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Neurohospitalist Core Competencies

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Abstract

The Neurohospitalist Core Competencies comprise a set of competency-based learning objectives that encapsulate the knowledge, skills, and attitudes of neurohospitalitists who specialize in the care of hospitalized patients with neurologic conditions. These competencies serve to characterize the rapidly expanding field of neurohospitalist medicine. The 27 chapters are divided into 3 sections entitled: neurological conditions, clinical interventions and interpretation of ancillary studies, and neurohospitalist role in the healthcare system. Each individual learning objective in the chapters describes a specific concept with an action verb to illustrate the behavior that the neurohospitalist exhibits. The individual neurohospitalist may not exhibit mastery in each of the topics included as individual practices vary in scope and practice pattern. A few examples of how the complete set of competencies may be used include in the creation of curricula for neurohospitalist fellowships, to assist in defining the scope of practice of neurohospitalists for administrative leaders of hospitals and departments, and in influencing the direction of further research and quality improvement in the field.

Keywords

neurohospitalist, techniques, education, quality, safety

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Section 1: Neurological Conditions

1.0 Vascular Diseases of the Nervous System

1.1 Ischemic Stroke and Transient Ischemic Attack (TIA)

Stroke is the leading cause of long term disability in industrialized countries and one of the major causes of mortality worldwide. Acute stroke management requires a neurohospitalist to perform efficiently to ensure timely administration of acute stroke therapies to optimize stroke outcomes.[1] The neurohospitalist must know the appropriate diagnostic evaluation to identify the stroke etiology in order to initiate effective secondary prevention strategies, which can result in a cumulative relative risk reduction of 80% for recurrent stroke.[2] Preventing common complications of stroke in the hospital and initiation of rehabilitative service are also paramount to ensuring optimal patient outcomes.[3]

Knowledge

Neurohospitalists should be able to:

- Describe risk factors and common taxonomy systems for ischemic stroke etiologies (e.g. TOAST, ASCOD, ESUS).
- Recognize the indications for early specialty consultation and potential need for transfer if practicing in a center without neurocritical care, neurosurgery, or endovascular specialists.
- Describe the common causes and presentation of stroke/TIA mimics, including retinal ischemia.
- Localize the most likely anatomic location of stroke and most likely vascular territory(ies) affected based on the clinical presentation.
- Describe the current acute therapeutic options for acute ischemic stroke.
- Describe the indications, contraindications (absolute and relative), and mechanisms of action of thrombolytic therapy, along with potential complications of thrombolysis and their management
- Describe the indications for endovascular interventions.
- Explain how to appropriately manage blood pressure in the acute and subacute settings.
- Describe the antithrombotic treatment of each ischemic stroke subtype.
- List the appropriate imaging, cardiac testing, and laboratory testing to evaluate patients with suspected stroke/TIA from both common and uncommon etiologies.
- Recognize when advanced diagnostic testing may be indicated to further elucidate the etiology of stroke.

- Be familiar with current trends in pharmacological management of vascular risk factors, such as diabetes, hypertension, dyslipidemia, and atrial fibrillation.
- Know the factors involved in assessing the risks, benefits, and timing of initiation of anticoagulation following stroke when an indication for anticoagulation is present.
- Be familiar with procedural options to reduce stroke risk or burden of atrial fibrillation.
- Know the indication, timing of intervention, and various procedures available for carotid revascularization.
- Know how to select patients most likely to benefit from closure of a patent foramen ovale.
- Recognize stroke risk factors specific to women, such as exogenous estrogen use, pregnancy, and peripartum stroke, as well as etiologies of stroke more common in women such as migrainous infarction and reversible cerebral vasoconstriction syndrome.
- Explain goals for hospital discharge, including specific measures of clinical stability for safe care transition.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant medical history to assess for symptoms that are typical of stroke.
- Expeditiously examine patients with clinical symptoms concerning for stroke, including performing a stroke severity score, such as the National Institutes of Health Stroke Scale (NIHSS).
- Succinctly make a decision regarding thrombolysis in acute stroke patients.
- Identify patients at risk for acute decompensation, which may include those with a large hemispheric or cerebellar infarction, high-grade vascular stenosis, intravascular thrombi, or acute intracranial occlusion.
- Diagnose the most likely etiology of stroke through interpretation of testing including, but not limited to, cardiac imaging and rhythm monitoring, vascular and parenchymal imaging, and laboratory results.
- Identify patients at risk for aspiration following stroke and address fluid and nutritional issues.
- Manage or obtain appropriate and timely assistance with management of airway compromise, temperature elevations, abnormal blood pressure, and hyperglycemia when present.
- Initiate prophylaxis against common complications of stroke, which may include urinary tract infection, aspiration pneumonia, and venous thromboembolism.
- Address resuscitation status early during hospital stay; identify goals of care on an ongoing basis with patients/patient representatives.
- Initiate secondary stroke prevention measures based upon the likely stroke etiology, including procedures when indicated.
- Counsel patients on the etiology of their stroke, and on lifestyle modifications to reduce stroke recurrence.
- Communicate with patients and families to explain the use and potential adverse effects of pharmacologic agents, and to explain tests and procedures, along with their indications.
- Communicate with patients and families to explain the goals of care, discharge instructions, and management after hospital discharge to ensure safe follow-up and transitions of care.
- Recognize barriers to follow-up care of stroke patients and involve multidisciplinary hospital staff to accordingly tailor medications and transition of care plans.
- Document the treatment plan and provide clear discharge instructions for post-discharge clinicians, which may include outpatient rehabilitation.

Attitudes

Neurohospitalists should be able to:

- Employ an early and multidisciplinary approach to the care of patients who have had a stroke that begins at admission and continues through all care transitions.
- Follow evidence-based recommendations, protocols, and risk stratification tools for the treatment of stroke.
- Work collaboratively with allied health professionals (e.g., physical therapy, occupational therapy) to develop comprehensive care plans to address deficits or limitations that result from stroke.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary efforts to develop protocols to rapidly identify patients with stroke who have indications for acute interventions and to minimize time to intervention.
- Lead, coordinate, and/or participate in multidisciplinary initiatives to promote patient safety and optimize resource use, including aggressive treatment of risk factors and early assessment for rehabilitation.
- Participate in regional efforts to optimize appropriate stroke care including emergency medical services (EMS) triage and routing, stroke center certification processes, and development of telestroke networks.

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1.2 Hemorrhagic Stroke

Hemorrhagic stroke accounts for approximately 30% of all incident strokes globally. A hemorrhagic stroke includes intraparenchymal, subarachnoid, and intraventricular hemorrhage.[1,2] Acute hemorrhagic stroke management requires a neurohospitalist to ensure timely administration of acute therapies when indicated. The neurohospitalist must know the appropriate diagnostic evaluation to identify the etiology of hemorrhagic stroke in order to initiate effective secondary prevention strategies. Lifestyle modification, alcohol moderation, sympathomimetic drug avoidance, and blood pressure control can reduce the risk of recurrent hemorrhagic stroke. Decisions regarding use versus avoidance of antithrombotic agents often require input from the neurohospitalist in patients at risk for both ischemic and hemorrhagic stroke. Preventing common complications of stroke in the hospital and initiation of rehabilitative service are also paramount to ensuring optimal patient outcomes. Coordinating inpatient care as well as ensuring timely and appropriate outpatient follow up are also within the purview of the neurohospitalist.

Knowledge

Neurohospitalists should be able to:

- List risk factors for hemorrhagic stroke.
- Know the most common primary and secondary causes of intracerebral hemorrhage.
- Know the most common causes of non-traumatic subarachnoid hemorrhage, including perimesencephalic subarachnoid hemorrhage.
- Recognize conditions more likely to present with cortical subarachnoid bleeding.
- Know the current acute therapeutic options for acute hemorrhagic stroke management, including neurosurgical interventions.
- Recognize the indications for early specialty consultation and potential need for transfer if not practicing in a center with neurocritical care, neurosurgery, or endovascular specialists.
- Know the indications, contraindications (absolute and relative), and mechanisms of action of reversal agents for anticoagulation-associated hemorrhage and thrombolysis-associated hemorrhage.
- Know how to appropriately manage blood pressure following intracerebral and subarachnoid hemorrhage in the acute and subacute settings.
- Recognize and know the management strategies for common complications of subarachnoid hemorrhage, including vasospasm, re-bleeding, and hydrocephalus.
- Be familiar with the clinical presentations, imaging findings, associated conditions, and management of cerebral vascular malformations, including cavernous malformations, arteriovenous malformation, dural arteriovenous fistulas, developmental venous anomalies, and capillary telangiectasias.
- Know the appropriate imaging, laboratory testing, and advanced diagnostic testing necessary to evaluate for an etiology in patients with hemorrhagic stroke.
- Know the indications, contraindications, and mechanisms of action of pharmacological agents used for hemorrhagic stroke prevention.
- Know the factors involved in assessing the risks, benefits, and timing of initiation of anticoagulation following hemorrhagic stroke when an indication for anticoagulation is present.
- Know the indication, timing of intervention, and various procedures available for treatment of cerebral aneurysms and arteriovenous malformations.
- Know how to estimate the rupture risk of incidentally identified aneurysms based on size, location, morphology, and patient specific risk factors, and how to counsel patients accordingly.
- Be able to prognosticate the most likely functional outcome after hemorrhagic stroke based on individual patient characteristics, early clinical course, and rehab potential.
- Explain goals for hospital discharge, including specific measures of clinical stability for safe care transition.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant medical history to assess for symptoms that are typical of a hemorrhagic stroke.
- Perform an appropriate physical examination to identify focal neurological deficits suggestive of a hemorrhagic stroke.
- Be able to accurately and expeditiously calculate hemorrhagic stroke severity scores, such as the Hunt and Hess Score or ICH Score.

- Assess patients with hemorrhagic stroke quickly in order to make a decision regarding blood pressure targets, indication for reversal agents, and need for endovascular or neurosurgical evaluation.
- Identify which hemorrhagic stroke patients are at risk for acute decompensation.
- Identify patients at risk for aspiration following hemorrhagic stroke and address fluid and nutritional issues.
- Manage or obtain appropriate and timely assistance with management of airway compromise, temperature elevations, abnormal blood pressure, and hyperglycemia when present.
- Initiate prophylaxis against common complications in hemorrhagic stroke patients, which may include urinary tract infection, aspiration pneumonia, and venous thromboembolism.
- Address resuscitation status early during hospital stay; identify goals of care on an ongoing basis with patients/patient representatives.
- Initiate hemorrhagic stroke prevention measures, including procedures when indicated.
- Counsel patients on lifestyle modification to reduce hemorrhagic stroke recurrence.
- Communicate with patients and families to explain the use and potential adverse effects of pharmacologic agents, and to explain tests and procedures.
- Communicate with patients and families to explain the history and prognosis of their hemorrhagic stroke, the goals of care, discharge instructions, and management after hospital discharge to ensure safe follow-up and transitions of care.
- Recognize barriers to follow-up care of patients who have had a hemorrhagic stroke, and involve multidisciplinary hospital staff to accordingly tailor medications and transition of care plans.
- Document the treatment plan and provide clear discharge instructions for post-discharge clinicians, which may include outpatient rehabilitation.

Attitudes

Neurohospitalists should be able to:

- Employ an early and multidisciplinary approach to the care of patients who have had a hemorrhagic stroke that begins at admission and continues through all care transitions.
- Follow evidence-based recommendations, protocols, and risk stratification tools for the treatment of hemorrhagic stroke.
- Work collaboratively with allied health professionals (e.g. physical therapy, occupational therapy) to develop comprehensive care plans to address deficits or limitations that result from hemorrhagic stroke.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary efforts to develop protocols to rapidly identify patients with hemorrhagic stroke who have indications for acute interventions and to minimize time to intervention.

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1.3 Central Venous Thrombosis

Central venous thrombosis (CVT) accounts for approximately 0.5% – 1.0% of all strokes.[1] Thrombosis of a dural sinus and/or cerebral veins can present with isolated headache, seizures, focal neurological deficits from cerebral ischemia (a "venous infarction") or hemorrhage, or alterations in levels of consciousness due to cerebral edema. This subtype of stroke is more likely to occur in women, affect young patients, and carries a different risk factor profile than more common forms of stroke. Risk factors for CVT include cranial infection or trauma, pregnancy/puerperium, inflammatory bowel disease, antiphospholipid syndrome, cancer, and exogenous hormones.[2] The neurohospitalist must know the appropriate diagnostic evaluation to identify the most likely etiology of thrombosis in order to initiate effective secondary prevention strategies. As with other types of stroke, preventing common complications of stroke in the hospital and initiation of rehabilitative service are also paramount to ensuring optimal patient outcomes.

Knowledge

Neurohospitalists should be able to:

- List risk factors for CVT.
- Expeditiously evaluate patients with clinical symptoms concerning for CVT.
- Recognize the typical imaging findings that suggest a CVT is present.

- Understand the venous anatomy and common variations in anatomy.
- Know the current acute therapeutic options for CVT, including the indications, contraindications (absolute and relative), and mechanisms of action of anticoagulation when used to treat CVT.
- Recognize the need to urgently manage any condition associated with the thrombosis, such as dehydration, infection, elevated intracranial pressure, or seizures.
- Recognize the indications for early specialty consultation and potential need for transfer if practicing in a center without neurocritical care, neurosurgery, or endovascular specialists.
- Know the appropriate imaging and laboratory testing to evaluate for the etiology in patients with central venous thrombosis.
- Know the indication, timing of intervention, and various procedures available for treatment of CVT and complications of CVT.
- Know the indications, contraindications, and recommended duration of use of oral anticoagulants used for treatment of CVT.
- Be able to prognosticate the most likely functional outcome after CVT based on individual patient characteristics, early clinical course, and rehab potential.
- Explain goals for hospital discharge, including specific measures of clinical stability for safe care transition.
- Recognize delayed complications of CVT, including the development of chronic headaches, neuropsychological and mood disorders, dural arteriovenous fistulae, and intracranial hypertension.
- Know how to address issues specific to women in the setting of CVT prevention.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant medical history to assess for symptoms that are typical of CVT.
- Perform an appropriate physical examination to identify focal neurological deficits suggestive of CVT.
- Assess patients with CVT and make rapid decisions regarding use of anticoagulation.
- Recognize that invasive procedures such as endovascular intervention (e.g. transvenous thrombolysis) or decompressive hemicraniectomy may be considered when clinical deterioration occurs despite appropriate medical management.
- Identify patients at risk for aspiration following CVT and address fluid and nutritional issues.
- Counsel patients on lifestyle modification to reduce CVT recurrence.
- Communicate with patients and families to explain the history and prognosis of the CVT.
- Recognize barriers to follow-up care of patients who have had a CVT and involve multidisciplinary hospital staff to accordingly tailor medications and transition of care plans.

Attitudes

Neurohospitalists should be able to:

- Employ an early and multidisciplinary approach to the care of patients who have had a CVT that begins at admission and continues through all care transitions.
- Follow evidence-based recommendations, protocols, and risk stratification tools for the treatment of CVT.
- Work collaboratively with allied health professionals (e.g. physical therapy, occupational therapy) to develop comprehensive care plans to address deficits or limitations that result from CVT.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary efforts to develop protocols to rapidly identify patients with CVT who have indications for acute interventions and to minimize time to intervention.

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2.0 Seizures and Status Epilepticus

2.1 Seizures

Seizure is a very common reason for inpatient consultation of a neuro-hospitalist. Each individual person faces an 8-10% risk of a seizure at some point during their lifetime.[1] In addition, approximately 3.4 million people live with epilepsy, defined as 2 or more unprovoked seizures.[2] A Neurohospitalist must know how to expeditiously diagnose and treat seizures in order to optimize patient outcomes.[3] Seizures

can be distressing to patients, their caregivers, and providers who are not familiar with managing them. By providing expert care in the management of seizures, neurohospitalists are well suited to avoid misdiagnosis and prevent harms of both uncontrolled seizures and unnecessary exposure to antiseizure medicines.

Knowledge

Neurohospitalists should be able to:

- Describe the risk factors for seizures and epilepsy.
- Identify antiseizure medications, their indications, contraindications, and side effect profile.
- Describe the mechanism of action of antiseizure medications, and potential interactions with other commonly used medications.
- Recognize when patients should be referred to a specialty epilepsy surgical center.
- Describe the detailed work up of a first time seizure.
- List magnetic resonance imaging (MRI) sequences necessary in the work up of patient with suspected seizure.
- Identify when to initiate antiseizure medications in a patient with seizures.
- Identify the common etiologies of provoked seizures.
- Be familiar with the surgical or neuro-modulation options for refractory epilepsy.
- Recognize the clinical presentation of common focal onset and generalized seizures.
- Recognize common seizure mimics such as syncope, metabolic abnormalities, drug toxicities, and stroke.
- Explain when to safely discharge a patient after having a seizure.
- Identify those patients in need of continuous video electroencephalogram (EEG) monitoring.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant history in patients presenting with seizure or possible seizure, including semiology, frequency, precipitants, and past treatment trials with particular attention to symptoms that may suggest focal onset.
- Expeditiously examine patients with clinical symptoms concerning for seizure.
- Make timely treatment decisions regarding treatment of seizures.
- Communicate with patients and families about the potential adverse effects and benefits of antiseizure medicines.
- Monitor for common complications of seizures including aspiration pneumonia and rhabdomyolysis.
- Identify the likely etiology of seizure based on available diagnostic testing.
- Recognize epileptic EEG patterns and common normal variants on an EEG report.
- Provide clear discharge instructions for patients, families, and post discharge providers including seizure precautions, local driving restrictions, rescue options, and return precautions.

Attitudes

Neurohospitalists should be able to:

- Assume clinical and intellectual responsibility for management decisions related to seizures.
- Follow evidence based guidelines and protocols for the treatment of seizures.
- Value and support a multidisciplinary approach to the care of patients admitted with seizures.
- Promote safe transitions of care for patients with new onset seizures.

System Organization and Improvement

To improve efficiency and quality within their organization, neurohospitalists should:

- Lead and/or participate in multidisciplinary teams to optimize length of stay and minimize intensive care unit (ICU) needs of patients with seizures.
- Lead and/or participate in system wide efforts to expand resources of patients with seizures (e.g. drug formularies, EEG access).

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2.2 Status Epilepticus

The Neurocritical Care Society defines status epilepticus (SE) as greater than five minutes of continuous clinical or electrographic seizure activity or recurrent seizure activity without recovery to baseline between seizures.[1] Its incidence is expected to be between 9.9-41 per 100,000 person years.[2] Mortality is dependent on the underlying etiology of SE but

still remains quite high with ranges from 10-20%.[3] A neurohospitalist must be competent in rapidly diagnosing and treating SE to optimize patient outcomes. In addition, they should evaluate for the underlying etiology to initiate treatments/interventions that may increase the likelihood of aborting SE. Monitoring for secondary medical and neurologic complications also falls within the neurohospitalist's purview, with appropriate management of such complications leading to better long term outcomes.[4]

Knowledge

Neurohospitalists should be able to:

- Identify patients presenting with SEs.
- Identify intravenous antiseizure medication (ASM) options, dosage, and common contraindications, both absolute and relative.
- List, identify, and appropriately diagnose the common underlying etiologies of SE, including toxic, metabolic, infectious, vascular, traumatic, and autoimmune etiologies.
- Identify the preferred options for treating pregnant patients with SE.
- Describe the mechanism of action of ASMs used for SE.
- Describe the laboratory and imaging work up necessary in the evaluation of SE.
- Be familiar with the epidemiology, mortality, and outcomes of SE.
- Identify factors determining when it is safe for patients to transfer out of the intensive care unit following SE treatment.
- List and recognize the major complications of intravenous anesthetic agents commonly used for SE.
- Understand definitions and treatment protocols for SE, refractory SE, and super refractory SE.

Skills

Neurohospitalists should be able to:

- Obtain a relevant history in patients with SE, with a focus on identifying its etiology.
- Perform a physical exam focused on neurologic deficits that may suggest a structural lesion in patients presenting with SE.
- Manage or obtain timely assistance for airway compromise in patients with SE.
- Monitor and initiate prophylaxis for common medical and neurologic complications of SE, including venous thromboembolism and aspiration pneumonia.
- Recognize when additional work up to assess the etiology of SE is needed, such as a lumbar puncture or MRI.
- Identify patients with SE who are in need of continuous EEG monitoring.
- Recognize when continuous EEG monitoring can be safely discontinued.
- Perform a lumbar puncture if needed as part of SE work up.
- Identify and discuss goals of care with patients and families in the management of SE.
- Communicate the results of testing to patients and families in the management of SE.
- Recognize the most common convulsive and non convulsive SEs patterns on EEG.
- Interpret laboratory and radiological results in the work up of patients with SE.
- Recognize when intravenous (IV) anesthetic treatments are needed to abort SE.
- Counsel patients on antiseizure medication compliance after SE.
- Counsel patients on risk of sudden unexplained death in epilepsy patients (SUDEP).

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based recommendations, protocols, and risk stratification tools for the treatment of SE.
- Work within a multidisciplinary care team to develop comprehensive care plans to address deficits and promote recovery from SE.
- Collaborate with medicine teams and other specialties involved in the care of patients with SE.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead and/or participate in organizational initiative to improve early treatment of SE.
- Participate in organizational and regional initiatives to coordinate the early steps, care, and potential need for transfer of patients with SE.
- Be available to work with pharmacy and therapeutic committees as needed to ensure adequate ASMs and anesthetic agents are available in the emergent setting.

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3.0 Acute Disorders of Consciousness and Cognition

Acute disorders of consciousness and cognition are referred to in clinical practice and medical literature in a variety of ways including acute encephalopathy, altered mental status, coma, and confusion. These fundamental functions of the brain are crucial to human life and are not yet fully understood despite centuries of study by scientists and philosophers. The interconnected networks in the central nervous system that promote arousal and cognitive processes can be affected by structural lesions and systemic abnormalities that will be explored below.

3.1 Anoxic Brain Injury

Anoxic brain injury (ABI) is the most devastating sequelae for patients who survive cardiopulmonary arrest, affecting thousands of patients every year worldwide.[1] Cardiopulmonary arrest refers to the acute cessation of respiration or circulation which can be caused by a wide variety of conditions including myocardial infarction, cardiac arrhythmia, airway obstruction, respiratory failure, and massive pulmonary embolism. The underlying etiology is emergently evaluated and managed by emergency medicine and critical care providers, but the focus of the neurohospitalist should be the management of the consequent global hypoperfusion and associated anoxic brain injury. The degree of neurological deficit can be mild or irreversibly severe and depends on patient-specific factors regarding baseline health and the inciting anoxic event.[2,3] It is crucial for neurohospitalists to diagnose and manage this acute disorder of consciousness.

Knowledge

Neurohospitalists should be able to:

- Identify the most common causes of anoxic brain injury.
- Describe the mechanism of brain injury after an anoxic event.
- Recognize the patient-specific factors that affect the decision to utilize targeted temperature management (TTM) after cardiopulmonary arrest.
- Describe the indications and contraindications for TTM after cardiopulmonary arrest.
- Recognize the reasons for transferring a patient with ABI to a center with higher level of care if certain electrodiagnostic studies, neuroimaging, temperature management, and other critical care therapies are not available.
- Identify the most common patterns on EEG seen after anoxic brain injury.
- Recognize the clinical and electrographic findings that would require acute treatment with anti-seizure medications after ABI.
- Identify the clinical factors that influence the neurological examination of a patient with ABI.
- Explain the findings, or lack thereof, on magnetic resonance imaging (MRI) and computed tomography imaging (CT) after ABI.
- Identify the evidence-based markers that assist in neuroprognostication after ABI and describe their limitations.
- Describe the therapeutic options that can be utilized after ABI.
- Identify alternative diagnoses that can accompany or mimic ABI including structural and metabolic abnormalities that affect consciousness and cognition.

Skills

Neurohospitalists should be able to:

- Elicit a thorough history from the patient, family members, bystanders, or other health care professionals regarding the inciting cardiopulmonary arrest event leading to the possible ABI.
- Reliably examine patients for level of arousal, responsiveness to stimuli, brainstem reflexes, and appendicular motor responses regardless of their level of consciousness.
- Identify myoclonus during examination at the bedside.
- Counsel patients and families on the mechanism of brain injury suffered after cardiopulmonary arrest.
- Counsel patients and families on the findings identified during neurological examination.
- Interpret neuroimaging and electrodiagnostic studies and communicate these findings to other providers and the family in an appropriate manner.
- Communicate with patients, families, and multidisciplinary teams regarding evidence-based markers for neurologic prognosis in patients with ABI, including the accompanying uncertainty.
- Communicate with multidisciplinary teams to provide complex care for patients with prolonged disorders of cognition and consciousness after ABI.

- Counsel patients and families on the long-term expectations for physical therapy, occupational therapy, and speech/cognitive therapy.
- Answer questions from caretakers about the long-term needs for patients with ABI who will require assistance with activities of daily living.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based guidelines for evaluating patients with ABI to determine diagnosis, acute management, and prognosis for recovery.
- Employ facility-specific protocols to efficiently utilize electrodiagnostic and neuroimaging studies that are available to evaluate patients with anoxic brain injury.
- Work collaboratively with critical care specialists, nursing staff, physical therapists, occupational therapists, speech languagepathologists, and social workers to manage the complex care of patients with ABI.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Work closely with critical care specialists and other providers involved in the acute management of patients who experience cardiopulmonary arrest to rapidly identify ABI and initiate neurological management.

References

1. Gräsner JT, Lefering R, Koster RW, et al. EuReCa ONE-27 Nations, ONE Europe, ONE Registry: A prospective one month analysis of out-of-hospital cardiac arrest outcomes in 27 countries in Europe. Resuscitation. 2016;105:188-95. doi: 10.1016/j.resuscitation.2016.06.004.
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3.2 Disorders of Consciousness from Stroke and Neurotrauma

Stroke and traumatic brain injury are two of the most common causes of disability and mortality.[1,2] These processes can lead to acute disorders of consciousness and cognition because of localized structural abnormalities or global central nervous system dysfunction. Stroke must involve the ascending reticular activating system or higher order cognitive networks in order to lead to changes in arousal or cognition.[3] Neurotrauma can cause diffuse axonal injury, intraparenchymal contusions, hydrocephalus, and/or hemorrhage in the epidural, subdural, or subarachnoid spaces. These sequelae can all directly lead to acute disorders of consciousness after trauma.[3] Progression of these conditions either through cerebral edema or hemorrhage expansion can lead to acute changes in consciousness via herniation and brainstem compression. Neurohospitalists can have a profound impact on the disability and mortality outcomes for these patients with emergent recognition and targeted treatment of these disorders.

