* See SWIFT for list of qualifying boards for continuing education hours.
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**Purpose**

The purpose of this packet is to provide the nurse with education on neurological evaluation of the adult patient. Orlando Health is an Approved Provider of continuing nursing education by Florida Board of Nursing (Provider No. FBN 2459) and the North Carolina Nurses Association, an accredited approver by the American Nurses Credentialing Center’s Commission on Accreditation (AP 085).

**Objectives**

At the completion of this self-learning packet, the participant should be able to:

1. Describe the purpose of a neurological examination.
2. Identify the impact of various conditions on neurological function.
3. Describe the five comprehensive components of a nursing neurological exam.
4. Explain how to evaluate cerebral/mental function, including level of consciousness.
5. Identify various levels of consciousness and altered states of consciousness based on accepted definitions.
6. Assign the appropriate Glasgow Coma Scale score based on patient findings.
7. Describe how to evaluate the 12 cranial nerves.
8. Describe how to perform a comprehensive evaluation of the pupils.
9. Describe how to evaluate and rate motor function.
10. Explain how to evaluate cerebellar function and findings.
11. Describe how to evaluate sensory function.
12. Describe how to evaluate and rate neurological reflexes.
13. Identify the cardinal signs of deterioration.
14. Identify situations which require further intervention, assessment, or reporting to the physician.
15. Differentiate between the evaluation performed on a conscious patient (GCS>8) vs. an unconscious patient (GCS<8).

**Instructions**

In order to receive 4 contact hours, you must:

**Directions:**

**For Non-Orlando Health employees:** Complete this test using the bubble sheet provided. Return to: Orlando Health Education & Development, MP14, 1414 Kuhl Ave, Orlando, FL 32806

**For Orlando Health Team Member:** Please complete testing via Online Testing Center. Log on to: SWIFT→ Departments→ E-Learning→ Testing Center. Use your Orlando Health Network Login and password. Select “SLP” under type of test; choose correct SLP Title. Payroll authorization is required to download test.

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Introduction

The nurse must be able to assess each system independently and to incorporate these findings together to obtain a complete picture of the patient. The goal is to establish a baseline in order to detect and trend any changes in the patient’s function. A key area that is often overlooked is the neurological system. It is very important to accurately assess the neurological status of patients because subtle changes can indicate critical problems. By performing an accurate neurological examination, appropriate interventions can be implemented and outcomes can be optimized.

It is important to relate the assessment with the functional anatomy to understand its significance and to prevent further insult to the neurological system. The following diagram identifies the lobes of the brain and their individual function. The cerebrum consists of the frontal, parietal, occipital, and temporal lobes. The cerebrum interprets and responds to the environment. The brainstem consists of the midbrain, pons and medulla. The brainstem is responsible for arousal and regulatory centers which regulate heart rate, blood pressure and respirations. The cerebellum is responsible for balance, muscle tone, posture and coordination of movement. Each area interacts with the others.

<table>
<thead>
<tr>
<th>Right Hemisphere Pathology</th>
<th>Left Hemisphere Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Motor loss on LEFT side</td>
<td>- Motor loss on RIGHT side</td>
</tr>
<tr>
<td>- Ignoring the affected side – leading to falls</td>
<td>- Inability to communicate effectively</td>
</tr>
<tr>
<td>- Pockets food – potential for aspiration</td>
<td>- Difficulty swallowing due to motor impairments</td>
</tr>
<tr>
<td>- Demonstrates verbally correct behavior, even though disoriented</td>
<td>- Unable to use the dominate upper extremity for ADLs</td>
</tr>
</tbody>
</table>

The right hemisphere controls hand dominance on the left side, artistic functions, music, art awareness, spatial orientation, creativity and insight. The left hemisphere controls hand dominance on the right side, number skills, spoken language, written language, abstract reasoning and scientific functions. The corpus collasum connects the right and left hemispheres of the cerebrum, coordinating the function of the two halves.
**Intravascular Component**

It is important for the brain to maintain a constant flow of blood for brain activity to occur. The arterial blood flow to the brain consists of approximately 20% of the cardiac output. Normal cerebral blood flow (CBF) is 750 ml/min. The brain autoregulates blood flow over a wide range of blood pressure through vasodilation or vasoconstriction. Two pair of major arteries supplies the brain: the right and left carotid arteries and the right and left vertebral arteries.

The carotid arteries provide circulation to the anterior portion of the brain (frontal, temporal, parietal and occipital lobes). This accounts for approximately 80% of the blood flow to the brain. The vertebral arteries join to form the basilar artery and comprise the posterior circulation of the brain (cerebellum, brainstem, and base of occipital and temporal lobes). This accounts for approximately 20% of the blood flow to the brain. The anterior and posterior circulation function separately; however, they connect together by communicating arteries to form the Circle of Willis. In response to decreased arterial flow, the Circle of Willis can act as a protective mechanism by shunting blood from one side to the other or from front to back. Due to this compensatory mechanism there is sometimes a delay in neurological signs and symptoms in patients.

**Arteries that supply the brain**
Artery Distribution – Anterior Circulation

<table>
<thead>
<tr>
<th>Artery Distribution – Anterior Circulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior Cerebral Artery (ACA)</td>
</tr>
<tr>
<td>Anterior Communicating Artery (AcomA)</td>
</tr>
<tr>
<td>Internal Carotid Artery (ICA)</td>
</tr>
<tr>
<td>Middle Cerebral Artery (MCA)</td>
</tr>
</tbody>
</table>

Artery Distribution - Posterior Circulation

<table>
<thead>
<tr>
<th>Artery Distribution - Posterior Circulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior Communicating Artery (PcomA)</td>
</tr>
<tr>
<td>Posterior Cerebral Artery (PCA)</td>
</tr>
<tr>
<td>Basilar Artery (BA)</td>
</tr>
<tr>
<td>Vertebral Artery (VA)</td>
</tr>
</tbody>
</table>

Venous Drainage System

The brain is drained by cerebral veins which drain into large venous channels called venous sinuses and then into the right and left internal jugular veins. The venous sinuses are found within the folds of the dura mater. The veins and sinuses of the brain do not have valves so blood flows freely and by gravity. The face and scalp veins can also flow into the brain venous sinuses; therefore, infection can easily be spread into the dural venous sinuses and then enter into the brain.

Patient position can prevent or promote venous drainage from the brain. Head turning and tilting may kink the jugular vein and decrease or stop venous flow from the brain. This then increases the pressure inside the cranial vault. To promote venous drainage, the head should be maintained in a neutral position and the head of bed elevated up to 30 degrees.

Clinical Application:

It is important to maintain the head and neck in a neutral position to maintain blood flow to the brain and allow for venous drainage through the jugular veins.
Pre-Neurological Examination

Although not officially part of the neurological examination, it is important to gather information about the patient’s current and past medical and surgical history. There are a variety of conditions that may produce changes in neurological function. These include mass lesions (blood clots, tumors, abscesses, edema, hydrocephalus), disruptions in blood flow (ischemic or hemorrhagic stroke), metabolic disorders (electrolyte imbalances, high ammonia levels, decreased oxygen levels), and infectious disorders (bacterial or viral infections). A mnemonic to remember is you can get “T.I.P.S.S.” if you know your vowels – “A.E.I.O.U.”

<table>
<thead>
<tr>
<th>T.I.P.S.S.</th>
<th>A.E.I.O.U.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tumor</td>
<td>Alcohol</td>
</tr>
<tr>
<td>Injury</td>
<td>Epilepsy</td>
</tr>
<tr>
<td>Psychological disorders</td>
<td>Insulin</td>
</tr>
<tr>
<td>Stroke</td>
<td>Opium</td>
</tr>
<tr>
<td>Sepsis</td>
<td>Uremia</td>
</tr>
</tbody>
</table>

The neurological examination is closely associated with the cardiovascular and respiratory systems. The nurse must first rule out problems in these systems prior to identifying a neurological deficit. This is accomplished by evaluating the patient’s airway, breathing, and circulation. Key to this is evaluation of the patient’s perfusion and oxygenation status.

Perfusion

For our discussion, we are focusing on perfusion to the brain. One way to indirectly assess perfusion of the brain is to calculate the Mean Arterial Pressure or MAP. MAP is equal to 2 x the diastolic blood pressure (DBP) plus the systolic blood pressure (SBP) divided by 3.

\[
\text{MAP} = \frac{2 \times \text{DBP} + \text{SBP}}{3}
\]
In a patient with signs of neurological disease (intracranial hypertension), the MAP should be $\geq 90$ mm Hg. However, patients function may be better at a lower or higher range, so this may need to be adjusted to reflect the level at which the best neurological status is achieved. In other words, a patient may actually have a better neurological status when he has a MAP of 80 rather than 90.

**Oxygenation**

In general, it is recommended that patients with a neurological disease should have a SpO$_2$ of 95% or greater.

**Components of Neurological Examination**

A comprehensive neurological exam includes the following five components, each of which will be covered in detail in this packet:

- **Cerebral function** – Examination of level of consciousness, mental status, awareness, arousal, cognitive function, and behavior.
- **Cranial nerve and pupillary examination** – Reflects brainstem function. Examination of areas including pupils, eye movements, cough reflex, corneal reflex, and gag reflex.
- **Motor and cerebellar functions** – Examination of strength, movement, gait, and posture.
- **Sensory system** – Examination of tactile and pain sensations.
- **Reflexes** – Determination of superficial and deep tendon reflexes.

**Cerebral/ Mental Function**

The frequency of the neurological and mental function examinations is dependent on how the patient has responded to the initial and continued examinations. Changes can occur at any time and the nurse must be ready to investigate further. The nurse can easily assess the cognitive functions of the patient just by monitoring activities of daily living and watching for anything unusual or different from the patient’s normal behavior. For example, if the patient has a change in level of activity or speech.

There are several elements that should be included in the examination. Evaluating the cerebral functioning includes observing the patient’s appearance and behavior, communication skills, cognitive abilities, mentation, and most importantly the level of consciousness (LOC). Each area will be covered in the sections below.

**Level of Consciousness & Orientation**

This is a very important component of the assessment that is performed continually since it is a very sensitive and early indicator of intracranial pathology. It is not unusual for there to be subtle changes in level of consciousness long before any other neurological changes.

As you enter the room, observe the patient for his state of arousal. Is the patient awake and alert, dozing, or asleep? Does the patient seem to understand your questions and respond appropriately.

Further Information on Level of Consciousness:

- Definitions: page 12
- Special States: pages 13-14
- Glasgow Coma Scale: pages 15-16
without hesitancy? If the patient is dozing or asleep, does he awake when you arouse him? If the patient does not arouse, you need to use increasing levels of stimulation and evaluate his level of consciousness using the Glasgow Coma Scale (GCS). Use of this scale is covered in a later section. If the patient is not awake, you will not be able to assess further mental functioning.

If the patient is awake, even if drowsy, continue by assessing orientation to self, place, and time. Ask the patient their name, where they are, and what time it is. When asking about place if they cannot be specific, e.g. “I am in the hospital or at a specific hospital such as “Orlando Regional Medical Center”, ask them what city or state they are in and document accordingly. When asking about time, if they cannot tell you the day or time, ask them to tell you what month it is or what year and document accordingly.

**Communication & Attention Span**

Language is a function of the dominant cerebral hemisphere, which is divided into emotional and conceptual. There are three disorders of speech and language: dysarthria, dysphonia, and dysphasia. Dysarthria is a disturbance in articulation. The patient may have difficulty pronouncing the following letters: “t,” “m,” “l,” or “g.” Dysphonia is the inability to produce an adequate sound (e.g. whispers, breathy) and is due to respiratory disease or vocal cord paralysis. Dysphasia is the loss of production or comprehension of spoken and/or written language due to brain damage. When talking with the patient, observe the quantity and the quality of what the patient says. Evaluation of communication will identify aphasia, which can be receptive, expressive, both expressive and receptive (global), or conduction.

Patients with receptive aphasia have difficulty understanding and/or processing what they hear. Patients with expressive aphasia have difficulty saying words or finding the right words to say. Some questions to consider when assessing this area include the following. Does the patient:

- answer questions appropriately?
- use complete sentences or just single words?
- seem to be searching for words, use incorrect words, or use vulgar words when speaking?
- have any speech or articulation problems, such as slurring?

