems-Based Practice 3: Population and Health Advocacy **Overall Intent:** To adapt care to a specific patient population to ensure high-quality patient outcomes	
Milestones	**Examples**
Level 1 *Demonstrates knowledge of population and community health needs and equities* *Describes social determinants of health and their roles in neuromuscular disease*	● Identifies components of social determinants of health and how they impact the delivery of patient care ● Recognizes the need for help with transportation for neuromuscular patients based on social history taking
Level 2 *Identifies specific population and community health needs and inequities for the local population and community* *Identifies behavioral and social interventions that can improve neuromuscular health*	● Identifies patients at risk for specific health outcomes related to health literacy concerns ● Help patients register with resourceful organizations such as the MDA and the ALS Association
Level 3 *Effectively uses local resources to meet the needs of a patient population and community* *Effectively advocates for interventions that can improve social determinants of health*	● Works with community palliative care and hospice teams for patients with ALS ● Involves a social worker to help with the care of patients without health insurance and low socioeconomic status
Level 4 *Adapts approach to patient care to provide for the needs of specific populations* *Implements social and behavioral changes for patients and patient's families that improve health, such as exercise and diet*	● Works with program director to alter clinic hours for working patients ● Working with physical therapists, coordinates exercise routine for patients with muscular dystrophies that works within the patient's environment
Level 5 *Leads innovations in adapting patient care for populations and communities with health care inequities* *Leads community-based interventions that improve population health*	● Designs a curriculum on social determinants of health ● Develops a telehealth program for outlying clinics ● Creates a support group that targets socioeconomically disadvantaged neuromuscular patients
Assessment Models or Tools	● Direct observation ● Medical record (chart) audit ● Multisource feedback ● Simulation

Curriculum Mapping	●
Notes or Resources	● CDC. Population Health Training. https://www.cdc.gov/pophealthtraining/whatis.html. 2021. ● Roberts AL, Johnson NJ, Chen JT, Cudkowicz ME, et al. Race/ethnicity, socioeconomic status, and ALS mortality in the United States. *Neurology*. 2016;87(22):2300-2308. https://pubmed.ncbi.nlm.nih.gov/27742817/. 2021. ● Skochelak SE, Hawkins RE, Lawson LE, Starr SR, Borkan JM, Gonzalo JD. *AMA Education Consortium: Health Systems Science.* 1st ed. Philadelphia, PA: Elsevier; 2016. https://commerce.ama-assn.org/store/ui/catalog/productDetail?product_id=prod2780003. 2021.

Systems-Based Practice 4: Physician Role in Health Care Systems **Overall Intent:** To understand own role in the complex health care system and how to optimize the system to improve patient care and the health system's performance	
Milestones	**Examples**
Level 1 *Describes how components of a complex health care system are interrelated, and how this impacts patient care*	● Recognizes the multiple, often competing forces, in the health care system ● Recognizes that insurance restrictions may limit or delay the ability for a patient to receive care from a specific provider ● Recognizes that lack of communication between EHR systems may be a barrier to coordinating care
Describes basic health care payment systems, (e.g., government, private, public, uninsured care) and practice models	● Recognizes there are different payment systems, such as Medicare, Medicaid, US Veterans Affairs (the VA), and commercial third-party payors ● Understands the impact of health plan features, including formularies
Identifies basic knowledge domains for effective transition to practice (e.g., information technology, legal, billing and coding, financial, personnel)	● Understands proper documentation is required for billing and coding
Level 2 *Identifies how the health care system limits access to care, creates financial burdens to patients, and leads to inequity in care*	● Identifies that late discharges impact bed availability ● Identifies that patients who are poorly equipped to use technology hinders access to tele-health visits
Delivers patient-centered care that considers each patient's medical needs, as well as the payment model	● Completes documentation to obtain approval for prior authorization
Demonstrates use of information technology required for medical practice (e.g., electronic health record, documentation required for billing and coding)	● Applies appropriate coding, with supervision, in compliance with regulations
Level 3 *Engages with components of the complex health care system to provide efficient and effective patient care for everyone who needs it, regardless of finances, social status, or insurance coverage*	● Works with patient insurance, pharmacy, and social worker to obtain alternative immunomodulatory medication in a myasthenic who has failed first-line therapies ● In patients with limited financial resources, coordinates charity care with social worker and case manager