Please see chapters 1.1 (Vascular Disease of the Nervous System) and 1.11 (Traumatic Injuries of the Nervous System) for the knowledge, skills, and attitudes that neurohospitalists should have for both stroke and neurotraumatic disorders.

References

1. Ahmad FB, Anderson RN. The Leading Causes of Death in the US for 2020. JAMA. 2021;325(18): 1829–1830. doi: 10.1001/jama.2021.5469
2. Forman-Hoffman VL, Ault KL, Anderson WL, et al. Disability status, mortality, and leading causes of death in the United States community population. Med Care. 2015;53(4):346-54. doi: 10.1097/MLR.0000000000000321
3. Posner JB, Saper CB, Schiff ND, Claassen J. Plum and Posner's Diagnosis and Treatment of Stupor and Coma. 5th ed. New York: Oxford University Press; 2019.

3.3 Disorders of Consciousness from Seizures and Status Epilepticus

Seizures, both provoked and unprovoked, can commonly affect consciousness and cognition. Focal seizures with impaired awareness and generalized seizures cause intra-ictal change in consciousness; post-ictal encephalopathy is also prevalent after many types of seizures. Status epilepticus (SE) is the most important disorder for the neurohospitalist to rapidly diagnose and manage because of its high morbidity and mortality.[1] Importantly, non-convulsive status epilepticus is a conspicuous cause of altered consciousness and should be on the differential diagnosis when neurohospitalists are evaluating patients with acute disorders of consciousness and cognition.[2]

Knowledge

Neurohospitalists should be able to:

- Describe the seizure types that can affect consciousness and cognition.
- Identify patient-specific factors that increase risk for subclinical seizures and non-convulsive SE.
- Explain the indications for urgent electrodiagnostic studies (e.g. EEG) and neuroimaging (e.g. CT, MRI) in the evaluation of patients with acute disorders of consciousness.

Skills

Neurohospitalists should be able to:

- Elicit a focused history from patients' family members or bystanders regarding witnessed seizure-like activity prior to hospitalization.
- Reliably examine patients with altered consciousness or cognition for any signs of subclinical seizures or non-convulsive SE.
- Interpret electrodiagnostic study reports for patients with acute disorders of consciousness, particularly in the rapid recognition of non-convulsive SE.
- Communicate with multidisciplinary teams to coordinate urgent evaluation and management of non-convulsive SE; teams include electrodiagnostic technicians, nursing staff, and other healthcare providers.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based guidelines for emergently evaluating patients with acute disorders of consciousness and suspected subclinical seizures or non-convulsive SE.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Work closely with emergency medicine and critical care providers to rapidly recognize non-convulsive SE in order to begin the neurological evaluation and management promptly.

References

1. Boggs JG. Mortality Associated with Status Epilepticus. Epilepsy Curr. 2004;4(1):25-27. doi: 10.1111/j.1535-7597.2004.04110.x
2. Posner JB, Saper CB, Schiff ND, Claassen J. Plum and Posner's Diagnosis and Treatment of Stupor and Coma. 5th ed. New York, NY: Oxford University Press; 2019.

3.4 Disorders of Consciousness from Toxic or Metabolic Encephalopathy

The central nervous system is acutely sensitive to systemic changes in the internal milieu of the human body.[1] Complications from dysfunction of almost every other organ in the body can lead to changes in consciousness and cognition, and neurohospitalists should have a good grasp of general medicine for this reason. The brain is affected by changes in cerebral blood flow, oxygen delivery, glucose utilization, neurotransmitter function, electrolyte balance, enzymes, and hormones.[1,2] Cognition can also be acutely disrupted by exogenous toxins, prescription medications, and recreational drugs. Hospitalized patients often experience encephalopathy secondary to their primary medical problems, so neurohospitalists will frequently be consulted to evaluate these conditions. Laboratory studies, neuroimaging, and electrodiagnostic studies can all be helpful but should be effectively synthesized and interpreted when caring for complex hospitalized patients.

Knowledge

Neurohospitalists should be able to:

- Identify the most common causes of toxic and metabolic encephalopathy that can lead to changes in consciousness and cognition.
- Recognize the patient-specific factors that increase risk for changes in consciousness and cognition from toxic/metabolic derangements.
- Describe the indications for laboratory studies, neuroimaging, and electrodiagnostic studies in the evaluation of hospitalized patients with acute changes in consciousness and cognition.
- Recognize the reasons for transferring a patient with acute disorders of consciousness and cognition to a center with higher level of care if they require further evaluation with electrodiagnostic studies, neuroimaging, or other advanced care that is not available.

Skills

Neurohospitalists should be able to:

- Elicit a thorough history regarding the ongoing medical conditions leading to the patient's altered consciousness and cognition.
- Reliably examine patients for level of arousal, responsiveness to stimuli, brainstem reflexes, and appendicular motor responses in order to distinguish structural brain lesions from global cerebral dysfunction.
- Examine language and cognitive deficits closely in order to distinguish encephalopathy from aphasia.

- Communicate with multidisciplinary teams to coordinate complex care for patients with prolonged disorders of cognition and consciousness due to severe medical disease, including recommendation for medical and procedural therapies that can be utilized to mitigate encephalopathy via targeted treatment.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based guidelines for evaluating patients with acute disorders of consciousness and cognition due to suspected toxic and metabolic derangements.

References

1. Posner JB, Saper CB, Schiff ND, Claassen J. Plum and Posner's Diagnosis and Treatment of Stupor and Coma. 5th ed. New York, NY: Oxford University Press; 2019.
2. Angel MJ, Young GB. Metabolic encephalopathies. Neurologic Clinics. 2011; 29(4): 837–882. doi: 10.1016/j.ncl.2011.08.002

4.0 Infectious Disorders of the Nervous System

Neuroinfectious disease is a rapidly evolving field due to the identification of new pathogens, expansion of diagnostic testing, and increased use of immunosuppressive medications. The Infectious Disease Society of America's Emerging Infections Network reported that 12.1% of all inquiries were related to neuroinfectious disease,[1] encompassing bacterial, viral, and parasitic infections of the central and peripheral nervous system. This large percentage will have substantial public health impact as nervous system infection and post-infectious autoimmune syndromes result in significant neurological sequelae. As focal neurologic deficits and encephalopathy are common presentations of neuroinfectious disease, the neurohospitalist must have expertise in recognizing, diagnosing, and treating neuroinfectious disease and its mimics.

Knowledge

Neurohospitalists should be able to:

- Describe risk factors for neuroinfectious disease.
- Generate a differential diagnosis in patients with neuroinfectious disease and mimics.
- Generate an appropriate and prioritized approach to diagnostic testing in patients with neuroinfectious disease and mimics, including imaging, neurophysiologic testing, serum and cerebrospinal fluid testing.
- Know the management of common neuroinfectious diseases and identify how to determine the management of uncommon neuroinfectious diseases.
- Know the pathogens endemic to the local region of practice.
- Be familiar with the local cerebrospinal fluid hospital test catalog, and mechanisms for send out testing, next-generation sequencing, and other advanced diagnostic testing.
- Describe the common causes, mimics, risk factors, presentation, diagnostic evaluation, and management of infectious meningitis, including acute bacterial meningitis, viral meningitis, eosinophilic meningitis, health care-associated meningitis, chronic meningitis, and recurrent meningitis.
- Distinguish between meningitis, encephalitis, and meningoencephalitis.
- Describe the common causes, mimics, risk factors, presentation, diagnostic evaluation, and management of acute and chronic infectious encephalitis and/or meningoencephalitis.
- Describe the common causes, mimics, risk factors, presentation, diagnostic evaluation, and medical and surgical management of central nervous system abscesses.
- Describe the common infectious causes and mimics of acute and chronic myelitis.
- Describe the common infectious causes and mimics of polyradiculitis.
- Understand how to appropriately adjust the clinical approach to patients with neuroinfectious diseases based upon the immune status of the patient, including those with human immunodeficiency virus (HIV).
- Recognize risk factors and clinical presentation of infective endocarditis, and diagnose and manage its neurologic sequelae.
- Describe and identify the presentation and management of immune reconstitution inflammatory syndrome (IRIS).
- Describe and recognize the presentation of prion-related diseases and their mimics, along with their evaluation and management.
- Be familiar with neuroinfectious bioterrorism threats.
- Know the most common antimicrobial therapies used in neuro-infectious disease management, with understanding of central nervous system penetration and side effects.
- Identify neuroinfectious diseases in which adjunctive immunomodulatory therapy is indicated.

Skills

Neurohospitalists should be able to:

- Obtain a comprehensive neurologic history with attention to infectious disease review of systems, travel

history, exposure information, social history, and past medical history.
- Perform a detailed neurologic examination, including fundoscopy, with attention to general physical examination signs of infection or inflammation (e.g. skin, joint, lymph node evaluation).
- Interpret magnetic resonance imaging (MRI) and computed tomography (CT) neuroimaging of the brain and spine, recognizing findings suggestive of neuroinfectious disease.
- Recognize patterns of neurophysiologic testing suggestive of neuroinfectious disease, including electroencephalogram (EEG) and electromyography (EMG).
- Perform lumbar puncture with opening pressure using appropriate infectious precautions.
- Interpret cerebrospinal fluid patterns in a manner that stratifies likelihood of neuroinfectious disease, including bacterial, viral, fungal, parasitic and prion-related disorders.
- Perform expanded spinal fluid testing to increase diagnostic yield in a cost-effective manner.
- Order and interpret both specific and unbiased spinal fluid testing (next-generation sequencing) for infectious diseases of the nervous system.
- Promptly initiate appropriate empiric and/or targeted therapy for neuroinfectious diseases, and narrow antimicrobial treatment as able throughout hospital course.
- Engage and collaborate with neurological surgery to pursue procedural interventions when indicated for diagnosis, treatment, and or management of neuroinfectious diseases.
- Enlist and/or collaborate with other medical and surgical services as needed in the care of patients with neuroinfectious diseases or neurologic complications of infectious disease.
- Address length of treatment and plans for ongoing monitoring and follow up after hospital discharge to ensure safe transitions of care.
- Counsel patients and families on the indications and risks of diagnostic procedures or treatments in the management of suspected neuroinfectious disease.
- Counsel patients and families on neuroinfectious disease diagnosis, treatment, monitoring, and prognosis.
- Recognize and address barriers to follow-up care of neuroinfectious disease patients and involve multidisciplinary hospital staff to customize medication and transition of care plans.

Attitudes

Neurohospitalists should be able to:

- Support an early and multidisciplinary approach to diagnostic evaluation and care of patient with suspected neuroinfectious disease through admission and throughout all care transitions.
- Prioritize provision of the latest evidence-based recommendations for the evaluation and treatment of neuroinfectious disease.
- Value collaboration with consultant referrals and allied health professionals to develop a comprehensive care plan to address the cause and treatment of neurologic infection, ongoing management of neurologic sequelae, and prevent recurrent or new infection.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary teams to develop institutional protocols or algorithms for specific neuroinfectious disease including prion disease.
- Lead, coordinate, and/or participate in multidisciplinary initiatives to promote hospital infection control.
- Participate in local or state level public health department reporting processes.

References

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2. Venkatesan A, Chow FC, Aksamit A, et al. Building a neuroinfectious disease consensus curriculum. Neurology. 2019;93(5):208-216. doi:10.1212/WNL.0000000000007872

5.0 Acute Toxic and Metabolic Conditions of the Nervous System

Knowledge

Neurohospitalists should be familiar with the toxic, metabolic, infectious, iatrogenic, and systemic medical conditions that can adversely affect levels of consciousness and cognitive function.[1-3] Specifically, neurohospitalists should be able to explain the pathophysiology and identify the typical neurologic syndrome and associated physical and neurological examination findings for each condition. The diagnostic workup, approach to treatment, and prognostic indicators are also within the neurohospitalists purview.[1-4]

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant medical history to assess for symptoms that are typical of commonly

encountered systemic conditions that result in cognitive dysfunction in hospitalized patients.
- Expeditiously perform a neurological assessment on a patient with altered mental status and be able to correctly interpret findings of global cerebral dysfunction seen in acute toxic and metabolic encephalopathies as distinct from the acute focal findings identified in cerebral vascular events.
- Describe the pathophysiology, risk factors, and typical and atypical clinical features of the diseases and conditions associated with toxic-metabolic encephalopathies.
- Describe the approach to patients with acute confusional state and delirium.
- Describe the approach to utilization of laboratory tests, electroencephalography, lumbar puncture, and imaging modalities to make the diagnosis of commonly encountered toxic-metabolic encephalopathies.
- Be familiar with the approach to treatment of the most commonly encountered toxic-metabolic encephalopathies.
- Be familiar with the prognostication of the most commonly encountered toxic-metabolic encephalopathies.

Attitudes

Neurohospitalists should be able to:

- Employ a multidisciplinary approach to the care of patients with toxic-metabolic encephalopathies, that begins at admission and continues through all care transitions.
- Follow evidence-based recommendations, practice guidelines, protocols, risk stratification tools, and tools for prognostication where available for any specific conditions identified in the course of the work up for a toxic-metabolic encephalopathy.

System Organization and Improvement

Neurohospitalists should be able to:

- Participate in multidisciplinary efforts to identify patients at risk for delirium, institute delirium prevention strategies, and assist with patient/family education.

References

1. The Acquired Metabolic Disorders of the Nervous System. In: Ropper AH, Samuels MA, Klein JP, Prasad S. eds. Adams and Victor's Principles of Neurology, 12e. McGraw-Hill Education; 2023:Chapter 39.
2. Krishnan V, Leung LY, Caplan LR. A neurologist's approach to delirium: diagnosis and management of toxic metabolic encephalopathies. Eur J Intern Med. 2014;25(2):112-6. doi: 10.1016/j.ejim.2013.11.010. Epub 2013 Dec 10.
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6.0 Acute Headache

6.1 Primary Headache Syndromes

Active headache disorders have a prevalence of 52% worldwide.[1] In the United States, acute headache accounts for 2.2% of all emergency department presentations, with about 5% of these patients being diagnosed with a secondary cause of headache.[2,3] Neurohospitalists must be adept at distinguishing primary headache disorders from secondary causes of headache and guiding management.

Knowledge

Neurohospitalists should be able to:

- Describe common clinical symptoms that are consistent with primary headache syndromes, such as migraine, tension-type headache, and cluster headache.
- Describe the hypothesis of cortical spreading depression and its importance in migraine aura.
- Recognize clinical symptoms and signs consistent with migraine aura, including typical aura, brainstem aura, hemiplegic migraine, and retinal migraine.
- Recognize signs and symptoms of trigeminal autonomic cephalalgias (TACs) and trigeminal neuralgia
- Describe when acute imaging is indicated in patients with headache, using a validated framework such as SNNOOP10.[4]
- Describe pharmacological and non-pharmacologic treatment modalities for headache, including side effects and any monitoring requirements.
- Know procedural interventions that may be beneficial in some patients.
- Define status migrainosus and treatment options for this condition.
- Recognize medication-overuse and rebound headache.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant medical history to differentiate between primary headache syndromes and secondary causes of headache.
- Perform an appropriate physical examination, including funduscopy, to identify abnormalities suggestive of secondary causes of headache.

- Make decisions regarding the utility of imaging, labs, and lumbar puncture in the work-up of headache etiology.
- Decide on appropriate medical therapy for symptomatic headache treatment based on the suspected or confirmed cause of symptoms.
- Communicate with patients and families to explain the benefits and potential adverse effects of pharmacologic agents.
- Communicate with patients and families to explain the course and prognosis of their headache syndrome.
- Recognize barriers to follow-up care of patients who have primary or secondary headaches and help guide patients to the most appropriate follow-up.
- Document the treatment plan and provide clear discharge instructions for post-discharge clinicians.

Attitudes

Neurohospitalists should be able to:

- Employ a thorough and nonjudgmental approach to the care of patients who have primary headache syndromes and secondary causes of headache.
- Follow evidence-based recommendations and protocols for the evaluation and treatment of primary headache syndromes and secondary causes of headache.
- Work collaboratively with other health professionals to develop comprehensive care plans to address headache in the inpatient setting.
- Work collaboratively with other health professionals to aid in transitioning long-term care for patients with headache syndromes to the outpatient setting.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary initiatives to promote patient safety, optimize resource use, create pathways for care transitions, and minimize hospital presentations for recurrent headache.

References

1. Stovner LJ, Hagen K, Linde M, Steiner TJ. The global prevalence of headache: an update, with analysis of the influences of methodological factors on prevalence estimates. J Headache Pain. 2022;23(1):34. Published 2022 Apr 12. doi:10.1186/s10194-022-01402-2
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4. Do TP, Remmers A, Schytz HW, et al. Red and orange flags for secondary headaches in clinical practice: SNNOOP10 list. Neurology. 2019;92(3):134-144. doi:10.1212/WNL.0000000000006697

6.2 Headache Due to Head and Neck Trauma

Headache is a common symptom in head/neck injury both in the acute and chronic phases. In one longitudinal study, 41% of patients with head/neck injury reported headache at initial evaluation, with 71% of patients reporting headache 12 months later.[1] Headache can also indicate complications of traumatic injury, such as arterial dissection, cerebral venous thrombosis, and cerebrospinal fluid (CSF) leak. Neurohospitalists have an important role in evaluating headache and associated symptoms to guide management after traumatic head and neck injury. This section does not cover post-traumatic intracranial hemorrhage.

Knowledge

Neurohospitalists should be able to:

- Recognize headache as a common complication of head and neck trauma.
- Recognize arterial dissection as a cause of headache after head and neck trauma.
- Recognize cerebral venous thrombosis (CVT) as a cause of headache after head and neck trauma.
- Recognize headache as a long-term complication of head and neck trauma.
- Recognize the headache features typically associated with traumatic CSF leak.
- Know the appropriate imaging to order to evaluate for neurological complications of head and neck trauma that present with persistent cervicocephalic pain syndromes such as arterial dissection, CVT and CSF leak.

Skills

Neurohospitalists should be able to:

- Elicit a thorough history of symptoms and collateral history in patients with head and neck trauma.
- Clinically correlate imaging findings suggesting neurological complications of head and neck trauma that present with persistent cervicocephalic pain syndromes.

- Rapidly decide when a new or changing post-traumatic headache may require additional evaluation.
- Balance risks and benefits of holding versus continuing antithrombotic medications in various situations in the setting of acute head and neck trauma complicated by intra-axial bleeding.

Attitudes

Neurohospitalists should be able to:

- Employ a thorough and practical approach to the care of patients who have had head and neck trauma.
- Follow evidence-based recommendations and protocols for the evaluation and treatment of headache in head and neck trauma.
- Work collaboratively with other health professionals to develop comprehensive care plans to address acute and chronic headache in head and neck trauma in the inpatient setting.

Reference

1. Hoffman JM, Lucas S, Dikmen S, et al. Natural history of headache after traumatic brain injury. J Neurotrauma. 2011;28(9):1719-25. doi: 10.1089/neu.2011.1914

6.3 Headache Syndromes Attributed to Cranial and/or Cervical Vascular Disorder

Headache is a common symptom of various central nervous system (CNS) vascular diseases. Thunderclap headache is widely recognized as a major red flag for subarachnoid hemorrhage (SAH), but can be seen in other cerebrovascular disorders. Headache occurs in approximately 19% of acute ischemic stroke patients and 68% in CVT patients as reported in cohort studies.[1,2] Vascular causes of headache require urgent evaluation and management. Neurohospitalists have an important role in obtaining the headache history in conjunction with associated symptoms to identify vascular causes of headache, and to effectively guide management.

Knowledge

Neurohospitalists should be able to:

- Recognize that headache may be a presenting symptom of intracranial hemorrhage, ischemic stroke, SAH, reversible cerebral vasoconstriction syndrome (RCVS), intracranial or extracranial dissection, and posterior reversible encephalopathy syndrome (PRES).
- Describe common conditions and medications associated with RCVS, along with the management of RCVS.
- Recognize the indications for and utility of CT and MR angiography in evaluating a patient with suspected RCVS, including when to refer patients for digital subtraction angiography.
- Describe the clinical signs and symptoms as well as situations that may indicate PRES, along with the typical management of PRES.
- Be aware of the role and limitations of different types of vascular imaging used to evaluate for potential dissection.
- Be familiar with the association of headache with vasculitis (primary CNS or systemic).
- Recognize the indications for early specialty consultation and potential need for transfer in vascular causes of headache if not practicing in a center with neurocritical care, neurosurgery, or an endovascular specialist.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant medical history to identify presentations concerning for vascular causes of acute headache.
- Perform an appropriate physical examination to identify focal neurological deficits suggestive of vascular causes associated with headache.
- Make decisions on appropriate treatment of vascular causes of headache, and recognize other factors that may alter the usual recommended treatments.
- Facilitate prompt involvement of other specialists, such as neurocritical care, neurosurgery, etc. when necessary for the situation.
- Communicate with patients and families to explain the history and prognosis of different vascular causes of acute headache, including guidance during the course of hospital stay as various phases of evaluation/treatment occur.

Attitudes

Neurohospitalists should be able to:

- Employ a thorough and practical approach to the care of patients who have vascular causes of acute headache.
- Follow evidence-based recommendations and protocols for the evaluation and treatment of vascular causes of headache.

References

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2. Wasay M, Kojan S, Dai AI, Bobustuc G, Sheikh Z. Headache in Cerebral Venous Thrombosis: incidence, pattern and location in 200 consecutive patients. J Headache Pain. 2010;11(2):137-9. doi: 10.1007/s10194-010-0186-3

6.4 Headache Due to Disorders of Intracranial Pressure

Headache is a common symptom associated with disorders of intracranial pressure (ICP), both low ICP and high ICP. A headache due to a disorder of ICP is often, but not always, positional. Increased ICP headaches characteristically worsen in a supine position and can be associated with visual changes and pulsatile tinnitus (which can be seen in up to 68% of patients with idiopathic intracranial hypertension).[1] In contrast, intracranial hypotension usually presents with orthostatic headache, including after post-dural puncture.[2] Neurohospitalists have an important role in distinguishing between a headache due to low or high ICP to effectively guide further evaluation and management.

Knowledge

Neurohospitalists should be able to:

- Know the clinical symptoms that may indicate increased ICP or decreased ICP.
- Recognize features of positional headaches that correlate with intracranial hypotension.
- Recognize clinical symptoms or signs that indicate the need for a more urgent evaluation, such as visual loss, rapidly progressing headache, or episodes of altered consciousness.
- Recognize imaging features that may be associated with increased ICP or decreased ICP.
- Describe the imaging that can be performed to find the etiology of intracranial hypotension.
- Be familiar with procedures and interventions that aid in management of idiopathic intracranial hypertension (IIH) and clinical situations that may necessitate these.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant history to identify patients who may have symptoms of increased ICP.
- Perform a fundoscopic exam to assess for signs of optic disc edema that may correlate with symptoms of increased ICP.
- Make rapid decisions regarding imaging as well as subsequent lumbar puncture as appropriate.
- Facilitate urgent ophthalmologic evaluation in patients at high risk of visual loss.
- Decide when further testing for secondary causes of increased ICP is warranted.
- Evaluate patients with intracranial hypotension (including post-dural puncture) and decide on conservative versus procedural management.
- Communicate with patients and families to explain the use and potential adverse effects of medications used to manage IIH.
- Communicate with patients and families to explain the history and prognosis of IIH, any lifestyle changes to make, and warning signs for worsening ICP.
- Communicate with patients and families to explain the goals of care, discharge instructions, and management after hospital discharge to ensure safe follow-up and transitions of care.

Attitudes

Neurohospitalists should be able to:

- Employ a thorough and practical approach to the care of patients who have suspected increased or decreased ICP.
- Follow evidence-based recommendations and protocols for the evaluation and treatment of elevated ICP or decreased ICP.
- Work collaboratively with other health professionals (ophthalmology, neurosurgery, primary care, etc.) to develop comprehensive care plans to address causes of increased or decreased ICP in the inpatient and ultimately outpatient setting.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary efforts to develop protocols from the emergency department to the inpatient wards in order to best utilize healthcare resources to identify patients requiring deeper diagnostic evaluation, as well as prompt involvement of ophthalmology and neurosurgery when necessary.
- Lead, coordinate, and/or participate in multidisciplinary initiatives to promote patient safety, optimize resource use, create pathways for care transitions, and minimize hospital presentations for recurrent headache associated with increased or decreased ICP.

References

1. Wall M, Kupersmith MJ, Kieburtz KD, et al. The idiopathic intracranial hypertension treatment trial: clinical profile at baseline. JAMA Neurol. 2014;71(6):693-701. doi: 10.1001/jamaneurol.2014.133

2. Lin JP, Zhang SD, He FF, Liu MJ, Ma XX. The status of diagnosis and treatment to intracranial hypotension, including SIH. J Headache Pain. 2017;18(1):4. doi: 10.1186/s10194-016-0708-8

6.5 Headache Associated with Infection and Inflammatory Disorders

Headache is a common symptom of CNS infectious or inflammatory disorders. Among the typical features suggestive of bacterial meningitis (fever, headache, neck stiffness, altered mental status), headache was found to be present in 87% of cases in a large prospective cohort of bacterial meningitis patients.[1] CNS inflammatory disorders (or systemic disease with CNS spread) can have variable degrees of associated headache, which can be an important diagnostic clue.[2] Neurohospitalists must also be attuned to changes in headache suggestive of further brain injury which may complicate infectious and inflammatory disorders.

