Neurocritical Care Learning Objectives for Neurosurgery Residents
Updated 12/11/24

Goal: Adult neurosurgery residents will achieve all these objectives by the conclusion of their training.

Learning objectives (by system):

1. **Neurologic**
    a. **Coma and brain death**
        i. **Objective: Teach the elements of the coma exam**
        ii. **Objective: Teach the elements of the brain death exam**
        iii. **Objective: Appraise the available clinical data in making a diagnosis of brain death**

            Methods: Peer teaching, supervised clinical experience, simulation (assessment)

            Details:
            Domains: cognitive, psychomotor; understanding, evaluating
            Rationale: The coma and brain death exams are more focused than the comprehensive neurologic exam—which cannot be performed in many neurocritically ill patients—and require application of brainstem functional anatomy. Brain death is often misunderstood, and misdiagnosis has grave ramifications for the patient and for the medical field in general.
            References: 1, 3, 4

    b. **Neuroimaging**
        i. **Objective: Interpret neuroimaging (both CT and MRI) to recognize common critical pathologies and the compartment(s) affected**
        ii. **Objective: Hypothesize what impending clinicoradiographic progression may be at risk of occurring (e.g. stroke types, herniations, hydrocephalus) based on imaging interpretation**

            Methods: Problem-based learning, team-based learning

            Details:
            Domains: cognitive; remembering, analyzing, creating
            Rationale: Localization of the compartment in which a pathology lies informs the etiology and risk profile. Providing clinical correlation and anticipating what progression could entail helps to inform the clinical team of the early signs/symptoms to monitor, which may help improve outcomes.
            References: 1

    c. **ICP monitoring**
        i. **Objective: Identify the different modalities and strengths/weaknesses of ICP monitoring**

ii. **Objective: Interpret abnormal ICP waveforms (e.g. plateau waves)**
iii. **Objective: Recognize the signs/symptoms of elevated ICP in the absence of invasive monitoring (i.e. plateau waves)**

Methods: Reading, problem-based learning

Details:
Domains: cognitive; remembering, analyzing
Rationale: Abnormal waveforms may provide clues to impending decline despite normal quantitative ICP measurements. However, when invasive monitoring is not available, patients may exhibit non-specific signs and symptoms that, in the clinical context, require swift recognition and intervention to prevent morbidity and mortality.
References: 1, 2

iv. **Objective: Select a management strategy for managing elevated ICPs, whether known via invasive monitoring or by clinical signs/symptoms**

Methods: Problem-based learning, simulation (educational)

Details:
Domains: cognitive; applying, analyzing
Rationale: Elevated ICP can result from a variety of neurologic pathologies, and medical management—as well as indication for surgical management such as CSF diversion or decompressive craniectomy—is needed to appropriately manage patients
References: 1, 2, 3, 4

d. EEG

i. **Objective: Explain the indications for continuous EEG**

Methods: Lecture, online learning resources

Details:
Domains: cognitive; remembering
Rationale: Continuous EEG is a ubiquitous diagnostic test in neurocritical care, but its use and application are nuanced. Knowledge of the indications will guide appropriate utilization.
References: 1, 4

e. Common neurosurgical emergencies

i. **Objective: Describe the pathophysiology of ischemic stroke**
ii. **Objective: Summarize the diagnostic and therapeutic management of ischemic stroke**
iii. **Objective: Describe the pathophysiology of IPH**

iv. **Objective: Summarize the diagnostic and therapeutic management of IPH**
v. **Objective: Describe the pathophysiology of SAH**
vi. **Objective: Summarize the diagnostic and therapeutic management of SAH**
vii. **Objective: Describe the pathophysiology of SDH**
viii. **Objective: Summarize the diagnostic and therapeutic management of SDH**
ix. **Objective: Describe the pathophysiology of EDH**
x. **Objective: Summarize the diagnostic and therapeutic management of EDH**
xi. **Objective: Describe the pathophysiology of IVH**
xii. **Objective: Summarize the diagnostic and therapeutic management of IVH**
xiii. **Objective: Describe the pathophysiology of TBI**
xiv. **Objective: Summarize the diagnostic and therapeutic management of TBI**
xv. **Objective: Describe the pathophysiology of tSCI**
xvi. **Objective: Summarize the diagnostic and therapeutic management of tSCI**

