Neurologic examination information can be used to communicate current status as well as potential concerns to other team members.
Veterinary professionals lack the luxury of patients describing their medical problem and, therefore, must rely on studious examination to reach a conclusion. In patients presenting with neurologic signs, systematic examination of the nervous system can identify an area of concern, a process called neuroanatomic localization. The neurologic examination, joined with patient history and physical examination, is therefore an invaluable diagnostic and monitoring tool in veterinary medicine. Veterinary nurses who understand neurologic concerns can improve patient outcomes with appropriate care, observation, and interventions.

FUNCTIONAL ANATOMY OF THE NERVOUS SYSTEM
The nervous system includes the brain, which is structurally divided into the forebrain, cerebellum, and brainstem; the spinal cord; and peripheral nerves (FIGURE 1). The central nervous system (CNS) comprises the brain and spinal cord, while the peripheral nerves make up the peripheral nervous system (PNS).

Brain
The forebrain performs many functions, including integration of sensory information such as vision, hearing, touch, pain, and body position. It also initiates and controls voluntary movement and is critical for learning, behavior, and memory. The cerebellum controls force and range of movement, producing fluid muscle activity, and is closely associated with the vestibular system, providing input to control the body’s equilibrium and balance. The brainstem connects the spinal cord to the forebrain and relays information between the two. Additionally, it regulates the autonomic functions of the body, such as respiratory rate, blood pressure, and heart rate.

Spinal Cord
The spinal cord extends from the brainstem caudally through the vertebral canal. Information from the brain travels through the spinal cord to the rest of the body. Clinically, the spinal cord is separated into 4 regions: C1–C5, C6–T2, T3–L3, and L4–S3.
Peripheral Nerves

Peripheral nerves arise from the brainstem and spinal cord and innervate muscles, glands, and organs. The PNS receives sensory input from both within and outside the body and transmits that information to the CNS, where an appropriate reaction is determined. Expression of this reaction is then carried out by the peripheral nerves. This sensory input/motor output cycle is intrinsic to nearly all aspects of the neurologic examination.

**FIGURE 1.** Functional anatomy of the (A) central and (B) peripheral nervous system. In A, the pathway of the pupillary light reflex is shown. B shows the nerves involved in testing spinal reflexes. CN=cranial nerve.
NEUROLOGIC EXAMINATION FUNDAMENTALS
The neurologic examination systematically evaluates all parts of the nervous system through a series of simple tests and observation of the results. The neurologic examination can be divided into 5 parts: mentation, posture, and gait observation; postural reactions; cranial nerve evaluation; spinal reflex evaluation; and spinal palpation.

Mentation and General Observation
This phase of the neurologic examination begins before the patient is handled. At this time, the patient is observed with little to no intervention from the evaluators. Note should be taken of the patient’s mental status, any unusual movements or postures, difficulty navigating the environment, and gait. Evaluation of the patient’s mental state can be of critical concern and should be considered first.

Mentation
Defining mental status can be difficult and nuanced; however, characterizing a patient’s level of consciousness as well as quality of consciousness can give the clearest picture of the patient’s mental state. Consciousness is produced by the appropriate function of both the forebrain and the ascending reticular activating system in the brainstem. Dysfunction of either of these areas, or both, results in the clinical observation of abnormal mental state.

Although level of consciousness is a spectrum, 4 distinct categories can be clinically recognized. In order of increasing severity, these categories are normal, obtunded, stuporous, and comatose. Characteristics of each are described in BOX 1. Some patients with stuporous or comatose level of consciousness may also exhibit decerebrate rigidity characterized by opisthotonos and extension of all limbs.

In an awake patient, the quality of consciousness should also be considered. Confusion, disorientation, and inappropriate reaction to stimulation may indicate forebrain dysfunction. As a few examples, a patient may stand at the wrong side of a door to enter or exit, gentle petting may invoke a painful response (hyperesthesia), or the patient may vacillate unpredictably from aggressive to compliant. It is important to note that a patient’s level and quality of consciousness can wax and wane; therefore, keeping a frequent record of mental status can be of benefit.

Posture
Additionally, body position and posture should be observed for each patient. Abnormal head carriage such as a head tilt (FIGURE 2) or head turn indicates disease affecting the vestibular system or forebrain.