Knowledge

Neurohospitalists should be able to:

- Recognize clinical symptoms or signs (e.g. meningismus) that indicate a high likelihood of CNS infection (meningitis/encephalitis).
- Obtain a relevant history in patients with suspected inflammatory cause of headache, including evaluating for signs of giant cell arteritis (GCA).
- Recognize the uses and limitations of lab tests and imaging in suspected GCA.
- Be aware of the role of acute steroids and temporal artery biopsy to facilitate diagnosis/treatment in suspected GCA.
- Recognize the role of headache in signifying the presence of CNS inflammatory disease, including in the presence of systemic inflammatory disease.

Skills

Neurohospitalists should be able to:

- Perform a thorough physical exam to identify patients with signs of meningismus or temporal artery inflammation.
- Aid in the evaluation and management of suspected GCA.
- Communicate with patients and families to explain the history, prognosis, and potential complications of various CNS infections.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based recommendations and protocols for the evaluation and treatment of CNS infections and inflammatory disorders with associated headache.

References

1. van de Beek D, de Gans J, Spanjaard L, Weisfelt M, Reitsma JB, Vermeulen M. Clinical features and prognostic factors in adults with bacterial meningitis [published correction appears in N Engl J Med. 2005 Mar 3;352(9):950]. N Engl J Med. 2004;351(18): 1849-1859. doi:10.1056/NEJMoa040845
2. Headache Classification Committee of the International Headache Society (IHS) The International Classification of Headache Disorders, 3rd edition. Cephalalgia. 2018;38(1):1-211. doi:10.1177/0333102417738202

6.6 Headache Associated with Pregnancy and Postpartum Period

Headache can affect a large proportion of pregnant people, up to 57.6% in one series.[1] Patients with pre-existing primary headaches, in particular migraine, typically experience an improvement in their headache syndromes during pregnancy.[2] However, some pregnant patients may have worsening headaches requiring management. Of high concern are secondary headaches in pregnancy and the postpartum period.[2] These secondary headaches are usually most concerning for vascular conditions such as pre-eclampsia, PRES, RCVS, and CVT. Neurohospitalists must be knowledgeable of these conditions and thoughtful in their evaluation and management of pregnant and postpartum patients with headache.

Knowledge

Neurohospitalists should be able to:

- Recognize the value of differentiating between primary and secondary headaches that present in pregnancy.
- Know how thrombotic and hemorrhagic risk changes during pregnancy, including the postpartum period.
- Describe the secondary causes of headache in pregnant and postpartum patients.
- Describe the imaging that will aid in distinguishing between secondary causes of headache in pregnant and postpartum patients.
- Know the clinical symptoms and signs associated with pre-eclampsia, and imaging findings that may be seen on CT or MRI evaluation.
- Recognize that low pressure headaches can be a consequence of spinal epidural punctures.
- Know the medications that can be used in treatment of headache in pregnant patients as well as the relative and absolute contraindications present with certain medications.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant history in pregnant patients with headache.

- Expeditiously evaluate pregnant or postpartum patients with an acute headache.
- Perform an appropriate exam, including a fundoscopic exam, in the headache patient.
- Make rapid decisions regarding imaging.
- Expeditiously work with obstetrics team to make rapid diagnostic and treatment decisions.
- Communicate with patients and families to explain the need for higher-risk imaging in pregnancy.
- Communicate with patients and families regarding the benefits and contraindications of various. medications that may be used for symptomatic treatment of headache in pregnancy.

Attitudes

Neurohospitalists should be able to:

- Employ a thorough and practical approach to the care of patients who have headache in pregnancy or in the postpartum period.
- Follow evidence-based recommendations and protocols for the evaluation and treatment of headache in pregnancy and the postpartum period.
- Work collaboratively with other health professionals (obstetrics in particular) to develop comprehensive care plans to address various causes of headache in pregnancy and the post-partum period in the inpatient and ultimately outpatient setting.

References

1. Raffaelli B, Siebert E, Körner J, Liman T, Reuter U, Neeb L. Characteristics and diagnoses of acute headache in pregnant women - a retrospective cross-sectional study. J Headache Pain. 2017;18(1):114. Published 2017 Dec 4. doi:10.1186/s10194-017-0823-1
2. Negro A, Delaruelle Z, Ivanova TA, et al. Headache and pregnancy: a systematic review. J Headache Pain. 2017;18(1):106. doi: 10.1186/s10194-017-0816-0

7.0 Acute Disorders of the Peripheral Nervous System

7.1 Acute Disorders of Peripheral Nerves

Acute peripheral neuropathies, disorders of neuromuscular transmission, and myopathies may lead to disabling pain, reduced function, respiratory failure, and systemic complications depending on what part of the motor unit (nerve, neuromuscular junction, muscle) and what aspect of each (e.g., motor, sensory, autonomic nerves) are involved. Neurohospitalists will be called upon to manage such disorders in the hospitalized setting.

Knowledge

Neurohospitalists should be able to:

- Identify symptoms of acute neuropathies, disorders of neuromuscular transmission, and acute myopathy.
- Localize a set of signs to the peripheral nerve, neuromuscular junction, or muscle.
- Decide when electrophysiological testing (e.g., electromyogram and nerve conduction study) is indicated in the inpatient setting.
- Recognize symptoms and signs of rapidly progressing neuromuscular weakness, including neuromuscular respiratory failure that will require triage to an appropriate care setting.
- Discuss the utility of tracking bedside pulmonary function tests in the management of patients with neuromuscular respiratory weakness.
- Generate a differential diagnosis of peripheral neuropathies that may present acutely (e.g., Guillain-Barré syndrome (GBS), porphyria, nutritional deficiencies, vasculitic/inflammatory, infectious).
- Generate a differential diagnosis of disorders of neuromuscular transmission that may present acutely (e.g., myasthenia gravis, botulism, Lambert Eaton myasthenic syndrome (LEMS)).
- Generate a differential diagnosis for acute myopathy (e.g., toxic, inflammatory, infectious, metabolic, genetic).
- Recognize laboratory data that can help in diagnosing the etiology of an acute neuropathy, disorder of neuromuscular transmission, or myopathy.

Skills

Neurohospitalists should be able to:

- Perform a focused neurological examination of the peripheral nervous system.
- Perform an appropriate examination to determine possible risk of acute neuromuscular respiratory failure.
- Collaborate with neuromuscular subspecialists and/or electrophysiologists to obtain electrodiagnostic testing when indicated.
- Collaborate with intensivists when care in the intensive care unit is required.
- Communicate with allied health professionals (e.g., physical therapy, occupational therapy, respiratory therapy, speech therapy, nutrition) to develop a comprehensive plan of care for patients with peripheral nervous system disorders.
- Initiate appropriate treatments, both symptomatic and disease modifying.
- Communicate with patients and their families regarding treatment options, their risks and benefits, and prognosis.

Attitudes

Neurohospitalists should be able to:

- Discuss etiologies of peripheral neuropathies with family and primary care teams.
- Understand and address a patient's experience, including their presence or absence of neuropathic pain.
- Educate colleagues regarding the initial management and workup of an acute peripheral neuropathy.
- Educate patients regarding the initial workup and management of acute peripheral neuropathies.

7.1 Guillain Barré Syndrome

Guillain Barré Syndrome (GBS) or Acute Inflammatory Demyelinating Polyradiculoneuropathy (AIDP) is a common cause for acute flaccid paralysis. It has an incidence of 1-2 per 100,000 person-years.[1] It is important to recognize that GBS can lead to neuromuscular respiratory failure in 20-25% of patients despite treatment.[1] GBS can have autonomic manifestations ranging from isolated tachycardia and hypertension to cardiac arrhythmia, which may lead to additional hospital morbidity.[1]

Knowledge

Neurohospitalists should be able to:

- Identify symptoms and signs accompanying GBS.
- Recognize autonomic manifestations of GBS.
- Identify and treat conditions associated with GBS (respiratory failure, venous thromboembolism, aspiration pneumonia, pressure injuries, exposure keratopathy).
- Apply established consensus diagnostic criteria for the diagnosis of GBS.

Skills

Neurohospitalists should be able to:

- Utilize GBS-specific tools to determine risk of neuromuscular respiratory failure.
- Prescribe treatments for the management of GBS.
- Prescribe medications for the management of neuropathic pain if present.
- Initiate prophylaxis against complications related to GBS including venous thromboembolism.

Attitudes

Neurohospitalists should be able to:

- Employ evidence-based treatment for the management of GBS.

Reference

1. Leonhard SE, Mandarakas MR, Gondim FAA, et al. Diagnosis and management of Guillain-Barré syndrome in ten steps. Nat Rev Neurol 2019; 15(11):671-683. doi:10.1038/s41582-019-0250-9

7.2 Acute Disorders of the Neuromuscular Junction

Disorders of neuromuscular transmission can lead to acute bulbar weakness requiring inpatient hospitalization. Myasthenia gravis is among the most common causes for bulbar dysfunction, and has an estimated prevalence of 10 to 20 cases per 100,000 people.[1] A myasthenia gravis exacerbation can become a crisis, defined as an exacerbation requiring ventilator support (invasive or non-invasive), and neurohospitalists are at the helm of this management.[2]

Knowledge

Neurohospitalists should be able to:

- Identify symptoms and signs that differentiate between myasthenia gravis, botulism, and LEMS.
- Recognize factors that may lead to an exacerbation of myasthenia gravis.
- Identify patients in whom botulism antitoxin is indicated.

Skills

Neurohospitalists should be able to:

- Implement acute treatment for a myasthenic crisis and exacerbation.
- Obtain botulism antitoxin treatment for patients when indicated.
- Communicate with physicians caring for patients with myasthenia gravis hospitalized for other reasons to prevent exacerbation.

Attitudes

Neurohospitalists should be able to:

- Employ evidence-based treatments for the management of myasthenia gravis.
- Collaborate with outpatient neurologists for long-term follow up care of patients hospitalized with myasthenia gravis exacerbation.
- Collaborate with infectious disease consultants and departments of public health to diagnose and treat patients with suspected botulism.

References

1. Phillips LH 2nd. The epidemiology of myasthenia gravis. Ann New York Acad Sci 2003;998:407-412. doi:10.1196/annals.1254.053
2. Sanders, DB, Wolfe GI, Benetar M, et al. International consensus guidance for the management of myasthenia gravis. Neurology 2016;87:419-425.doi: 10.1212/WNL.0000000000002790

7.3 Acute Disorders of Muscle

Muscle diseases leading to inpatient hospitalizations are relatively rare events. However, inflammatory myopathies, a family of diseases that includes dermatomyositis, necrotizing autoimmune myopathy, anti-synthetase syndrome, polymyositis and overlap myopathy can lead to dysphagia, interstitial lung disease, respiratory failure and cardiac arrhythmias.[1] The identification and management of these muscle diseases is critical for neurohospitalists as they may be called upon to manage or consult upon these patients in the inpatient setting.

Knowledge

Neurohospitalists should be able to:

- Identify the presenting signs and symptoms of myopathy.
- Recognize co-morbid conditions and systemic signs associated with inflammatory myopathies.
- Discuss when muscle biopsy is indicated in the workup of acute myopathy.

Skills

Neurohospitalists should be able to:

- Design a diagnostic plan to determine the cause of a patient's myopathy including use of electrodiagnostics, serologic testing, imaging, and pathology.
- Consult appropriate surgical colleagues when muscle biopsy is required.

Attitudes

Neurohospitalists should be able to:

- Employ evidence-based treatments for the management of acute myopathy.
- Collaborate with other specialty services (e.g., rheumatology, radiology, surgery) in designing diagnostic pathways for patients admitted with acute myopathies.
- Collaborate with outpatient providers in the coordination of care of patients presenting with new acute myopathic illness.

Reference

1. Asthon C, Paramalingam S, Stevenson B, Brusch A,Needham M. Idiopathic inflammatory myopathies: a review. Intern Med J. 2021;51(6):845-852. doi: 10.1111/imj.15358

8.0 Neoplastic Disorders of the Nervous System

8.1 Neuro-Oncology Emergencies

Neurologic complications of cancer occur in roughly 15% of cancer patients over the course of their treatment, and can arise in individuals with primary central nervous system (CNS) malignancies as well as systemic cancers.[1] These complications are often serious, requiring a hospital admission. The neurohospitalist must have familiarity with the clinical manifestations of neuro-oncologic emergencies, including the management of mass effect and herniation, neurovascular complications of malignancy,[2] metastatic epidural spinal cord compression,[3] and other specific acute neuro-oncologic presentations.

Knowledge

Neurohospitalists should be able to:

- Recognize central nervous system mass effect and herniation syndromes.
- Describe acute medical therapies to treat cerebral edema and/or herniation.
- Describe nontraditional ischemic stroke mechanisms that are seen in individuals with cancer and how they are evaluated.
- Discuss the risk of hemorrhage with anticoagulation therapy in individuals with venous thromboembolism and an intracranial mass lesion.
- Recognize common presenting clinical symptoms of epidural spinal cord compression and the indications for emergent spine imaging.
- Recognize seizures due to a CNS tumor.
- Diagnose pituitary apoplexy based on clinical and radiographic features.

Skills

Neurohospitalists should be able to:

- Effectively dose, escalate, and monitor acute medical therapies for management of cerebral edema and/or herniation.
- Effectively treat seizures associated with a CNS tumor.
- Identify clinical situations in which emergency neurosurgical consultation is indicated for treatment of mass effect/herniation.

- Use available evidence and guidelines to determine the most appropriate acute stroke therapy for an individual with acute ischemic stroke and cancer, communicate this recommendation to team members and families, and document the rationale for this decision.
- Counsel patients, families, and colleagues about the risks and benefits of anticoagulation in the setting of acute symptomatic venous thromboembolism and intracranial mass lesion(s).
- Ensure that emergent whole spine imaging is obtained for individuals with suspected metastatic epidural spinal cord compression and progressive neurologic impairment.
- Coordinate emergent surgical versus radiation therapy for individuals with confirmed metastatic epidural spinal cord compression.
- Arrange appropriate urgent medical and surgical consultation for acute management of pituitary apoplexy.
- Establish relevant goals of care and lead or facilitate conversations on code status and neurologic prognosis.

Attitudes

Neurohospitalists should be able to:

- Engage effectively with colleagues in emergency medicine, neurosurgery, oncology/neuro-oncology, and radiation oncology to communicate important neurological exam findings and clinical changes.
- Partner with longitudinal oncology providers and family/caregivers to establish the disease trajectory, treatment strategy, and identify the most appropriate medical interventions.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead and/or participate in efforts to develop clinical pathways with medicine, oncology, and neurosurgical teams to most effectively coordinate interdisciplinary care of patients with neoplastic disorders of the CNS.

References

1. Rogers LR. Neurologic Complications of Cancer, 2nd ed. Contemporary Neurology Series. Neuro Oncol. 2009;11(1):96-97. doi:10.1215/15228517-2008-118
2. Navi B B, Iadecola C. Ischemic stroke in cancer patients: A review of an underappreciated pathology. Ann Neurol. 2018;83(5):873-883. doi:10.1002/ana.25227
3. Cole JS, Patchell RA. Metastatic epidural spinal cord compression. Lancet Neurol. 2008;7(5):459-466. doi:10.1016/S1474-4422(08)70089-9

8.2 Intracranial Mass Lesions and Leptomeningeal Cancer

Neurohospitalists often see individuals presenting with symptoms from intracranial mass lesions, and are tasked with performing a diagnostic evaluation and managing symptoms related to the mass lesion or suspected leptomeningeal cancer. Often, if a cancer has not been identified, the neurohospitalist is the main contributor to this diagnostic evaluation. While the differential diagnosis may include infections, autoimmune/inflammatory etiologies, or a variety of malignancies, it is important for the neurohospitalist to have a diagnostic approach to intracranial mass lesions.

Knowledge

Neurohospitalists should be able to:

- Identify the common clinical presentations of an intracranial mass lesion.
- Identify the characteristic acute neurologic presentations of leptomeningeal cancer including: headache, cranial neuropathy, and signs/symptoms of elevated intracranial pressure.
- Know clinical and radiographic features that differentiate different types of intracranial tumors and tumors from abscess or tumefactive demyelination.
- Know which clinical, imaging, or other diagnostic testing are most appropriate to evaluate for the presence of systemic malignancy.
- Discern when surgery/tissue or cytology is required, and when it is possible to treat without CNS tissue confirmation.
- Know the uses, limitations, sensitivity and specificity of serum and cerebrospinal fluid (CSF) diagnostic studies for CNS tumors and leptomeningeal cancer.

Skills

Neurohospitalists should be able to:

- Determine when lumbar puncture is safe versus unsafe due to herniation risk in the presence of a CNS mass lesion.
- Order and interpret imaging to generate a prioritized differential diagnosis for a CNS mass lesion.
- Perform an efficient and comprehensive diagnostic evaluation for suspected CNS lymphoma.
- Perform an effective screen for systemic malignancy for individuals with suspected brain metastasis.
- Diagnose leptomeningeal cancer based on clinical presentation, imaging, and CSF studies.

Attitudes

Neurohospitalists should be able to:

- Employ an early and multidisciplinary approach to the care of patients who have an intracranial mass lesion

that begins at admission and continues through all care transitions.
- Counsel individuals and families throughout the process of diagnosis and treatment for an intracranial mass lesion, being careful to convey an accurate sense of what is known and the purpose of each step in the evaluation.
- Convey patient-centered prognostication based on the best available evidence.
- Clearly communicate uncertainty.
- Have conversations about goals of care and what matters most for the individual with an intracranial mass lesion early and often.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in efforts to reduce unnecessary testing and diagnostic delays in the evaluation of an intracranial mass lesion.

Reference

1. Louis DN, Perry A, Wesseling P, et al. The 2021 WHO classification of tumors of the central nervous system: a summary. Neuro Oncol. 2021;23(8):1231-1251. doi: 10.1093/neuonc/noab106

8.3 Acute Neurologic Manifestations of Systemic Malignancy and Neurologic Complications of Cancer Therapies

The neurohospitalist must often discern whether the development of neurologic symptoms is due to neurologic spread of cancer, a paraneoplastic neurologic disorder (see section 1.9), or a neurologic complication of cancer therapies. The status and extent of an individual's systemic cancer, the temporal evolution of symptoms, and the timing of symptom onset relative to cancer therapy are all important to know when deciding how to interpret new neurologic findings. With cancer therapeutics rapidly evolving, it is challenging to maintain an updated knowledge of all neurologic side-effects of cancer therapies. An understanding of prominent neurologic side-effects as well as a reliable way to learn neurologic effects of chemotherapeutic agents is an effective diagnostic approach.

Knowledge

Neurohospitalists should be able to:

- Describe the potential neurologic side-effects acutely, subacutely, and remotely following radiation therapy.
- Discuss the acute neurologic side-effects of intrathecal chemotherapy.
- Identify side-effects of chemotherapeutic agents used to treat oncologic disease.
- Identify the spectrum of central and peripheral nervous system presentations that may occur in association with immune checkpoint inhibitor therapy.

Skills

Neurohospitalists should be able to:

- Manage neurologic complications of cranial and spine radiation therapy.
- Identify potentially causative chemotherapeutic agents in individuals with cancer receiving systemic therapies and experiencing neurologic symptoms.
- Effectively diagnose and treat neurologic side-effects of immune checkpoint inhibitor therapy.

Attitudes

Neurohospitalists should be able to:

- Collaborate with oncology teams to effectively communicate, diagnose, and treat neurologic conditions in individuals with systemic cancers.
- Follow evidence-based recommendations and guidelines for the treatment of neurologic problems associated with systemic cancers and cancer therapies.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Engage with inpatient and outpatient oncology providers to fully understand the nature of an individual's cancer diagnosis, treatment, and prognosis.

Reference

1. Dietrich J. Neurotoxicity of Cancer Therapies. Continuum (Minneap Minn). 2020;26(6):1646-1672. doi: 10.1212/CON.0000000000000943

9.0 Autoimmune and Paraneoplastic Conditions of the Nervous System

9.1 Acute Demyelinating Disease of the Central Nervous System

Demyelinating diseases are some of the most common illnesses encountered by the neurohospitalist.[1] Diagnosis of multiple sclerosis can be made based upon a single inpatient encounter and therapy is warranted in order to reduce the duration of acute symptoms.[2,3] The neurohospitalist must

know the appropriate diagnostic evaluation to identify demyelinating disease of the central nervous system and initiate treatment while supporting transition to an outpatient neurologist for consideration of disease modifying therapy.[4]

Knowledge

Neurohospitalists should be able to:

- Recognize risk factors for development of demyelinating conditions of the central nervous system.
- Describe and differentiate between the clinical features of multiple sclerosis, neuromyelitis optica (NMO) and NMO spectrum disorder, Myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD), acute disseminated encephalomyelitis, and tumefactive demyelination.
- Identify imaging features suggestive of the aforementioned acute demyelinating disorders of the central nervous system.
- Understand the appropriate serum and cerebrospinal fluid testing appropriate to diagnose demyelinating diseases of the central nervous system and their common mimics.
- Recognize the classic pathologic abnormalities on brain biopsy of a demyelinating disorder as written in a neuropathologic report.
- Identify acute treatment options for patients presenting with an acute demyelinating disorder of the central nervous system and describe their risks and benefits.
- Anticipate, recognize, and manage acute and chronic symptoms of demyelinating diseases of the central nervous system in need of inpatient supportive management, including spasticity, nausea/vomiting, pseudobulbar affect, spasms, etc.
- Anticipate, recognize, and manage complications of fulminant demyelinating diseases of the central nervous system in need of supportive management, including increased intracranial pressure, seeking support from consulting services as needed.
- List appropriate testing to perform in advance of initiating a disease-modifying agent for demyelinating disorders of the central nervous system.
- Be familiar with recent trends in disease-modifying agents used for chronic management of demyelinating disorders of the central nervous system.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant medical history to assess for symptoms and risk factors of demyelinating disorders of the central nervous system.
- Perform a targeted examination of patients with clinical symptoms concerning for demyelinating disorders of the central nervous system.
- Diagnose the most likely specific entity causing acute demyelination of the central nervous system.
- Counsel patients on the pathophysiology and prognosis of their acute demyelinating episode.
- Communicate with patients and families to explain the indications, benefits, and potential adverse effects of tests and pharmacologic agents relevant to their acute demyelinating episode.
- Employ an early and multidisciplinary approach to the care of patients who have had an acute demyelinating disease of the central nervous system that begins at admission and continues through all care transitions.

Attitudes

Neurohospitalists should be able to:

- Direct management decisions as related to an acute demyelinating episode of the central nervous system during hospitalization.
- Follow evidence-based recommendations for the evaluation and treatment of acute demyelinating disease of the central nervous system.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in a conscientious discharge plan, including supporting the transition of care into an outpatient neurologic practice experienced in chronic management of demyelinating disease of the central nervous system.

References

1. Douglas VC, Scott BJ, Berg G, Freeman WD, Josephson SA. Effect of a neurohospitalist service on outcomes at an academic medical center. Neurology. 2012;79(10): 988-994. doi:10.1212/WNL.0b013e31826846cb
2. Thompson AJ, Banwell BL, Barkhof F, et al. Diagnosis of multiple sclerosis: 2017 revisions of the McDonald criteria. Lancet Neurol. 2018;17(2):162-173. doi:10.1016/S1474-4422(17)30470-2
3. Filippini G, Brusaferri F, Sibley WA, et al. Corticosteroids or ACTH for acute exacerbations in multiple sclerosis. Cochrane Database Syst Rev. 2000;(4): CD001331. doi:10.1002/14651858.CD001331
4. Rae-Grant A, Day GS, Marrie RA, et al. Practice guideline recommendations summary: Disease-modifying therapies for adults with multiple sclerosis: Report of the Guideline Development, Dissemination,

and Implementation Subcommittee of the American Academy of Neurology [published correction appears in Neurology. 2019 Jan 8;92(2):112]. Neurology. 2018; 90(17):777-788. doi:10.1212/WNL.0000000000005347

9.2 Autoantibody and Paraneoplastic Syndromes

The discovery of autoimmune and paraneoplastic encephalitides significantly altered the landscape of neurohospitalist practice, as it became possible to both diagnose and treat many acute neurologic syndromes previously thought to be idiopathic.[1] Neurohospitalists should be able to identify patients with autoimmune and paraneoplastic disorders of the central and peripheral nervous system in order to promote timely delivery of therapy directed toward both the primary autoimmune pathology and potential associated neoplasm.[2,3]

Knowledge

Neurohospitalists should be able to:

- Recognize risk factors for the development of a neural autoantibody syndrome.
- Recognize typical clinical syndromes suggestive of a specific neural autoantibody.
- Be familiar with pathophysiologic distinctions commonly used to categorize neural autoantibody syndromes, including whether an antigen is intracellular or extracellular, pathogenic, or a biomarker.
- List the most common cancers associated with neural autoantibody syndromes.
- Identify important factors influencing the sensitivity and specificity of neural autoantibody testing.
- Describe appropriate serum and cerebrospinal fluid testing appropriate to diagnose neural autoantibody syndromes or their common mimics.
- List appropriate inpatient and outpatient screening tests for evaluation of potential neoplasms associated with a neural autoantibody syndrome.
- Identify and describe risks and benefits of acute treatment options for patients presenting with neural autoantibody syndromes, including steroids, plasma exchange, intravenous immunoglobulin, and B-cell directed therapy.
- Recognize the importance of addressing the underlying malignancy in those with paraneoplastic neural autoantibody syndromes.
- Be familiar with supportive management of the symptoms and complications of neural autoantibody syndromes, such as autonomic dysfunction, movement disorders, and seizures.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant medical history to assess for symptoms of and risk factors for neural autoantibody syndromes.
- Employ an early and multidisciplinary approach to the care of patients who have neural autoantibody syndromes that begins at admission and continues through all care transitions.
- Pursue workup, diagnosis, and treatment of potential neoplastic disease associated with a neural autoantibody syndrome, collaborating with inpatient consultants as needed.
- Recognize those patients for whom empiric therapy for a neural autoantibody syndrome is warranted prior to confirmation of a specific autoantibody.
- Delay diagnostics that carry higher risks, such as brain biopsy, and await lower-risk diagnostic results in those patients for whom a neural autoantibody is highly likely.
- Counsel patients on the pathophysiology and prognosis of their neural autoantibody syndrome.
- Anticipate, recognize, and manage symptoms and complications of neural autoantibody syndromes in need of supportive management.
- Communicate with patients and families to explain the indications, benefits, and potential adverse effects of tests and treatments relevant to their neural autoantibody syndrome.
- Document the treatment plan and provide clear discharge instructions for post-discharge clinicians.