Next, ask the patient to follow a brief command, such as show me two fingers, wiggle your toes, or stick out your tongue. This further evaluates the patient’s ability to hear and understand you.
When assessing attention span observe if the patient is able to focus and concentrate on the conversation or task. Observe to see if the patient becomes distracted by the surrounding environmental stimuli or if he dozes off during conversations or tasks. Attention span can also be assessed by asking the patient to spell “WORLD” backward or count backward from 100 either by single digits, by 3’s, or by 7’s.

**Memory**

Memory includes long-term and short-term memory. To assess long-term memory, ask relevant questions about the person’s past that can be validated, for example, “What year were you born?” “Where were you born?” or “Where did you go to school?” To check short term memory, tell the patient to remember three words or your name. Have the patient immediately repeat the memorized information. Then about five minutes later ask them to tell you what you have asked him to remember.

**Higher Cognitive Functions**

This area will likely not be assessed unless there is known or suspected neurological disease. It includes evaluation of the patient’s knowledge, calculating ability, abstract thinking, and construction ability (drawing).

**Knowledge** can be assessed by asking specific facts. For example, “Who is the president?” or “Name the last three or four presidents.” Make sure the questions ask something that would be common knowledge and can be reasonably answered by the patient.

**Calculation** can be tested by asking the person simple addition or multiplication questions, such as “4 + 3” or “5 x 6.” The questions can be made more difficult by using two-digit numbers, “12 + 15” or “25 x 6.” Alternatively, a functional question can be asked. For example: “If something costs 82 cents and you give the clerk one dollar, how much change should you get back?”

**Abstract** thinking can be tested in two ways.

- **Proverbs:** The first way is to tell the patient a proverb and ask him to explain what it means. The answer can help determine if they think in concrete terms or in abstract terms. For example, if you asked what “a stitch in time saves nine” means and he said it means sew small tears up so they don’t get bigger, it reflects concrete thinking. However, if he said it means address problems while they are small to prevent bigger problems, it reflects abstract thinking. It is very important when asking proverbs to make sure it is something the person would understand. Many proverbs are cultural, so someone from another culture may interpret it literally even if abstract thinking is intact.

- **Similarities:** The second way is asking the patient how two items are similar. For example, a cat and a mouse. If he said they both have tails, it reflects concrete thinking. If he said they are both animals, it reflects abstract thinking. If he said the cat chases the mouse, it would not be relevant.

**Constructional ability** can be testing by asking the patient to copy figures of increasing complexity. To do this, show each of the figures shown here to the patient one at a time and ask him to draw it on a blank piece of paper.
Level of Consciousness Definitions

The LOC can range from full consciousness to a totally unresponsive state. These levels may be considered subjective and frequently have a very different meaning from one healthcare provider to another. The following are accepted neurological definitions (Hickey, 2009).

Full consciousness
Patient is awake, alert and oriented to time, place and person. They are able to comprehend the spoken and written word and express ideas either verbally or in writing. Patient demonstrates socially responsible and acceptable behavior.

Confusion
Patient is disoriented to time, place, or person. They have a shortened attention span and memory difficulties. In addition, they may have difficulty following commands and easily become agitated, restless, and irritable. There may be nocturnal confusion. Patients in this category are at high risk for injury due to falls. It is important for staff and family to appropriately observe the patient.

Lethargy
Patient is oriented to time, place, and person; however, speech, mental processes, and motor activities are slower than expected. This patient population is at high risk for injury secondary to falls and burns. An important aspect of nursing care is to appropriately monitor these patients’ activities.

Obtundation
Patient can only be aroused with tactile stimulation and usually responds verbally to these stimuli with only one or two words. This patient can follow simple commands only when stimulated. Patients in this category are also at high risk for injury due to falls. Again, it is important to closely observe these patients.

Stupor
Stupor is defined as a minimal spontaneous movement of the patient except when vigorous and constant stimuli are applied. The patient’s verbal response only consists of moaning or groaning. When noxious stimuli are applied to the patient, they will respond purposefully.

Coma
Coma is defined as the total absence of awareness of self and environment. Coma patients do not exhibit any response to external stimulation or internal needs. Patients may appear to be sleeping with no response noted to verbal stimuli. Patients can exhibits purposeful or non-purposeful movement, or be completely unresponsive. Patients in this category have a Glasgow Coma Scale (GCS) rating less than 8. Brainstem reflexes such as the cough and gag reflex are weakened. Prevention of aspiration is necessary. The nurse must closely observe the patient and monitor for signs of aspiration.
**Special States of Altered Consciousness**

There are five special states of altered consciousness that will be defined and discussed below.

**Persistent Vegetative State (PVS)**

Acute traumatic and non-traumatic brain injuries, degenerative and metabolic brain disorders, and severe congenital malformations of the nervous system can cause Persistent Vegetative State (PVS). The American Academy of Neurology defines PVS as a clinical condition of complete unawareness of the self and the environment, accompanied by sleep-wake cycles, with either complete or partial preservation of hypothalamic and brainstem autonomic functions. If this condition persists for more than a month, it is called persistent vegetative state. The life expectancy of this patient population depends on the cause; however survival ranges from 2 to 5 years. The clinical presentation of the patient may include:

- No evidence of sustained, reproducible, purposeful, or voluntary behavioral responses to visual, auditory, tactile or noxious stimuli.
- No evidence of language comprehension or ability for appropriate expression.
- No bowel or bladder control.
- Does not react to pain.
- Varying response patterns are seen in cranial nerves, primitive reflexes and spinal reflexes.
- Spontaneous respirations while maintaining vital signs.
- Spontaneous movement and eye opening, appear to visually follow people in the room, however they are unable to follow commands.

**Locked-in Syndrome**

Locked-in syndrome is caused by the interruptions of the descending corticobulbar and corticospinal tracts at or below the pons (brainstem). Locked-in syndrome refers to a condition in which full consciousness and cognition are intact, but the patient is unable to respond by moving or communicating. This syndrome may be associated with myasthenia gravis, poliomyelitis, infarctions occurring in the pontine area (brainstem), peripheral motor neuron diseases, and administration of neuromuscular blocking agents (NMBA).

**Dementia**

Dementia is a progressive disease and has many known causes including primary organic disorders of the cerebral cortex or hemispheres owing to diffuse injuries or degenerative disorders. Dementia is characterized by persistent deficits in at least three of the following areas: memory, language, visuospatial skills, personality or emotional state, and cognition. Dementia usually is considered an irreversible condition except in vitamin deficiency and normal pressure hydrocephalus. These patients are unable to function independently. The three most common causes of dementia are Alzheimer’s disease, multi-infarct dementia and dementia associated with concurrent neurological diseases such as Parkinson’s disease.

**Delirium**

Delirium (acute confusional state) is an acute disturbance of cerebral function with an impaired conscious level, hallucinations and autonomic over-activity as a result of a precipitating illness, drug intoxication, neurological disorder, metabolic and nutritional imbalance, or iatrogenic
disorders of hospitalization. Delirium is usually reversible by treating the cause, providing medications such as antipsychotics and antidepressants, reassurance, and structured environment. For agitation a low keyed environment is needed, and for lethargy and quiet confused patients increased stimulation and attention is needed. The major characteristics of the acute confusional state (ACS) are altered attention behaviors (disoriented, irritable), perceptual disturbances (hallucinations, fear), incoherent speech, and disturbance of sleep-wake cycle.

Reversible causes of confusion:
Metabolic or biochemical abnormality, infection, impaction, inability to void, injury, neoplasm, nutritional deficiency, normal pressure hydrocephalus, drug withdrawal, environmental toxins, sleep deprivation, sensory overload, sensory deprivation, cerebrovascular or central nervous system diseases, alcohol withdrawal, anemia, pain, emotional and mental illness.

Brain Death
Brain death is defined as a state of irreversible loss of both cortical and brainstem activity. There will be an absence of spontaneous respirations, brainstem reflexes, and/or cranial nerve function. By current medical definition, this is an irreversible condition.

The physician may order the following tests which are performed at the bedside for brain death determination:

- Oculocephalic reflex (Doll’s eyes)
- Oculovestibular reflex (Cold caloric test)
- Apnea test

These are procedures that are only performed by the physician.
Glasgow Coma Scale & Level of Consciousness

The level of conscious (LOC) is the most sensitive indicator of intracranial pathology. The LOC is a combination of an arousal and awareness to the environment and the ability to receive, interpret and respond to the stimuli from the environment. The content part of consciousness (awareness of the environment) is stimulated by messages sent from the reticular activating system (RAS) to the cortex.

One method of measurement is the Glasgow Coma Scale (GCS), which assesses eye opening, verbal response, and motor response in a patient. The score is then totaled and trended. When a total score is below 8, this indicates coma and the need to intubate the patient for airway protection and respiratory support.

Use of the GCS requires maximum stimulation of the patient prior to your examination. The stimulation should be 15 to 30 seconds long and the rating is performed based on the person’s best response to the stimulus according to the type and degree of stimulus used. Patients with artificial airways (endotracheal tube or tracheostomy) must have their verbal response tested by using eye blinks, finger signals, and communication boards.

Order of stimulus includes:
- **Presence** – entering a patient room and noting patient response
- **Verbal** – entering a patient room, calling patient by name and noting patient response
- **Tactile** – no response to above stimuli, touching patient and noting patient response
- **Central noxious/painful stimulus** – no response to above stimuli, using noxious stimuli (sternal rub, trapezius squeeze, retromandibular pressure or supraorbital pressure) applied to right and left side of patient and noting patient response.

**Note:** Avoid applying nail bed pressure to the base of the patient’s toenails or pinching the nipples because this may produce an abnormal spinal cord reflex.

- **Peripheral noxious/painful stimulus** – no response to the above central noxious/painful stimuli, using noxious stimuli (nail bed pressure) applied to the extremity/extremities that did not respond to central noxious stimuli. This is done to assess the spinal reflex and observe lower motor neuron function to determine movement of the extremity.
**Eye opening**
This area assesses the function of the reticular activating system (RAS) located in the brainstem. It controls alertness and arousal to the environment (normal sleep/wake cycles).

A patient who only opens one eye to stimulus, while the other eye remains closed, must be rated on the response for the open eye. This reflects the best response.

<table>
<thead>
<tr>
<th>Eye Opening</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opens eyes spontaneously when approached</td>
<td>4</td>
</tr>
<tr>
<td>Opens eyes in response to speech (normal or shout)</td>
<td>3</td>
</tr>
<tr>
<td>Opens eyes only to painful stimuli (sternal rub, trapezius pinch, retromandibular, or supraorbital pressure)</td>
<td>2</td>
</tr>
<tr>
<td>Does not open eyes to painful stimuli</td>
<td>1</td>
</tr>
</tbody>
</table>

**Verbal response**
This area reflects the functions of the cerebral cortex. It is associated with the RAS and is responsible for awareness to the environment and the ability to carry on a conversation appropriately.

Caution: Patients can learn responses to repetitive questions. It is important to vary conversations and interactions to identify whether the patient is confused. If the patient answers incorrectly, correct their mistakes and reassess their memory to identify impairment. Remember that a patient with impaired memory is at risk for falling or injury and requires close observation.

<table>
<thead>
<tr>
<th>Verbal Response</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oriented to time, place, and self</td>
<td>5</td>
</tr>
<tr>
<td>Converses, although confused</td>
<td>4</td>
</tr>
<tr>
<td>Speaks only in words or phrases that make little or no sense</td>
<td>3</td>
</tr>
<tr>
<td>Responds with incomprehensible sounds (groans, moans)</td>
<td>2</td>
</tr>
<tr>
<td>No verbal response</td>
<td>1</td>
</tr>
</tbody>
</table>

**Motor response**
This area reflects the function of the cerebral hemispheres, the diencephalon, and/or the brain stem. It also measures the function of corticospinal tracts, which is the motor portion of the cerebral cortex.

Function is evaluated by the patient’s ability to move bilaterally. If abnormal functional responses are found during the examination, this indicates the hemisphere and area of impairment. Muscle weakness is a cardinal sign of neurological dysfunction.