Engages with patients in shared decision making, informed by each patient's payment models	● Uses shared decision making and adapts choice of testing depending on the relevant clinical needs
Consistently demonstrates timely and accurate documentation, including coding and billing requirements	● Completes notes for patient encounters within timeframe established by the institution
Level 4 *Leads teams to provide efficient and effective patient care by managing components of the complex health care system while advocating for systems changes that address inequities*	● Collaborates with the institution to improve patient assistance resources ● Leads efforts on promoting neuromuscular specific education to community physical, occupational, and speech therapists
Uses available resources to promote optimal patient care (e.g., community resources, patient assistance resources) considering each patient's payment model	● Participates in peer-to-peer discussions for individual patients ● Refers the patient to community resources such as the ALS Association, the MDA, or respite care
Implements changes in individual practice patterns in response to professional requirements and in preparation for practice	● Develops a post-residency plan for individual practice or additional education
Level 5 *Leads advocacy efforts for systems change that enhances equitable, high-value, efficient, and effective patient care that is accessible to all who need it*	● Develops processes to decrease opioid prescribing for one or more clinical services ● Engages the patient's insurance company or hospital to add a specific medication to the formulary
Participates in health policy advocacy activities to promote better access and quality of care	● Improves informed consent process for non-English-speaking patients requiring interpreter services
Educates others to prepare them for transition to practice	● Works with state medical association to advocate for access to neurologic care
Assessment Models or Tools	● Direct observation ● Medical record (chart) audit
Curriculum Mapping	●
Notes or Resources	● Agency for Healthcare Research and Quality. Major Physician Measurement Sets. https://www.ahrq.gov/professionals/quality-patient-safety/talkingquality/create/physician/measurementsets.html. 2021.

	● Dzau VJ, McClellan MB, McGinnis JM, et al. Vital directions for health and health care: priorities from a National Academy of Medicine initiative. *JAMA*. 2017;317(14):1461-1470. https://nam.edu/vital-directions-for-health-health-care-priorities-from-a-national-academy-of-medicine-initiative/. 2021. ● The Commonwealth Fund. Health Reform Resource Center. http://www.commonwealthfund.org/interactives-and-data/health-reform-resource-center#/f:@facasubcategoriesfacet63677=[Individual%20and%20Employer%20Responsibility. 2021. ● The Kaiser Family Foundation. www.kff.org. 2021.

Practice-Based Learning and Improvement 1: Evidence-Based and Informed Practice **Overall Intent:** To incorporate evidence from varied sources to optimize patient care, and to critically appraise the sources and analyze conflicting evidence	
Milestones	**Examples**
Level 1 *Demonstrates how to access and use available evidence, and to incorporate patient preferences and values to the care of a routine patient*	● Searches for appropriate evidence-based guidelines for a patient with myasthenia gravis ● Uses online resources to answer daily treatment questions focusing on best available evidence, for example medication interactions, and dosing frequency
Level 2 *Articulates clinical questions and elicits patient preferences and values to guide evidence-based care*	● Asks about patient preferences for nutritional support in advanced ALS and searches literature for available options ● Asks about patient preferences regarding the use of non-invasive ventilation in ALS patients
Level 3 *Locates and applies the best available evidence, integrated with patient preference, to the care of complex patients*	● Applies evidence for alternate rescue therapy in a patient with myasthenia gravis who declines blood products ● Discusses other treatment options such as tacrolimus, cyclosporine, or eculizumab for patients with myasthenia gravis who are not responding to azathioprine, and/or mycophenolate and requiring frequent admissions for plasmapheresis or intravenous immunoglobulin
Level 4 *Critically appraises and applies evidence, even in the face of uncertainty, and interprets conflicting evidence to guide care tailored to the individual patient*	● Accesses the primary literature to address a unique clinical situation when a medication is under investigation or with conflicting evidence ● Identifies new evidence that challenges current practice and appropriately applies ● Reviews and discusses with the patient the evidence about the use of rituximab for anti-myelin-associated glycoprotein (anti-MAG) neuropathy
Level 5 *Coaches others to critically appraise and apply evidence for complex patients, and/or participates in the development of guidelines*	● Teaches an evidence-based neuromuscular course ● Discusses up to date journal papers on new neuromuscular therapies
Assessment Models or Tools	● Direct observation ● Journal club assessment ● Presentation
Curriculum Mapping	●
Notes or Resources	● U.S. National Library of Medicine. PubMed Tutorial. https://www.nlm.nih.gov/bsd/disted/pubmedtutorial/cover.html. 2021.