Attitudes

Neurohospitalists should be able to:

- Assume primary clinical and intellectual responsibility for management decisions as related to a neural autoantibody syndrome during hospitalization.
- Prioritize provision of the latest evidence-based recommendations for the evaluation and treatment of neural autoantibody syndromes.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary teams early in the hospital course to reduce complications, facilitate patient education, and identify and treat potential neoplastic disease associated with neural autoantibody syndromes.

References

1. Dalmau J, Graus F. Antibody-mediated encephalitis. N Engl J Med. 2018;378(9):840-851. doi:10.1056/NEJMra1708712
2. Abboud H, Probasco JC, Irani S, et al. Autoimmune encephalitis: proposed best practice recommendations for diagnosis and acute management. J Neurol Neurosurg Psychiatry. 2021;92(7):757-768. doi:10.1136/jnnp-2020-325300
3. Vedeler CA, Antoine JC, Giometto B, et al. Management of paraneoplastic neurological syndromes: report of an EFNS Task Force. Eur J Neurol. 2006;13(7):682-690. doi:10.1111/j.1468-1331.2006.01266.x

9.3 Granulomatous, Vasculitic, and Other Autoimmune Diseases of the Nervous System

Some autoimmune diseases of the nervous system are challenging to diagnose based upon imaging features or serologic testing alone, and diagnosis may frequently require a biopsy of the nervous system or of an alternative systemic target.[1] These diseases include, but are not limited to, granulomatous, vasculitic, amyloid-associated disease, and diseases related to systemic rheumatologic conditions. Neurohospitalists must be able to support the expedient and systematic workup of these treatable processes in patients presenting with acute symptoms requiring hospitalization.

Knowledge

Neurohospitalists should be able to:

- Differentiate between autoimmune diseases of the nervous system that are neither demyelinating nor neural antibody associated, including, but not limited to, disease associated with systemic rheumatologic conditions, granulomatous, vasculitic, or amyloid-associated diseases.
- Recognize typical imaging findings that suggest an autoimmune disease of the nervous system in the aforementioned categories.
- Identify the appropriate imaging and laboratory testing used to evaluate the potential presence of the aforementioned autoimmune diseases of the nervous system.
- List potential infectious and neoplastic mimics of the aforementioned autoimmune diseases of the nervous system.
- Recognize and describe factors that influence the sensitivity and specificity of a biopsy of the central or peripheral nervous system.
- Identify and describe risks and benefits of acute treatment options for patients presenting with autoimmune disease of the nervous system, including steroids and cyclophosphamide.

Skills

Neurohospitalists should be able to:

- Elicit a thorough and relevant medical history to assess for symptoms and risk factors for other autoimmune diseases of the nervous system felt unlikely to represent demyelinating or autoantibody syndromes.
- Perform an evaluation for systemic involvement of autoimmune disease of the nervous system that may offer a potential biopsy target or other diagnostic alternative to performing a brain biopsy, collaborating with consultants as needed.
- Recognize those patients for whom biopsy of central or peripheral nervous tissue is an appropriate diagnostic step in the evaluation of an autoimmune disease of the nervous system.
- Identify an appropriate target for biopsy of the central or peripheral nervous system in patients in whom it is an appropriate next step.
- Participate in a multidisciplinary pathologic review of a biopsy specimen of the nervous system.
- Identify those patients for whom biopsy is not feasible or appropriate and initiate a systematic empiric treatment regimen with an associated plan for interval clinical and diagnostic follow up.
- Initiate disease-specific treatment regimens in patients for whom an autoimmune disease of the nervous system has been confirmed, in conjunction with an associated plan for interval clinical and diagnostic follow up.
- Anticipate, recognize, and manage symptoms and complications of autoimmune neurologic diseases.
- Communicate with patients and families to explain the indications, benefits, and potential adverse effects of tests and treatments relevant to their autoimmune neurologic disease.
- Counsel patients on the pathophysiology and prognosis of their autoimmune neurologic disease.

Attitudes

Neurohospitalists should be able to:

- Recognize and accept the diagnostic uncertainty that arises in the management of autoimmune disease of the nervous system.
- Maintain humility and re-explore diagnostic possibilities in patients for whom the disease course is not proceeding as expected, including considering alternative disease categories such as infection, neoplasm, or genetic conditions.
- Respect and appreciate the value in direct and collaborative pathologic review of biopsy specimens of the nervous system in a multidisciplinary manner.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Support the generation and maintenance of robust referral networks that facilitate transfer of patients to hospitals capable of providing higher level-of-care services for patients with autoimmune diseases of the nervous system, including brain biopsy.

Reference

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10.0 Acute Disorders of the Vestibular System

Dizziness is a common complaint of patients presenting to the emergency department, and vestibular disorders are one of the many causes. Neurohospitalists provide valuable evaluations of these patients in identifying both the more common causes of dizziness and vertigo, along with the dangerous. While stroke is a rare cause of isolated vertigo in the emergency room, it is common for patients to receive neuroimaging due to concern for stroke. Neurohospitalists should partner with emergency room providers to perform comprehensive clinical evaluations to allow for cost-effective medicine while still ensuring neurovascular events are appropriately recognized.

Knowledge

Neurohospitalists should be able to:

- Describe and recognize the common disorders of the peripheral vestibular system, including benign paroxysmal peripheral vertigo, acute unilateral peripheral vestibulopathy (vestibular neuritis), and Meniere's disease.
- Describe and recognize disorders of the central vestibular system, including stroke, multiple sclerosis, and vestibular migraine.
- Identify mimics of vestibular disorders such as orthostatic hypotension, cardiac arrhythmias, medication effect, and panic attacks.
- Recognize red flag features that may indicate an urgent process is ongoing, such as stroke, bacterial labyrinthitis, or a cardiac arrhythmia.
- Understand indications for vestibular suppressants, anti-inflammatories, and antiviral medications for vestibular disorders.
- List elements of a diagnostic workup for patients with vertigo and dizziness, and recognize when diagnostic imaging is indicated.

Skills

Neurohospitalists should be able to:

- Elicit a thorough history for symptoms typical of vestibular disorders and their mimics, including the description of the dizziness, patient risk factors, symptom timing, onset, duration, triggers, recurrence patterns, and other associated symptoms with particular attention toward symptoms of brainstem dysfunction.
- Perform physical exam maneuvers as appropriate that will help differentiate between the types of vestibular disorders, including, but not limited to, head impulse testing, test of skew, Dix-Hallpike Maneuver, and otologic examination.
- Perform otolith repositioning maneuvers in appropriate situations, such as the Epley and half-somersault, or collaborate with physical therapy to perform these maneuvers, and educate patients on how to perform them independently.
- Obtain neuroimaging in patients with high-risk features for central or structural etiology.
- Prescribe appropriate medications for the patient's diagnosis, if indicated.
- Recommend vestibular rehabilitation services when appropriate.
- Counsel patients regarding the etiology, treatment, and prognosis of vestibular disorders.

Attitudes

Neurohospitalists should be able to:

- Accept primary responsibility for differentiation of peripheral and central causes of vertigo using a neurologic history and examination.
- Act as a steward for appropriate resource utilization in the emergency department in the evaluation of patients presenting with dizziness.

System Organization and Improvement

To improve safety and quality within their organizations, neurohospitalists should:

- Create protocols to determine the appropriate use of advanced neuroimaging in patients with vestibular disorders.

References

1. Fife TD. Approach to the history and evaluation of vertigo and dizziness. Continuum (Minneap Minn). 2021;27(2):306-329. doi:10.1212/CON.0000000000000938

2. Strupp M, Mandalà M, López-Escámez JA. Peripheral vestibular disorders: an update. Curr Opin Neurol. 2019; 32(1):165-173. doi:10.1097/WCO.0000000000000649

11.0 Traumatic Injuries to the Nervous System Background

Traumatic injuries to the nervous system are a frequent occurrence, with traumatic brain injury alone affecting an estimated 69 million individuals worldwide per year.[1] Such injuries can refer to damage done to the central nervous system (CNS) including brain and spinal cord injuries, but trauma can also affect the peripheral nervous system (PNS). Brain injury medicine is an important subspecialty within neurology as well as rehabilitation medicine, requiring a multidisciplinary approach to the patient.

11.1 Traumatic Brain Injuries (TBI)

TBIs are defined as an "alteration in brain function, or other evidence of brain pathology, caused by an external force,"[2] and can result in a variety of pathologies, including intracranial hemorrhages, diffuse axonal injury, concussions, and penetrating brain injury.

Knowledge

Neurohospitalists should be able to:

- List frequent comorbid conditions that can lead to a TBI, such as substance abuse disorder and disorders resulting in impaired balance.
- Describe the patient's level of impairment of consciousness using the Glasgow Coma Scale (GCS) to assign severity of TBI.
- List attributes of the event and clinical presentation that increase the risk of brain injury.
- Describe the pathophysiology of diffuse axonal injury (DAI).
- Be familiar with signs of elevated intracranial pressure and the indications for interventions.
- Describe when electroencephalogram (EEG) monitoring is indicated.
- Describe indications for prophylactic initiation of antiepileptic medications to prevent post-traumatic seizures, along with their duration of treatment.
- Understand duration of antiepileptic therapy if a seizure occurs during the hospitalization.
- Be familiar with local anticoagulation reversal policies.
- Assist with identifying appropriate indications for and timing of restarting anticoagulation after TBI.
- List common complications of TBI.
- Understand when palliative care services are indicated.
- Understand the current evidence-based recommendations for return to school, work, and sports.
- Recognize which patients may benefit from neuropsychological referral for cognitive evaluation.
- Be familiar with local rehabilitation services, both inpatient and outpatient, for patients with TBI.

Skills

Neurohospitalists should be able to:

- Elicit a comprehensive history about the injury in an expedited fashion.
- Be able to independently assess neuroimaging studies for signs of intracranial hemorrhage, cerebral edema, and signs of axonal injury.
- Appropriately triage TBI patients to the correct level of care, and recognize when escalation of care is needed.
- Identify when neurosurgical intervention may be indicated and communicate with the neurosurgical team accordingly.
- Utilize hospital algorithms for the appropriate reversal of anticoagulation in TBI patients on anticoagulation who present with intracerebral hemorrhage, and assess if and when resuming anticoagulation may be safe.
- Treat agitation related to TBI, using pharmacological and non-pharmacological approaches.
- Treat associated complications of TBI, such as electrolyte abnormalities (diabetes insipidus, syndrome of inappropriate antidiuretic hormone secretion (SIADH)), or the treatment of TBI (such as sunken flap syndrome after hemicraniectomy).
- Communicate with families in a manner that builds trust and maintains compassion.
- Work collaboratively with multidisciplinary teams in order to develop a comprehensive treatment plan.
- Obtain timely assistance from the trauma and neurointensive care teams when appropriate.
- Clearly communicate likely prognosis with consulting teams and families.
- Identify risk factors that lead to TBI and counsel patients accordingly regarding the prevention of "second hit syndrome."
- Approximate when return to usual activities can occur, and communicate these recommendations to patients and their families.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based guidelines in the treatment of TBI.
- Work collaboratively in multidisciplinary teams to coordinate care in an efficient manner.

System Organization and Improvement

To improve efficiency and quality within their organization, neurohospitalists should:

- Create care pathways in a multidisciplinary fashion with the goal of ensuring equitable care.
- Collaborate with other institutions within the healthcare system to optimize the triage and appropriate transfer of patients with TBI as indicated.

11.2 Traumatic Spinal Cord Injuries (SCIs)

Traumatic Injuries to the spinal cord can result in a varying degree of disability and impairment, depending on the severity of the injury (complete vs. incomplete) and the level of the injury. The majority of SCIs occur in younger males and are mainly due to motor vehicle accidents, followed by falls.[4] According to the National Spinal Cord Injury Statistical Center, in the US, SCIs are estimated to occur at an annual rate of approximately 54 cases per 1 million people.[5]

Knowledge

Neurohospitalists should be able to:

- Be familiar with the acute care of SCI, in conjunction with other disciplines, as it pertains to respiratory treatment, neurogenic shock, prevention of thromboembolism, etc.
- Be able to list common complications that can occur after SCI, such as autonomic dysreflexia, neurogenic bladder and bowel, pressure injuries, spasticity, and impaired sexual function.
- Be aware that SCIs are frequently associated with TBIs and know how to screen for coexisting TBI.
- Know that avoiding hypotension leads to improved outcomes.
- Know the importance of pain management for the patient with SCI.
- Prognosticate an expected level of function after SCI.
- Ensure the patient receives the appropriate level of rehabilitation after SCI.
- Be familiar with chronic medical complications of SCI, such as accelerated atherosclerosis, neurogenic obesity, and insulin resistance.

Skills

Neurohospitalists should be able to:

- Recognize the clinical presentation of common SCI Syndromes (Brown Séquard Syndrome, Central Cord Syndrome, Anterior and Posterior Cord Syndrome).
- Assess the motor and sensory levels of SCI and perform a neurological exam despite immobilization or precautionary devices in place.
- Assess the level of completeness of SCI (ASIA scale).
- Obtain timely assistance of other services and disciplines as needed to appropriately care for the patient.
- Recommend appropriate bowel and bladder regimens for dysfunction.
- Weigh risks and benefits of early deep vein thrombosis (DVT) prophylaxis with heparin or recommend sequential compression devices.
- Clearly communicate prognosis and possible treatment pathways with other service lines, when acting as a consultant.

Attitudes

Neurohospitalists should be able to:

- Encourage the patient to discuss issues associated with SCI such as bladder, bowel, and sexual dysfunction.
- Have an open and encouraging demeanor allowing the patient to discuss emotional problems following their SCI.
- Work collaboratively in multidisciplinary teams addressing the best acute and chronic management for the patient, including rehabilitation services.
- Focus on the patient in a holistic manner, as SCI can affect every aspect of a patient's life.
- Be a resource for other professionals to problem-solve clinical challenges surrounding the SCI.

11.3 Traumatic Injuries to the Peripheral Nervous System (PNS)

Traumatic Injuries to the PNS can result in loss of function and be associated with significant debility as well as long lasting pain. Nerve injuries can be classified into three categories:

- Neurapraxia refers to a reduction in conduction velocity caused by focal demyelination due to mild compression or traction of the nerve. The axons and connective tissues however remain intact in neurapraxia.
- Axonotmesis refers to damage to the axon combined with focal demyelination, with the structure of the nerve still being intact.
- Neurotmesis is the most severe form of nerve injury referring to damage of the myelin, axon and nerve connective tissue, resulting in discontinuity of the nerve.[6]

Knowledge

Neurohospitalists should be able to:

- Know the anatomy of the PNS.
- Using their knowledge about the anatomy of the PNS, localize traumatic injuries to the plexus, root, or peripheral nerve.

- Understand the pathophysiology of nerve injury including Wallerian Degeneration.
- Know the basics of electromyography (EMG) and nerve conduction studies in order to understand an EMG interpretation.
- Know the conservative and surgical treatment options for radiculopathy and be able to assist in the selection of the most appropriate course of treatment.

Skills

Neurohospitalists should be able to:

- Localize an injury within the PNS based on a neurological exam.
- Understand the classification of nerve injuries and the prognosis of each respective stage.
- Prescribe appropriate pain medications or consult pain specialists as appropriate.
- Obtain appropriate imaging or electrodiagnostic studies as indicated.
- Collaborate with neurosurgical colleagues if a surgical intervention is indicated.

Attitudes

Neurohospitalists should be able to:

- Maintain vigilance in recognition of a possible injury to the PNS in a patient with multi-trauma.
- Work collaboratively in multidisciplinary teams addressing the best acute and chronic management for the patient, including rehabilitation services.
- Be a resource for other professionals to problem-solve clinical challenges surrounding the PNS injury.
- Understand that PNS can result in long lasting impairment of function and inability to return to work and counsel the patient accordingly.

System Organization and Improvement

To improve quality of care for the patient with injuries to the PNS in their respective healthcare organization, neurohospitalists should:

- Collaborate with outpatient colleagues to obtain inpatient EMG when appropriate.

References

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2. Menon DK, Schwab K, Wright DW, Maas AI; Demographics and Clinical Assessment Working Group of the International and Interagency Initiative toward Common Data Elements for Research on Traumatic Brain Injury and Psychological Health. Position statement: definition of traumatic brain injury. Arch Phys Med Rehabil. 2010;91(11):1637-1640. doi: 10.1016/j.apmr.2010.05.017
3. Capizzi A, Woo J, Verduzco-Gutierrez M. Traumatic brain injury: an overview of epidemiology, pathophysiology, and medical management. Med Clin North Am. 2020;104(2):213-238. doi:10.1016/j.mcna.2019.11.001
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6. Menorca RM, Fussell TS, Elfar JC. Nerve physiology: mechanisms of injury and recovery. Hand Clin. 2013; 29(3):317-330. doi:10.1016/j.hcl.2013.04.002

12.0 Neurologic Conditions Specific to Reproduction, Sex, and Gender

12.1 Neurologic Disease and Reproduction

There is a growing body of knowledge about the influence of sex and sex hormones on patients with neurologic disease throughout their reproductive years. Neurohospitalists must understand sex-related risk factors for neurologic conditions and hormonal interactions with commonly prescribed medications for neurological conditions. It is important for neurohospitalists to be part of a team of physicians who can effectively counsel and support patients in selecting appropriate medications for their conditions based on their reproductive goals.

Knowledge

Neurohospitalists should be able to:

- Be familiar with sex-related incidence in various neurologic conditions.
- Recognize risks of contraception options in patients with migraine with aura, tobacco use, history of clotting disorder, or ischemic stroke.
- Anticipate patients' seizure frequency may be associated with reproductive hormone changes.
- Identify interactions with hormonal birth control with commonly prescribed neurologic medications, particularly in the treatment of epilepsy.
- Recognize the relationship between meningiomas and exogenous sex hormones.

- Identify the symptoms of pituitary adenoma and pituitary apoplexy.
- Anticipate the risk of gonadotoxic effects of certain immunosuppressants commonly given in the inpatient setting, including cyclophosphamide, and provide appropriate counseling, along with consultation to reproductive endocrinology when available.
- Identify neurologic conditions which may be hereditary.

Skills

Neurohospitalists should be able to:

- Counsel patients capable of childbearing on the teratogenicity of their medication for their neurologic conditions when applicable, along with the use of high efficacy birth control.
- Counsel patients on possible medication interactions between their neurologic treatment and hormonal therapy.

Attitudes

Neurohospitalists should be able to:

- Direct neurologic aspects of care for inpatients hospitalized for reproductive reasons.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Collaborate with multidisciplinary colleagues, including primary care providers, obstetrician gynecologists, maternal fetal medicine specialists, and anesthesiologists when appropriate in the management of care of inpatients with neurologic disease and reproductive issues.

References

1. O'Neal, MA. (Neurology and Psychiatry of Women: A Guide to Gender-based Issues in Evaluation, Diagnosis, and Treatment. 1st ed. . Springer International Publishing; 2019
2. Toscano M, Thornburg LL. Neurological diseases in pregnancy. Curr Opin Obstet Gynecol. 2019;31(2):97-109. doi:10.1097/GCO.0000000000000525

12.2 Pregnancy, Delivery and Postpartum

Pregnancy results in physiologic changes that can influence chronic neurologic conditions as well as alter risks for other diseases. The neurohospitalist should be aware of the basic pregnancy-related terminology, as well as changes that occur during pregnancy and delivery that may impact neurologic conditions. Neurohospitalists should also be knowledgeable in the diagnosis and management of unique life-threatening conditions in the peripartum period including preeclampsia and eclampsia. Additionally awareness of medication effects in pregnancy and lactation is critical to safely counsel patients.

Knowledge

Neurohospitalists should be able to:

- Understand essential reproductive terminology and appreciate the reproductive context in which inpatient neurologic issues may arise pertaining to the peripartum period.
- Identify the risk of gadolinium to the fetus in pregnancy.
- List neurologic medications that may need dose adjustments during pregnancy.
- Identify neurologic risks associated with delivery, particularly high risk situations such as spinal cord injury patients.
- Recognize increased risk of stroke and cerebral venous sinus thrombosis in pregnancy and in postpartum patients.
- Describe current guidelines regarding receipt of intravenous thrombolysis or endovascular thrombectomy in pregnant patients with stroke.
- Consider possible neurologic medication interactions with medical abortion treatments.
- Recognize the risk for neurological emergencies as pertaining to their timing relative to delivery, including the potential for occurrence in the postpartum period.

Skills

Neurohospitalists should be able to:

- Perform a risk assessment of neurologic treatment options in a pregnant patient.
- Engage in risk-benefit discussions on neurologic medication use during pregnancy.
- Recognize and minimize the risk associated with ionizing radiation of computed tomography (CT) scans in pregnancy and weigh this against potential need such as in the need for CT in a pregnant patient with an acute neurologic presentation.
- Appropriately monitor drug levels (particularly antiseizure medication levels) that change during pregnancy.
- Collaborate with obstetrical providers regarding the use of antiplatelet and anticoagulation medications surrounding delivery in patients with neurologic indications for these medications.

- Assess the neurologic risks of valsalva and the potential need for assisted delivery.
- Contribute to a multidisciplinary discussion of candidacy for neuraxial anesthesia for delivery in patients with neurologic disease.
- Identify and assist in the treatment of patients with neurologic symptoms in the setting of pre-eclampsia/eclampsia.
- Provide appropriate counseling for patients seeking abortion who receive anticoagulation or antiplatelet therapy for neurologic indications.
- Assess for and recognize concerning features of headaches in pregnant women suggestive of sinus venous thrombosis, reversible cerebral vasoconstriction syndrome (RCVS), and preeclampsia.
- Diagnose and recommend treatment in patients with neurologic complications of neuraxial anesthesia.
- Counsel patients on risks and benefits of various neurologic medications in pregnancy and lactation.
- Recognize neurological emergencies throughout pregnancy and the postpartum period.
- Anticipate, diagnose and treat postpartum relapse in multiple sclerosis, myasthenia gravis and other neurologic autoimmune conditions.
- Recognize and treat common peripheral neuropathies in pregnancy and the peripartum period, and identify those patients requiring further imaging.

Attitudes

Neurohospitalists should be able to:

- Have a collaborative conversation regarding the risks and benefit of neurologic imaging in pregnant patients.
- Appreciate the unique medical legal concerns that can arise regarding neurologic complications of pregnancy and the peripartum period and support obstetrical colleagues in the provision of the highest quality and safest neurologic care in this setting.
- Follow evidence-based recommendations and protocols for pregnant patients with stroke, eclampsia, and preeclampsia.

References

1. O'Neal MA. A Review of Women's Neurology. Am J Med. 2018 Jul;131(7):735-744. doi: 10.1016/j.amjmed.2017.11.053.
2. O'Neal MA, Lewis SL. Neurology of pregnancy. Continuum (Minneap Minn). 2022 Feb 1;28(1).

12.3 Women's Health and Aging

The structure and function of the brain is influenced by sex hormone changes during menopause. Hormonal changes have been implicated in a number of sex differences in neurologic disease including Alzheimer's disease. The neurohospitalist should recognize how hormonal changes in older patients may influence neurologic disease.

Knowledge

Neurohospitalists should be able to:

- Define menopause and list common sleep and mood related changes.
- Identify neurologic risks of postmenopausal hormone replacement therapy including stroke.
- Consider sex-related differences in head injury from falls.

Skills

Neurohospitalists should be able to:

- Assess for menopause and hormone therapies when relevant.
- Anticipate the risks to bone health of certain medications, including chronic oral steroids and some antiseizure medications, and consider the need for prophylaxis to reduce risk of osteoporosis, including bisphosphonates, calcium, and vitamin D.

References

1. Tasić T, Tadić M, Lozić M. Hypertension in Women. Front Cardiovasc Med. 2022;9:905504. Published 2022 Jun 3. doi: 10.3389/fcvm.2022.905504.
2. Henderson VW. The neurology of menopause. Neurologist. 2006;12(3):149-59. doi: 10.1097/01.nrl.0000215750.52786.b1.

12.4 Sexual and Gender Minorities

More rigorous research is needed to characterize the neurologic health needs of sexual and gender minority individuals. Understanding specific needs of this population is necessary to provide high quality care for their neurologic illnesses.

Knowledge

Neurohospitalists should be able to:

- Define gender identity, sex assigned at birth, sexual orientation, and gender expression.
- Recognize conditions in which gender minorities may experience greater risk and identify possible contributing factors.
- Identify how social determinants of health may influence hospitalization and care.
- Recognize how exogenous estrogen may influence migraine and seizure frequency, along with stroke risk.

- Recognize how exogenous testosterone may increase the risk of hyperlipidemia and erythropoiesis, and also affect thyroid function.
- Know the importance of not just stopping gender affirming hormone treatment and consider alternative options such as transdermal estrogen.
- Consult providers familiar with transgender care when needed.

Skills

Neurohospitalists should be able to:

- Use gender-neutral, patient-first terminology.
- Elicit and use correct gender pronouns for patients.
- Promote a clinical environment that is inclusive of patients of sexual and gender minorities and supportive of their authentic self.
- Gather a medication-use history in patients of sexual and gender minorities, including use of gender-affirming therapy, consider potential interactions with neurologic medications, and counsel patients about any associated risks.
- Recognize barriers to follow-up care for patients of sexual and gender minorities and work with multidisciplinary hospital staff accordingly to develop transition-of-care plans.

Attitudes

Neurohospitalists should be able to:

- Employ an early and multidisciplinary approach to the care of patients who are gender and sexual minorities that begins at admission and continues through all care transitions.
- Accept the existence of their own biases as they relate to patients who are gender and sexual minorities and strive to identify and address them.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Recognize elements of the inpatient clinical environment that are discriminatory and/or inequitable toward patients of sex and gender minorities and identify interventions to address these elements.