<table>
<thead>
<tr>
<th>Motor Response</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can obey a simple command (squeeze my hand)</td>
<td>6</td>
</tr>
<tr>
<td>Localizes to painful stimuli and attempts to remove source</td>
<td>5</td>
</tr>
<tr>
<td>Withdrawal in response to pain</td>
<td>4</td>
</tr>
<tr>
<td>Flexes elbows and wrists while extending lower legs to pain</td>
<td>3</td>
</tr>
<tr>
<td>Extends upper and lower extremities to pain</td>
<td>2</td>
</tr>
<tr>
<td>No motor response to pain on any limb</td>
<td>1</td>
</tr>
</tbody>
</table>
Posturing, flexion and/or extension of the extremities indicates possible extensive damage to the cerebral hemispheres and brainstem. Two of the more common postures are decorticate (flexion) and decerebrate (extension).

**Decorticate - flexion:**
The upper arms are held tight to the sides with the elbows, wrists, and fingers flexed. The legs are extended and internally rotated. The feet are plantar flexed. This implies a destructive lesion of the corticospinal tracts within or very near the cerebral hemispheres.

**Decerebrate - extension:**
The arms are adducted and the elbows are stiffly extended. The forearms are pronated and the wrists and fingers are flexed. The legs are stiffly extended at the knees, with the feet plantar flexed. This implies a lesion in the lower parts of the brain (diencephalon, midbrain, or pons).

**Cranial Nerve (CN) Examination**

The patient’s condition determines to what extent the cranial nerves need to be assessed. Assessing the twelve pairs (right and left) of cranial nerves can be important due to the close anatomical proximity to the posterior fossa. Deficits that can be present include inability to follow specific commands (e.g. smile, stick out tongue) or the patient reporting subjective changes in neurological function (e.g. double vision). The nurse needs to have a clear understanding of the patient’s admitting diagnosis or complaint and the specific examinations that are continually needed. In general, not all twelve nerves are assessed by the nurse. Most often CN II (Optic), III (Oculomotor), IV (Trochlear), and VI (Abducens) are evaluated. However, the nurse may need to assess the other nerves depending on the patient’s history, treatment plan or symptoms. CN I and II
pass through or innervate in the thalamus. CN III, IV, and V innervate and extend from the midbrain. CN VI, VII, VIII innervate and extend through the pons. CN IX, X, XI, and XII pass through and extend through the medulla. Knowing the function and location of the cranial nerves can assist the practitioner in detecting changes in neurological conditions and adjust the treatment plan as indicated.

The twelve cranial nerves are listed in the table below along with common mnemonics that are helpful to remember them and whether the nerve is sensory, motor, or a combination of both.

<table>
<thead>
<tr>
<th>Cranial Nerve</th>
<th>Mnemonic</th>
<th>Mnemonic</th>
<th>Motor or Sensory Function</th>
<th>Mnemonic</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN I</td>
<td>Olfactory</td>
<td>Oh</td>
<td>On</td>
<td>Sensory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Some</td>
</tr>
<tr>
<td>CN II</td>
<td>Optic</td>
<td>Oh</td>
<td>Old</td>
<td>Sensory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Say</td>
</tr>
<tr>
<td>CN III</td>
<td>Oculomotor</td>
<td>Oh</td>
<td>Olympus’</td>
<td>Motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Marry</td>
</tr>
<tr>
<td>CN IV</td>
<td>Trochlear</td>
<td>To</td>
<td>Towering</td>
<td>Motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Money</td>
</tr>
<tr>
<td>CN V</td>
<td>Trigeminal</td>
<td>Touch</td>
<td>Top</td>
<td>Both</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>But</td>
</tr>
<tr>
<td>CN VI</td>
<td>Abducens</td>
<td>And</td>
<td>A</td>
<td>Motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>My</td>
</tr>
<tr>
<td>CN VII</td>
<td>Facial</td>
<td>Feel</td>
<td>Finn</td>
<td>Both</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Brother</td>
</tr>
<tr>
<td>CN VIII</td>
<td>Acoustic</td>
<td>A</td>
<td>And</td>
<td>Sensory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Says</td>
</tr>
<tr>
<td>CN IX</td>
<td>Glossopharyngeal</td>
<td>Great</td>
<td>German</td>
<td>Both</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bad</td>
</tr>
<tr>
<td>CN X</td>
<td>Vagus</td>
<td>Vein</td>
<td>Viewed</td>
<td>Both</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Business</td>
</tr>
<tr>
<td>CN XI</td>
<td>Spinal Accessory</td>
<td>Ah</td>
<td>Some</td>
<td>Motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Marry</td>
</tr>
<tr>
<td>CN XII</td>
<td>Hypoglossal</td>
<td>Heaven</td>
<td>Hops</td>
<td>Motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Money</td>
</tr>
</tbody>
</table>

The following page shows the location and innervation of each of the cranial nerves.
Cranial Nerve I (Olfactory)

This nerve controls the sense of smell. It is most commonly affected by trauma or lesions in the frontal lobe.

Testing:

After checking the patency of the patient’s nostrils, have the patient close their eyes and occlude one nostril. Then hold a familiar pungent substance (camphor, lemon oil, coffee, or peppermint) under the patient’s nose and ask its identity. Repeat this technique for the other nostril. Patients may be able to detect that there is an odor, but not be able to specify the odor. If this is the case, give them several choices of odors to pick from.

Cranial Nerve II (Optic)

This nerve controls the visual system, including both central and peripheral vision. Damage here may result in a variety of visual alterations.

Homonymous hemianopia is a same-sided visual field cut, caused by strokes that involve the middle cerebral artery. Bitemporal hemianopia is loss of outer visual fields in each eye, which can be caused by a lesion involving the pituitary gland at the optic chiasm where the two tracks of the nerve intersect.

Testing:

To evaluate central vision, test the ability to read letters near and far. Allow patient to wear their corrective lenses.

Peripheral vision can be evaluated using the confrontation test. Stand opposite the patient and ask them to stare straight ahead. Then slowly bring your fingers from beyond the limits of the visual field and ask the patient to let you know when he sees...
your fingers. This should be repeated for each visual quadrant. If defects are noted, each eye should be checked separately. This information is documented in the narrative notes.

**Cranial Nerves III (Oculomotor), IV (Trochlear), and VI (Abducens)**

These three nerves control the ocular muscles. CN III specifically controls muscles of the iris and therefore the pupil and it also raises the eye lid. Damage to these nerves may result in weakness or paralysis with diplopia as well as change in or loss of pupillary reaction. Other abnormalities that may be seen include abnormal extraocular movements (EOM), nystagmus, ptosis (droopy eyelid) and inability to focus the eyes in various positions of gaze (upward, downward, lateral, etc.). Damage to CN III can cause the pupils to be unequal or misshapen. It may also cause abnormal pupillary constriction to light or accommodation. Accommodation is the ability to focus on an object from far to a nearby point. Damage to CN III can also cause ptosis and compromise the ability of the eye to look upward, toward the nose, and toward the downward, outward position. Damage to CN IV will compromise downward, inward movement of the eyeball. Damage to CN VI will result in the compromise of looking toward the ear.

Disorders of gaze primarily follow vascular events such as ischemic or hemorrhagic stroke however they can occur in traumatic, inflammatory or neoplastic diseases. In gaze palsy, eye movements are symmetrically limited in one direction.

**Conjugate deviation of the eyes:**

- **Seizure** – eyes deviate towards the affected limbs in a jerking fashion
- **Hemiparesis** – eyes deviate away from the hemiparetic limb ipsilateral to the lesion in the brain or toward the hemiparetic limb indicating a lesion in the pons which is contralateral to the direction of eye deviation.

**Vertical Gaze Palsy:**

- **Parinaud’s syndrome** – impaired upward eye movement identified with dorsal midbrain lesions, third ventricular tumors, Pineal tumors, hydrocephalus, Multiple Sclerosis, Wernicke’s encephalopathy, and encephalitis. The pupils may dilate in reaction to light; however, accommodation is impaired.

**Nystagmus:**

Nystagmus is identified by involuntary movement of the eyes in a horizontal, vertical, rotatory or mixed direction. It is a result of retinal disease, labyrinthine disease or disorders affecting the central nervous system – cerebellum or brainstem.
Cranial Nerve | Movement
--- | ---
CN III – Oculomotor Third nerve palsy | Normal eye movement: Up, down, and in (three separate movements)  
Palsy: manifested by a dilated pupil, ptosis, an eye that deviates outward, or a combination of these deficits, ipsilateral to the side of the lesion (on the same side)

CN IV – Trochlear Fourth nerve palsy | Normal: down and in (toward the tip of nose)  
Palsy: inability of the contralateral (opposite side) eye to look down and in.

CN VI – Abducens Sixth nerve palsy | Normal: lateral (toward the ear)  
Palsy: patient unable to look laterally, ipsilateral to the side of the lesion (on the same side)

Testing of Pupils:
Pupillary examination is a major component in the physical examination of patient in order to determine the presence of intracranial pressure changes and herniation syndromes. Pupils may be examined in both the conscious and unconscious patient. Neuromuscular blocking agents and sedatives have an effect on the reactivity of the pupil but have minimal effect on its size. Serial examinations are important. The examiner must utilize the appropriate techniques, recognize abnormalities, document the findings and notify the physician immediately with any changes or signs of deterioration.

The pupils must be compared for size, shape, symmetry and reaction to light. Size is documented in millimeters as found on a standard pupillary chart. It is important to dim the ambient light in the room. The size of the pupils is documented before you shine the light on the pupils. Large pupils may occur if the patient is afraid, medications such as atropine or scopolamine have been administered, or if the brain is herniating. Small pupils may indicate narcotic overdose, pontine damage, or lower brainstem compression. For a small number of people it is normal to have a discrepancy of up to 1 mm between the two pupils. This condition of unequal pupils is known as anisocoria. However, when there is a new or increased pupil size discrepancy, findings should be immediately reported to the physician.

If there is an increase in intracranial pressure (ICP), the pupils shape may change from round to oval; this indicates that CN III is involved. With oculomotor (CN III) involvement, the direct light reflex and consensual light reflex is altered in the affected pupil. Please remember that pupillary changes are usually a LATE SIGN of elevated intracranial pressure. Ophthalmic surgery such as iridectomy (sector – keyhole, or peripheral iridectomy) can change the shape of the iris. This may or may not affect the iris reaction to light. Other abnormalities in shape should also be noted and monitored for changes in the assessment.
Direct Light Reflex is pupillary reaction to light which is tested by directly shining a narrow-beamed bright light into the eye from the outer canthus. The reaction is either noted as

- Brisk (B)
- Sluggish (S)
- Nonreactive or fixed (F)

A brisk reaction would be a normal finding. All other findings are abnormal and should be reported to the physician immediately.

Consensual Light Reflex is defined as a pupillary response of constriction in the opposite eye when testing for the direct light reflex.

Convergence occurs when the eyes move together to focus on an object held directly in front of the face.

Etiology of Pupillary Abnormalities:

- Neurological disease
- Acute intraocular inflammation resulting in spasm or atony of the pupillary sphincter
- Previous inflammation causing adhesions of the iris
- Prior surgical alteration
- Effect of systemic or eye medications
- Benign variations of normal

Types of Abnormal Pupils

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Etiology/Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaurotic Pupil</td>
<td>No direct light response, no consensual response in the blind eye</td>
<td>Disease of the retina or optic nerve</td>
</tr>
<tr>
<td>(Blind eye)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marcus-Gunn Pupil</td>
<td>Normal bilateral light response when the light is shown into the intact eye; but when light is shown into the diseased eye it responds with dilation</td>
<td>Lesions/atrophy of the retina or optic nerve</td>
</tr>
<tr>
<td>(Swinging flashlight sign)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argyll-Robertson Pupil</td>
<td>Small irregular shaped pupils that react (constrict) to accommodation but not to direct light</td>
<td>Neurosyphilis (tabes dorsalis)</td>
</tr>
<tr>
<td>Adie Pupil</td>
<td>Unilateral dilated pupil that reacts slowly to light after prolonged stimulation with slow accommodation.</td>
<td>Postganglionic denervation of the parasympathetic pupillary innervation. Cause unknown; may be seen post viral infection</td>
</tr>
<tr>
<td>(Tonic Pupil)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mydriatic Pupil</td>
<td>Bilateral or unilateral large pupils.</td>
<td>Certain drugs: hallucinogens, antihistamines, glutethiamide, anticholinergics, and dopamine. Direct eye trauma to nerve endings of the iris sphincter muscle</td>
</tr>
<tr>
<td>(Large Pupils &gt; 6mm in size)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Types of Abnormal Pupils (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Etiology/Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horner’s Syndrome</td>
<td>Unilateral small pupil with ptosis of eyelid, and usually loss of sweating on the affected side. Both pupils react to direct light and accommodation.</td>
<td>Lesions of descending sympathetic fibers in ipsilateral brainstem or upper cord, or the ascending sympathetic fibers in neck or head; results in unilateral interruption.</td>
</tr>
<tr>
<td>Miotic Pupils</td>
<td>Bilateral or unilateral small pupils</td>
<td>Certain drugs such as acethlcholine chloride, carbachol, cemecarium bromide, echothiphate iodide, isoflurophate, physostigmine, pilocarpine, and narcotics. Also due to pontine hemorrhage or infarct, direct orbital injury to the eye with destruction of the sympathetic innervation and sleep.</td>
</tr>
</tbody>
</table>

Testing of Extraocular Movements (EOM)

This is tested in the conscious patient by asking them to follow your finger through the six different visual fields as seen in the diagram. Normally the patient’s eyes move smoothly. If there is a lack of movement or nystagmus, this would be abnormal. Physiological nystagmus can occur when the eyes deviate to the endpoint of the gaze direction.