FIGURE 2. Dog with head tilt characteristic of vestibular disease.
respectively. Disease affecting these areas may also cause the patient to circle or only turn in one direction. A wide-based stance (FIGURE 3), swaying, or leaning on objects for support indicates vestibular system or cerebellar dysfunction. Continuous or intermittent tremors or other uncontrolled movements are nonspecific observations indicating neurologic abnormalities that can arise from many potential causes.

**Gait**

Gait evaluation allows for observation of independent ambulation and identification of lameness, ataxia, or paresis. Ambulation is the ability of a patient to walk using all limbs without support or assistance. Lameness is a shortened stride of 1 or more limbs and is most often the result of orthopedic injury; however, some neurologic conditions, such as peripheral nerve sheath tumors, can cause lameness. Ataxia is an incoordination of gait that indicates disease in a particular area of the nervous system (BOX 2). Ataxia can occur with or without paresis, which is defined as weakness in 1 or more limbs.

Complete paralysis is the result of total loss of voluntary motor function in the affected limbs. This is best described with quantifying terminology indicating the number of limbs affected. For example, describing a patient as paraplegic indicates that the patient has lost motor function in 2 limbs.

**Postural Reactions**

Proprioception is awareness of the body’s position and actions. Proprioceptive receptors are present in muscles,
joints, and tendons throughout the body, and they relay proprioceptive information to the forebrain to adjust posture or limb position. As such, testing proprioception is a simple but important way to generally evaluate the nervous system.

Several techniques can be used to assess proprioception in a veterinary patient. The most commonly performed is proprioceptive placing, often referred to as “conscious proprioception” or “CP” testing. In this technique, the patient’s weight is semisupported and the paw is turned over, so the dorsal surface is touching the ground (FIGURE 4). The patient should return its paw to a normal position rapidly for a normal result. A delay or inability to correct the paw indicates a nonspecific neurologic deficit. Other techniques that may be performed along with or in lieu of proprioceptive placing include hopping, hemi-walking, wheelbarrowing, extensor postural thrust, and visual or tactile placing (BOX 3). Although these techniques all evaluate the patient’s proprioception, the choice of which to use is based on the patient’s temperament or even species.

**Cranial Nerve Evaluation**

Cranial nerves are peripheral nerves that originate primarily from the brainstem and provide sensory and motor functions to the head and neck (BOX 4). Each cranial nerve has specific functions, and most can be evaluated through the following standard tests:

- **Menace response:** Waving the hand toward the patient’s face in a “menacing” gesture elicits a blink (FIGURE 5). This is used to evaluate the optic nerve, forebrain, cerebellum, and facial nerve.
- **Pupillary light reflex:** Shining a bright light into one eye causes constriction of that pupil as well as the pupil in the opposite eye. This is used to evaluate the optic nerve and oculomotor nerve.
- **Palpebral reflex:** Touching the medial and lateral canthus of the eye elicits a blink. This is used to evaluate the trigeminal nerve and facial nerve.
- **Oculocephalic reflex:** Turning the patient’s head from side to side elicits a rapid movement of the eye in the direction the head is turned. This is used to evaluate the vestibulocochlear nerve, oculomotor nerve, trochlear nerve, and abducent nerve.

**Types of Ataxia**

- **Cerebellar:** Characterized by irregularity in rate and range of limb movement, most often described as hypermetric. Often seen with intention tremors of the head or truncal sway. Disease affecting the cerebellum, which coordinates motor activity, causes this clinical appearance.
- **Vestibular:** Characterized by leaning or falling to one side or an inability to ambulate due to loss of balance. Often this is seen along with head tilt or nystagmus. Occurs in disease affecting the vestibular system (inner ear, vestibulocochlear nerve, brainstem, and cerebellum), which controls balance and equilibrium.
- **Proprioceptive:** Characterized by scuffing, knuckling, crossing over, or dragging affected limbs. It is the result of a loss of awareness of limb position, most often from spinal cord disease, but can also be present with brainstem or forebrain disease.