Practice-Based Learning and Improvement 2: Reflective Practice and Commitment to Personal Growth **Overall Intent:** To seek performance data and develop a learning plan	
Milestones	**Examples**
Level 1 *Accepts responsibility for personal and professional development by establishing goals*	● Establishes a timeline for independently performing nerve conduction studies
Identifies the factors that contribute to gap(s) between expectations and actual performance	● Identifies that lack of experience and review of the literature contributes to performance gaps
Actively seeks opportunities to improve	● Seeks feedback from other team members
Level 2 *Demonstrates openness to performance data (feedback and other input) to inform goals*	● Identifies gaps in diagnostic skills using feedback from others ● Seeks opportunity to improve communication skills
Analyzes and reflects on the factors that contribute to gap(s) between expectations and actual performance	● Analyzes a low subsection score on the Neuromuscular Self-Assessment Examination (NMSAE) to recognize areas to broaden exposure
Designs and implements a learning plan, with prompting	● Meets with mentor to select elective experiences to remedy performance gaps
Level 3 *Seeks performance data sporadically, with adaptability and humility*	● Takes input from peers/colleagues and supervisors to gain complex insight into personal strengths and weaknesses ● Accepts feedback in an appreciative and non-defensive manner
Institutes behavioral change(s) to narrow the gap(s) between expectations and actual performance	● Implements a structured reading plan
Independently creates and implements a learning plan	● Independently selects elective experiences to remedy performance gaps
Level 4 *Seeks performance data consistently*	● Establishes a quarterly meeting with a mentor to review continuity clinic performance data
Challenges assumptions and considers alternatives in narrowing the gap(s) between expectations and actual performance	● Proposes study sessions with colleagues on specific topics

Uses performance data to measure the effectiveness of the learning plan and, when necessary, improves it	● Reviews NMSAE score and revises the learning plan accordingly
Level 5 *Role models seeking performance data with adaptability and humility* *Coaches others on reflective practice* *Facilitates the design and implementation of learning plans for others*	● Discusses personal successes and challenges in performance gaps with junior residents ● Counsels others in effective team dynamics ● Mentors residents in review of performance data and advises on design of learning plan
Assessment Models or Tools	● Direct observation ● Multisource feedback ● Portfolios ● Review of individual learning plans and rotation schedule ● Self-assessment exam
Curriculum Mapping	●
Notes or Resources	● Hojat M, Veloski JJ, Gonnella JS. Measurement and correlates of physicians' lifelong learning. *Academic Medicine.* 2009;84(8):1066-1074. https://journals.lww.com/academicmedicine/fulltext/2009/08000/Measurement_and_Correlates_of_Physicians__Lifelong.21.aspx. 2021. ● Lockspeiser TM, Schmitter PA, Lane JL, Hanson JL, Rosenberg AA, Park YS. Assessing residents' written learning goals and goal writing skill: Validity evidence for the learning goal scoring rubric. *Academic Medicine*. 2013;88(10):1558-1563. https://journals.lww.com/academicmedicine/fulltext/2013/10000/Assessing_Residents__Written_Learning_Goals_and.39.aspx. 2021.