EOM may be tested in the unconscious patient by assessing for the oculocephalic reflex, otherwise known as Doll’s eyes. To assess, the examiner holds the patient’s eyelids open and briskly rotates the head to the side while observing the eye movements, then quickly rotates the head to the other side and observes the eye movement. If the eyes move to the opposite direction in which the head is turned, Doll’s eyes are present and the oculocephalic reflex is intact. Lack of response, where the eyes remain midline and move with the head, indicates brainstem injury.

In the unconscious patient a final tool, the oculovestibular reflex (cold caloric test), is used for brainstem evaluation of the pupillary examination. This is performed by the physician after confirming that the tympanic membrane is intact. Ice water is injected (20 – 100 ml) into the external auditory canal. If the brainstem is intact, the eyes will deviate slowly and nystagmus may occur, towards the irrigated ear canal. Nausea, vomiting, and dizziness may also occur. Abnormal responses include dysconjugate eye movements or no eye movement.

Complete Pupillary Examination Includes:
- Direct Light Reflex
- Consensual Light Reflex
- Extra-ocular Movements (EOM’s)
- Accommodation
- Visual Field Examination
Cranial Nerve V (Trigeminal)

This nerve has both a motor and a sensory component, and it includes an ophthalmic branch. The sensory component controls sensation of the face, the motor component controls chewing, and the ophthalmic branch controls the corneal reflex. Damage to this nerve can result in decreased or absent facial sensation, reflex changes, and atrophy of masseter and temporal muscles of chewing. Diminished or absent corneal reflex can result in a corneal abrasion, ulceration, or even blindness.

Testing

Sensory: With the patient’s eyes closed, test for light touch using a wisp of cotton. Touch each of the areas innervated by the three branches of the nerve bilaterally, and ask the patient to tell you where you touched. Then lightly touch the face with alternating sharp and dull objects and ask the patient to tell you if they feel sharp or dull. If deficits are noted, try touching the patient’s face with warm and cold water in a clean lab tube.

Motor: Ask the patient to clench his teeth, and palpate masseter and temporal muscles. Note the strength of the muscle contraction.

Corneal reflex: Ask the patient to look up and away from you. Approaching the patient from the outer side, out of the patient’s line of vision, touch a wisp of cotton dampened with sterile saline to the patient’s cornea. The patient normally would blink. Use of contact lenses can diminish or abolish this reflex. Light touch is through the afferent route of CN V, the efferent route is through CN VII.

Clinical Application

The most common neurological disease associated with this CN is Trigeminal Neuralgia, which presents as a sharp, stabbing, shooting paroxysmal pain.

Cranial Nerve VII (Facial)

This nerve controls symmetrical facial expressions, such as smiling, frowning, raising the eyebrows, and closing the eyes. Damage may result in spasms, weakness, atrophy, and/or tremors. This nerve also controls the sense of taste in the anterior two-thirds of the tongue.

Testing

Carefully observe the patient’s face during conversation and look for any asymmetry or abnormal movements. Also ask the patient to smile, frown, raise eyebrows, close eyes tightly, show both upper and lower teeth, and puff out both cheeks.

If a deficit in taste is reported, have the patient identify different substances that are sweet, sour or salty. Between each substance have the patient take a sip of water to cleanse the palate.
**Cranial Nerve VIII (Acoustic)**

This nerve controls hearing and vestibular function (balance). Hearing loss and disequilibrium in a patient may be the result of an injury to this nerve. To differentiate conductive deafness from perceptive deafness, the physician performs the following two tests: Weber’s and Rinne’s test. In Weber’s test the vibrating tuning fork is placed against the top middle of the skull. If normal, the sound is conducted equally. With a conductive defect, the sound is louder in the affected ear. If the sound is louder in the normal ear, there may be nerve deafness. The Rinne’s test uses the tuning fork in two positions. The first is placing the base of the vibrating tuning fork against the mastoid bone. The patient should indicate when the noise disappears. Then place the tuning fork near the external meatus, the patient should hear the sound again. In conductive deafness, bone conduction is better than air conduction. In nerve deafness, both bone and air conduction are impaired.

**Testing**

**Hearing:** Rub the fingertips of one hand by patient’s ear and have them identify in which ear they heard the sound.

**Balance:** Specific tests of vestibular function are seldom included in the usual neurological examination. However, if the patient appears to have trouble walking or standing, further examination may be appropriate. Tests that combine evaluation of balance and cerebellar function can be found in the motor section of this packet.

**Cranial Nerves IX (Glossopharyngeal) and X (Vagus)**

These two nerves are tested together. CN IX affects the sensory function of the pharynx and the ability to taste on the posterior third of the tongue. CN X’s main function is the motor ability of the soft palatal, pharyngeal, and laryngeal muscles. These areas are all important to voice sounds. Both nerves supply the posterior pharyngeal wall and when this area is touched the muscles contract and the person may gag.

**Testing**

Listen to the patient’s voice. It should sound strong and clear. If there is harshness or hoarseness in the voice, there may be a deficit. If both sides are affected, the speech may be severely impaired and there may also be difficulty swallowing.

Next, while the patient’s mouth is open, ask them to say “ah” and note the position of the uvula and soft palate. It should stay midline. However, if a defect is present, the uvula will deviate towards the intact side.

Lastly, check the gag reflex by lightly touching the posterior pharyngeal wall. If the patient does not gag, the nerve may be impaired and aspiration precautions should be implemented.
Cranial Nerve XI (Spinal Accessory)

This nerve controls the muscles of the neck (sternocleidomastoid muscle) and shoulder (trapezius muscle).

Testing

To test the sternocleidomastoid muscle cup the side of the patient’s face with your hand and ask the patient to turn his head to that side against your manual resistance. Then repeat on the opposite side. Assess the symmetry, size, and strength of the muscle.

To test the trapezius, place one hand on each shoulder and ask the patient to elevate his shoulders against your manual resistance. Assess the symmetry, size, and strength bilaterally of the muscle.

Clinical Application

In patients with Myasthenia Gravis and Cervical Spinal Cord Injuries, evaluation of CN XI is an important part of the neurological assessment.

Cranial Nerve XII (Hypoglossal)

This nerve is a motor function and controls tongue movement.

Testing

Ask the patient to stick his tongue out. Normally, it should be midline. Note any deviation, atrophy, or twitching. Deviations usually occur toward the impaired side.

Then ask the patient to move his tongue to the right, left, up, and down with the mouth open. Normally it should be able to move up and down and to the right and left equally.

Then place your hand on the patient’s cheeks and ask them to push against your hands with their tongue. Note the symmetry and strength of the tongue.
**Motor & Cerebellar Function**

A complete neurological examination should assess the motor system (muscle size, tone, and strength) and the cerebellar function (balance, coordination, and gait).

**Motor System**

Examination of motor function includes body position, involuntary movements, muscle size, tone and strength. During both rest and movement, closely observe the patient to note body position or movements. When noting any abnormalities such as contractures, limps, stuttering gait, etc. Also observe for any involuntary movements such as tremor or tics. Abnormal findings may indicate neurological disease such as tumors or Parkinson’s.

<table>
<thead>
<tr>
<th>Tone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decrease in Tone</strong></td>
</tr>
<tr>
<td><strong>Increase in Tone:</strong></td>
</tr>
<tr>
<td>o Clasp-knife – the initial resistance to the movement is suddenly overcome (upper motor lesion)</td>
</tr>
<tr>
<td>o Lead-pipe – a steady increase in resistance throughout the movement (extrapyramidal lesion)</td>
</tr>
<tr>
<td>oCog-wheel – ratchet-like increase in resistance (extrapyramidal lesion)</td>
</tr>
<tr>
<td>o Clonus – persistent oscillatory beats after applying sudden and sustained flexion as to the ankle</td>
</tr>
</tbody>
</table>

When assessing muscle size, tone, strength and movement, it is important to rate and compare the patient’s right and left sides. Muscle size can be evaluated by comparing the size and contours of muscles bilaterally. Atrophy is evidenced by flat or concave muscles. Some atrophy is normal with aging, especially in the hands, shoulders, and thighs. Tone can be assessed by asking the patient to relax and then put the joint through the normal range of motion. Normally, the joint should move with only slight, consistent resistance. Abnormal results would include any spasticity, rigidity, or flaccidity.
Strength is routinely checked by assessing a patient’s grips and push/pulls of the feet. This is a minimum examination of strength. A full examination checks the strength of all of the following:

<table>
<thead>
<tr>
<th>Vertebral Level</th>
<th>Movement Level and Nerves Involved</th>
<th>Expected Muscle Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 5, C6</td>
<td>Elbow Flexion – Musculocutaneous nerve Radial nerve</td>
<td>Biceps: Arm flexed against resistance with the hand fully supinated Brachioradialis: Arm flexed against resistance with hand in mid-position between pronation and supination</td>
</tr>
<tr>
<td>C5, C6</td>
<td>Elbow Extension – Radial nerve</td>
<td>Triceps: Patient extends arm against resistance</td>
</tr>
<tr>
<td>C7, C8</td>
<td>Finger Extension – Posterior interosseous nerve Thumb Extension Finger Flexion – Median nerve Ulnar nerve</td>
<td>Extensor Digitorium: Patient extends fingers against resistance Extensor pollicis longus and brevis: Thumb is extended against resistance Flexor digitorum profundus I and II/Flexor digitorum profundus III and IV: Examiner tries to extend patient's flexed terminal phalanges</td>
</tr>
<tr>
<td>C8, T1</td>
<td>Thumb Opposition – Median nerve Finger Abduction – Ulnar nerve</td>
<td>Opponens pollicis: Patient tries to touch the base of the 5th finger with thumb against resistance Dorsal interosseus/Abductor digiti minimi: Finger abducted against resistance</td>
</tr>
<tr>
<td>L1, L2, L3</td>
<td>Hip Flexion – Femoral nerve</td>
<td>Ilio-psoas: Hip flexed against resistance</td>
</tr>
<tr>
<td>L2, L3, L4</td>
<td>Hip Adduction – Obturator nerve Knee Extension – Femoral nerve</td>
<td>Adductors: Patient lying on back tries to pull knees together against resistance Quadriceps: Patient tries to extend knee against resistance</td>
</tr>
<tr>
<td>L4, L5, S1</td>
<td>Hip Abduction – Superior gluteal nerve Dorsiflexion – Deep peroneal nerve</td>
<td>Gluteus medius and minimus and tensor fasciae latae: Patient lying on back tries to abduct the leg against resistance Tibialis anterior: Patient dorsiflexes the ankle against resistance. May have difficulty in walking on heels</td>
</tr>
<tr>
<td>L4, L5</td>
<td>Inversion – Tibial nerve</td>
<td>Tibialis posterior: Patient inverts foot against resistance</td>
</tr>
<tr>
<td>L5, S1</td>
<td>Toe Extension – Deep peroneal nerve Eversion – Superficial peroneal nerve</td>
<td>Extensor hallucis longus, extensor digitorum longus: Patient dorsiflexes the toes against resistance Peroneus longus and brevis: Patient everts foot against resistance</td>
</tr>
<tr>
<td>L5, S1, S2</td>
<td>Hip Extension – Inferior gluteal nerve Knee Flexion – Sciatic nerve</td>
<td>Gluteus maximus: Patient attempts to keep heel on bed against resistance Hamstrings: Patient pulls heel towards the buttock and tries to maintain this position against resistance</td>
</tr>
<tr>
<td>S1, S2</td>
<td>Plantarflexion – Tibial nerve</td>
<td>Gastrocnemius, soleus: Patient plantarflexes the ankle against resistance. May have difficulty in walking on toes before weakness can be directly detected.</td>
</tr>
</tbody>
</table>
Strength is rated on a scale of 0 to 5, with 0 being absence of muscle contraction and 5 being normal (as noted below). Evaluators may also make further distinctions by added a plus or minus sign before the number. For example, -5 would indicate a trace of weakness or +4 would indicate good but not quite full strength. To avoid getting hurt when assessing grips, cross your middle finger over your index finger using only two fingers. If the patient has a normal grip, you should have difficulty removing your fingers from the patient’s grip.