References

1. Rosendale N. Social determinants of health in neurology. Neurol Clin. 2022;40(1):231-247. doi:10.1016/j.ncl.2021.08.012
2. Rosendale N, Josephson SA. The importance of lesbian, gay, bisexual, and transgender health in neurology: what's in a name? JAMA Neurol. 2015;72(8):855–856. doi:10.1001/jamaneurol.2015.0226

13.0 Perioperative and Transplant Neurology

13.1 Perioperative General Neurology

Neurological conditions have a lifetime prevalence of approximately 6%,[1] with the incidence increasing with age-associated conditions such as neurodegenerative and cerebrovascular disease. The risk of mortality with elective surgery is approximately 1.3% in those under the age of 60, drastically increasing to 11.3% in those over 80 years old.[2] Optimal preoperative evaluation and perioperative management is essential to prevent avoidable morbidity and mortality. The neurohospitalist must be proficient at recommending presurgical testing, optimizing long term medications, recommending use or avoidance of perioperative medications, and counseling the neurological patient and surgical team on potential adverse neurological complications from surgery.

Knowledge

Neurohospitalists should be able to:

- Describe neurological disease-specific perioperative and postoperative risks.
- Identify modifiable and nonmodifiable risk factors which increase neurological perioperative risk.
- Recognize that many neurological disorders increase the risk of delirium in perioperative patients.
- Know the perioperative strategies for minimizing adverse outcomes in patients with neuromuscular disease.
- Understand the diagnosis and management of neuromuscular conditions associated with surgery.
- Identify and manage operative patients at risk for seizures.
- Know the interactions of medications used for neurological diseases with perioperative anesthesia, antibiotics, and pain medications, especially those known to exacerbate some neurological diseases.
- Recognize whether medications used for neurological conditions should be continued or held, and the timing to restart therapy in the perioperative period.
- Be familiar with diagnosis and management of perioperative compressive or ischemic neuropathies.
- Be familiar with diagnosis and management of postsurgical inflammatory neuropathies and plexopathies.
- Be familiar with the presentation of malignant hyperthermia syndrome.

Skills

Neurohospitalists should be able to:

- Assess hospitalized patients to determine the perioperative management of both neurologic medications and devices, along with the risk of adverse effects when discontinued or turned off.

- Counsel surgical team and nursing staff on importance of timing of medication administration in conditions such as Parkinson's disease.
- Identify those at high risk for perioperative complications including respiratory compromise or aspiration and arrange for appropriate monitoring and therapy (e.g. NIF/VC and use of NIV).
- Initiate acute treatment for disease exacerbation when indicated.
- Assist in the management of malignant hyperthermia syndrome.

Attitudes

Neurohospitalists should be able to:

- Follow neurological disease-specific evidence-based recommendations, protocols, and risk stratification tools for reducing perioperative complications.
- Work collaboratively with the surgical team, anesthesia team, and ancillary care team to prevent, monitor, identify, and treat those experiencing perioperative neurologic complications.

References

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13.2 Perioperative Stroke

Perioperative stroke is stroke that occurs during or within 30 days of surgery, and occurs at an incidence of 0.1-1% in non-cardiac, non-neurological operations. There are over 25,000 perioperative strokes in the U.S. annually, which is associated with significant poor health outcomes, including higher 30-day mortality, increased length of stay, and an increased risk of discharge to a long term care facility. The neurohospitalist must be able to optimize perioperative stroke risks, and identify and treat those who experience a perioperative stroke.

Knowledge

Neurohospitalists should be able to:

- Know how to calculate the indirect risk of perioperative stroke using AHA/ASA recommended tools, such as the ACS surgical risk calculator.
- Describe the potential mechanisms and etiology of perioperative stroke.
- Describe risk factors for perioperative stroke, including patient factors and surgical considerations (emergent vs elective and procedure type).
- Know the current AHA/ASA recommendations for timing of elective surgery after stroke, especially in patients with endocarditis.
- Be familiar with the perioperative management of symptomatic and asymptomatic high grade extracranial carotid artery stenosis, including indications for preoperative carotid artery stenosis screening, carotid revascularization options, and timing of intervention in relation to the planned surgery.
- Know how to quantify the risk of thromboembolism and bleeding in patients on antithrombotics or anticoagulants.
- Describe intraoperative management strategies to reduce stroke risk, including blood pressure management, transfusion threshold, and ventilation strategy.

Skills

Neurohospitalists should be able to:

- Perform a comprehensive cerebrovascular history that includes active symptoms of cerebrovascular ischemia, prior stroke/transient ischemic attack (TIA) etiology along with etiologic testing performed, and the current management of the patient's stroke risk factors.
- Document and communicate patient risk factors for perioperative stroke and recommended testing to the surgical team.
- Assist the surgical team in choosing appropriate perioperative management of antithrombotic and anticoagulation to reduce risk of perioperative stroke.
- Diagnose patients who experienced periprocedural stroke and provide acute and/or subacute stroke intervention and management, including etiologic evaluation and risk factor management.

Attitudes

Neurohospitalists should be able to:

- Employ risk stratification tools and follow guideline recommended management to reduce risk of perioperative stroke.
- Use a just culture mindset (a process where mistakes or errors do not result in automatic punishment, but rather a process to uncover the source of the error) when discussing postoperative stroke assessment and treatment to the surgical team.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead and assist in developing protocols for rapid evaluation of patients in perioperative spaces, including the post anesthesia care unit (PACU), with symptoms concerning for acute stroke.

References

1. Benesch C, Glance LG, Derdeyn CP, et al. Perioperative neurological evaluation and management to lower the risk of acute stroke in patients undergoing noncardiac, nonneurological surgery: a scientific statement from the American Heart Association/American Stroke Association. Circulation. 2021;143(19):e923-e946. doi:10.1161/CIR.0000000000000968
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13.3 Transplant Neurology

Ongoing advances in solid organ transplantation and stem cell transplantation have dramatically improved the survival of patients with end organ failure and hematopoietic disorders. Transplant recipients experience neurologic complications in 30% of cases.[1] Therefore, it is essential for the neurohospitalist to be adept at diagnosing and managing neurologic complications in the acute and chronic transplantation periods.

Knowledge

Neurohospitalists should be able to:

- Describe organ transplant specific neurological complications (e.g. liver transplant and osmotic demyelination syndrome or hyperammonemic encephalopathy).
- Describe the different neurologic complications in the acute and chronic periods after transplantation.
- Describe the neurotoxicities of antirejection medication, including the evaluation and diagnosis of drug neurotoxicity, and treatment options.
- Describe the common opportunistic infections affecting the central and peripheral nervous systems, the appropriate diagnostic testing, and the initial broad spectrum antimicrobial coverage.
- Know the nervous system infections common to transplant type.
- Describe and recognize the presentation of central nervous system (CNS) immune reconstitution inflammatory syndrome (IRIS) and treatment options.
- Describe the nervous system presentations of post-transplantation lymphoproliferative disease (PTLD).

Skills

Neurohospitalists should be able to:

- Recognize the signs concerning for central or peripheral nervous system infection in the immunocompromised transplant patient and initiate proper diagnostic evaluation.
- Diagnose the most likely cause of CNS lesions in post-transplant patients by clinical presentation, examination, and interpretation of diagnostic testing.
- Identify transplant patients experiencing neurotoxicity from treatment of the underlying disease or from anti rejection medications, and discuss therapeutic options with the transplant team.
- Communicate with patient and family tests and procedures, along with their indications throughout the diagnostic work up.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based recommendations in the diagnosis and treatment of neurological complications in the acute and chronic phase associated with organ and stem cell transplant.
- Work collaboratively with the transplant team and other consulting services to develop a comprehensive care plan in managing neurological complications of transplant.

References

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2. Pruitt AA, Graus F, Rosenfeld MR. Neurological complications of solid organ transplantation. Neurohospitalist. 2013;3(3):152-166. doi:10.1177/1941874412466090

14.0 Functional Neurological Disorders

Background

Functional neurologic disorders (FND) are highly prevalent and frequently encountered in inpatient and outpatient clinical settings, with population studies estimating 50-100 cases per 100,000.[1] FND presentations commonly encountered in the inpatient setting include psychogenic non-epileptic seizures (PNES), functional weakness, functional movement disorders, and persistent postural perceptual dizziness (PPPD).

In an economic evaluation using three large US health care databases reviewing data from 2008-2017, functional neurologic

disorders were found to account for 0.5% of all adult neurology admissions.[2] Patients with FND were more likely to undergo advanced neurologic work-up than patients admitted with other neurologic disorders. In 2017, the annual total inpatient charges for adults with FND was $1,066 million, compared with $1,241 million for anterior horn cell disease. Charges for adult and pediatric emergency department (ED) visits for FND in 2017 were $163 million, compared with $135 million for refractory epilepsy.

Knowledge

Neurohospitalists should be able to:

- Be familiar with the DSM V criteria for the diagnosis of FND.
- Generate an appropriate differential diagnosis and workup for patients presenting with various possible functional neurologic disorders.
- Know the features and exam findings in patients with FND that are helpful in differentiating it from anatomic neurological dysfunction.

Skills

Neurohospitalists should be able to:

- Obtain a history from a patient with possible FND in a thorough and therapeutic manner.
- Perform the neurologic exam and identify inconsistencies that can aid in the diagnosis of FND, including: giveaway weakness, Hoover sign, drift without pronation, co-contraction, and splitting the midline.[1]
- Perform an appropriate workup to exclude alternative diagnoses that would better explain the patient's symptom or deficits.
- Perform an appropriate workup for superimposed other neurologic conditions that could be contributing to functional symptoms.
- Use clear and compassionate communication to deliver the diagnosis of FND to patients, with key skills including (adapted from Stone et al.[3]):
  - Taking the problem seriously
  - Making it clear that there is a diagnosis
  - Demonstrating the rationale for the diagnosis
  - Conveying the potential for reversibility
  - Triaging for further treatment as needed with psychiatry, physical, and occupational therapy
- Understand available treatment options including cognitive behavioral therapy and physical therapy.

Attitudes

Neurohospitalists should be able to:

- Be aware that patients with FND have often been dismissed by other physicians, impacting their healthcare experience.
- Incorporate knowledge of psychosocial biases that may impact their interaction with patients with FND.
- Appreciate that patients may experience FND superimposed upon another neurologic condition and accept responsibility for evaluating for potential additional diagnoses.

System Organization and Improvement

Neurohospitalists should be able to:

- Understand the local and online resources for patients with FND.
- Utilize local multidisciplinary groups for care of patients with FND or assist with creation of these groups.

References

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Section 2: Clinical Interventions and Interpretation of Ancillary Studies

1.0 Determine Death by Neurological Criteria

Brain death is death. Between 2 and 12% of adults and 20% of pediatric patients who are declared dead are declared using brain death criteria. Neurohospitalists are often asked to perform brain death examinations, and the cause of brain death is highly variable. Neurohospitalists must work with all of the medical teams providing care to the patient to ensure that medications have been metabolized, alternative causes of coma are not found, and that the patient's state is irreversible. Neurohospitalists must approach each patient with compassion. Education provided to the patient's family is paramount, as the concept of brain death can be misunderstood and synthesis of complex information during a time of grief is challenging. Coordination surrounding the timing of declaring death is critical, as some patients may be eligible for organ donation, and families may wish to convene to say their goodbyes. Institutions each have their own policies and

procedures surrounding brain death and local laws provide additional regulations; therefore, neurohospitalists must be aware of the criteria for declaration of brain death in their specific institution.

Knowledge

Neurohospitalists should be able to:

- Be familiar with local policies, procedures and laws surrounding brain death. Understand how to access each of these as a reference when presented with specific clinical questions.
- Know medications that can commonly affect physical examinations, and which medications are affected by hepatic dysfunction or renal insufficiency.
- Know common confounders to the brain death examination, such as: body temperature, blood pressure, medications, illicit drugs, and abnormal laboratory values.
- Describe each of the components of the detailed brain death exam, including the difference between spinal and central reflexes.
- Recognize contraindications to apnea testing such as severe obesity and chronic obstructive pulmonary disease.
- Understand when to use ancillary testing (electroencephalogram (EEG), radionuclide cerebral perfusion testing, etc.) to determine brain death.
- Show curiosity in exploring patient's beliefs surrounding brain death, taking into account unique cultural, religious, or ethnic perspectives. If there are language barriers, ensure that high-quality translation services are used to maintain clear communication in the patient's relatives' or legal representative's preferred language.

Skills

Neurohospitalists should be able to:

- Determine alternative pathologies are not causing the patients' clinical presentation.
- Evaluate laboratory values that may influence the physical exam.
- Educate family/legal representatives surrounding the meaning of brain death and the subsequent steps that will occur, such as extubation and cessation of other organ's functions, if the patient is found to be brain dead.
- Recognize appropriate timing of a brain death examination, with consideration of the half lives of medications and illicit substances that can confound the examination, and in coordination with organ donation services and respiratory therapy for apnea testing.
- Perform a brain death examination.
- Proactively identify unsafe conditions for portions of the brain death examination.
- Appropriately use ancillary testing when the institution requires, such as if the apnea test or other portion of the examination cannot be performed.
- Recognize when an ethics, palliative care or other consultation may be beneficial to provide guidance surrounding complex patient presentations and social dynamics.

Attitudes

Neurohospitalists should be able to:

- Employ an early and multidisciplinary approach to patients suspected to meet criteria for brain death.
- Follow evidence-based policy and procedures for determination of brain death.
- Empathetically discuss the patient's clinical state in a way that respects different cultural backgrounds.
- Educate families regarding the meaning of brain death and the implications for the patient.
- Employ a multidisciplinary approach with other providers, such as palliative care, spiritual counselors, and social workers as needed to help with social support and education.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead or participate in the creation of policies and procedures surrounding brain death with multidisciplinary experts.

References

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2. Wijdicks EFM, Varelas PN, Gronseth GS, Greer DM; American Academy of Neurology. Evidence-based guideline update: determining brain death in adults: report of the Quality Standards Subcommittee of the American Academy of Neurology. Neurology 2010; 74(23):1911–1918. doi:10.1212/WNL.0b013e3181e242a8

2.0 Intravenous Thrombolysis

Acute ischemic stroke remains the fifth leading cause of death in the United States, and a major cause of disability.[1] For acute ischemic stroke patients, intravenous (IV) thrombolysis is the only pharmacologic therapy shown to improve outcomes,[2–4] and is strongly time-dependent.[5] However, due to the intricacies of patient selection and rapid pace of the science behind

thrombolytic treatment, guidance from neurologists, either at the bedside or via telehealth, is often sought prior to administration. The neurohospitalist must be intimately familiar with the process of early and rapid acute stroke patient evaluation and thrombolytic treatment decision making.

Knowledge

Neurohospitalists should be able to:

- Be familiar with American Heart Association/American Stroke Association (AHA) Guidelines for the Early Management of Patients with Acute Ischemic Stroke[6]; specifically, sections regarding IV thrombolysis and the rapid changes of the field.
- Know all IV thrombolysis absolute and relative contraindications.[7]
- Describe risks and benefits of IV thrombolysis based on current available evidence.
- Be comfortable using currently available thrombolytic agents, and know which are Food and Drug Administration (FDA) approved for acute ischemic stroke and under what circumstances, along with which are commonly used outside of FDA approval
- Know dosing of currently available thrombolytic agents.
- Understand time-dependent nature of early thrombolysis.
- Describe risks of thrombolytic treatment in stroke mimics.
- Identify appropriate imaging modalities used to aid acute thrombolytic treatment decisions in various clinical scenarios.
- Know blood pressure goals prior-to and during IV thrombolytic treatment, as well as acute management best practices to reach those goals rapidly and safely when needed.
- Know how to manage complications of IV thrombolysis, including hemorrhage and angioedema.
- Know post-thrombolytic treatment monitoring standards.
- Understand stroke center certification-level specific quality metrics/targets and be familiar with accreditation processes if practicing at an accredited center.

Skills

Neurohospitalists should be able to:

- Elicit a focused history from the patient or relevant bystanders to identify and exclude any contraindications to intravenous thrombolysis.
- Perform a rapid and accurate physical examination to evaluate ischemic stroke-related neurologic signs and deficits.
- Accurately perform a National Institutes of Health Stroke Scale (NIHSS).
- Identify stroke mimics.
- Communicate risks and benefits of thrombolytic treatment such that patients and family members can make informed decisions.
- Interpret imaging studies in order to make appropriate thrombolytic treatment decisions.
- Expeditiously make thrombolytic treatment decisions.
- Manage acute severe hypertension rapidly to allow administration of thrombolytics when indicated.
- Manage potential complications of IV thrombolysis including cerebral hemorrhage and angioedema.
- Communicate clearly with emergency medicine or consulting team providers and bedside nurse regarding treatment decisions and acute management before, during, and after thrombolytic administration.
- Document detailed neurologic exam, consent conversation or reasoning/contraindications for not administering thrombolytics, and treatment plans following acute stroke evaluation.
- Ensure appropriate post-thrombolysis monitoring is ordered and patient is admitted/transferred to the appropriate level of care.

Attitudes

Neurohospitalists should be able to:

- Work collaboratively with Emergency Department or consulting team physicians, Advanced Practice Providers (APPs) and bedside nursing staff on acute evaluation and management before, during, and after thrombolytic administration.
- Follow evidence-based best-practices in identifying eligible patients, and treating with thrombolytics within accepted standards.
- Follow institutional protocols and standards for thrombolytic administration and post-treatment monitoring.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary teams to develop and implement protocols to improve efficiency of identification of thrombolytic-eligible patients.
- Lead, coordinate, and/or participate in multidisciplinary teams to identify barriers and system-based delays in the administration of IV thrombolysis, and develop standard work and protocols to minimize or eliminate these barriers and delays.
- Lead, coordinate, and/or participate in multidisciplinary teams to establish institutional standards for post-thrombolysis management and admission level of care commensurate with local practices and abilities.
- Lead, coordinate, and/or participate in detailed data collection efforts for the purposes of acute stroke management

process improvement, as well as quality metric measurement and Stroke Center accreditation process.
- Lead, coordinate, and/or participate in community and regional efforts to coordinate acute stroke systems of care, to improve prehospital stroke identification and appropriate patient routing and transfer processes.

References

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2. Hacke W, Donnan G, Fieschi C, et al. Association of outcome with early stroke treatment: pooled analysis of ATLANTIS, ECASS, and NINDS rt-PA stroke trials. Lancet. 2004;363(9411):768-774. doi:10.1016/S0140-6736(04)15692-4 3. National Institute of Neurological Disorders and Stroke rt-PA Stroke Study Group. Tissue plasminogen activator for acute ischemic stroke. N. Engl. J. Med. 1995;333(24):1581-1587. doi:10.1056/NEJM199512143332401
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3.0 Lumbar Puncture

Lumbar punctures (LPs) are a commonly performed hospital procedure, and the most common invasive procedure performed by neurohospitalists. Therefore, neurohospitalists should be fully aware of the indications and contraindications for LPs, as well as the risks of the procedure. They should also be cognizant of which patients need basic diagnostic studies and which need specialized testing, as many of these tests are costly and have a long turnaround time. As such, neurohospitalists may be consulted not only to perform the procedure, but comment on the diagnostic testing to be ordered.

Knowledge

Neurohospitalists should be able to:

- Describe the indications for LP in the hospital setting, including but not limited to the diagnosis and/or management of central nervous system infection, subarachnoid hemorrhage, demyelinating disease, central nervous system malignancies, idiopathic intracranial hypertension, normal pressure hydrocephalus, and Guillain-Barré Syndrome.
- Explain the risks of the procedure to patients, including but not limited to failure of the procedure, headache, pain at the puncture site, bleeding, infection, damage to spinal nerve roots.
- Recognize which patients may need neuroimaging prior to performing the procedure (to rule out a mass lesion).
- Describe the contraindications to LP (such as: coagulopathy, intracranial mass lesion, presence of epidural abscess/overlying infection, patient refusal).
- Recognize factors which may increase the difficulty of the procedure, including but not limited to increased body habitus, spinal misalignments and deformities, anxiety, and altered mental status.
- Identify patients who may require the procedure under radiologic guidance.
- Identify patients who may require procedural sedation or anesthesia.
- Recognize factors which may increase the risk of post-dural puncture headache, including but not limited to patient anxiety, use of large bore or cutting needle, younger age, pregnancy.
- Identify patients who require large volume cerebrospinal fluid (CSF) removal, either for diagnostic purposes (Tuberculosis testing, cytology/flow cytometry) or therapeutic purposes (idiopathic intracranial hypertension, cryptococcal meningitis).

Skills

Neurohospitalists should be able to:

- Elicit a clear history and perform a complete neurologic examination to determine the indications for the procedure as well as identifying any potential contraindications.
- Identify appropriate anatomical landmarks to guide needle insertion.

- Correctly position the patient to maximize safety and chances of a successful procedure.
- Use ultrasound-guided marking in appropriate patients.
- Set up and maintain a sterile field.
- Perform safe and adequate infiltration of local anesthetic.
- Perform the LP at bedside, under sterile technique.
- Accurately measure opening pressure measurement in all patients unless contraindicated (such as if the patient is in upright position).
- Measure closing pressure in patients who may benefit from repeat procedure, including but not limited to idiopathic intracranial hypertension and cryptococcal meningitis.
- Order and interpret appropriate CSF diagnostic studies based on the patient presentation, identifying those who need more than routine tests, including but not limited to immunologic markers (oligoclonal bands, myelin basic protein, etc.), autoantibody panels, atypical/opportunistic infectious panels, cytology/flow cytometry, etc.
- Synthesize data obtained from the diagnostic studies and correlate with clinical presentation, imaging studies, and any other laboratory or neurophysiologic data, and outline a clear treatment plan.
- Communicate with the patient and nursing staff regarding post-procedural care.
- Diagnose and treat post-LP complications, including post-dural puncture headache.
- Diagnose patients who may benefit from an epidural blood patch.
- Interpret pre- and post-procedural cognitive and gait assessments for patients with suspected normal pressure hydrocephalus (NPH) and identify appropriate candidates for extraventricular shunting/CSF diversion.

Attitudes

Neurohospitalists should be able to:

- Employ a standardized approach to pre-procedural preparation.
- Communicate clearly with patients and families regarding the outline of the procedure, why it is being performed, the potential risks, and the expected aftercare.
- Use a standard LP kit with all the necessary materials.
- Follow organizational guidance on safe performance of LP.
- Follow institutional guidance on procedure performance e.g., pre-procedure time-out and timely and complete documentation of the procedure.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, co-ordinate and/or participate in departmental efforts to reduce post-LP complications, including headache and infection.
- Implement a standardized LP kit, with all necessary components, that is easily accessible to performing physicians.

References

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4.0 Indications and Clinical Correlation of Nervous System Diagnostic Imaging

Computed Tomography (CT)

CT represents the backbone of neuroimaging, with rapid and readily available imaging of the brain and spine. CT is used as initial imaging in a variety of acute neurological conditions, due to rapid acquisition time and as a quickly available resource across a variety of healthcare settings.

Magnetic Resonance Imaging (MRI)

MRI is an imaging modality used to image the brain and spine without radiation. MRI images are derived from the application of various radiofrequency pulse sequences to molecules in the body that are aligned in a strong magnetic field. MRI is more sensitive than CT for the detection of acute ischemic stroke and is often obtained after an initial CT has excluded intracranial hemorrhage.

Ultrasound (US)

technology is used in several ways to assist the neurohospitalist. Carotid US is often used in the evaluation of the stroke patient, particularly to assess for extracranial carotid stenosis. While computed tomography angiography (CTA) and magnetic resonance angiography (MRA) are more commonly used modalities for evaluation of the extracranial vasculature, some patients may not be able to undergo these techniques, and so carotid US continues to be a useful imaging modality. Transcranial doppler studies (TCDs) are used to assess the velocity of blood flow in the proximal intracranial vessels. This is commonly used in the serial

assessment of patients with subarachnoid hemorrhage for evaluation of cerebral vasospasm. TCD can also be used for emboli detection as part of a stroke workup.

Catheter Angiography

Catheter angiography is an invasive technique using contrast dye injected through intra-arterial catheters inserted in the groin, arm, or neck. Catheter angiography is often performed emergently in the management and assessment of acute ischemic stroke, and can be combined with endovascular techniques in treatment of a large vessel occlusion. It is also used in the treatment of patients with ruptured or unruptured cerebral aneurysms, or non-emergently to evaluate for other cerebrovascular disorders such as vasculitis, reversible cerebral vasoconstriction syndrome, arteriovenous fistula or malformation, and other disorders.

Knowledge

Neurohospitalists should be able to:

- Identify key indications for neuroimaging modalities including CT, MRI, US, and catheter angiography.
- Identify key differences in the diagnostic utility of CT and MRI in the assessment of the patient with acute stroke.
- Recognize the key differences in the utility of CTA and MRA in the patient with stroke.
- Discuss risks and benefits of additional radiation incurred through CTA and CT perfusion imaging.
- Be aware of the risks and benefits associated with use of contrast dye in CT and MRI.
- Discuss utility of diagnostic imaging (including the use of intravenous contrast) with the patient, and how this will benefit their neurological evaluation.
- Assess for appropriate timing of imaging in the evaluation of the patient with acute and non-acute neurological disorders.
- Follow evidence-based recommendations and protocols for use of diagnostic imaging in the patient with neurological symptoms.

Skills

Neurohospitalists should be able to:

- Perform basic evaluation and interpretation of CT and MR imaging and provide clinical correlation to the neurological patient.
- Interpret available diagnostic reports of imaging and incorporate these in the treatment plan for the patient.
- Discuss results of diagnostic imaging with patients, as well their families and caregivers, and discuss importance of results with their neurological evaluation.
- Differentiate patterns of neurological disease on diagnostic imaging from benign variation.
- Be aware of limitations of the various diagnostic imaging studies, and differentiate between the utility of various studies for various neurological conditions.