Professionalism 1: Professional Behavior and Ethical Principles **Overall Intent:** To demonstrate ethical/professional behaviors and use resources to address ethical/ professional conflicts	
Milestones	**Examples**
Level 1 *Identifies and describes potential triggers for professionalism lapses and how to report them* *Demonstrates knowledge of ethical principles related to patient care*	● Understands that sleep deprivation can be a trigger for a lapse in professionalism ● Demonstrates knowledge of system to report breaches of professionalism in own institution ● Discusses the basic principles underlying ethics and professionalism and how they apply in various situations ● Respects patient's autonomy
Level 2 *Demonstrates insight into professional behavior in routine situations and takes responsibility for one's own behavior* *Analyzes straightforward situations using ethical principles*	● Communicates respectfully in daily interactions ● Acknowledges lapses without becoming defensive, making excuses, or blaming others, and takes steps to make amends ● Monitors and responds to fatigue, hunger, stress, etc. in self and team members ● Applies ethical principles to straightforward informed consent
Level 3 *Demonstrates professional behavior in complex or stressful situations* *Analyzes complex situations using ethical principles*	● Navigates situations while under stress or when there are system barriers ● Pauses electrodiagnostic testing to allow nurses to perform checks and administer medications for inpatients ● Applies ethical principles to end-of-life situations ● Applies ethical principles to returning urgent patient phone calls and messages
Level 4 *Intervenes to prevent professionalism lapses in oneself and others* *Recognizes and uses appropriate resources for managing and resolving ethical dilemmas as needed*	● Focuses on behavior rather than intent in colleagues ● Takes action to help colleague who is distressed or using substances ● Requests ethics consult for patients who are unable to make their own decisions and who do not have a health care proxy
Level 5 *Coaches others when their behavior fails to meet professional expectations* *Identifies and seeks to address system-level factors that induce or exacerbate ethical problems or impede their resolution*	● Serves as peer advisor about professional expectations and behavior ● Serves as the resident member of the Institutional Review Board (IRB), Ethics, or Peer-Review Committee ● Identifies and works to resolve institutional policies that contribute to clinician stress
Assessment Models or Tools	● Case-based assessment

	● Direct observation ● Multisource feedback ● Simulation
Curriculum Mapping	●
Notes or Resources	● American Medical Association (AMA). Ethics. https://www.ama-assn.org/delivering-care/ama-code-medical-ethics. 2021. ● Bernat JL. *Ethical Issues in Neurology*. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2008. ISBN:978-0781790604. ● Bynny RL, Paauw DS, Papadakis MA, Pfeil S. *Medical Professionalism Best Practices: Professionalism in the Modern Era*. Aurora, CO: Alpha Omega Alpha Medical Society; 2017. *Medical Professionalism Best Practices: Professionalism in the Modern Era*. Aurora, CO: Alpha Omega Alpha Medical Society; 2017. http://alphaomegaalpha.org/pdfs/Monograph2018.pdf. 2021. ● Levinson W, Ginsburg S, Hafferty FW, Lucey CR. *Understanding Medical Professionalism*. 1st ed. New York, NY: McGraw-Hill Education; 2014. ISBN:978-0071807432.

Professionalism 2: Accountability/Conscientiousness **Overall Intent:** To take responsibility for personal actions and the impact of actions and behavior on patients and members of the team	
Milestones	**Examples**
Level 1 *Takes responsibility for failure to complete tasks and responsibilities, identifies potential contributing factors, and describes strategies for ensuring timely task completion in the future*	● Adapts workflow to improve timeliness of note completion ● Has timely attendance at conferences ● Responds promptly to reminders from program administrator to complete work hour logs
Level 2 *Performs tasks and responsibilities in a timely manner, recognizing situations that may impact one's own ability to do so*	● Completes and documents safety modules, procedure review, and licensing requirements on time ● Completes accurate documentation ● Proactively recognizes it may be difficult to complete a task before going out of town and makes plans accordingly
Level 3 *Proactively implements strategies to ensure that the needs of patients, teams, and systems are met*	● Triages multiple consults and phone calls to provide timely, safe, and comprehensive care ● Asks for assistance from other residents/fellows or faculty members when needed ● Adopts solutions developed through QI projects
Level 4 *Recognizes situations in which one's own behavior may impact others' ability to complete tasks and responsibilities in a timely manner*	● Demonstrates awareness of others' interdependence upon them in team-based activities ● Addresses team issues that impede efficient completion of patient care tasks ● Redistributes team workload to ensure equitable balance
Level 5 *Develops or implements strategies to improve system-wide problems to improve ability for oneself and others to complete tasks and responsibilities in a timely fashion*	● Establishes daily nurse manager meetings to streamline patient discharges ● Develops strategies to improve neuromuscular medicine patient multidisciplinary clinic flow
Assessment Models or Tools	● Compliance with deadlines and timelines ● Direct observation ● Multisource feedback ● Self-evaluations and reflective tools ● Simulation
Curriculum Mapping	●
Notes or Resources	● AMA. Ethics. https://www.ama-assn.org/sites/ama-assn.org/files/corp/media-browser/principles-of-medical-ethics.pdf. 2020. ● Code of conduct from fellow institutional manual ● Expectations of fellowship program regarding accountability and professionalism