<table>
<thead>
<tr>
<th>Strength</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Zero</td>
</tr>
<tr>
<td>1</td>
<td>Trace</td>
</tr>
<tr>
<td>2</td>
<td>Poor</td>
</tr>
<tr>
<td>3</td>
<td>Fair</td>
</tr>
<tr>
<td>4</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>Normal</td>
</tr>
</tbody>
</table>

0 Zero No active muscle contraction; flaccid
1 Trace A flicker of muscle contraction, but no movement
2 Poor Muscle contraction with movement in a non-gravity plane (abduction of leg)
3 Fair Muscle movement against gravity without resistance (lifting leg or arm up)
4 Good Muscle movement against gravity with mild to moderate resistance (placing hand against lifted leg)
5 Normal Movement through full joint range of motion with maximum resistance (straightening and lifting leg against maximum resistance of examiner)

Findings can either be documented in a narrative note, in a flowchart, or using a stick figure.

**Cerebellar Evaluation**

The two main components of evaluating cerebellar function are balance and coordination. This examination is also related to the functioning of cranial nerve VIII (acoustic). The acoustic nerve is linked with vestibular function which affects a person’s sense of balance. An impairment of this nerve can cause a person to easily lose their balance. However, individuals can have impaired cerebellar function and still have this cranial nerve completely intact.

Evaluation of cerebellar function is not routinely performed on all patients but can easily be evaluated just by observing a patient walking and moving. There are a variety of specific methods to assess cerebellar function.

<table>
<thead>
<tr>
<th>Flowchart of Upper and Lower Extremities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strength</strong></td>
</tr>
<tr>
<td>UE R/L</td>
</tr>
<tr>
<td>LE R/L</td>
</tr>
<tr>
<td>5/2</td>
</tr>
<tr>
<td>5/2</td>
</tr>
</tbody>
</table>
**Finger-to-Nose/ Finger-Nose-Finger Movements**

There are two variations. It is only necessary to conduct one of the two variations.

- **Finger-to-nose**: Ask the patient to stretch his arms out to the sides and then to touch his nose with the index finger of one hand and then the other. Do this first with the eyes open and then closed. Note the speed, flow of movement, and accuracy.

- **Finger-nose-finger**: Ask the patient, with his eyes open, to touch his nose and then your finger at a distance of approximately 45cm. Ask the patient to increase the speed with which he does this as you move your finger to different locations. Test each hand separately. Note the speed, flow of movement, and accuracy.

Normally, the patient is able to accurately target both the nose and finger. When there is cerebellar impairment, the patient may have varying speed, force, and direction during movement and may overshoot the mark. Impairment may become more pronounced when the eyes are closed, which suggests a loss of the sense of position. If the deviation is consistently to one side, it may suggest cerebellar or vestibular (inner ear) disease.

**Rapid Alternating Movements**

To perform this examination, ask the patient to pat his thigh with the palm of his hand and then the back of the hand while seated. Then ask him to repeat this alternating movement as rapidly as possible. Repeat this on the other side. Observe the rhythm, speed, and smoothness of movements.

Normally, the non-dominant hand performs somewhat less well, but both sides should be reasonably smooth, quick and even in rhythm. When cerebellar disease is present, the patient’s movement may be slow, irregular, and clumsy.

**Heel to Shin**

This examination is especially useful for patients who cannot ambulate or have restricted movements. Have the patient lay with eyes open and ask him to run the heel of each foot down the opposite shin to the big toe. Repeat with eyes closed to evaluate the patient’s sense of position.

Normally, patients can do this without any difficulty. In cases of cerebellar impairment, the heel may overshoot the knee and then move from side to side down the shin. If the sense of position is impaired, the patient will often lift the heel high when his eyes are closed. Overall, performance of this test is better when eyes are open.

**Romberg Test**

This evaluates the patient’s sense of position, cerebellar function, and balance. To assess, ask the patient to stand with feet together, hands by their side, first with eyes open and then with the eyes closed for 20-30 seconds. Be sure to stand close enough to the patient to prevent falling.

Normally this test should be negative and there is only slight swaying. A Romberg test is considered positive if the patient loses his balance when his eyes are closed. In cases of loss of position, the patient can normally stand straight with eyes open, but will lose balance when their eyes are closed. In cases of cerebellar impairment, the patient may have difficulty regardless of their eyes being open or closed and will usually fall or lean toward the side with cerebellar damage.
Patients who have difficulty balancing may have trouble standing straight with eyes open or closed. However, it will be more difficult with their eyes closed.

**Pronator Drift**

This evaluates the patient’s sense of position, cerebellar function, and upper extremity weakness. To perform this examination, ask the patient to stand (if not able, this can be done while seated) and extend both arms straight forward, palms up and eyes closed. This position should be held for 20-30 seconds. Observe the arms to see if they stay in position. Normally patients will be able to maintain their arms in position. If one arm pronates (turns inward and downward), this indicates impairment of the opposite side of the brain. If one arm drifts moving sideward or upward, it can indicate a loss in the sense of position or upper extremity weakness.

Next tell the patient you are going to lightly tap on their arm, but they need to try to keep their arms out straight in front of them. Tap the arms briskly downward and observe for return to the previous position. Patients with impaired sense of position may not recognize that an arm has been displaced and when told to make the correction, they will do poorly. Patients with cerebellar impairment will return the arm to its original position, but will often overshoot and bounce.

**Walking/Gait**

This is commonly assessed by observing the patient walking across the room or down a hallway. The elements to observe include the smoothness of the gait, symmetry of arm and leg movement, position of the feet (normal or broad based), presence of any abnormal movements, height of step (high, shuffling, or normal), and length of step (short, long, or normal).

Then ask the patient to walk heel-to-toe in a straight line. Observe for balance and the ability to maintain a straight line. Normally a patient should be able to heel-to-toe walk without difficulty. However, patients with impaired balance, cerebellar function, or sense of position may have difficulty balancing and maintaining a straight line.

There are many diseases that can alter a patient’s gait. Some of these are identified in the table below.
Sensory Examination

Sensory examination is not routinely evaluated on every patient. However, if the patient has had an injury, is complaining of numbness or tingling, or is having deficits in other areas, it may be performed. Usually the patient’s ability to sense light touch and to differentiate between sharp/dull is evaluated.

- **Light Touch:** To evaluate light touch, ask the patient to close their eyes and using a wisp of cotton lightly touch the patient in various areas. Ask the patient to tell you when they feel the wisp touching them. Since calloused skin is normally relatively insensitive, try to avoid those areas. Make note of any areas where the patient is not able to sense light touch.

- **Sharp vs. Dull:** To evaluate the ability to distinguish between dull versus sharp, ask the patient to close his eyes. Then using an open safety pin lightly touch the patient in various locations switching randomly between the sharp point and the rounded end. Ask the patient to tell you when they feel something and whether it is sharp or dull. Do NOT use too much pressure and pierce the skin.

<table>
<thead>
<tr>
<th>Type of Gait</th>
<th>Cause</th>
<th>Description of Gait</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spastic hemiparesis</td>
<td>Unilateral upper motor neuron disease</td>
<td>One arm is flexed, close to the side, and immobile. The leg on the same side circles outward and forward, often with the big toe dragging.</td>
</tr>
<tr>
<td>Scissors gait</td>
<td>Bilateral spastic paresis of the legs</td>
<td>Each leg is advanced slowly and the thighs tend to cross forward on each other at each step. The steps are short and the patient looks as if he were walking through water.</td>
</tr>
<tr>
<td>Steppage gait</td>
<td>Foot-drop, usually secondary to lower motor neuron disease</td>
<td>The feet are lifted high, with the knees flexed, and then brought down with a slap. The patients look as if they are walking up steps.</td>
</tr>
<tr>
<td>Sensory ataxia</td>
<td>Loss of position sense in the legs</td>
<td>The gait is unsteady and wide-based. The feet are lifted high and brought down with a slap. Patients watch the ground to guide their steps and they have a positive Romberg test.</td>
</tr>
<tr>
<td>Cerebellar ataxia</td>
<td>Disease of the cerebellum or associated tracts</td>
<td>The gait is staggering, unsteady, and wide-based, with exaggerated difficulty on turns. The patient has a positive Romberg test, even with eyes open.</td>
</tr>
<tr>
<td>Parkinsonian gait</td>
<td>Basal ganglia or Parkinson’s disease</td>
<td>The posture is stooped with the hips and knees slightly flexed. The steps are short and often shuffling. Arm swings are decreased and the patient turns around stiffly, moving the entire body at the same time.</td>
</tr>
</tbody>
</table>
Furthermore, because of the potential for bloodborne transmission, discard the safety pin in the sharps container after use. Document any areas where the patient is not able to sense touch or differentiate between dull or sharp.

Occasionally, advanced methods of sensory examination may be conducted by the physician or healthcare provider. The various advanced tests with descriptions are listed below.

- **Temperature:** This is usually done if the patient cannot sense sharp versus dull. Two test tubes are filled with water, one hot and one cold. The patient closes his eyes and the examiner touches the tubes to different parts of the body, asking the patient to state when they feel the tube and whether it is hot or cold.

- **Vibration:** This sense is often the first sensation to be lost in peripheral neuropathy. It is tested by using a low-pitched tuning fork (128 Hz or 256 Hz). The fork is tapped on the heel of the examiners hand and firmly placed over a distal interphalangeal joint of the finger or toe (often the big toe is used). The patient is asked to describe what he feels and to tell the examiner when it stops. If the distal site is impaired, testing proceeds proximally to the wrist and elbow or to the medial malleolus or knee.

- **Position/Proprioception:** Loss of position sense suggests either posterior column disease or a lesion of the peripheral nerve or root. It is tested by grasping the patient’s big toe by its sides between the examiner’s thumb and index finger and then pull it away from the other toes to avoid friction. The patient is shown what is meant by “up” and “down.” The patient closes his eyes and the examiner moves the toe up or down and asks the patient to identify which position it is in. This is repeated several times on each side. If it is impaired, then more proximal sites are tested (ankle, wrist, elbows, etc.).

- **Stereognosis:** This is the ability to identify an object by feeling it. To test this sense, the patient closes his eyes and then tries to identify familiar objects (coin, paperclip, key, pencil) that are placed in his hand. Each hand is tested individually.

- **Number Identification:** This is also called graphaesthesia. This can be substituted for the stereognosis test in patients who are unable to hold and manipulate an object. To test this sense, the patient closes his eyes and the examiner uses the blunt end of a pen or pencil to draw numbers on the palm of the hand. The patient is asked to identify the number. A normal person can identify most such numbers.

- **Two-Point Discrimination:** This is tested using two ends of an opened paperclip. The patient closes his eyes and the examiner touches either one or two points simultaneously to the finger pad of the patient. The patient is asked to identify if they feel one or two points. If the patient cannot feel two points, the points are moved further apart.
Reflex Examination

Reflexes indicate the status of the central nervous system (specifically the corticospinal pathway) in both the conscious and unconscious patient. There are 3 types of motor or sensory reflexes: deep tendon, superficial, and pathological.

Deep Tendon Reflexes

Deep tendon reflexes are graded on a scale of 0 to 4+.