Attitudes

Neurohospitalists should be able to:

- Discuss imaging modality selection and use with colleagues from Radiology as well as other departments to arrive at the best diagnostic plan for the patient.
- Discuss with the patient the risks, benefits, and alternatives of diagnostic imaging modalities during their neurological assessment and plan.
- Discuss and interpret results of diagnostic imaging in a multidisciplinary manner with Radiology, Hospital Medicine, Emergency Medicine, Neurosurgery, etc.
- Work in a multidisciplinary manner with other clinicians to determine appropriate timing of diagnostic imaging studies and evaluation of the neurological patient.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Coordinate with Radiology to implement evidence-based protocols for evaluation for the acute stroke patient.

References

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5.0 Indications and Clinical Correlation of Neurophysiology Studies

Neurophysiology Studies

Clinical neurophysiology is the recording of the generation and propagation of electrical potentials of nerve and muscle cells. The most commonly used neurophysiology studies include Electroencephalogram (EEG), Evoked potentials (EP), Nerve conduction study (NCS) and electromyogram (EMG) . While neurohospitalists are not required to perform or interpret these studies, they are essential in the evaluation and management of disorders commonly managed by neurohospitalists.

5.1 Electroencephalogram (EEG)

EEG records the summation of postsynaptic potentials generated by pyramidal cells in the cerebral cortex.[1] The most important utilization of EEG is to evaluate for epileptic seizures (convulsive or non-convulsive). Continuous EEG monitoring is extremely valuable in identifying non-convulsive seizures and non-epileptic seizures, as there is no other test that can be used to definitively diagnose these conditions. EEG also provides information regarding level of consciousness and degree of brain injury of the patient and may aid in prognosis. Inter-ictal EEG findings such as spikes, sharp waves, and spike waves are helpful in diagnosing patients with epilepsy and for classification and localization of an epilepsy focus. Continuous EEG monitoring is often utilized as part of post cardiac arrest therapeutic hypothermia (TH) protocol because EEG findings remain highly predictive of neurologic outcome after the routine implementation of TH.[2]

Knowledge

Neurohospitalists should be able to:

- Understand evidence based recommendations in regards to the appropriate type of EEG to order.
- Recognize the utility and limitations of EEG studies.
- Understand common nomenclature used in EEG reports.[3]

Skills

Neurohospitalists should be able to:

- Interpret and explain EEG reports to patients, their families, and consulting teams.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based recommendations, protocols, and risk stratification tools for the utilization of EEG in inpatient settings.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary efforts to develop protocols to rapidly identify patients with status epilepticus and seizures who have indications for acute interventions and to minimize time to intervention.

References

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5.2 Nerve Conduction Studies and Electromyography (NCSs/EMG)

For patients presenting with disorders of the peripheral nervous system, NCSs in conjunction with EMG provide invaluable information regarding the state of myelinated nerve fibers and muscles.

Knowledge

Neurohospitalists should be able to:

- Understand evidence based recommendations and protocols in ordering NCS/ EMG studies for evaluation of peripheral nervous system disorders in the inpatient setting.
- Recognize the utility and limitations of NCS/EMG studies, especially in the inpatient setting.
- Localize the lesion/ pathology based on NCS/ EMG studies in conjunction with a history and physical examination.

Skills

Neurohospitalists should be able to:

- Explain EMG results to patients, families, and consulting teams and incorporate the information to develop a treatment plan for the patient.
- Recognize the indications for obtaining an urgent vs outpatient EMG/ NCS.

Attitudes

Neurohospitalists should be able to:

- Employ a multidisciplinary approach to develop a strategic plan for the best utilization of EMG resources in their hospital system.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary efforts to develop protocols to identify patients who need an urgent EMG study in inpatient settings.

References

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5.3 Somatosensory Evoked Potentials (SSEPs)

SSEPs are helpful in the evaluation of lesions along nervous pathways in addition to prognosticating recovery after a cardiac arrest in the appropriate clinical settings.

Knowledge

Neurohospitalists should be able to:

- Understand evidence-based recommendations and protocols in ordering SSEP studies for prognostication in anoxic brain injury patients.
- Recognize the utility and limitations of SSEP studies.
- Understand the origin and significance of common obligatory waveforms and interpeak latencies described in SSEP reports (e.g., EP, N13, N20).

Skills

Neurohospitalists should be able to:

- Interpret and explain the significance of the results of SSEP testing to patients, families, and consulting teams.
- Incorporate the results of SSEP testing, in conjunction with clinical and other data (laboratory, EEG, imaging, etc.) to provide neuroprognostication in patients in the appropriate clinical settings.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based recommendations, protocols, and risk stratification tools for the utilization of SSEPs in the appropriate clinical settings.

Reference

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Section 3: Neurohospitalist Role in the Healthcare System

1.0 Equitable and Inclusive Care

Bias and oppression, both explicit and structural, can impact patients in multiple aspects of their identities, including, but not limited to, race, sex and gender, religious and political beliefs, class/socioeconomic status, and ability. In these competencies, we refer to all these potential disparities broadly, unless we specify otherwise. Neurohospitalists should be aware of healthcare disparities affecting their patient populations and how to effectively combat these inequalities. Examples include disparities in utilization of emergency and inpatient care by patients belonging to racial or ethnic minorities[1] and disparate neurologic care access and outcomes among sex and gender minorities.[2]

Knowledge

Neurohospitalists should be able to:

- Identify the impacts of bias and oppression (explicit or structural) on the outcomes of different neurologic conditions and in different patient populations.3
- Recognize personal bias and countertransference and the potential impact on the patient populations they serve.
- Understand the roles of support services such as social work and language interpreters to optimize patient outcomes during hospitalization and post-discharge.
- Maintain awareness of and respect for evolving standards of inclusive language.

Skills

Neurohospitalists should be able to:

- Mitigate the effects of personal bias in clinical decision making and delivery of patient care.

- Identify disparities within the healthcare system to improve outcomes for patients, families, communities, and members of the healthcare delivery system.
- Practice inclusive listening when encountering patients, regardless of their background.

Attitude

Neurohospitalists should be able to:

- Respect cultural differences in approach to healthcare values and decisions.
- Identify opportunities to improve the healthcare delivery environment to foster a more inclusive healthcare environment.
- Practice moral courage, self-advocacy, and allyship to address injustices.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Engage in efforts to eliminate healthcare disparities in the patient populations they serve.
- Advocate for practices that advance the diversity of the healthcare delivery system.
- Identify opportunities to improve the healthcare delivery environment to foster a more inclusive healthcare environment.
- Provide culturally appropriate resources to patients.

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2.0 Inpatient Perioperative Consultation for Neurologic Patients

2.1 Perioperative Consultation for Stroke

Stroke in the perioperative period is an uncommon but potentially devastating complication for patients undergoing surgery.[1,2,3] While the risk of stroke in the operative setting varies depending on type and extent of the surgical procedure, it can occur in the setting of any surgery, particularly in patients with pre-existing risk factors. Neurohospitalists need to be aware of these risk factors so that they can adequately advise the patient and the surgical team on the potential risks of undergoing treatment and also recommend risk reduction strategies. Additionally, neurohospitalists must be able to promptly diagnose stroke in the postoperative setting, including rapidly identifying patients who are candidates for thrombolytic and/or endovascular treatment.

Knowledge

Neurohospitalists should be able to:

- Know the definition of perioperative stroke.
- Assess the risk of perioperative stroke in individual patients.
- Assess the risk of perioperative stroke associated with specific surgeries.
- Be aware of the role of additional investigations that may be helpful to further delineate perioperative stroke risk.
- Be aware of the risk of and potential impacts of periprocedural silent cerebral infarcts after cardiac surgery.
- Assist with recommendations regarding timing of elective surgery in patients with a recent history of ischemic stroke and/or transient ischemic attack (TIA).
- Recognize which patients need special management of medications in the perioperative setting.
- Identify which patients may need bridging of anticoagulation prior to undergoing surgery.
- Identify patients who may benefit from revascularization procedures prior to surgery.
- Define the risk of perioperative complications for patients with infective endocarditis who require cardiothoracic intervention.

Skills

Neurohospitalists should be able to:

- Obtain a complete history of previous stroke, TIA, or other vascular events, and identify relevant risk factors for ischemic stroke.
- Expeditiously examine patients who present with potential acute ischemic stroke in the post-operative period, and rapidly identify those who may benefit from emergent therapy.
- Expeditiously interpret post-operative imaging studies to determine eligibility for hyperacute ischemic stroke therapies.
- Communicate with anesthesiologists regarding strategies to reduce risk of both ischemic and hemorrhagic stroke.

- Diagnose the most likely mechanism of perioperative ischemic stroke based on patient presentation, imaging characteristics, and the specific risks associated with the procedure.
- Perform risk stratification of ischemic stroke for patients undergoing surgery.
- Interpret vascular imaging of patients with infective endocarditis as part of risk assessment.
- Communicate with the primary team regarding perioperative plans for antithrombotics and/or anticoagulation, such as bridging period and/or when anticoagulation is safe to resume.
- Communicate effectively with patients and family members about the risk of perioperative stroke and whether alternative treatment may be available and/or feasible.
- Document the treatment plan clearly for the patient and primary team, including safety of antithrombotics, timing of initiation, and need for any additional diagnostic tests or secondary prevention measures.

Attitudes

Neurohospitalists should be able to:

- Follow validated risk stratification methods to identify patients at risk for perioperative ischemic stroke.
- Follow institutional and organizational guidelines for the management of perioperative stroke risk for high-risk surgical procedures.
- Follow evidence-based guidance for antithrombotic and anticoagulation management in the perioperative period.
- Recognize when specialty consultation may be needed, including but not limited to Neurocritical Care, Cardiology, Neurosurgery, Cardiothoracic surgery, Interventional Neuroradiology.

System Organization and Management

To improve efficiency and quality within their organizations, neurohospitalists should:

- Coordinate preoperative assessment for high-risk patients with the appropriate teams lead, coordinate, and/or participate in multidisciplinary efforts to promote early recognition of post-operative stroke.

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2.2 Perioperative Consultation for Patients with Epilepsy

Patients with epilepsy are at greater risk for postoperative complications than the general population, including breakthrough seizures as well as medical complications such as stroke and systemic infection. Neurohospitalists should be able to identify patients with epilepsy who are at highest risk of complications and implement measures to mitigate this risk as much as possible.

Knowledge

Neurohospitalists should be able to:

- Define which patients are at highest risk for breakthrough seizure in the perioperative period.
- Identify which patients may need closer monitoring of electrolytes, renal function, and anti-seizure drug levels.
- Know which anesthetic agents may lower the seizure threshold and which may be relatively protective against seizures.
- Identify patients who may be at risk of acute symptomatic seizures due to metabolic derangements in specific surgical procedures (e.g., hypocalcemia after thyroid/parathyroid surgery, hyponatremia after intracranial or urological procedures etc.).

Skills

Neurohospitalists should be able to:

- Elicit a complete history of epilepsy including recent seizure control, medication intolerances, and prior experiences with anesthesia.
- Recommend alternative anti-seizure regimens and/or formulations as needed during the perioperative
- Clearly document the plan for anti-seizure medications for epileptic patients, including dose changes, formulation, and timing.
- Identify and optimize modifiable factors prior to surgery to reduce the risk of breakthrough seizure, including but not limited to sleep disturbance, delays in medication administration, and fasting periods.

- Promptly diagnose and treat breakthrough seizures and/or status epilepticus in the perioperative setting.
- Diagnose seizure mimics in the post-operative period, such as shivering and myoclonus.
- Clearly communicate the treatment plan with the patient, surgical team, and other staff to ensure minimal interruptions to anti-seizure medications.

Attitudes

Neurohospitalists should be able to:

- Employ evidence-based measures and clear communication skills regarding the use of anti-seizure medication in the perioperative setting.

Systems Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Coordinate with the primary surgical team regarding efforts to reduce the risk of breakthrough seizures in epileptic patients requiring surgery.
- Collaborate with surgeons, anesthesiologists, and other key stakeholders to create general guidelines for the continuation of anti-seizure medications in the perioperative setting.

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2.3 Perioperative Consultation for Patients with Existing or Neuromuscular Conditions

Patients with neuromuscular disease, particularly those with ventilatory dysfunction, may be at elevated risk for perioperative complications. Neurohospitalists are vital in the assessment of these patients and are positioned to advise on risk reduction strategies. Neurohospitalists are also vital in the diagnosis of postoperative neuromuscular weakness, respiratory failure, or compressive neuropathy.

Knowledge

Neurohospitalists should be able to:

- Identify patients with neuromuscular disease who may require specific ventilation parameters in the perioperative setting.
- Identify patients with neuromuscular disease who may require measurement of pulmonary function prior to undergoing surgery.
- Identify patients with neuromuscular disease who may require preoperative cardiac testing and/or monitoring for arrhythmia.
- Identify which patients may require medication adjustment or other treatments prior to surgery.
- Describe which anesthetic medications are safe to use for patients with myasthenia gravis and which should be avoided.
- Explain which postoperative medications can precipitate myasthenic crisis and should therefore be avoided.
- Identify patients at risk of compressive mononeuropathy in the intraoperative period.
- Recognize that patients without a prior diagnosis of neuromuscular disease may have manifestations in the postoperative setting.

Skills

Neurohospitalists should be able to:

- Monitor and treat perioperative clinical deterioration in patients with known neuromuscular disorders.
- Evaluate, diagnose, and treat new-onset neuromuscular disorders in postoperative patients.

Attitudes

Neurohospitalists should be able to:

- Employ a systematic and evidence-based approach to the management of neuromuscular disorders in the perioperative setting.
- Employ evidence-based risk assessment, based on clinical history and pulmonary function testing, to predict the need for postoperative mechanical ventilation requirements.
- Employ judicious use of diagnostic testing in the postoperative period through appropriate patient selection.
- Collaborate with neuromuscular specialists in the care of patients with known and emergent neuromuscular conditions.

Systems Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Implement clear guidance on medications to avoid in patients with myasthenia gravis.
- Implement evidence-based guidelines for the perioperative management of patients with neuromuscular disease, including which patients should have

pulmonary function testing and which patients require specialized ventilation strategies.
- Lead, coordinate and/or participate in multidisciplinary efforts to reduce length of stay in patients requiring ventilator support for neuromuscular disease.
- Coordinate multidisciplinary efforts to reduce the risks of intraoperative nerve injury.
- Ensure effective transitions of care.

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2.4 Perioperative Consultation for Patients with Parkinson Disease

Parkinson disease is a prevalent and disabling condition, with high rates of complications in the perioperative setting related to mobility issues, cognitive and/or psychiatric symptoms, medication management, and autonomic dysfunction. Neurohospitalists work closely with surgical teams to coordinate safe continuation of medications, reduce risk of postoperative complications, and initiate early rehabilitation. Neurohospitalists should also be aware of management of Deep Brain Stimulators in patients undergoing surgery.

Knowledge

Neurohospitalists should be able to:

- Explain the need to continue Parkinson disease medication for as long as possible prior to undergoing surgery and restarting as soon as possible after surgery.
- Describe the correct timing of medications in multiple formulations, including medications administered by feeding tube.
- Know that patients with Parkinson disease are at higher risk of perioperative complications including but not limited to delirium, hallucinosis, post-op infection, urinary retention, falls, and sleep disturbances.
- Know that patients with Parkinson disease may have autonomic dysfunction that can complicate the perioperative course, including but not limited to orthostatic hypotension, urinary dysfunction, dysphagia, and constipation.
- Recognize which Parkinson's medications may contribute to delirium in the perioperative setting.
- Know how Deep Brain Stimulators should be managed for different surgical procedures to reduce the risk of interference with the implanted pulse generator.
- Identify patients who may benefit from a formal swallow evaluation in the perioperative setting.

Skills

Neurohospitalists should be able to:

- Elicit a clear history of severity of Parkinson's disease symptoms, medications used, medication dosing and timing, and prior experiences with surgery, if any.
- Assist with the management of movement abnormalities, orthostatic hypotension, dysphagia, and psychiatric symptoms.
- Document the plan regarding changing, stopping or restarting medications for Parkinson disease, with clear instructions on dosing, formulation, timing, and potential adverse effects.

Attitudes

Neurohospitalists should be able to:

- Employ a systematic and evidence-based approach to prescribing and altering medications for Parkinson disease in the perioperative setting.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate and/or participate in multidisciplinary efforts to reduce post-operative complications for patients with Parkinson disease, including but not limited to aspiration pneumonia, urinary tract infection, and falls.
- Implement guidelines for the management of medications for Parkinson disease in the perioperative setting.
- Lead, coordinate and/or participate in multidisciplinary efforts to promote early mobilization and rehabilitation for post-operative patients with Parkinson disease.
- Ensure effective transitions of care for patients with Parkinson disease.

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3.0 Neuroprognostication

3.1 Central Nervous System Injury

Central nervous system injury can have widely variable outcomes, depending on the mechanism and severity of the insult. Neurohospitalists are often called to offer a prognosis—an attempt to accurately determine if the patient will recover a quality of life in accord with their values and (if available) advance directives[1]. Appropriate neuroprognostication for patients with disorders of consciousness (DoC) after brain injury can inform and empower surrogate decision makers, facilitate goals-of-care discussions, support bedside providers, and has broader implications for health system resource allocation. However, neuroprognostication is fraught with the potential for error due to lack of good data, psychosocial and ethical factors[2]. Accurate prognosis is highly mechanism-dependent; our understanding of the sensitivity and specificity of prognostic tools evolves rapidly; there is subjectivity in the understanding of "good" and "bad" prognosis; and the determination of prognosis can lead to "self-fulfilling prophecy" decision making.[1-5] It is of critical importance for neurohospitalists to apply mechanism-appropriate prognostic tools and understand their implications so they can reliably and effectively counsel caregivers and consulting providers.

Knowledge

Neurohospitalists should be able to:

- Identify different mechanisms of brain injury and the importance of mechanism to prognosis.
- Be familiar with, describe, and appropriately use evolving terminology for states of disordered consciousness.
- Understand the impact that statements about neuroprognostication have on goals of care, versus pre-existing patient directives, physiological futility, and pre-existing comorbid disease states.
- Be familiar with relevant clinical tools and rating scales for assessing disorders of consciousness.
- Be familiar with evolving imaging and clinical neurophysiology studies for assessing DoC (eg. fMRI BOLD, evoked potentials, electroencephalogram (EEG)).
- Describe multimodal neuroprognostication.
- Articulate the differences between neuroprognostication and brain death assessment in technical and non-clinical terms.
- Understand the basis for guidelines recommending against early definitive prognostic statements for brain injury leading to DoC.

Skills

Neurohospitalists should be able to:

- Perform a complete and accurate exam on a comatose patient.
- Interpret structural neuroimaging relevant to brain injury and DoC.
- Interpret EEG reports and findings relevant to brain injury and DoC.
- Identify situations in which advanced functional neuroimaging or clinical neurophysiological studies may provide additional prognostic information in DoC.
- Assemble and articulate multimodal neuroprognostic assessments in technical and non-technical terms.
- Manage and/or assist in managing goals of care discussions for care teams and patient decision makers.
- Demonstrate comfort with expressing clinical ambiguity and a range of potential outcomes to care teams and patient decision makers.
- Partner with patient decision makers to understand patient values regarding quality of life and functional independence.
- Appropriately consult support services, such as palliative care and chaplain services.

Attitudes

Neurohospitalists should be able to:

- Appreciate the ethical implications of neuroprognostication, including the subjectivity of perceived quality of life and the ramifications of self-fulfilling prophecies.
- Follow evidence-based guidelines for prognostication in the setting of DoC.
- Employ a multidisciplinary approach to multimodal neuroprognostication and appreciate the need for clear communication with providers, patient caregivers, and other services when goals of care discussions are indicated.
- Respect cultural differences in the approach to cognitive and physical disability.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in hospital or health-system initiatives to standardize assessments for neuroprognostication in brain injury.
- Coordinate with subspecialty clinical neurophysiology, radiology, and laboratory service lines to ensure, as appropriate, the availability and consistency of studies related to neuroprognostication.
- Lead, coordinate, and/or participate in hospital or health-system ethical support programs to help ensure consistent neurological expertise in these challenging cases.

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3.2 Post-Cardiac Arrest Brain Injury

Post-cardiac arrest brain injury (PACBI) is the result of cascading insults initiated by both circulatory arrest and subsequent reperfusion injury.[1] It is the most common cause of death in patients who obtain return of spontaneous circulation (ROSC) after arrest. It is also the most common cause of long-term disability following cardiac arrest. It bears distinct consideration in discussions of neuroprognostication, in part to its mechanistic homogeneity, ubiquity, and the relatively protocolized nature of cardiac arrest management. The field of PCABI-neuroprognostication is rapidly evolving, with a large body of data for outcomes of disordered consciousness after arrest of highly variable quality.[2-4]

Knowledge

Neurohospitalists should be able to:

- Describe basics of mechanisms of injury due to cardiac arrest (eg. primary hypoxic injury, post-ROSC hypoperfusion, reperfusion injury, intracranial hypertension).
- Describe the impact of temperature management on neurological outcomes.
- Be aware of the effects of hypothermia on the metabolism of some sedating medications, including propofol, which can affect the neurological examination.
- Describe multimodal neuroprognostication specifically for PACBI and identify sources for consensus guidelines and workflows
- Articulate the differences between neuroprognostication and brain death assessment in technical and non-technical terms.
- Describe the timing of various neuroprognostication studies and clinical assessments.
- Recognize the dominant definition of "poor" clinical outcome in neuroprognostic literature for PACBI.
- Identify exam features associated with a poor neurological prognosis in PACBI.
- Identify and describe the strengths and limitations of ancillary testing in PACBI.

Skills

Neurohospitalists should be able to:

- Perform a complete and accurate exam in a comatose patient and identify pertinent clinical findings for PACBI neuroprognostication.
- Identify and describe the strengths and limitations, and interpret the findings of ancillary testing in PACBI.
- Assemble multimodal prognosis for anoxic brain injury utilizing clinical, and as appropriate, clinical neurophysiological imaging, and laboratory findings.
- Articulate the implications of prognostic findings to care teams and patient decision makers.
- Manage or assist with goals of care discussions for patients with poor prognosis in PACBI.
- Appropriately consult support services, such as palliative care and chaplain services.

Attitudes

Neurohospitalists should be able to:

- Appreciate the ethical implications of neuroprognostication in PACBI, including the subjectivity of perceived patient quality of life and the ramifications of self-fulfilling prophecy.
- Follow evidence-based guidelines for multimodal neuroprognostication in PACBI, and appreciate the rapid evolution of neuroprognostication in this field.
- Employ a multidisciplinary approach to multimodal neuroprognostication and appreciate the need for clear communication with providers, patient caregivers, and other services when goals-of-care discussions are indicated.
- Respect cultural differences in the approach to cognitive and physical disability.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in hospital or health-system initiatives to standardize neuroprognostication for PACBI for consistent and ethical guideline-driven care.
- Lead, coordinate, and/or participate in multidisciplinary teams early in the hospital course to coordinate the appropriate timing and interpretation of multimodal prognostic assessments, set appropriate expectations, and compassionately convey results.
- Coordinate with subspecialty clinical neurophysiology, radiology, and laboratory service lines, as appropriate, to ensure the availability and consistency of neuroprognostication studies.

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4.0 Teleneurology

Telemedicine is a rapidly growing field which increases access to healthcare. Telemedicine is a broad term that can be applied to communication via phone or email, review of diagnostic tests and imaging, as well as "face-to face" visits by video. Neurohospitalists' skills may be leveraged via telestroke or teleneurology services to help in place of, or to augment, in-person neurohospitalist or neurologist coverage.[1-2]

Knowledge

Neurohospitalists should be able to:

- Describe the limitations of telemedicine.
- Maintain awareness of the availability of local resources and levels of care available at sites of care.
- Be familiar with the telemedicine equipment provided for the consultation itself.
- Describe the licensure requirements surrounding telemedicine services.
- Be aware of the privacy requirements set forth in the Health Insurance Portability and Accountability Act (HIPAA) and the Health Information Technology for Economic and Clinical Health Act.

Skills

Neurohospitalists should be able to:

- Modify the neurological exam to the limitations of the telemedicine interaction.
- Conduct a focused neurological examination and establish rapport remotely.
- Engage assistants who might participate in the telemedicine visit in order to improve the exam.
- Identify when escalation of care is indicated.
- Provide effective communication with the patient and local care team regarding diagnosis, prognosis, and treatment plan.

Attitudes

Neurohospitalists should be able to:

- Work collaboratively with family members, caregivers, and other health professionals possibly present at the visit to perform a succinct exam and develop comprehensive treatment plans.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Collaborate to develop meaningful outcome measures.
- Actively participate in the oversight and improvement of quality metrics.

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5.0 Neurological Risk Reduction for the Hospitalized Patient

5.1 Delirium and Falls

Encephalopathy, nonfocal deterioration in alertness and cognitive performance, is the most common neurologic complication of a critically ill hospitalized patient. It indicates the inability of the brain to maintain normal function under severe physiologic stress and can be compared to failure of other end organs.[1,2] Delirium is a common manifestation of mild to moderate encephalopathy and is defined as an acute and fluctuating change in mental and cognitive status. Delirium presents as decreased arousal and attention with incoherent thought and speech. Hospital delirium has an overall prevalence of 23% amongst hospitalized older adults, with an increased prevalence in the intensive care unit (31% to 75%).[3] Development of delirium has been found to be an important predictor of both morbidity and mortality in critically ill patients.[4]

One common adverse event in the inpatient setting that can be the result of delirium is falls. The rate of hospital falls have been decreasing over the past few years, but they are still the most common adverse event reported in the hospital. Each year, there are roughly 700,000 to 1 million patient falls resulting in around 250,000 injuries and 11,000 deaths. These falls are both a physical and economic burden to patients in addition to also significantly impacting medical organizations.[5]

Knowledge

Neurohospitalists should be able to:

- Describe risk factors for patients at increased potential for development of delirium.
- Be familiar with different methods of measuring and assessing for delirium in the hospitalized patient (e.g., Confusion Assessment Method (CAM-ICU), the 4 A's test (4AT), Delirium Rating Scale (DRS), etc.).
- Recognize when further medical workup/imaging are required in a patient with delirium symptoms.
- Describe pharmacologic and non-pharmacological methods to intervene in the prevention /management of delirium in the inpatient setting.
- Describe factors associated with increased risk of falls in hospitalized patients.
- Explain how different characteristics (use of anticoagulation, age of patient, recent medical interventions, etc.) can stratify falls from having minor to major impact.
- Be familiar with various measurement strategies in assessment of fall risk (e.g., Morse Fall Scale, St. Thomas Risk Assessment Tool in Falling elderly inpatients [STRATIFY], Hendrich II Fall Risk Model instruments, etc.).
- Describe ways to manage a hospitalized patient after they sustain a fall.
- Recognize when further medical workup/imaging are required in a patient with in-hospital fall.
- Recognize the indications for escalation of care.