Professionalism 3: Well-Being **Overall Intent:** To develop a plan for personal and professional well-being	
Milestones	**Examples**
Level 1 *Recognizes status of personal and professional well-being, with assistance*	● Discusses the impact of burnout on well-being
Level 2 *Identifies resources to improve well-being*	● Knows how to access local mental health resources ● Attends institutional lecture on available resources
Level 3 *Independently recognizes status of personal and professional well-being*	● Works with a mentor to optimize work-life integration
Level 4 *Independently develops a strategy to optimize personal and professional well-being*	● Organizes group outing for co-residents/fellows
Level 5 *Coaches others when emotional responses or limitations in knowledge/ skills do not meet professional expectations*	● Develops a departmental or institutional wellness program ● Serves as a member of a departmental or institutional wellness committee
Assessment Models or Tools	● Direct observation ● Group interview or discussions for team activities ● Individual interview ● Institutional online training modules
Curriculum Mapping	●
Notes or Resources	● This subcompetency is not intended to evaluate a fellow's well-being. Rather, the intent is to ensure that each fellow has the fundamental knowledge of factors that impact well-being, the mechanism by which those factors impact well-being, and available resources and tools to improve well-being. ● ACGME. "Well-Being Tools and Resources." https://dl.acgme.org/pages/well-being-tools-resources. 2021. ● Local resources, including Employee Assistance

Interpersonal and Communication Skills 1: Patient- and Family-Centered Communication **Overall Intent:** To deliberately use language and behaviors to form constructive relationships with patients	
Milestones	**Examples**
Level 1 *Uses language and non-verbal behavior to demonstrate respect and establish rapport* *Identifies the need to individualize communication strategies based on the patient's/patient's family's expectations and understanding*	● Monitors and controls tone, non-verbal responses, and language to encourage dialogue ● Accurately communicates role in the health care system to patients/families ● Ensures communication is at the appropriate level for a lay person
Level 2 *Establishes an effective patient-physician relationship in straightforward encounters using active listening and clear language* *Communicates compassionately with the patient/patient's family to clarify expectations and verify understanding of the clinical situation*	● Restates patient perspective when discussing diagnosis and management ● Counsels patient with decreased forced vital capacity from neuromuscular respiratory weakness on the importance of consistent use of non-invasive ventilatory support at night ● Participates in a family meeting to discuss patient care goals
Level 3 *Establishes an effective patient-physician relationship in challenging patient encounters* *Communicates medical information in the context of the patient's/patient's family's values, uncertainty, and conflict*	● Effectively counsels a patient with opioid use disorder on pain management strategies ● Effectively counsels a young woman with myasthenia on choices of immunomodulatory therapies and potential risks for pregnancy ● Organizes a family meeting to address caregiver expectations for a patient with bulbar ALS and potential communication and feeding needs; reassesses patient and family understanding and anxiety
Level 4 *Easily establishes effective patient-physician relationships, with attention to the patient's/patient's family's concerns and context, regardless of complexity* *Uses shared decision making to align the patient's/patient's family's values, goals, and preferences with treatment options*	● Continues to engage family members with disparate goals in the care of a patient with Guillain-Barre syndrome who is quadriplegic and intubated and just completed full course of intravenous immunoglobulin ● Recommends a plan for a patient with ALS to align patient and family goals for patient to remain at home
Level 5 *Mentors others in situational awareness and critical self-reflection to consistently develop positive therapeutic relationships*	● Leads debriefing after a difficult family meeting ● Leads teaching session on conflict resolution

Role models shared decision making in the context of the patient's/patient's family's values, uncertainty, and conflict	● Establishes effective relationships with families after a grievance
Assessment Models or Tools	● Direct observation ● Self-assessment including self-reflection exercises ● Standardized patients ● Structured case discussions
Curriculum Mapping	●
Notes or Resources	● Laidlaw A, Hart J. Communication skills: An essential component of medical curricula. Part I: Assessment of clinical communication: AMEE Guide No. 51. *Med Teach*. 2011;33(1):6-8. https://www.tandfonline.com/doi/full/10.3109/0142159X.2011.531170. 2021. ● Symons AB, Swanson A, McGuigan D, Orrange S, Akl EA. A tool for self-assessment of communication skills and professionalism in residents. *BMC Med Educ*. 2009;9:1. https://bmcmededuc.biomedcentral.com/articles/10.1186/1472-6920-9-1. 2021.