Methods: Lecture, online learning resources, simulation (educational)

Details:
Domains: cognitive; understanding
Rationale: These are the most common neurologic emergencies that neurosurgeons will either primarily manage or on which they'll be consulted. Selection and prioritization of diagnostic and therapeutic options (particularly guideline-recommended surgical indications) follow from an understanding of the applicable pathophysiology, and may reduce the chances of leaving out any key task. There are several guideline recommendations for indications for operative intervention (e.g. early decompression of malignant MCA infarcts, size and/or other clinical characteristics for EDH or SDH, ICP monitoring for severe TBI).
References: 1, 2, 3, 4

2. **Respiratory**
    a. **Airway protection**
        i. **Objective: Indicate whether a patient's airway protection capacities are impaired**
        ii. **Objective: List common signs suggestive of such impaired airway protection**

Methods: Supervised clinical experience, peer teaching

Details:
Domains: cognitive; understanding
Rationale: Acutely ill neurosurgical patients frequently lose their ability to protect their airway as a result of their underlying pathology. Recognition of this is crucial to ensure care is escalated appropriately early before complications develop or accrue.
References: 2

3. **Cardiac**
    a. **Heart failure**
        i. **Objective: Recognize clinical signs and symptoms suggestive of decompensated heart failure**

        Methods: Peer teaching, supervised clinical experience

        Details:
        Domains: cognitive; remembering
        Rationale: Neurosurgical patients often have relevant comorbid cardiac disease. Conventional management of several acute neurosurgical illnesses often entails liberal fluid administration, which may exacerbate heart failure and contribute to poorer outcomes.
        References: 1, 2

    b. **Anticoagulation**
        i. **Objective: Identify the indications for thrombolysis and therapeutic anticoagulation for pulmonary embolism**
        ii. **Objective: Weigh the risk/benefit profile for delaying thrombolysis and/or therapeutic anticoagulation for pulmonary embolism**
        iii. **Objective: Identify the indications for therapeutic anticoagulation for atrial fibrillation**
        iv. **Objective: Weigh the risk/benefit profile for delaying therapeutic anticoagulation for atrial fibrillation**

        Methods: Lecture, problem-based learning

        Details:
        Domains: cognitive; remembering, evaluating
        Rationale: Neurosurgical patients are at high risk of developing pulmonary embolism and atrial fibrillation. The standard treatments of thrombolysis and therapeutic anticoagulation are typically contraindicated in the acute postoperative period. However, complex situations exist (e.g. emerging obstructive shock and progression to cardiac arrest) and require a careful weighing of the risks and benefits to identify the optimal treatment plan.
        References: 1, 2, 3, 4

4. **Gastrointestinal**
    a. **Enteral tube placement**
        i. **Objective: Interpret plain film abdominal radiography to determine if enteral tube placement is correct**

            Methods: Problem-based learning

            Details:
            Domains: cognitive; analyzing
            Rationale: Acutely ill neurosurgical patients frequently develop oropharyngeal dysphagia that necessitates enteral tube placement. Confirmation of tube placement in the GI tract rather than bronchopulmonary tree is essential.
            References: 1, 2

5. **Hematologic**
    a. **Coagulopathy**
        i. **Objective: Identify indications for acquisition of viscoelastic assays (i.e. ROTEM, TEG)**
        ii. **Objective: Interpret the results of viscoelastic assays to select the appropriate treatment strategy if coagulopathy is present**