Skills

Neurohospitalists should be able to:

- Identify patients at risk for delirium through examination of a patient's medical history, medication list, and relevant in-hospital medical interventions.
- Utilize physical exam findings to identify patients who may be developing delirium, or whose level of consciousness/cognition may be fluctuating and worsening.
- Monitor for common causes/triggers to the development of delirium in the hospitalized patient.
- Communicate with patients and families why delirium occurs, and what the usual trajectory is/how delirium can impact the hospitalization.
- Communicate with patients and families to explain the use and potential adverse effects of pharmacologic agents used for delirium, and explain the rationale behind non-pharmacological methods.
- Identify patients at risk for falls while hospitalized and implement strategies to try to avoid falls.
- Communicate with patients and families if a fall does arise, the reasons why it may have occurred and how to prevent future falls.

Attitudes

Neurohospitalists should be able to:

- Employ an early and multidisciplinary approach to the care of patients who are at risk for delirium, or have developed delirium through all care transitions.
- Follow evidence-based recommendations, protocols, and risk stratification tools for the identification, monitoring, and treatment of delirium.
- Work collaboratively with other health professionals (Registered Nurses (RNs), Occupational Therapists (OTs), Physical Therapists (PTs), environmental services, etc.) to develop methods to identify and alleviate both intrinsic (orthostatic hypotension, cognitive impairments, balance and gait abnormalities) and extrinsic (setup of the room, height of bed, availability of walking aids/assistive devices) fall risk factors.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary teams to implement strategies to reduce hospital acquired delirium.

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5.2 Withdrawal

Withdrawal from central nervous system (CNS) depressant substances such as alcohol, opiates, muscle relaxants, and benzodiazepines is common in hospitalized patients and can be potentially lethal. It is estimated that 10% of hospitalized patients experience alcohol withdrawal. Early treatment reduces neurological complications such as seizures. Early identification and optimized usage of a treatment protocol can be crucial to improving outcomes and decreasing morbidity.[1]

Knowledge

Neurohospitalists should be able to:

- Identify the symptoms of alcohol withdrawal and know the timing at which neurological complications, such as delirium tremens or seizures, are likeliest to occur.
- Understand the rationale for high dose thiamine repletion in patients with alcohol use disorder.
- Identify symptoms of withdrawal from different recreational drugs.
- Understand the difference between withdrawal from short-acting and long-acting opioids.
- Describe the neurological effects/complications of withdrawal from commonly used psychotropic medications.

Skills

Neurohospitalists should be able to:

- Institute treatment protocol based on appropriate reassessments of patients using commonly utilized scales.
- Follow evidence-based recommendations, protocols, and risk stratification tools for the identification, monitoring, and treatment of withdrawal syndromes that include neurological signs and symptoms.

Attitudes

Neurohospitalists should be able to:

- Collaboratively support patients at risk for or experiencing withdrawal, including engagement of social workers and experts in Addiction Medicine where appropriate.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Evaluate and learn from deviations from evidence-based recommendations.
- Employ a multidisciplinary approach to the care of patients who are at risk for or develop withdrawal syndromes, including effective transitions of care.

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5.3 Deconditioning, Critical Illness Polyneuropathy and Myopathy

Weakness after critical illness is a pervasive problem. This is secondary to not only diffuse atrophy secondary to disuse of skeletal muscles, but also due to cellular injury to peripheral nerves and muscles during critical illness. Critical illness polyneuropathy (CIP) and myopathy (CIM) are distinct entities, but can often coexist as critical illness polyneuromyopathy

(CIPNM). This is very prevalent in the critically ill population, with 70% of patients with sepsis and 100% of patients with multiorgan failure having measurable neuromyopathy.[1] This can have a significant impact on patient morbidity and mortality, as neuromuscular respiratory weakness may be so profound that there is secondary impediment to weaning from mechanical ventilation. A detailed 2013 study of critically ill patients found through serial biopsies that muscle protein synthesis starts to be depressed on day 1 compared to healthy controls.[2]

Knowledge

Neurohospitalists should be able to:

- Recognize factors that put patients at higher risk for development of CIP and CIM.
- Recognize clinical findings and diagnostic criteria for CIP and CIM.
- Identify the medications that increase the risk of critical illness polyneuropathy and myopathy.
- Recognize the role of EMG/NCS when a diagnosis of CIP and CIM is uncertain.
- Understand the long-term recovery trajectory and prognosis for patients who develop CIP and CIM.

Skills

Neurohospitalists should be able to:

- Understand which interventions have been found to be useful in the prevention and treatment of CIP and CIM.
- Know when to utilize laboratory investigations, imaging modalities, and other neuro-diagnostic testing.

Attitudes

Neurohospitalists should be able to:

- Discuss different approaches to nutritional support for patients with CIP and CIM.
- Employ an early and multidisciplinary approach to the care of patients who are at risk for CIP/CIM or have developed CIP/CIM.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Enhance awareness amongst critical care providers in their institutions to identify the risk factors and symptoms of CIN/CIM early on to involve Neurology.
- Eliminate medication that might contribute to worsening and ensure involvement of rehabilitative specialists for mobilization and physical rehabilitation.

References

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5.4 Complications of Hospitalization for Patients with Chronic Neurological Diseases

Underlying neurologic disability exacerbates the vulnerability of the nervous system tissue to impairment and injury. This can manifest in different ways.

Recrudescence is the reemergence of neurologic deficits in the context of physiologic stress (toxic-metabolic factors, infection, electrolyte derangements, unstable vital signs). This can be seen in patients with prior resolved stroke deficits, remitted demyelinating symptoms and other focal structural injuries to the brain and spinal cord.[1]

Patients with underlying neurodegenerative diseases, particularly those causing dementia, often experience an exacerbation of baseline disease symptoms and a deterioration in clinical status out of proportion to the physiologic disturbances that cause them. In most cases, symptomatic treatments that are typically effective at baseline become less effective, and escalation of doses is often more likely to cause adverse effects than to improve symptoms. Abrupt discontinuation of certain medications (like for Parkinson's Disease) when patients are not safe to swallow can cause detrimental effects and certain disease-modifying immunosuppressive treatments may need to be held while there is an active infection. Thus, a thorough review and alternatives for chronic medications for neurological diseases should be instigated.

Knowledge

Neurohospitalists should be able to:

- Understand which medications that are used for chronic neurological conditions are necessary to be continued in some formulation, even in patients who are unable to take anything by mouth.
- Identify when common medications used in the critical care setting are contraindicated in patients with certain chronic neurological conditions.
- Recognize medications that can exacerbate/provoke symptoms in patients with underlying chronic neurological conditions in the setting of surgery or acute illness.

Skills

Neurohospitalists should be able to:

- Identify which medications used for chronic neurological conditions should be held and which should be continued while a patient is hospitalized.
- Communicate with patients and families to explain the possibility of recrudescence affecting the in-patient clinical symptoms.
- Differentiate recrudescence from new neurological conditions.

Attitudes

Neurohospitalists should be able to:

- Collaborate with different members of the healthcare team to understand how the patient's underlying chronic neurological conditions may impact the current hospitalization.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Have clear communication with the patient/patient's representative, bedside RNs and/or consulting or admitting teams to ensure patient's baseline medications are appropriately held/continued in the inpatient setting.

Reference

1. Topcuoglu MA, Saka E, Silverman SB, Schwamm LH, Singhal AB. Recrudescence of Deficits After Stroke: Clinical and Imaging Phenotype, Triggers, and Risk Factors. JAMA Neurol. 2017;74(9):1048-1055. doi:10.1001/jamaneurol.2017.1668

6.0 Medical Risk Reduction for the Neurologic Inpatient

Hospitalization of neurologic patients can result in unintended adverse events, particularly in older adult patients. Disruption of home environments and typical sleep patterns, lack of proper nutrition, tethers (e.g., intravenous lines, restraints, urinary catheters, telemetry), and polypharmacy can all contribute to functional decline.[1] While some aspects of functional decline may be nearly unavoidable in the setting of acute neurologic illness, many of the harmful risks associated with hospitalization can be minimized with proper planning. In the following sections, we discuss approaches to minimize risks.

Reference

1. Creditor MC. Hazards of hospitalization of the elderly. *Ann Intern Med.* 1993; 118(3):219. doi:10.7326/0003-4819-118-3-199302010-00011

6.1 Sleep Deprivation

Hospitalized neurologic patients commonly encounter unfamiliar sleep environments, prolonged periods of bed rest, frequent nighttime awakenings for care (e.g., vital sign checks, medication schedules, phlebotomy), and are exposed to environmental factors including excess noise and light, all of which contribute to sleeplessness and sleep deprivation. Multicomponent interventions addressing sleep deprivation and delirium prevention have been shown to decrease risk of developing delirium and reduce hospital length of stay, 30-day readmission rates, and hospital costs.[1,2]

Knowledge

Neurohospitalists should be able to:

- Describe factors associated with increased risk of sleep deprivation in hospitalized patients.
- Identify methods to improve sleep for hospitalized patients.
- Be familiar with different methods of assessing and intervening in delirium, as well as non-pharmacologic and pharmacological methods of preventing and managing delirium in the hospitalized patient.

Skills

Neurohospitalists should be able to:

- Communicate with patients and families about sleep deprivation and delirium in the hospital setting and how these complications can impact the hospitalization.
- Communicate with patients, families, and multidisciplinary team members methods that can improve sleep quality in the hospital setting.

Attitudes

Neurohospitalists should be able to:

- Employ an early and multidisciplinary approach to the care of patients at risk of sleep deprivation or who have already developed sleep deprivation and associated complications.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Participate in multidisciplinary efforts to implement interventions such as sleep enhancement protocols, which have been shown to improve sleep quality among hospitalized patients.

References

1. LaHue SC, Maselli J, Rogers S, et al. Outcomes following implementation of a hospital-wide, multicomponent delirium care pathway. *J Hosp Med.* 2021; 16(7):397-403. doi:10.12788/jhm.3604
2. Inouye SK, Bogardus ST Jr, Charpentier PA, et al. A multicomponent intervention to prevent delirium in hospitalized older patients. *N Engl J Med.* 1999; 340(9):669. doi:10.1056/NEJM199903043400901

6.2 Malnutrition

Poor nutrition in hospitalized neurologic patients can result from difficulties in self-feeding, restriction in movement, restrictive diet orders (e.g., alternative texture diets for dysphagia, nothing by mouth, etc.), impaired cognition, and poor appetite, nausea, or constipation. Malnutrition is associated with increased mortality risk, comorbid hospital complications such as pressure sores, and specific micronutrient deficiencies can exacerbate underlying neurologic illness.[1-3] Interventions from the multidisciplinary inpatient team, including evaluation by a dietician or nutritionist, have been shown to decrease associated mortality in this setting.[1]

Knowledge

Neurohospitalists should be able to:

- Describe factors associated with increased risk of malnutrition.
- Recognize findings concerning for malnutrition on history, physical examination, and diagnostic studies.
- Explain the relationship between malnutrition and morbidity and mortality.
- Understand the relationship between dysphagia and malnutrition.
- Recognize that restricted diets are generally not necessary for hospitalized neurologic patients and that when ordered these diets may limit the nutritional intake of acutely ill neurologic patients.

Skills

Neurohospitalists should be able to:

- Diagnose malnutrition based on criteria by the Academy of Nutrition and Dietetics and the American Society for Parenteral and Enteral Nutrition (ASPEN).4
- Communicate with multidisciplinary team members, including nutritionists and dieticians, to effectively assess malnutrition and implement targeted treatment strategies.
- Communicate with patients and family members the importance of adequate nutritional intake and its role in recovery from acute neurologic illness.
- Collaborate with multidisciplinary team members, including occupational therapists and speech and language pathologists, to appropriately assess dysphagia and implement effective nutritional regimens that balance risks associated with aspiration versus malnutrition.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based recommendations and protocols for the identification/monitoring/treatment of malnutrition.
- Employ an early and multidisciplinary approach to the care of patients at risk for malnutrition.
- Employ multidisciplinary approaches and follow evidence-based recommendations for the assessment of dysphagia and associated nutritional repletion strategies (whether oral, enteral, or parenteral).

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Participate in multidisciplinary efforts to reduce risks of malnutrition and implement best practices in targeted treatment strategies in neurological patients.
- Participate in multidisciplinary efforts to assess risks of dysphagia and implement best practices in nutritional repletion strategies in neurological patients.

References

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6.3 Nosocomial Infections

Acutely ill neurologic patients are at increased risk for hospital-acquired (or nosocomial) infections. A high index of suspicion may be necessary to identify infection, as neurologic deficits may mask typical signs and symptoms of infection. Commonly encountered nosocomial infections among hospitalized patients include pneumonia, urinary tract infections, Clostridium difficile associated diarrhea, and catheter-related infections.[1]

Knowledge

Neurohospitalists should be able to:

- Describe common risk factors associated with nosocomial infections (e.g., use of indwelling medical devices, surgical procedures, injections, overuse or improper use of antibiotics, prolonged hospitalization, immunodeficiency, and extremes of age).
- Understand best practices and judicious use of antibiotics.
- Explain standard (universal) precautions.
- Understand the appropriate uses for catheterization, catheterizing only when necessary and for the shortest period needed.

Skills

Neurohospitalists should be able to:

- Properly use personal protective equipment (including appropriate donning and doffing best practices and periodic education on use of this equipment).
- Interpret microbiologic studies with caution and relate findings to a patient's clinical symptoms and signs, instead of in isolation.
- Communicate with patients and family members the need for compliance with antibiotics.

Attitudes

Neurohospitalists should be able to:

- Employ hand hygiene best practices.
- Follow Infectious Diseases Society of America practice guidelines in treatment of community acquired and hospital acquired infections.
- Employ standard (universal) precautions.
- Follow appropriate isolation precautions as necessary.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Participate in a patient safety culture in which consistent hand hygiene and infection control are a priority.

Reference

1. Govindarajan R. Prevention and management of health care-associated infections. Continuum (Minneap Minn). 2015;21(6 Neuroinfectious Disease): 1751-1756. doi:10.1212/CON.0000000000000247

6.4 Polypharmacy

Multiple medications, particularly multiple new medications brought forth during hospitalization, have the potential to place patients at risk for further nutritional, functional, and cognitive decline during their hospitalization.[1] By criteria, polypharmacy is defined as the use of 5 or more medications per day. Among neurologic inpatients, particularly older patients, polypharmacy has been shown to be an independent risk factor for falls, delirium, nursing home admission, and mortality.[2,3] Minimizing the use of unnecessary medications is essential to reducing the risk of adverse drug events. When needed, starting new medications at the lowest possible therapeutic dose can similarly help avoid adverse drug events. With older neurologic patients specifically, clinical monitoring of weight and renal and/or hepatic impairment can guide dose adjustments and minimize the burden of risk.

Knowledge

Neurohospitalists should be able to:

- Identify common medication interactions and medications that put patients at the highest risk for developing inpatient complications.

Skills

Neurohospitalists should be able to:

- Perform medication reconciliations appropriately and regularly.
- Collaborate with multidisciplinary colleagues (e.g., pharmacists) to minimize the use of nonessential medications as appropriate.
- Find potential alternatives to high-risk medications in the inpatient setting.

Attitudes

Neurohospitalists should be able to:

- Employ an early and multidisciplinary approach to the care of patients who are at risk for polypharmacy and withdrawal.
- Follow medication reconciliation best practices particularly at times of transition into or out of the hospital.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Coordinate with community providers to identify the patients who are at high risk for development of adverse events from polypharmacy and work together to see if medication consolidation and/or reduction is possible.

References

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6.5 Venous Thromboembolism

Delivering risk-appropriate prophylaxis to hospitalized patients can prevent up to 70% of venous thromboembolism (VTE), deep vein thrombosis (DVT), and potentially fatal pulmonary embolism (PE).[1] Hospitalized neurology patients, especially those with ischemic stroke or CNS malignancy, are at increased risk of developing VTE.[2, 3]

Current guidelines recommend routine use of anticoagulant pharmacologic thromboprophylaxis for VTE prevention in acutely or critically ill hospitalized patients, except in those with high bleeding risk in which case mechanical methods such as intermittent pneumatic compression are recommended.[4, 5] Despite this, numerous studies show that thromboprophylaxis is not consistently offered to a large number of hospitalized patients.[1, 4] Conversely, studies also suggest that increased bleeding risk associated with standard anticoagulant thromboprophylaxis may negate its mortality benefit in some patients.[1]

Individual patient factors must be continually reassessed during hospitalization to optimally balance risks of bleeding and clotting. A multifaceted approach combining evidence-based predictive models, electronic hospital decision support programs, monitoring systems, as well as patient and nurse education can improve adherence to best practices while avoiding unnecessary use of thromboprophylaxis in low-risk patients.[1]

Knowledge

Neurohospitalists should be able to:

- Identify VTE risk factors and contraindications to VTE prophylaxis.
- Describe complications of pharmacologic thromboprophylaxis.

Skills

Neurohospitalists should be able to:

- Perform individual VTE-prevention risk assessments.
- Select risk-appropriate VTE thromboprophylaxis.
- Recognize signs and symptoms of VTE, as well as complications of thromboprophylaxis, such as bleeding and heparin-induced thrombocytopenia.
- Communicate with patients and family members the importance of compliance with VTE prophylaxis.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based recommendations for the prevention and identification of VTE.
- Ensure risk-appropriate VTE prophylaxis compliance and continuous risk reassessment.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Ensure admitted neurology patients are included in hospital decision support programs to ensure risk-appropriate use of VTE thromboprophylaxis, such as electronic order-sets, and clinician alerts.

References

1. Nicholson M, Chan N, Bhagirath V, Ginsberg J. Prevention of Venous Thromboembolism in 2020 and Beyond. J Clin Med. 2020;9(8):2467. Published 2020 Aug 1. doi:10.3390/jcm9082467
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6.6 Pressure-Induced Skin and Soft Tissue Injury

Hospitalized neurologic patients are at increased risk of developing pressure-induced skin and soft tissue injuries due to immobility, sensory disturbances, incontinence, and compromised nutritional status.[1] Prevention of pressure-induced injuries is both cost-saving and increases quality-adjusted life-years.[2]

Knowledge

Neurohospitalists should be able to:

- Recognize when their patients are at risk of pressure-induced skin and soft tissue injuries.
- Be familiar with pressure-injury risk reduction strategies, such as elevation of paretic extremities, pressure redistribution, and use of pressure-reducing products.
- Involve wound care specialist when appropriate to care for patients with concern for pressure-induced skin and soft tissue injury.

Skills

Neurohospitalists should be able to:

- Participate in multidisciplinary efforts to monitor for the development and prevent pressure-induced injuries.
- Communicate with patients and family members the importance of pressure injury prevention and management.

Attitudes

Neurohospitalists should be able to:

- Recognize the value of an early and multidisciplinary approach to the care of patients at risk of developing pressure injuries.
- Recognize the value of a multidisciplinary approach to pressure-injury management.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Advocate for a patient safety culture in which pressure-injury prevention and monitoring is a priority.

References

1. Padula WV, Pronovost PJ, Makic MBF, et al. Value of hospital resources for effective pressure injury prevention: a cost-effectiveness analysis. BMJ Qual Saf. 2019;28(2):132-141. doi:10.1136/bmjqs-2017-007505
2. de Laat EH, Pickkers P, Schoonhoven L, Verbeek AL, Feuth T, van Achterberg T. Guideline implementation results in a decrease of pressure ulcer incidence in critically ill patients. Crit Care Med. 2007;35(3):815-820. doi:10.1097/01.CCM.0000257072.10313.56

6.7 Tethers

Tethering medical devices such as urinary catheters, intravascular lines, cardiac telemetry leads, oxygen tubing, drains, and intermittent pneumatic compression devices are associated with increased rates of infection, delirium, and falls.[1, 2] Tethers are frequently ordered when not indicated or may be kept in place when no longer appropriate. The risks and benefits of each tethering device must be assessed daily to ensure timely discontinuation when use is no longer justified.

Knowledge

Neurohospitalists should be able to:

- Recognize when frequently used medical tethering devices, such as indwelling urinary catheters, intravascular lines, cardiac telemetry leads, oxygen tubing, and intermittent pneumatic compressions, are no longer clinically indicated.
- Recognize that there are potential complications of medical tethering devices and these should be discontinued as soon as they are no longer medically necessary.

Skills

Neurohospitalists should be able to:

- Collaborate with multidisciplinary team members (e.g., nursing, respiratory therapy) to minimize inappropriate utilization of tethering devices

- Communicate with patients and families regarding the risks and benefits of keeping tethering devices in place.

Attitudes

Neurohospitalists should be able to:

- Follow evidence-based recommendations and protocols for the initiation, maintenance, and discontinuation of tethering devices.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Promote a patient safety culture in which continuous reassessment of the appropriateness use of tethering devices is a priority.

References

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7.0 Neurohospitalist as Educator

Education within the inpatient setting is a critical aspect of patient care. Learners include not only medical students, residents, fellows and advanced practitioners, but also members of the multidisciplinary care team, patients, and families. Multiple studies have demonstrated that medical students and trainees report improved teaching from hospitalists on the internal medicine, pediatrics, and more recently neurology inpatient services compared to traditional models.[1-6] Neurohospitalists contribute their distinct skill set and knowledge of healthcare systems, quality improvement, and high value care in medical education. The educational benefits of the neurohospitalist model extend beyond teaching on rounds, as neurohospitalists are often more available to provide both formal and informal teaching opportunities for learners throughout the day.

The Accreditation Council for Graduate Medical Education (ACGME) requires all neurology training programs to have at least 6 months of inpatient neurology. Neurohospitalists are able to teach from a wide breadth of expertise across many neurologic subspecialties. In addition to teaching pathophysiology, the neurohospitalist is well-equipped to rolemodel interdisciplinary care and communication, patient safety, evidence-based medicine, and cost- and time-effective care. Hospitalists have been noted to be more available and approachable to learners and implement more frequent and reliable feedback.

Knowledge

Neurohospitalists should be able to:

- Provide formal and informal education about pathophysiology, diagnostic testing, and treatment for a wide range of neurologic conditions in the acute care setting.
- Teach the effective implementation of evidence-based medicine into clinical practice.
- Educate about patient safety, inpatient quality measures, and cost-effective care.
- Teach team members how to create care plans that optimize transitions of care within their hospital system.

Skills

Neurohospitalists should be able to:

- Employ different educational techniques to engage learners of different styles.
- Lead and model interdisciplinary communication and education to elevate patient care.
- Foster a learning environment that encourages autonomy at levels appropriate to the learner's training and competency.
- Highlight and model clinical pearls from patient histories and exams at the bedside.
- Identify teaching opportunities throughout the work day.
- Provide real time and summative feedback to learners.

Attitudes

Neurohospitalists should be able to:

- Create an inclusive learning environment for all students and trainees.
- Engage learners in medical decision making, interdisciplinary conversations, and systems-based learning.
- Foster engagement and support for struggling learners in partnership with education leaders (i.e., clerkship or program directors).
- Model humanistic and collaborative care.
- Be available and approachable for questions and feedback.

System Organization and Improvement

Neurohospitalists should be able to:

- Review or create educational objectives for inpatient rotations with residency and medical school leadership.

- Employ standardized 360 degree feedback for education on inpatient rotations.
- Implement time management skills and focused high-impact education to increase the efficiency of bedside teaching.

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8.0 Hospitalist Skills for the Neurohospitalist

8.1 Transitions of Care

Care transitions are defined as "a set of actions designed to ensure the coordination and continuity of healthcare as patients transfer between different locations or different levels of care within the same location."[1] Neurohospitalists, more than other specialty areas of neurology, must have a working understanding of the acute care system and how to most effectively coordinate specialized care across multiple care settings. This section addresses the core elements of effective inter- and intra-institutional care transitions applicable to a range of care settings.

Knowledge

Neurohospitalists should be able to:

- Be familiar with prehospital care systems including emergency medical services (EMS) triage of acute ischemic stroke.
- Recognize medical indications for inter-institutional transfer among individuals with neurologic illness.
- Understand Emergency Medical Treatment and Labor Act (EMTALA) and the impact on transfers of individuals with acute neurologic illness.
- Understand patient and system factors that may contribute to discharge delays.
- Understand patient and system factors that may contribute to increased rates of readmission.
- Be familiar with evidence-based interventions to reduce 30-day readmission rates and medication errors.
- Appreciate the economic impact of preventable hospital readmissions and ineffective care transitions on the healthcare system.
- Understand the structure of a neurohospitalist discharge clinic and benefits for follow-up care.[2]
- Adopt best practices for effective handoff between team members and hospital services.[3]
- Understand the patient safety risks and costs associated with ineffective intra-institutional care transitions.

Skills

Neurohospitalists should be able to:

- Effectively coordinate interfacility transfers to/from their institution.
- Establish the appropriate timeliness of transfer depending on the acuity of the neurological process.
- Complete effective discharge documentation and communication to optimize post-hospital care transitions.
- Use validated tools to identify individuals at high risk for hospital readmission.
- Consistently communicate with primary care, consultants, and post-acute care providers to ensure effective care coordination and follow-up at the time of care transitions out of the hospital.
- Utilize electronic resources to provide patient education and consistent reinforcement of best practices at the time of hospital discharge.
- Collaborate with emergency department (ED) providers to provide effective care transitions for individuals discharged from the ED.
- Effectively facilitate care transitions among various levels of care within the hospital system.