Interpersonal and Communication Skills 2: Barrier and Bias Mitigation **Overall Intent:** To recognize barriers and biases in communication and develop approaches to mitigate them	
Milestones	**Examples**
Level 1 *Identifies common barriers to effective patient care (e.g., language, disability)*	● Demonstrates awareness of interpretation services ● Demonstrates awareness of how to communicate with patients using an augmentative and alternative communication device
Level 2 *Identifies complex barriers to effective patient care (e.g., health literacy, cultural differences)*	● Demonstrates respect for different cultural practices ● Provides alternate patient education materials for patients with low health literacy
Level 3 *Recognizes personal biases and mitigates barriers to optimize patient care, when prompted*	● Reflects on assumptions about a patient's sexuality or gender identity ● Takes the implicit bias test
Level 4 *Recognizes personal biases and proactively mitigates barriers to optimize patient care*	● Identifies socioeconomic factors for patients labeled "non-compliant" and adapts regimens to improve accessibility
Level 5 *Mentors others on recognition of bias and mitigation of barriers to optimize patient care*	● Role models self-awareness and reflection around explicit and implicit biases ● Develops programs that mitigate barriers to patient education
Assessment Models or Tools	● Direct observation ● Self-assessment ● Standardized patients ● Structured case discussions
Curriculum Mapping	●
Notes or Resources	● Laidlaw A, Hart J. Communication skills: An essential component of medical curricula. Part I: Assessment of clinical communication: AMEE Guide No. 51. *Med Teach*. 2011;33(1):6-8. https://www.tandfonline.com/doi/full/10.3109/0142159X.2011.531170. 2021. ● Project Implicit. https://implicit.harvard.edu/implicit/takeatest.html. 2021. ● Symons AB, Swanson A, McGuigan D, Orrange S, Akl EA. A tool for self-assessment of communication skills and professionalism in residents. *BMC Med Educ*. 2009;9:1. https://bmcmededuc.biomedcentral.com/articles/10.1186/1472-6920-9-1. 2021.

Interpersonal and Communication Skills 3: Interprofessional and Team Communication **Overall Intent:** To effectively communicate with the health care team, including consultants, in both straightforward and complex situations	
Milestones	**Examples**
Level 1 *Recognizes the need for and professionally requests a consultation* *Recognizes the role of a neuromuscular consultant* *Understands and respects the role and function of interdisciplinary team members*	● Shows respect in health care team communications through words and actions ● Listens to and considers others' points of view; is nonjudgmental and actively engaged
Level 2 *Clearly and concisely formulates a consultation request* *Professionally accepts a consultation request* *Solicits insights from and uses language that demonstrates that one values all interdisciplinary team members*	● Verifies rationale for recommendations given ● Accepts all consult requests graciously ● Uses teach-back strategies to confirm understanding
Level 3 *Confirms understanding of a consultant's recommendations* *Clearly and concisely responds to a consultation request* *Integrates contributions from interdisciplinary team members into the care plan*	● Clarifies the rationale for ordering a sleep medicine consultation in a patient with a neuromuscular disorder ● Writes recommendations in the chart to clearly communicate rationale and plan ● Uses verbal and written communication strategies to improve understanding during consultations
Level 4 *Integrates recommendations from different members of the health care team to optimize patient care* *Solicits and communicates feedback to other members of the health care team* *Prevents and mediates conflict and distress among interdisciplinary team members*	● Reconciles conflicting recommendations from multiple consulting teams ● Respectfully provides end of rotation feedback to other members of the team ● Engages organizational development leaders to help resolves conflicts within the team