            Methods: Lecture, problem-based learning

            Details:
            Domains: cognitive; analyzing, evaluating
            Rationale: Coagulopathy can have deleterious effects on perioperative and operative outcomes. Viscoelastic assays are a tool that may be used to help identify patients' hemostatic status and the specific treatment agents (e.g. FFP, cryoprecipitate, platelets) that are needed.
            References: 1, 2

6. **Infectious disease**
    a. **Neurologic**
        i. **Objective: Interpret clinical and radiographic data in diagnosing meningoencephalitis and distinguishing between the infectious etiologies (e.g. bacterial, viral, fungal)**

            Methods: Problem-based learning

            Details:
            Domains: cognitive; analyzing
            Rationale: CNS infection is an important postoperative complication and may also require neurosurgical intervention (e.g. CSF diversion). Identifying this early leads to timely appropriate therapeutic intervention, improving morbidity and mortality.
            References: 1, 2, 3, 4

b. **Pulmonary**
    i. **Objective: Interpret clinical and radiographic data to support or refute a diagnosis of pneumonia or pneumonitis**

    Methods: Problem-based learning

    Details:
    Domains: cognitive; analyzing
    Rationale: Pneumonia is incredibly common in acutely ill neurosurgical patients, but there is no single test that confirms the diagnosis. Instead, several data points must be interpreted. Aspiration pneumonitis is often misdiagnosed as pneumonia. As infection is often thought to be a trigger for exacerbation of chronic neurologic illnesses, accurate diagnosis must be made to avoid premature diagnostic satisfaction and minimize inappropriate antimicrobial therapy. ATS and IDSA have consensus guidelines on the diagnosis and management of patients with community-acquired, hospital-acquired, and ventilator-associated pneumonia.
    References: 1, 2

c. **Urologic**
    i. **Objective: Interpret clinical data to support or refute a diagnosis of urinary tract infection**

    Methods: Problem-based learning

    Details:
    Domains: cognitive; analyzing
    Rationale: Urinary tract infections are commonly found in acute neurosurgical patients, whether as a cause for their symptoms or even as a result of their deficits. However, UTIs are frequently over-diagnosed, which can negatively impact patient outcomes and contribute to antimicrobial resistance. As infection is often thought to be a trigger for exacerbation of chronic neurologic illnesses, accurate diagnosis must be made to avoid premature diagnostic satisfaction.
    References: 1, 2

7. **Palliative care**
    a. **Communication**
        i. **Objective: Share prognostic information, including prognostic uncertainty, in family meetings**
        ii. **Objective: Support family and team members in navigating decision-making in the face of uncertainty**

        Methods: Simulation (educational), role-playing, small group discussion

Details:
Domains: cognitive, psychomotor; applying, evaluating
Rationale: The nature of many acute neurosurgical pathologies mandates that a key skill neurosurgeons must have is that of articulating prognostic uncertainty when offering operative intervention and helping guide others in decision-making in the face of this uncertainty. This is a key feature that differentiates family meetings in the neurocritically ill population from typical palliative care practice.
References: 1

b. End-of-life care

i. Objective: Discuss the ethical considerations surrounding brain death

Methods: Small group discussion, lecture

Details:
Domains: cognitive; understanding
Rationale: Brain death is often misunderstood. As many neurosurgical pathologies may lead to brain death, neurosurgeons must be able to explain the ethical considerations when managing patients and communicating with primary teams and the patients' loved ones.
References: 1, 2

References

1. ACGME Neurosurgery Milestones. Revised 03/2018. https://www.acgme.org/globalassets/pdfs/milestones/neurologicalsurgerymilestones.pdf

2. ABNS Oral Examination Exam Topics. Revised 2024. https://www.abns.org/oral-examination/

3. NCS ENLS Protocols. Revised 2022. https://www.neurocriticalcare.org/NCS-Learning-Center/ENLS/Protocols

4. NCS Neurocritical Care Guidelines. Revised 2023-2024. https://www.neurocriticalcare.org/Resources-Publications/Neurocritical-Care-Guidelines