- 4+ Very brisk, hyperactive, with clonus (rhythmic oscillations between flexion and extension)
- 3+ Brisker than average; possibly, but not necessarily indicative of disease
- 2+ Average, normal
- 1+ Somewhat diminished; low normal
- 0 No response

Hyperactive reflexes suggest central nervous system disease, especially when sustained clonus is seen. On the other hand, reflexes may be diminished or absent when sensation is lost, when the relevant spinal segments are damaged, or when the peripheral nerves are damaged. Decreased reflexes may also be due to diseases of the muscles neuromuscular junctions, medication administration or substance abuse.

When the muscle is relaxed and the joint is at midposition, the tendon is tapped directly using a percussion or reflex hammer. Normally, there is a contraction of the muscle with a quick movement of the limb innervated by the muscle. The deep tendon reflexes that are usually checked include the biceps, triceps, brachioradials, quadriceps (patellar or knee jerk), and achilles (ankle jerk).

Biceps - C5, C6 - musculocutaneous nerve

With the patient’s arm flexed, place thumb over the biceps tendon and strike the thumb with the reflex hammer. The normal response is flexion of the arm at the elbow.

Triceps - C6, C7, C8 - radial nerve

Have patient relax arm while examiner holds arm at elbow, abducted from the body with the hand hanging down. Then strike the triceps tendon. The normal response is extension of the elbow.
**Brachioradials (Supinator Jerk) - C6, C7 - radial nerve**

With the patient’s arm resting on their leg with the thumb side upward, strike the radius about 1-2 inches above the wrist. The normal response is flexion of the elbow and supination of the forearm, and flexion of the fingers and hand.

**Quadriceps (knee jerk) - L2, L3, L4**

Stand to the side and with the patient’s leg hanging freely over the side of the bed or chair, place hand above the patella and strike the tendon directly below the patella. If the client is supine, support the relaxed leg from behind the knee and strike the tendon just below the patella. The normal response is extension or kicking of the leg.

**Achilles (Ankle jerk) - S1, S2**

Holding the patient’s foot in a slightly dorsiflexed position with one hand, strike the Achilles tendon. The normal response is plantar flexion of the foot.

Reflexes may be enhanced by having the patient clench the teeth or try to pull apart clasped hands when they are difficult to elicit.

**Superficial Reflexes**

These reflexes are elicited by light rapid stroking of the skin or mucous membrane in a particular area. They are graded as either present (+) or absent (0). If they are present but weak, they may be documented as “weak.” The presence of superficial reflexes is considered normal, while absence is abnormal.
In general, these reflexes are not routinely tested on all patients, but may be assessed if a deficit is suspected. The following table lists the major superficial reflexes and how to test them.

<table>
<thead>
<tr>
<th>Reflex</th>
<th>Test and Patient’s Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corneal (CN V and VII)</td>
<td>Touch cornea lightly with a wisp of cotton that is moistened with sterile normal saline. Caution is used not to cause a corneal abrasion. Normally the lids should close quickly.</td>
</tr>
<tr>
<td>Gag (CN IX and X)</td>
<td>Stimulate the back of the pharynx with a tongue depressor. Normally the patient should gag.</td>
</tr>
<tr>
<td>Swallowing (CN IX and X)</td>
<td>Stimulate one side of the uvula with a cotton applicator. Normally the uvula should elevate.</td>
</tr>
<tr>
<td>Upper abdominal (T8 - T10)</td>
<td>Stroke the outer, upper abdomen toward the umbilicus using a tongue blade. Normally the umbilicus should move up and toward the area being stroked.</td>
</tr>
<tr>
<td>Lower abdominal (T10 - T12)</td>
<td>Stroke the outer, lower abdomen toward the umbilicus using a tongue blade. Normally the umbilicus should move down and toward the area being stroked.</td>
</tr>
<tr>
<td>Cremasteric – male (L1 - L2)</td>
<td>Lightly stroke the inner aspect of the thigh or lower abdomen. Normally this causes the testicle on the same side to elevate.</td>
</tr>
<tr>
<td>Perianal (S3 - S5) (Anal wink or bulbocavernous wink)</td>
<td>Using a dull object, scratch the tissue at the side of the anus. Normally there should be a puckering or contraction of the anus.</td>
</tr>
</tbody>
</table>

**Pathological Reflexes**

The most important of the pathological reflexes is the Babinski reflex. The grading of pathological reflexes is either present (+) or absent (-). The presence of pathological reflexes is considered abnormal, while absence is considered normal.

The Babinski reflex is tested by scratching the lateral border of the sole from heel to toe with a moderately sharp object such as a key or the end of a reflex hammer. See picture to right.

The normal response is plantar flexion of the toes. The positive or abnormal response (Babinski reflex) is extension or dorsiflexion of the big toe with fanning of the toes (see picture). A positive response indicates pyramidal tract disease or a lesion in the corticospinal tract.

**Additional Areas for Examination**

Nutrition, as it relates to a patient’s blood sugar, fluid volume status, and electrolyte balance, is also important. These should be evaluated in relation to the findings of your neurological examination.

Patients will often have neurological type symptoms when their blood sugars are below 60 or may become comatose with excessively high blood sugars. It is generally recommended that patient’s
with neurological disease maintain a blood sugar between 80-110 mg/dl for optimal neurological function (Hickey, 2009).

Additionally, fluid and electrolyte imbalances can influence neurological findings and can be impacted by neurological diseases. Specifically sodium, magnesium and calcium are important to neurological function. Sodium is important for transmission of nerve impulses and smooth muscle contractility. Magnesium ensures the transport of sodium and potassium across the cell membrane, which is needed for muscle contractility. Calcium in its ionized form plays an important role in maintaining the internal integrity of the cell.

Fluid balance is specifically linked to sodium, water, blood urea nitrogen (BUN), creatinine, and serum osmolality. Dehydration is commonly linked to a change in mental status and correcting the dehydration often greatly improves neurological findings. Hyponatremia and hypernatremia can lead to a decreased level of consciousness and if untreated can result in coma. Hyponatremia can also result in muscle weakness and twitching progressing to seizures and in extreme cases coma. Metabolism and soft tissue functions are influenced by magnesium, calcium, and phosphate levels. Alterations in these electrolytes can cause an increase or a decrease in muscle contractions. For example, hypomagnesemia can cause muscle weakness, twitching, tremors, leg or foot cramps, and seizures.

Conduction of neural and electrical impulses is influenced by potassium, chloride, and carbon dioxide levels. For example, hyperkalemia can result in the patient being listless, confused, and having spastic muscles followed by flaccid paralysis.

Clearly assessing lab values related to blood sugar, fluid volume status, and electrolytes can help uncover sources of neurological changes or side effects of neurological disease. Evaluating these findings in relationship to the neurological examination results can help in planning appropriate patient care. See Appendix on Fluid Physiology.

<table>
<thead>
<tr>
<th>Etiology in Changes in Level of Consciousness Other Than Diseases and Medications Given to Patients:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hypoxia</td>
</tr>
<tr>
<td>• Hyperglycemia</td>
</tr>
<tr>
<td>• Dehydration</td>
</tr>
<tr>
<td>• Hyponatremia</td>
</tr>
</tbody>
</table>

**Rapid Neurological Examination**

**Cardinal Signs of Potential Neurological Deterioration**

If any of the following signs are observed, assess the patient for further neurological problems and report findings as warranted by the patient’s condition.

- Sudden, severe headache. This can indicate increased intracranial pressure.
- Increased restlessness or agitation. This change in level of consciousness (LOC) may indicate decreased oxygen saturation or neurological change.
Patient becoming uncooperative, combative or unresponsive. This change in LOC may also indicate decreased oxygen saturation, a neurological change and/or hypoglycemia/hyperglycemia.

Decreased Glasgow Coma score (score < 15).

Motor weakness, especially if fairly acute onset.

Nausea and vomiting, especially if other neurological changes are present. This may indicate increased intracranial pressure.

Signs of meningeal irritation such as nuchal rigidity, flexion of hips and knees when neck is flexed (Brudzinski’s sign), or pain and resistance when hip is flexed and knee is extended (Kernig’s sign).

Changes in the hemodynamic status such as increases in systolic blood pressure with a widening pulse pressure, changes in heart rate (bradycardia) or respiratory rate (increased, or apneic), or a change in the pattern of respirations (hyperventilation or irregular). These are often late signs of increased intracranial pressure.

Pupillary changes such as size discrepancy, shape change, decreased reactivity. Remember, these are late signs.

### Early Signs and Symptoms of Neurological Deterioration:

<table>
<thead>
<tr>
<th>Early Signs and Symptoms of Neurological Deterioration:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Headache</td>
</tr>
<tr>
<td>• Restlessness</td>
</tr>
<tr>
<td>• Motor dysfunction</td>
</tr>
<tr>
<td>• Cranial Nerve Palsy</td>
</tr>
<tr>
<td>• Nausea/Vomiting or no nausea with vomiting</td>
</tr>
<tr>
<td>• Agitation</td>
</tr>
<tr>
<td>• Somnolence</td>
</tr>
<tr>
<td>• Visual disturbances</td>
</tr>
<tr>
<td>• Sensory dysfunction</td>
</tr>
<tr>
<td>• Changes in Level of Consciousness</td>
</tr>
</tbody>
</table>

### Deterioration in a patient’s condition warrants a COMPLETE and THOROUGH ASSESSMENT of all systems.

ABC’s (airway, breathing and circulation) assessment and interventions must be completed and maintained in all patients.

### Late Signs of Neurological Deterioration

Late signs include a further deteriorating level of consciousness (coma – GCS < 8), ipsilateral dilated pupil (> 4mm), hemiparesis or hemiplegia, and abnormal posturing (flexion and extension).

Cushing’s triad is the brain’s last attempt to perfuse itself. These late signs of intracranial hypertension include widening pulse pressure (elevated systolic pressure with a normal diastolic pressure) > 40 mm Hg, and bradycardia. If untreated this then could lead to respiratory and cardiac arrest. These true signs are seen only in approximately 40% of deteriorating patients.
**Critical Thinking in Assessing the Neurological Patient**

There are several key points to keep in mind when assessing and monitoring the patient with neurological impairment or neurological changes. The first is to always assume the worse possible change since neurological status can decline very rapidly and without advance warning. Second, always anticipate that the changes in condition will result in the worst possible outcome since the brain and nerves are not able to recover in the same way as other systems. Third, perform a complete examination of all body systems when there is a change in neurological status since the systems are all very interrelated and interdependent. This requires returning to the A, B, C, D’s (airway, breathing, circulation-perfusion to the brain, and deficit), monitoring lab values, and assessing fluid intake and output (I & O). Lastly, when in doubt notify the neurologist, neurosurgeon, or attending physician of changes. Delays in notification or responses can result in a poor outcome for the patient.

**Rapid Examination of the Conscious or Unconscious Patient**

This table is a quick guide of how to quickly assess the patient’s LOC. However, keep in mind that if deficits or changes are noted in any area, a further, detailed examination should be conducted and pertinent findings reported immediately.