Level 5 *Role models and facilitates flexible communication strategies that demonstrate the value of input from all health care team members, resolving conflict when needed* *Fosters a culture of open communication and effective teamwork within the interdisciplinary team*	● Organizes and leads a multidisciplinary team meeting to discuss and resolve potentially conflicting points of view on a plan of care
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback ● Simulation
Curriculum Mapping	●
Notes or Resources	● Green M, Parrott T, Crook G. Improving your communication skills. *BMJ.* 2012;344:e357. https://www.bmj.com/content/344/bmj.e357. 2021. ● Haig KM, Sutton S, Whittington J. SBAR: a shared mental model for improving communication between clinicians. *Jt Comm J Qual Patient Saf*. 2006;32(3):167-175. https://www.jointcommissionjournal.com/article/S1553-7250(06)32022-3/fulltext. 2021. ● Henry SG, Holmboe ES, Frankel RM. Evidence-based competencies for improving communication skills in graduate medical education: A review with suggestions for implementation. *Med Teach*. 2013;35(5):395-403. https://www.tandfonline.com/doi/full/10.3109/0142159X.2013.769677. 2021. ● Roth CG, Eldin KW, Padmanabhan V, Freidman EM. Twelve tips for the introduction of emotional intelligence in medical education. *Med Teach.* 2018:1-4. https://www.tandfonline.com/doi/full/10.1080/0142159X.2018.1481499. 2021.

Interpersonal and Communication Skills 4: Communication within Health Care Systems **Overall Intent:** To communicate effectively and appropriately using a variety of methods	
Milestones	**Examples**
Level 1 *Documents accurate and up-to-date patient information*	● Performs medication reconciliation
Recognizes the basic structure of the nerve conduction study report	● Recognizes where specific data regarding amplitude, latency, and conduction velocity is found on the EMG report
Communicates in a way that safeguards patient information	● Protects personal health information when communicating with other members of the health care team
Level 2 *Demonstrates diagnostic reasoning through organized and timely notes*	● In the medical record, documents rationale for obtaining creatine kinase prior to muscle biopsy
Creates a report for a nerve conduction study in conjunction with EMG	● Creates clear and concise summary of nerve conductions
Communicates through appropriate channels as required by institutional policy	● Only communicates patient information through secured methods
Level 3 *Communicates the diagnostic and therapeutic reasoning*	● Documents in the medical record rationale for an empiric trial of pyridostigmine in a patient with fatigable ptosis while awaiting antibody results
Provides a detailed report of common and uncommon nerve conduction study findings and neuromuscular junction testing	● Summarizes common anatomic variants such as Martin Gruber anastomosis ● Summarizes uncommon anatomic variants such as Riche-Cannieu anastomosis
Selects optimal mode of communication based on clinical context	● Calls patient directly with urgent lab results instead of sending message in the EHR
Level 4 *Demonstrates concise, organized written and verbal communication, including anticipatory guidance*	● Reviews with patient the importance of establishing a living will and discussing it with other family members.
Provides a detailed report of common and uncommon nerve conduction findings and cranial nerve testing	● Provides a detailed report on the blink reflex test ● Describes the results of short exercise testing in a patient with periodic paralysis ● Uses language that is concise and easily understood for describing main findings in impression of EMG report with goal of effective communication to referring provider

Demonstrates clear, concise communication with referring providers for continuity of care	● Communicates with referring provider for a patient on immunosuppression who will need laboratory monitoring
Level 5 *Guides departmental or institutional communication policies and procedures*	● Teaches colleagues how to improve discharge summaries and other communications
Assessment Models or Tools	● Direct observation ● Medical record (chart) review ● Multisource feedback ● Simulation
Curriculum Mapping	●
Notes or Resources	● Bierman JA, Hufmeyer KK, Liss DT, Weaver AC, Heiman HL. Promoting responsible electronic documentation: Validity evidence for a checklist to assess progress notes in the electronic health record. *Teach Learn Med.* 2017;29(4):420-432. https://www.tandfonline.com/doi/full/10.1080/10401334.2017.1303385. 2021. ● Haig KM, Sutton S, Whittington J. SBAR: A shared mental model for improving communication between clinicians. *Jt Comm J Qual Patient Saf*. 2006;32(3):167-175. https://www.jointcommissionjournal.com/article/S1553-7250(06)32022-3/fulltext. 2021.

To help programs transition to the new version of the Milestones, the ACGME has mapped the original Milestones 1.0 to the new Milestones 2.0. Indicated below are where the subcompetencies are similar between versions. These are not exact matches, but are areas that include similar elements. Not all subcompetencies map between versions. Inclusion or exclusion of any subcompetency does not change the educational value or impact on curriculum or assessment.