Attitudes

Neurohospitalists should be able to:

- Engage in regular communication with referring and/or receiving facilities to ensure effective care transitions.
- Educate and collaborate with hospital case managers to provide safe and effective care transitions and discharge care coordination.
- Advocate for timely acute inter-institutional transfer when indicated to optimize the care of individuals with complex neurologic care needs.
- Collaborate with ED providers and medicine hospitalists to promote effective intra-institutional care transitions.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Devise interventions to identify high-risk individuals and minimize preventable hospital readmissions.
- Interface with ambulatory care neurologists to optimize access to post-hospital neurologic care and address any barriers to timely specialty consultation.
- Neurohospitalists who work in hospitals that transfer patients to thrombectomy-capable centers should participate in quality improvement processes that focus on reducing door-in-door-out times for potential endovascular candidates.
- Participate in transfer center logistics and influence the prioritization of individuals with acute neurologic care needs.
- Ensure that the neurology service provides inclusive and equitable access to advanced acute care services.
- Develop ED pathways to facilitate comprehensive care and effective care transitions to ambulatory neurology or primary care where appropriate.
- Identify and follow quality and safety measures for intrahospital care transitions.
- Define appropriate criteria for direct hospital admission from specialty care clinics, and utilize clinics and ambulatory services to deliver care outside the hospital setting when medically appropriate.

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8.2 Patient Safety

Hospitalized patients are at risk for a variety of complications and patients with neurologic disease are particularly vulnerable to many of these.[1] Patient safety encompasses the prevention, reduction, reporting, and analysis of errors and harm that can occur during the course of care of hospitalized patients. Like medicine[2] and pediatric hospitalists,[3] the practicing neurohospitalist must be able to demonstrate competency in patient safety,[4] including anticipating complications, leading subspecialty-specific efforts to promote harm reduction, and promoting safety culture.[5]

Knowledge

Neurohospitalists should be able to:

- List common complications in the hospitalized patient with neurologic disease and their causes.
- Define and differentiate near misses, adverse events, and sentinel events.
- Describe the multifactorial role that human factors and system factors play in medical errors.
- Discuss factors unique to patients with neurologic disease that lead to increased risk for medication errors.
- Describe the role of patient and family engagement in patient safety.
- Review common patient safety interventions to reduce errors, including electronic order sets, clinical decision support best practice alerts, double checks, and practice guidelines.
- Describe common cognitive biases and review how these biases might contribute to diagnostic error.
- Review the components of "just culture,"[6] and describe how organizations can achieve them.
- Define common features of "high reliability organizations,"[7] and explain how high reliability principles apply to clinical care and work on patient safety initiatives.
- Review the role of neurohospitalists in maintaining national safety goals required by or suggested by accrediting and benchmarking organizations.

Skills

Neurohospitalists should be able to:

- Role model how to perform infection-control standard precautions, including but not limited to hand hygiene,

use of personal protective equipment, and use and proper disposal of sharps.
- Identify and order the level of nursing care and neurologic monitoring needed for safe patient care.
- Use tools for patient safety including "time outs," checklists, medication decision support, and medication reconciliation.
- Prevent iatrogenic complications and proactively reduce risks of hospitalization including falls, delirium, venous thromboembolism, hospital-acquired infections, decubitus ulcers, malnutrition, and medication-related adverse events.
- Monitor and review performance on key patient safety indicators as part of a multidisciplinary team.
- Use evidence-based evaluation methods and tools when defining problems and designing interventions to lead efforts to reduce recurrent error.
- Participate in a specialty-specific analysis of patient harm data to target improvement efforts.
- Demonstrate proficiency in reporting errors using safety reporting systems.
- Disclose patient safety events to patients and families.
- Participate in continuous readiness for accreditation agencies by consistently adhering to patient safety practices.

Attitudes

Neurohospitalists should be able to:

- Follow patient safety protocols and participate in processes for their continuous improvement.
- Role model behaviors that exemplify a "just culture," accountability, and learning from failure.
- Advocate for and foster a nonpunitive error-reporting environment.
- Support colleagues, trainees, and other providers who are involved in a patient safety issue ("second victim").
- Practice self-compassion when directly involved in a patient safety issue.
- Promote behaviors and systems interventions that minimize workforce fatigue, occupational illness and injury, and burnout.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary teams to develop and implement patient safety interventions involving inpatient neurology.
- Participate in hospital-wide safety committees and seek to become leaders in patient safety culture.
- Collaborate with hospital administration to foster a "just culture" across disciplines, including medicine, nursing, and pharmacy.

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8.3 Quality Improvement

In their seminal paper from 2000, "To Err Is Human," Kohn et al. reflect on the reports that 98,000 people die each year in the US alone as result of medical errors.[1] This started a conversation around the need to provide an honest, nonpunitive reporting structure to ensure errors are investigated for underlying system issues that might have allowed the error to occur. The Centers for Medicare and Medicaid Services (CMS) developed Core Measures of Quality (such as certain hospital-acquired infections) in 2003, which have been incorporated into their payment model, thus tying quality to reimbursement (Goodrich 2012).[2]

Quality, according to the Institute of Medicine, is, "the degree to which health care services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge."[1] Quality improvement (QI) aims to improve the

processes that result in desired outcomes. Performance improvement is a specific strategy and method for QI.

Knowledge

Neurohospitalists should be able to:

- Be familiar with common elements of QI, such as Plan-Do-Study-Act (PDSA) cycles, SMART goals (SMART: specific, measurable, actionable, relevant, timebound) and Key Drivers.
- Maintain awareness of the organizational structure pertaining to QI in their healthcare system.
- Be familiar with processes to report QI issues and concerns.
- Describe the quality metrics measured for their patient population, such as hospital length of stay and mortality rate.
- Maintain awareness of recent and historical performance on relevant quality metrics and areas that need most improvement.

Skills

Neurohospitalists should be able to:

- Create an environment of psychological safety that encourages thoughtful discussion of performance.
- Objectively assess poor quality outcomes and investigate using standardized tools.
- Collaborate with multidisciplinary teams to evaluate performance and improve outcomes using standardized and/or evidence-based tools and approaches.

Attitudes

Neurohospitalists should be able to:

- Role model curiosity about changes in performance on quality metrics.
- Maintain a culture of inclusion for suggestions brought by team members on how to improve quality.
- Demonstrate an open and welcoming, non-judgmental way of interacting, encouraging team members to come forward with concerns.
- Be sensitive to the needs of other team members and aware of how QI initiative might impact their workflow or workload.

System Organization and Improvement

A robust QI program can improve patient outcomes, decrease adverse events, improve workflows, and improve staff and provider satisfaction.[6]

To improve efficiency and quality within their organizations, neurohospitalists should:

- Collaborate with the healthcare organization to develop meaningful outcome measures.
- Actively participate in the oversight of quality metrics and evaluate whether those are routinely met.
- Lead, coordinate, and/or participate in multidisciplinary teams that address optimization of access to care.
- Lead, coordinate, and/or participate in multidisciplinary teams that address access to care issues at the spoke hospitals.
- Regularly report out quality measures to physicians in their own department and other disciplines, as well as leadership of the healthcare organization.

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8.4 Process Optimization

A process is defined as a series of actions or steps that lead to a specific outcome. Process optimization is defined as, "the discipline of adjusting a process to optimize a specified set of parameters without violating some constraint."[1] In business settings, common goals are maximizing efficiency while minimizing cost.

In the healthcare setting, Wolfenden et al. define process optimization as "a deliberate, iterative and data-driven process to improve a health intervention and/or its implementation to meet stakeholder-defined public health impacts within resource constraints."[2] Process optimization in the clinical setting could reasonably be defined as an effort to maximize efficiency and efficacy of care, while minimizing redundancy and waste.

Process optimization requires a detailed understanding of current workflows, institutional constraints (financial, environmental, among others), and departmental and institutional goals.

Knowledge

Neurohospitalists should be able to:

- Describe how process optimization relates to patient outcomes and possible reimbursement.
- Recognize common workflows, such as admission, discharge processes or care protocols for the acute stroke patient.
- Identify the process design, implementation, and measures of their department.
- Describe common concepts used in process optimization.

Skills

Neurohospitalists should be able to:

- Communicate effectively in a multidisciplinary team by listening carefully and integrating team reports on what is happening with outcomes data.
- Build trust among their teams, ensuring that process optimization projects aim to improve outcomes and reduce work burden.
- Communicate their vision for the processes and outcomes to be improved.
- Create an environment of constructive communication.
- Engage stakeholders across disciplines in order to learn current processes and discover ways to improve workflows.

Attitudes

Neurohospitalists should be able to:

- View themselves as team leaders when it comes to process optimization of acute neurological emergencies (stroke, status epilepticus).
- Have a curious mindset towards learning about methodologies for process optimization, such as Lean and Six Sigma.
- Be open and non-judgmental in their communication, encouraging other team members to contribute opinions to process optimization, and consider feedback.
- Be resilient to failures in their process optimization approach, and persistent in trying again.
- Be careful in considerations of balancing measures, i.e. how a change in workflow affects other team members.

System Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should be able to:

- Actively participate in the analysis and monitoring of quality outcomes that impact the care of their patients.
- Actively engage in conversations with different stakeholders to investigate whether poorly designed processes hinder achievement of good outcomes of their patients.
- Lead, coordinate, and/or participate in multidisciplinary teams that address process optimization around inpatient care of neurologic patients.
- Proactively learn from others at their institution how they have approached process optimization or addressed similar problems.

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8.5 Co-Management in the Hospital Setting

Neurohospitalists are a rapidly growing subspecialty within neurology.[1,2] Many academic medical centers are now employing a neurohospitalist driven model for coverage, in order to ensure better coverage and continuation of care. Benefits of a neurohospitalist coverage model include improved patient flow with reduced emergency department (ED) waiting times and decreased length of stay (LOS), greater patient satisfaction, and increased availability of the neurologist, improving staff and learner satisfaction.[3,6]

The way in which neurohospitalists provide care can differ between institutions,[4] with the main two models being: a) the neurohospitalist serving as the primary attending for the patient or b) the neurohospitalist serving as the consultant to patients that are primarily cared for on other services. A neurohospitalist's specific job description may also include a combination of these models. Neurohospitalists frequently also collaborate and supervise advanced practice providers (APPs).

In either model, the neurohospitalist will most often not be the only attending provider involved in the care of a patient, co-managing the patient with providers from other specialties.

Knowledge

Neurohospitalists should be able to:

- Define the co-management or service line agreements that exist in their specific organization, and review them regularly.
- Recognize the scope of practice pertaining to their role, as well as the scope of practice of other service lines.
- Know staffing models and ensure that provider/patient ratio is adequate on their service.
- Describe departmental quality outcome measures, and be mindful of how co-management structures might affect them.
- Know how to monitor patient volume for their service line.
- Describe best practices of communication between service lines.

Skills

Neurohospitalists should be able to:

- Assess satisfaction among providers and ancillary service staff.
- Recognize burnout within their own service line as well as other service lines.
- Engage in conflict resolution, practicing an open and non-judgemental communication style.
- Monitor existing co-management agreements.
- Define consistent expectations for their role as well as the role of co-managing teams and communicate these clearly to stakeholders.
- Engage in constructive collaboration with APPs, including supervision and teaching.
- Provide a comprehensive care plan for the patient and avoid redundancy in care.

Attitudes

Neurohospitalists should be able to:

- Remain flexible and adaptive to changes in the co-management structures as needed to optimize patient outcomes and staff satisfaction.
- Be actively engaged in the development of collaborative agreements.
- Be constructive in communication about input by other services regarding a patient's care.
- Be sensitive to cultural and role-related differences between members of the care team that may influence communication.

System Organization and Improvement

To improve co-management within their organizations, neurohospitalists should be able to:

- Actively participate in the analysis and monitoring of quality outcomes for their department.
- Lead, coordinate, and/or participate in multidisciplinary teams that address process optimization.

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8.6 Resource Stewardship

Resource stewardship aims to maximize the quality of patient care while responsibly utilizing and prioritizing resources including laboratory and imaging tests, medication and treatment selection, and engagement of consulting services and hospital personnel.[1] Core principles underpinning resource stewardship include the minimization of waste, the sustainable allocation of resources, and the implementation of high-value care through careful diagnostic reasoning.[1-3] High-value care refers to the maximization of positive patient outcomes and experiences in tandem with the minimization of costs.[1] While available resources are largely defined by practice setting, culture and individual health systems,[4-6] the neurohospitalist plays a crucial role in the thoughtful application of such resources. The neurohospitalist can additionally be a proponent of systems-level change to support high-value care.

Knowledge

Neurohospitalists should be able to:

- Understand, incorporate, and convey the risks versus benefits and relative costs of common tests, procedures, and treatments.

- Define the concept of pre-test probability and its application to diagnostic workup and interventions.
- Understand and define test performance characteristics including sensitivity and specificity, as well as negative predictive value and positive predictive value.
- Describe how to interpret test results in the context of disease prevalence, pretest probability of a disease, and test performance characteristics.
- Identify and utilize validated decision support tools.

Skills

Neurohospitalists should be able to:

- Effectively integrate the patient history and neurologic exam to prioritize appropriately indicated, high-yield diagnostic tests and targeted treatment.
- Reflect on the potential impact of diagnostic testing on management decisions.
- Incorporate evidence-based medicine, guidelines, appropriateness criteria, and best medical practices into diagnostic workup and management.
- Consider and modify care plans to be patient-centered and targeted to the individual circumstances and priorities of the patient and caregivers, incorporating shared decision making, and respect for cultural, spiritual, and social needs and beliefs.
- Identify and reduce or eliminate tests and interventions without clinical benefit and/or possible harm.

Attitudes

Neurohospitalists should be able to:

- Role model the incorporation of high-value care principles (cost-awareness, pretest probability of disease, and test performance characteristics) into clinical decision making.
- Promote the allocation of resources in an equitable manner upholding justice and equality.
- Practice accountability for their individual resource stewardship with a dedication to improvement.
- Strive for continuous quality improvement in hospital processes to attain high quality, safe, and high-value patient care.
- Role model transparent communication with patients and caregivers on diagnostic uncertainty as well as test and treatment decision-making processes.

System Organization and Improvement

To improve resource stewardship within their organizations, neurohospitalists should:

- Lead, support and/or engage in quality improvement efforts to refine and improve high-value care clinical pathways (from diagnostic testing to treatment algorithms), applying the latest scientific evidence for patients with neurologic disease.
- Participate in the development and implementation of best practice statements and guidelines for neurologic care.
- Leverage the electronic medical record and telehealth resources as applicable to reduce waste and redundancy.
- Lead, encourage, and/or engage in health economic analyses using tools and methods such as cost of illness, cost-minimization, cost-effectiveness, cost-benefit, and cost-utility analyses to support system-wide improvements.
- Collaborate with multidisciplinary teams representing different phases of care to identify systems- level opportunities to optimize care coordination, outcomes, minimize harm, and reduce wasteful clinical practices.

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8.7 Professionalism and Medical Ethics

Ethical considerations are a common aspect of hospitalist work, including patient consent to treatments, resource allocation, and end-of-life care.[1] These considerations may be magnified in patients with neurologic disease who at times are unable to communicate their own wishes.[2] Neurohospitalists must understand medical ethics, professional standards, and legal obligations to patients and their families while demonstrating commitment to providing respectful, unbiased care.

Knowledge

Neurohospitalists should be able to:

- Define the four basic ethical principles of autonomy, beneficence, nonmaleficence, and justice.[3]
- Describe the legal obligations, and consequences of violating them, associated with caring for patients.
- Define informed consent for care including presumed consent in emergency situations.[4]
- Describe methods for obtaining informed consent for neurological research.
- Describe potential conflicts of interest and the need to disclose these to patients.
- Identify the role for consultation with specialists in palliative care and medical ethics.
- Identify impairments in self-judgment and make steps towards improvement.
- Understand local laws and regulations surrounding common ethical and legal issues such as brain death and withdrawal of care.
- Describe laws that require mandatory reporting by physicians such as eligibility for driving.

Skills

Neurohospitalists should be able to:

- Communicate effectively with patients, family members, and surrogate decision-makers.
- Exhibit respect and honesty towards patients.
- Establish patient capacity to make decisions.
- Appropriately explain benefits and risks and disclose conflicts of interest related to care and research.
- Promote each patient's best interest and health.
- Maintain doctor-patient confidentiality.
- Provide care that respects patients regardless of sex, gender, race, religion, sexual orientation, income, country of origin, age, etc.

Attitudes

Neurohospitalists should be able to:

- Prioritize the best interest of patients.
- Respect patient autonomy and confidentiality.
- Exhibit cultural sensitivity and awareness.
- Commit to life-long learning.

System Organization and Improvement

To improve professionalism and medical ethics within their organizations, neurohospitalists should:

- Lead, coordinate, and/or participate in multidisciplinary efforts to identify healthcare differences and create strategies to improve outcomes across all groups.[5]
- Participate in hospital-wide committees seeking to promote professionalism and cultural competence.

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8.8 Care of the Caregiver

As of 2020, there were an estimated 47.9 million US adults who served as an informal (unpaid) caregiver to an adult family member or friend. Caregivers play a pivotal role in the health of their care recipient, with the majority providing assistance with activities of daily living, instrumental activities of daily living, and medical/nursing tasks.[1] Given the significant cognitive and physical impact that neurologic disorders can have, patients across the spectrum of neurologic illnesses can require caregivers. This role can take a significant toll on the cognitive, emotional, physical, and financial well being of caregivers.[1,2] In addition, high rates of caregiver burden and poor mental health are linked to worse patient outcomes in such diseases as stroke[3] and neurodegenerative disease.[4] Caregiver stress can be exacerbated during periods of hospitalization of the care recipient.[5] Therefore, recognizing and addressing caregiver burden is a key skill for the neurohospitalist and can have a profound impact on the overall health of our patients.

Knowledge

Neurohospitalists should be able to:

- Define the role and epidemiology of informal caregivers.
- Describe the impact caregiving has on the care recipient and on the caregiver.

- Identify factors that contribute to caregiver burden.
- Identify signs of caregiver burnout.
- Be familiar with assessment tools for caregiver burden, such as the Zarit Burden Interview.

Skills

Neurohospitalists should be able to:

- Assess for caregiver burden at the bedside.
- Communicate information regarding diagnostic and treatment plans to patients and caregivers clearly and free of medical jargon.
- Counsel caregivers on potential strategies to address burnout.

Attitudes

Neurohospitalists should be able to:

- Respect the opinions of patients and caregivers, including an openness to cultural values and beliefs that may be different from their own.
- Practice patient-centered care.

Systems Organizations and Improvement

To improve care for the caregiver within their organizations, neurohospitalists should:

- Work collaboratively with a multidisciplinary team to identify and respond to caregiver distress, as well as connect caregivers with local and national resources available to them.
- Optimize transitions of care as patients and their caregivers change care settings.

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8.9 Practice Management

Effective practice management for a neurohospitalist requires a combination of clinical expertise and organizational skills.[1] Practice management encompasses providing high-quality patient care in addition to efficiently managing various operational, financial, and administrative tasks.[2] Practice management also involves enhancing patient satisfaction, clear communication with multidisciplinary teams, and demonstration of value to key stakeholders such as hospital administrators. These areas of emphasis are essential in both academic and non-academic neurohospitalist careers.[3]

Knowledge

Neurohospitalists should be able to:

- Review the applicable healthcare laws, regulations, and accreditation standards (examples: Health Insurance Portability and Accountability Act (HIPAA), Occupational Safety and Health Administration (OSHA)).
- Describe hospital policies and procedures for admission and discharge to ensure optimal workflow.
- Describe tools to monitor and analyze practice performance and added value to the healthcare system.
- Review accurate documentation and coding of neurological services for proper reimbursement.
- List long-term strategies for practice growth and sustainability, including recruitment of support staff and additional neurologists.

Skills

Neurohospitalists should be able to:

- Manage patient admissions, discharges, and transfers effectively to optimize hospital bed utilization.
- Ensure smooth transitions of care between the hospital and the outpatient setting.
- Coordinate care with other healthcare professionals, including neurologists, primary care physicians, emergency room physicians, critical care physicians, internal medicine hospitalists, other hospital-based physicians, and allied health providers.
- Collect and address patient feedback to improve care and neurological outcomes.

- Facilitate multidisciplinary team meetings to discuss complex cases and coordinate care plans.
- Utilize electronic health records (EHR) and other healthcare technologies to optimize patient care.
- Manage work schedules, performance evaluations, and continuing education for allied health providers and learners.
- Assess the strengths and competencies of team members to delegate tasks appropriately.

Attitudes

Neurohospitalists should be able to:

- Demonstrate understanding and compassion towards patients, families, and staff.
- Maintain flexibility and openness to change in a dynamic healthcare environment with evolving technologies and therapies.
- Value teamwork and promote interdisciplinary collaboration.
- Promote awareness of cultural differences in healthcare practices and communication.
- Encourage and role model behaviors and policies that minimize fatigue and burnout.

Systems Organization and Improvement

To improve practice management within their organizations, neurohospitalists should:

- Collaborate with hospital administration to optimize workflow on the neurology services and transfer between institution and geographies.
- Lead new initiatives within the neurology department, such as technology implementations, and quality improvement strategies.
- Advocate for better resource allocation including laboratory tests, imaging, and facilities.
- Support inclusive practices for hiring, training, and supervising clinical and administrative staff.

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8.10 Information Management

Information management encompasses the acquisition, interpretation, and utilization of patient data in hospital activities, including but not limited to patient care. The neurohospitalist should be aware of their local practice's clinical information systems to provide efficient documentation, accurate order entry, and optimal patient care. Neurohospitalists can also coordinate efforts to develop order sets, documentation-based metrics, and decision support systems to improve patient outcomes, reduce costs, and streamline patient care for providers.

Knowledge

Neurohospitalists should be able to:

- Describe how hospital information systems are used by administrative departments to manage patient registration, coding, financial data, diagnostic results, and appointments for outpatient clinic and testing.
- Identify how to access clinical references to assist patient care, including but not limited to practice and/or society guidelines, clinical score calculators (e.g., MDCalc), literature search engines, journal databases, instructional videos for procedures or medical device management, podcasts, and online textbooks.
- Recognize and explain how information systems can assist with evidence-based decision making.
- Recognize the advantages and disadvantages of the use of electronic health records (EHRs) and computer physician order entry.
- Recognize practical use of artificial intelligence (AI) in delivery of patient information, including but not limited to automated coding, early detection and reporting of critical results, and diagnosis specification.
- Keep up to date with newer applications of computer systems and AI in neurology, including but not limited to automated analysis of neurophysiologic testing and algorithmic processing of neuroimaging.
- Be aware of and keep up to date with local practice usage of EHR algorithms, templates, order sets, decision support systems, and informatics-based metrics.
- Understand methods for data export and interpretation in an individual system.
- Recognize the limitations of EHRs and decision support systems, and know when and how to "bypass" these in the appropriate clinical context.
- Recognize and be mindful of Health Insurance Portability and Accountability Act (HIPAA) regulations when managing patient data.
- Describe how to transfer patient data efficiently and safely, while maintaining privacy and confidentiality per HIPAA.

- Recognize the different input systems and methods for interrogating and interpreting data from medical devices, including but not limited to Vagal Nerve Stimulators (VNS), Deep Brain Stimulators (DBS), and Intrathecal Baclofen Pumps (ITB), and know when to call the manufacturer representative for assistance.

Skills

Neurohospitalists should be able to:

- Efficiently retrieve patient data, including documentation, diagnostic results, imaging, and neurophysiologic tests, from the available information system.
- Document consultations, including history and physical examinations and interpretations of diagnostics, efficiently and in keeping with institutional informatics guidelines.
- Place computer physician orders accurately and efficiently.
- Access data from digital and/or automated devices, including but not limited to Telemetry monitoring, electroencephalogram (EEG) recordings, electromyography (EMG) / nerve conduction study (NCS) displays.
- Access and interpret information from web-based clinical sources, including but not limited to diagnostic algorithms, clinical databases, risk assessment calculators, and literature review.
- Use web-based or EHR-based communication with patients and/or other healthcare providers safely and in compliance with HIPAA regulations.
- Enter accurate billing codes for consultations, procedures, and other clinical duties.
- Respond promptly to queries regarding documentation, coding, order entry, prescriptions, or other issues from patients and/or healthcare providers.
- Interact local information technology teams to standardize processes for data input, export, and interpretation.

Attitudes

Neurohospitalists should be able to:

- Recognize the limitations of the technology used in their practice when interpreting clinical data, and use clinical judgment to adjust interpretation accordingly.
- Adhere to the principles of keeping patient data safe, secure, and confidential.
- Recognize that information systems are being upgraded and/or changed frequently, and to remain cognizant of these changes.
- Keep up to date with the latest technological advances in neurologic diagnostics and treatment, including but not limited to new diagnostic devices, new treatment delivery technology, or new AI-based algorithms for interpreting patient data.
- Foster collaboration with information technology (IT) teams to create efficient, data driven EHR tools.
- Recognize commercial biases when reviewing new AI-based diagnostics, medical devices, or information systems.

Systems Organization and Improvement

To improve efficiency and quality within their organizations, neurohospitalists should:

- Lead, co-ordinate and/or participate in departmental order set creation to facilitate expedited patient care in neurologic emergencies, including but not limited to acute stroke care, status epilepticus, and neurotrauma.
- Lead, co-ordinate and/or participate in multidisciplinary efforts to create and maintain efficient information systems which promote optimal patient care.
- Lead, co-ordinate and/or participate in efforts to continuously audit and improve hospital information systems based on physician feedback and metrics-based patient outcomes.
- Advocate for decision support systems and automated diagnostics interpretation systems which facilitate evidence-based decision making and optimal patient care.
- Participate in efforts to standardize clinical care based upon best practices.
- Advocate for improved access to devices and technology tools which may lead to more efficient patient care, including but not limited to earlier diagnosis or earlier treatment.

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