<table>
<thead>
<tr>
<th>Both Conscious (GSC &gt;8) and Unconscious (GCS &lt;8) Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Airway</strong></td>
</tr>
<tr>
<td>Assess ability to protect airway. In patients with GCS &lt;8, an artificial airway may be needed.</td>
</tr>
<tr>
<td><strong>Vital Signs</strong></td>
</tr>
<tr>
<td>Assess temperature, respirations, pulse, blood pressure and pain level. Also note respiratory pattern, effort and depth. If appropriate, assess patient’s perfusion and oxygenation.</td>
</tr>
<tr>
<td><strong>Level of Consciousness</strong></td>
</tr>
<tr>
<td>Assess orientation and GCS (eye opening, verbal response, and motor response).</td>
</tr>
<tr>
<td><strong>Observation of patient</strong></td>
</tr>
<tr>
<td>Note movement, symmetry, and speech. Evaluate any difficulties with speech, asymmetry or abnormal movements.</td>
</tr>
<tr>
<td><strong>Medical History</strong></td>
</tr>
<tr>
<td>Past and current medical surgical history, including medications (both prescribed and taken), laboratory values, physical findings.</td>
</tr>
</tbody>
</table>

(continued on next page)
<table>
<thead>
<tr>
<th></th>
<th>Conscious Patient (GCS &gt;8)</th>
<th>Unconscious Patient (GCS ≤8)</th>
</tr>
</thead>
</table>
| **Cranial Nerves & Pupils** | Usually just CN II (Optic), III (Oculomotor), IV (Trochlear), and VI (Abducens) are evaluated. Specifically assess vision, pupils (size, shape, symmetry, direct light reflex, consensual light reflex), convergence, visual fields, and extraocular movements. However, the nurse may need to assess the other nerves depending on the patient's history or symptoms. | Mainly testing CN III (Oculomotor). Assess pupil (size, shape, symmetry, direct light reflex, consensual light reflex), corneal reflex (CN V), and gaze preference (ability to track with eyes). The physician performs further testing such as the:  
  - oculocephalic reflex or Doll's eyes test.  
  - oculovesibular reflex or cold caloric test.  
  Apnea test (GCS=3) |
| **Motor Examination**  | Assess upper and lower extremity movement and test at a minimum grips, dorsiflexion, and plantar flexion. | May have to rely on only GCS, motor examination, but attempt to test grips, dorsiflexion, and plantar flexion. |
| **Sensory Examination** | Ask patient to close their eyes and with a finger, touch the patient bilaterally on the face, upper aspect of the arm, hand, leg and foot. Ask patient to point to where they feel your finger. | Not performed. |
| **Reflexes**            | Not routinely tested unless indicated by patient condition or treatment.                     | Not routinely tested, but may be tested by the physician or if indicated by treatment/condition. |
Clinical Application

Listed below are patient scenarios that apply the information that has been reviewed in this packet. This portion is not the test. It is utilized for self-assessment only. The answers are below each scenario.

Patient Scenario A

You have been assigned to take care of Mr. H. who is a 59 year-old black man admitted with complaints of palpitations, diaphoresis and dizziness. Fully alert, oriented, following all commands and moves all extremities equally. Past medical history reveals diabetes mellitus for 20 years, hypertension for 15 years, hypercholesterolemia for 10 years, and arterial fibrillation for 6 months. Surgical history reveals an appendectomy 24 years ago and an inguinal hernia repair 24 years ago. Medications: Simvastatin 20 mg PO every day; Warfarin Sodium 5 mg PO every other day, alternating 2.5 mg every other day; HCTZ 50 mg PO twice per day; Enalopril 5 mg PO every day; glucophage 500 mg PO twice per day. The patient has no known allergies.

Height = 185 cm   Weight = 113 Kg
BP = 198/110    HR= 98 Irregular   Temperature = 37.6°C   Respirations: 12 regular
BG = 160 fasting
GCS = 15/15, Oriented to name, place, date, and conversation is appropriate. Motor = 5/5 all extremities, Sensory = Intact throughout, Pupils equal -3 mm bilaterally.

1. What is missing from this neurological exam?

2. What are the potential major complications for his admitting diagnosis?

Mr. H. calls you to his room – he is extremely anxious and agitated about his hospitalization. You give him reassurance and discuss the plans to monitor his condition and ECG and review the medications the physician ordered. He calms down and asks if he can use his phone to call his family. You assure him that he may and you leave the room. Twenty minutes later, you receive a phone call at the nurses’ station from Mr. H’s daughter. She is anxious wanting to know what is going on with her father because he seems confused and is slurring his speech. You inform her that you will indeed go and check on her father at this time after relating to her your previous conversation with him.

Upon arrival in his room you note a disheveled Mr. H leaning to one side of the bed attempting to pull him unsuccessfully upright in bed.

3. What are you going to assess?
You note that he cannot move his left side upper or lower extremities and ignores them, his speech is slurred, he is confused, and he will not follow all commands. His pupils are equal, reactive to light. He tracks to midline only.

4. All signs and symptoms indicate he had a stroke. What type? Ischemic or hemorrhagic?

5. Why does he only track to midline With his eyes? Does this indicate a visual field deficit? If so where in the brain?

6. What order can you anticipate in orders from the MD?

**Answers for Self-Assessment**

**Answers for Patient Scenario A:**

1. Pupil accommodation, hearing, cough, gag (assumed intact because GCS 15)

2. 
   ▪ Hypertensive crisis
   ▪ Intracranial bleeding (coumadin – hypertensive bleed)
   ▪ Irregular HR – A-fibrillation – stroke
   ▪ SVT
   ▪ MI

3. 
   ▪ ABC’s – Oxygen saturation, Respiratory Rate, respiratory pattern, HR, BP.
     Neurological – Pupils, Speech, Motor, Sensory, Cranial Nerves.

4. Could be either HTN stroke or Ischemic Stroke – CT scan with diagnosis.

5. Homonymous Hemianopia, behind the optic chiasma – probable middle cerebral artery infarct/bleed.

6. Neurology consult, STAT CT Scan, BP control, Glucose control
Patient Scenario B

You have been assigned to take care of Mr. M, a 22-year-old male who is admitted 5 days ago with a diagnosis of a complete spinal cord injury at C7 level following a diving accident. He is fully alert, oriented, no movement or sensation in his extremities. Past medical history is non-significant and he takes no regular medications, is a social drinker, and does not smoke. No surgical history.

Height 5’9”  Weight 98 kg
BP = 118/58  HR = 56  Temperature = 36.8°C  Respirations 12 regular

1. How would you document his GCS?

2. How would you assess his sensory system?

3. What type of stimulus would you use to assess motor response?

4. What upper extremity muscle groups will he be able to utilize in his rehabilitation program?

Answers for Patient Scenario B:

1. GCS=15. In narrative notes indicate he cannot move extremities. Ask in motor exam for patient to shrug shoulders, turn head side to side to determine following motor commands.

2. Deratome levels bilaterally front and back using a safety pin.


4. Biceps, triceps questionable on thumb and finger flexion/extension.

Patient Scenario C

You have been assigned to take care of Mr. C, who was diagnosed with hepatic failure from severe hepatitis C presenting with confusion and memory disturbances and an ammonia level of 57 μmol/L. Past medical history: hepatitis C for 6 years, low protein diet, GI bleed 2 years ago.

Height 5’9”  Weight 89 kg
BP = 140/86  HR = 88  Temperature = 38.8°C  Respiratory Rate = 20 regular

Treatment plan has included administration of lactulose enemas and oral administration of neomycin to decrease the ammonia level.

1. What other neurological assessment findings would be appropriate?

**Answer for Patient Scenario C**

*Memory – short term and long term, changes in extremity strength and abnormal movement, rigidity, asterixis (flapping movement of the hands and wrists), hyperreflexia, spasticity in lower extremities, cranial nerve function especially CN IX, and CN X, and respiratory pattern.*

**Patient Scenario D**

You are taking care of Mrs. W. 61 year-old female who was admitted with 80% occlusion of her right internal carotid artery. She has had several trans-ischemic attacks (TIA’s) over the past 3 months with resolution of any neurological deficits. She is admitted for surgery. You are taking care of her 2-hour post operative right carotid endarterectomy. Past medical history includes hypertension for 10 years, hyperlipidemia for 5 years, and smoking for 27 years. Medications include: Simvastatin 10 mg PO every day and Enalopril 5mg PO every day. She has no known allergies. No surgical history.

Height 5’3”  Weight 72 kg

BP = 138/60  HR = 80 regular  Temperature = 37°C  Respiratory Rate = 14 regular

1. What neurological post-operative cranial nerve dysfunction can occur and which cranial nerve?
2. In the immediate post-operative period it is important to maintain a SBP > 110 mm Hg to prevent stroke-like symptoms from occurring. What neurological signs and symptoms would you expect?

**Answers for Patient Scenario D:**

1. *Horner’s syndrome-Miosis, ptosis, anhydrosis (ipsilateral smaller pupil, drooping eyelid, and loss of sweating on same side of face). Injury to CN V.*
2. *Motor loss on left side, ignoring the affected side (could lead to falls), pockets foods, potential for aspiration, demonstrates verbally correct behavior even though they are disoriented.*
Appendix - Fluid Physiology

Most hormones regulate fluid and electrolyte balance through a negative feedback mechanism. The target organs for many hormones are the kidney and liver, which then regulate the absorption and excretion of body water and electrolytes in the urine or gastrointestinal tract.

Instead of monitoring one single value, the nurse takes into account WHAT OTHER FACTORS influence and relate to the level. For example, if a sodium level is 159, what other values do you look at?

- Fluid intake and output (including NGT, CT’s, JP’s etc…)
- Recent medications
- IV fluid ordered/hanging
- Other current electrolyte levels (Sodium, Potassium, Chloride, Magnesium, Calcium)
- Other related values (Blood urea nitrogen, Creatinine, Phosphate, acid-base balance, carbon dioxide, and water balance)

**NORMAL VALUES:**

**Intravascular (5% of body wt)**
- Potassium – 3.5 – 5.0 mEq/L
- Sodium – 135 – 145 mEq/L
- Chloride – 97 – 110 mEq/L
- Calcium – 8.5- 10.5 mg/dl
- Phosphorus – 2.5 – 4.5 mg/dl
- Magnesium – 1.3 – 2.1 mEq/L

Sodium: important for transmission of nerve impulses, smooth muscle contractility
Magnesium: ensures the transport of sodium and potassium across the cell membrane.
Calcium: ionized form plays important role in maintaining the internal integrity of the cell.

**There are three basic categories:**

<table>
<thead>
<tr>
<th>Fluid balance</th>
<th>Metabolism and soft tissue</th>
<th>Electricity/impulse conduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>Magnesium</td>
<td>Potassium</td>
</tr>
<tr>
<td>Water</td>
<td>Calcium</td>
<td>Chloride</td>
</tr>
<tr>
<td>Serial I &amp; O’s</td>
<td>Phosphate</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>Blood urea nitrogen (BUN)</td>
<td></td>
<td>Acid-base balance</td>
</tr>
<tr>
<td>Creatinine</td>
<td></td>
<td></td>
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<tr>
<td>Serum osmolality</td>
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<tr>
<td>Physical assessment findings</td>
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</tr>
</tbody>
</table>
### Fluid Balance

#### Sodium

<table>
<thead>
<tr>
<th>Causes</th>
<th>Signs &amp; Symptoms</th>
</tr>
</thead>
</table>
| **Hyponatremia** | • Prolonged vomiting or diarrhea  
• Excessive or prolonged IV fluids without electrolytes (D5W)  
• Diuretics  
• Water intoxication  
• Low sodium diet  
• Profuse sweating  
• Metabolic acidosis  
• SIADH (syndrome of inappropriate ADH secretion)  
• Small cell cancer  
• Cancer of the lung | • Anxiety  
• Muscle weakness  
• Twitching progressing to seizures in extreme cases  
• Headache  
• Tachycardia  
• Fatigue  
• Apathy  
• Nausea and vomiting  
• Somnolent leading to coma |
| **Hypernatremia** | • Profuse sweating  
• Diarrhea  
• Polyurea  
• Diabetes insipidus  
• Diabetes mellitus  
• High protein feedings  
• Medications  
  - Sodium bicarbonate  
  - Ticarcillin  
  - Adrenocortical steroids  
  - Mannitol  
  - Urea  
  - Estrogens | • Thirst  
• Dry, sticky membranes  
• Flushed skin  
• Fever  
• Oliguria  
• Urine S.G. > 1.015 if water loss is nonrenal, < 1.010 if diabetes insipidus or diuretic phase of ATN. |

#### Blood Urea Nitrogen

<table>
<thead>
<tr>
<th>Causes</th>
<th>Signs &amp; Symptoms</th>
</tr>
</thead>
</table>
| **Elevated Blood Urea Nitrogen Levels (BUN)**  
Note: BUN and Creatinine exist as a 10 : 1 ratio | • Dehydration  
• Crush injuries  
• Starvation  
• Burns  
• Massive hemorrhage  
• High protein intake  
• Tumors  
• Stones  
• Prostatic enlargement  
• Scarring |
## Metabolism & Soft Tissue

### Magnesium

**Hypomagnesemia**
- Malabsorption syndromes
- Post bowel resection
- Prolonged IV therapy without supplementation
- NG suction
- Diuretic therapy
- Diabetic ketoacidosis
- Hypercalcaemia
- Alcoholism

**Note:** Hypocalcemia and Hypokalemia that does not respond to replacement therapy may indicate a magnesium deficiency.

**Signs & Symptoms:**
- Leg and foot cramps
- Cardia arrhythrias
- Muscle weakness
- Twitching
- Tremors
- Seizures

**Hypermagnesium**
- Increased intake of antacids (magnesium hydroxide)
- Epsom salts
- Milk of magnesia
- Decreased excretion as in chronic renal failure

**Causes:**
- Diminished reflexes
- Decreased level of consciousness
- Hypotension
- Bradycardia and heart blocks
- Hypothermia with flushed skin

### Calcium

**Causes:**
- Estrogen supplements
- Nephrotoxic antibiotics (gentamicin, tobramycin, insulin, excessive use of laxatives, loop diuretics or adrenocorticosteroids)
- Alcoholism
- Pancreatits
- Diarrhea
- Extensive infections
- Hyperphosphatemia
- Lack of vitamin D intake

**Hypercalcemia**
- Increased intake of calcium – antacids, excessive Vitamin D
- Cancers (lymphomas, leukemias, and metastasis)
- Prolonged immobilization
- Hyperparathyroidism

**Signs & Symptoms:**
- Trousseau’s sign (inflating BP cuff – hand twitches)
- Chvostek’s sign (tapping the facial nerve – upper lip twitches)
- Anorexia
- Nausea & vomiting
- Constipation
- Lethargy
- Confusion
- Polyuria
- Dehydration
- Complain of bone pain

This is a major influence on bone strength, nerve conduction and muscular contraction.
Phosphate
Calcium and phosphate maintain an inverse relationship. If the phosphate level is low, then the calcium level will be high. Symptoms of a calcium imbalance will often predominate over those of phosphate.