Milestones 1.0	Milestones 2.0
PC1: History	PC1: History
PC2: Neuromuscular Exam	PC2: Neuromuscular Examination
PC3: Management/Treatment	PC3: Management and Treatment
PC4: Nerve Conduction Studies	PC4: Nerve Conduction Studies
PC5: EMG	PC5: Electromyography (EMG)
PC6: Anterior Horn Cell Disorders	PC6: Anterior Horn Cell Disorders
PC7: Root, Plexus, Peripheral Nerve Disorders	PC7: Root, Plexus, Peripheral Nerve Disorders
PC8: Neuromuscular Junction Disorders	PC8: Neuromuscular Junction Disorders
PC9: Myopathies	PC9: Myopathies
	PC10: Digital Health
MK1: Localization	MK1: Localization
MK2: Formulation	MK2: Formulation
MK3: Diagnostic Investigation	MK3: Diagnostic Investigation
MK4: Muscle and Nerve Pathology	MK4: Muscle and Nerve Pathology
SBP1: Systems Thinking, Including Cost- and Risk-effective Practice	SBP4: Physician Role in Health Care Systems
SBP2: Work in Inter-professional Teams to Enhance Patient Safety and Patient Care	SBP1: Patient Safety and Quality Improvement SBP2: System Navigation for Patient-Centered Care ICS2: Interprofessional and Team Communication
	SPB3: Population Health and Advocacy
PBLI1: Self-directed Learning	PBLI2: Reflective Practice and Commitment to Personal Growth
PBLI2: Locate, Appraise, and Assimilate Evidence from Scientific Studies Related to the Patient's Health Problems	PBLI1: Evidence-Based and Informed Practice
PROF1: Compassion, Integrity, Accountability, and Respect for Self and Others	PROF1: Professional Behavior and Ethical Principles PROF2: Accountability/Conscientiousness PROF3: Well-Being
PROF2: Knowledge About, Respect for, and Adherence to the Ethical Principles Relevant to the Practice of Medicine, Remembering in	PROF1: Professional Behavior and Ethical Principles

Particular that Responsiveness to Patients that Supersedes Self-interest is an Essential Aspect of Medical Practice	
ICS1: Relationship Development, Teamwork, and Managing Conflict	ICS1: Patient- and Family-Centered Communication ICS2: Interprofessional and Team Communication
ICS2: Information Sharing, Gathering, and Technology	ICS1: Patient- and Family-Centered Communication ICS2: Interprofessional and Team Communication ICS3: Communication within Health Care Systems

Available Milestones Resources

Milestones 2.0: Assessment, Implementation, and Clinical Competency Committees Supplement, 2021 - *https://meridian.allenpress.com/jgme/issue/13/2s*

Milestones Guidebooks: https://www.acgme.org/milestones/resources/

- *Assessment Guidebook*
- *Clinical Competency Committee Guidebook*
- *Clinical Competency Committee Guidebook Executive Summaries*
- *Implementation Guidebook*
- *Milestones Guidebook*

Milestones Guidebook for Residents and Fellows: https://www.acgme.org/residents-and-fellows/the-acgme-for-residents-and-fellows/

- Milestones Guidebook for Residents and Fellows
- Milestones Guidebook for Residents and Fellows Presentation
- Milestones 2.0 Guide Sheet for Residents and Fellows

Milestones Research and Reports: https://www.acgme.org/milestones/research/

- *Milestones National Report*, updated each fall
- *Milestones Predictive Probability Report,* updated each fall
- *Milestones Bibliography*, updated twice each year

Developing Faculty Competencies in Assessment courses - https://www.acgme.org/meetings-and-educational-activities/courses-and-workshops/developing-faculty-competencies-in-assessment/

Assessment Tool: Direct Observation of Clinical Care (DOCC) - https://dl.acgme.org/pages/assessment

Assessment Tool: Teamwork Effectiveness Assessment Module (TEAM) - https://team.acgme.org/

Improving Assessment Using Direct Observation Toolkit - https://dl.acgme.org/pages/acgme-faculty-development-toolkit-improving-assessment-using-direct-observation

Remediation Toolkit - https://dl.acgme.org/courses/acgme-remediation-toolkit

Learn at ACGME has several courses on Assessment and Milestones - https://dl.acgme.org/