<table>
<thead>
<tr>
<th>Causes</th>
<th>Signs &amp; Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypophosphatemia</td>
<td>Nutritional depletion (protein-calorie malnutrition)</td>
</tr>
<tr>
<td></td>
<td>Alcohol withdrawal (vomiting, use of antacids, and diarrhea)</td>
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<tr>
<td></td>
<td>Diabetic ketoacidosis</td>
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<tr>
<td>Hyperphosphatemia</td>
<td>Acute and chronic renal failure</td>
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<tr>
<td></td>
<td>Decreased parathyroid activity</td>
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<td>Excessive use of laxatives</td>
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</tbody>
</table>

Electricity / Impulse Conduction
Potassium

<table>
<thead>
<tr>
<th>Causes</th>
<th>Signs &amp; Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypokalemia</td>
<td>Poor intake, abnormal routes or rate of excretion</td>
</tr>
<tr>
<td></td>
<td>Vomiting</td>
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<tr>
<td></td>
<td>Nasogastric suctioning</td>
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<td>Diarrhea</td>
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<td></td>
<td>Crash diets</td>
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<tr>
<td></td>
<td>Use of loop and osmotic diuretics</td>
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<tr>
<td></td>
<td>Excessive sweating</td>
</tr>
<tr>
<td>Hyperkalemia</td>
<td>Prerenal, renal, post renal failure</td>
</tr>
<tr>
<td></td>
<td>Crush injuries</td>
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<tr>
<td></td>
<td>Massive muscle injuries</td>
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<td></td>
<td>Severe infections</td>
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<tr>
<td></td>
<td>Addison’s disease</td>
</tr>
<tr>
<td></td>
<td>Tumor dissolution following chemotherapy</td>
</tr>
</tbody>
</table>
In order to receive 4.0 contact hours, you must:

Directions:

For Non-Orlando Health employees: Complete this test using the bubble sheet provided. Return to: Orlando Health Education & Development, MP14, 1414 Kuhl Ave, Orlando, FL 32806

For Orlando Health Team Member: Please complete testing via Online Testing Center. Log on to: SWIFT→ Departments→ E-Learning→ Testing Center. Use your Orlando Health Network Login and password. Select “SLP” under type of test; choose correct SLP Title. Payroll authorization is required to download test.
Post-test

1. Which of the following statements regarding performing a neurological examination is TRUE?
   a. Frequency depends on the result of the patient’s baseline and subsequent examinations.
   b. Changes require further investigation by the healthcare provider.
   c. Subtle changes in the neurological findings can indicate critical problems.
   d. All of the above

2. Which of the following is NOT one of the five components of the neurological examination:
   a. Mental status
   b. Motor activity
   c. Airway management
   d. Superficial and deep tendon reflexes

3. The MOST sensitive, early indicator of intracranial pathology is a?
   a. Negative oculocephalic reflex (Doll’s eyes)
   b. Sluggish, dilated, oval pupils
   c. Change in level of consciousness/mental status
   d. Hyperactive deep tendon reflexes

4. By asking the question, 'WHERE WERE YOU BORN?', what are you assessing?
   a. Short term memory
   b. Long term memory
   c. Higher cognitive functions
   d. Level of consciousness

5. By asking the question, 'WHERE ARE YOU?', what are you assessing?
   a. Short term memory
   b. Higher cognitive functions
   c. Level of consciousness
   d. Long term memory

6. By asking the patient to 'COUNT BACKWARDS FROM 100', what are you assessing?
   a. Short term memory
   b. Higher cognitive functions
   c. Communication/attention span
   d. Long term memory
7. By asking the question, 'WHAT THREE WORDS DID I ASK YOU TO REMEMBER?', what are you assessing?
   a. Short term memory
   b. Long term memory
   c. Higher cognitive functions
   d. Communication/attention span

8. By asking the question, 'WHO IS THE PRESIDENT?', what are you assessing?
   a. Short term memory
   b. Long term memory
   c. Higher cognitive functions
   d. Level of consciousness

9. Which level of consciousness is defined as: absence of spontaneous respirations, brainstem reflexes, and cranial nerve function.
   a. Stupor
   b. Lethargy
   c. Persistent vegetative state
   d. Brain death

10. Which level of consciousness is defined as: only moans to verbal stimulus and has minimal spontaneous movement other than when vigorous constant stimuli are applied?
    a. Stupor
    b. Confusion
    c. Lethargy
    d. Persistent vegetative state (PVS)

11. Which level of consciousness is defined as: Orientation with slow speech and motor processes?
    a. Stupor
    b. Lethargy
    c. Brain Death
    d. Confusion

12. Which level of consciousness is defined as: Disorientation with short attention span and restlessness?
    a. Stupor
    b. Lethargy
    c. Brain Death
    d. Confusion
13. Which level of consciousness is defined as: Spontaneous respirations, opens eyes, and appears to visually follow people, but with no evidence of sustained, reproducible, purposeful behavioral response to stimuli.
   a. Stupor
   b. Lethargy
   c. Confusion
   d. Persistent vegetative state (PVS)

14. Which of the following statements regarding the Glasgow Coma Score is FALSE? It is:
   a. Used to measure eye opening, best motor response, and best verbal response.
   b. Intended to trend neurological functioning.
   c. Easily modified for use on any patient.
   d. Meant to be used as a complete neurological examination tool.

15. When assessing the patient's level of consciousness, the response to stimuli is assessed in which order?
   a. Tactile, verbal, presence, noxious
   b. Verbal, presence, tactile, noxious
   c. Presence, verbal, noxious, tactile
   d. Presence, verbal, tactile, noxious

16. Providing a noxious stimuli by pinching the patient's toenails or nipples should be avoided as this may produce:
   a. Seizure activity
   b. A stroke
   c. An abnormal spinal cord reflex
   d. Nausea and vomiting

17. Upon examining a patient, the following was assessed and the results documented: no eye opening to noxious stimulus, extension response times all 4 extremities, no verbalization. What is the Glasgow coma score?
   a. E=2, V=1, M=1
   b. E=1, V=2, M=1
   c. E=1, V=1, M=2
   d. E=1, V=1, M=1

18. On initial evaluation, your patient has the ability to read letters near and far. Which cranial did you test to make this judgment?
   a. CN II (Optic)
   b. CN III (Oculomotor)
   c. CN X (Vagus)
   d. CN VII (Facial)
19. When the corneal reflex is being evaluated, which cranial nerve is being tested?
   a. CN II (Optic)
   b. CN V (Trigeminal)
   c. CN X (Vagus)
   d. CN VII (Facial)

20. An appropriate test to evaluate cerebellar function in a patient who is on bed rest would be:
   a. Romberg test
   b. Pronator test
   c. Plantar flexion
   d. Heel to shin

21. Pupillary changes are a(n):
   a. Early sign of neurologic recovery
   b. Late sign of neurologic recovery
   c. Early sign of elevating intracranial pressure
   d. Late sign of elevating intracranial pressure

22. Your patient’s neurological examination demonstrates the following results: Alert and Oriented X 3, moves all extremities, follows commands, pupils Right = 3.5 mm Brisk, Left 4 mm Brisk. The prior shift documented the same, except that the pupils were 3.5 mm bilaterally. Based on these findings your priority would be to:
   a. Immediately notify the MD that anisocoria has been found on this patient
   b. Do nothing as anisocoria is normal in a small percent of the population
   c. Immediately notify the MD regarding the GCS results
   d. Extensively assess the patient’s motor function

23. After the physician performs the oculocephalic reflex test on a patient, he documents negative doll’s eyes. This statement indicates that the patient’s
   a. Head rotated from side to side
   b. Eyes remain in midline position and move with the head
   c. Eyes move in the opposite direction in which the head is turned
   d. Eyes deviate slowly and nystagmus may occur

24. A complete pupillary/eye assessment includes the following:
   a. Size and reaction
   b. Size, reaction, visual acuity, extra-ocular movement, and accommodation
   c. Size, reaction, extra-ocular movement, and visual acuity
   d. Size, reaction, and extra-ocular movement
25. Your patient has weak grips, so you assess his bicep flexion and extension. How would you rate the strength of bicep flexion if he can flex his bicep only if no resistance is applied?
   a. 1
   b. 2
   c. 3
   d. 4

26. Which of the following tests is also used to assess motor weakness of the upper extremities?
   a. Pronator drift
   b. Romberg test
   c. CN XII (hypoglossal)
   d. Constructional ability

27. Your patient is reporting numbness and tingling in his left lower extremity. Motor function is intact to the extremity. What would be the next thing you would want to do?
   a. Administer pain medication and re-evaluate, including motor function, in 1-2 hours.
   b. Evaluate the patient’s ability to sense a wisp of cotton touched randomly to the lower extremities.
   c. Evaluate the patient’s ability to sense hot and cold items touched randomly to the lower extremities.
   d. Evaluate the patient’s Babinski reflex to see if there is evidence of a lesion in the corticospinal tract.

28. You have orders to test your patient’s quadriceps (knee) reflex every shift. When you strike the right knee, the leg barely moves. You check again and there is only slight movement. You would rate this as:
   a. 0
   b. 1+
   c. 2+
   d. 3+

29. When you stimulate the side of the uvula with a cotton applicator and the uvula elevates, this indicates:
   a. Cremasteric reflex is intact
   b. Wink (bublocavernous) reflex is intact
   c. Gag reflex is intact
   d. Swallowing reflect is intact
30. Which of the following is considered a cardinal sign of neurological dysfunction?
   a. Absent babinski reflex
   b. Muscle weakness
   c. Elevated blood glucose
   d. Positive oculovestibular reflex

31. Which of the following laboratory values can cause a deterioration in the level of consciousness?
   a. Hyponatremia
   b. Hypochloremia
   c. Hyperkalemia
   d. Hyperchloremia

32. Which cranial nerve are you assessing when you are assessing the gag reflex?
   a. CN II (optic)
   b. CN X (vagus)
   c. CN III (Oculomotor)
   d. CN V (trigeminal)

33. Which cranial nerve controls the ability to look toward nose with eyes?
   a. CN IV (trochlear)
   b. CN III (oculomotor)
   c. CN II (optic)
   d. CN V (Trigeminal)

34. When you test the pupil's reaction to light, which cranial nerve is responsible?
   a. CN IV (trochlear)
   b. CN V (vagus)
   c. CN II (optic)
   d. CN III (oculomotor)

35. If a patient experiences right hemisphere pathology you would expect to see:
   a. Motor loss on the right side
   b. Motor loss on the left side
   c. Inability to communicate effectively
   d. Unable to use the dominant upper extremity for ADL's
References