**Proprioceptive Testing Techniques**

- **Hopping:** Patient weight is shifted to testing limb. Patient is moved laterally, and the testing limb should move laterally to maintain support.
- **Hemi-walking:** Patient weight is shifted to one side of the body. Patient is moved laterally, and the testing limbs should oscillate laterally to maintain support.
- **Wheelbarrowing:** Patient weight is shifted onto thoracic limbs. Patient is moved forward, and the thoracic limbs should walk forward.
- **Extensor postural thrust:** Patient is lifted by the thorax and the pelvic limbs brought back to contact surface. The pelvic limbs should walk caudally to return to normal stance.
- **Visual placing:** Patient is carried toward the edge of a table. The patient will reach toward and place limbs on the table surface before touching the table edge.
- **Tactile placing:** With eyes covered, patient is carried toward the edge of a table. As the limbs contact the table edge, the patient will move the limbs to place on the table surface.
● Nasal stimulation response: Touching the nasal mucosa on the medial aspect of each nare with a blunted probe elicits withdrawal of head. This is used to evaluate the trigeminal nerve and the forebrain.

● Gag reflex: Transoral palpation or stimulation of the pharynx elicits constriction of pharyngeal structures. This is used to evaluate the glossopharyngeal nerve and vagus nerve. Patient temperament may preclude performance of this test.

Abnormal results in any of these tests can indicate a problem affecting the nerves being evaluated, the brainstem, or both.

Additional observations to note while evaluating the cranial nerves include eye movement, muscle tone, and facial symmetry. Nystagmus, or involuntary jerking eye movements with a fast-to-slow rhythm, occurs in disease involving the vestibular system. Strabismus, or deviation of 1 or both eyes, can occur naturally in certain breeds (e.g., pug). It may also indicate disease of the vestibular system, or the nerves involved with eye movement (oculomotor, trochlear, and abducent). Abnormal jaw tone, loss of muscle mass palpated in the muscles of mastication, or loss of facial sensation can occur in disease affecting the trigeminal nerve. Facial asymmetry can be observed in patients with dysfunction of the facial nerve, often with unilateral drooping of the lip and ear. The tongue should also be observed for symmetry and tone; abnormalities can occur with disease affecting the hypoglossal nerve. The olfactory nerve and spinal accessory nerve are rarely evaluated owing to subjectivity of test results and lack of significant clinical relevance in most cases.

Spinal Reflex Evaluation
As mentioned, the spinal cord is considered in 4 sections. The nerves that innervate the thoracic limb arise from the C6 through T2 segments of the spinal cord, while those that innervate the pelvic limb and tail arise from the L4 through S3 segments. Performing a spinal reflex examination assesses the integrity of the nerves involved in the reflex as well as the associated spinal cord segments.²

Several spinal reflexes exist, but the most reliable for testing are the withdrawal reflex in the thoracic limbs and the patellar reflex and withdrawal reflex in the pelvic limbs. The perineal reflex and cutaneous trunci reflex also provide additional clinical information. The techniques for these tests are as follows:

● Withdrawal reflex: Lightly pinching the interdigital skin stimulates the limb to withdraw toward the body, flexing at all joints (FIGURE 6). In the thoracic limb, this evaluates the C6 through T2 spinal cord segments as well as the brachial plexus (axillary, median, musculocutaneous, radial, and ulnar nerves). In the pelvic limb, this evaluates the L4 through S3 segments as well as the sciatic nerve. Evaluation of joint range of motion or pain can identify concurrent orthopedic concerns that may affect ability to flex the joints.

● Patellar reflex: Striking the patellar tendon elicits extension of the stifle. This evaluates the femoral

## Cranial Nerves

- Olfactory nerve (CN I)
- Optic nerve (CN II)
- Oculomotor nerve (CN III)
- Trochlear nerve (CN IV)
- Trigeminal nerve (CN V)
- Abducent nerve (CN VI)
- Facial nerve (CN VII)
- Vestibulocochlear nerve (CN VIII)
- Glossopharyngeal nerve (CN IX)
- Vagus nerve (CN X)
- Spinal accessory nerve (CN XI)
- Hypoglossal nerve (CN XII)

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**FIGURE 6.** Withdrawal reflex testing.
nerve and the L4 through L6 spinal cord segments.

- **Perineal reflex:** Brushing the perineum on each side elicits contraction of the anal sphincter and flexion of the tail. This evaluates the pudendal nerve and the S1 through caudal spinal cord segments.

- **Cutaneous trunci reflex:** Pinching the skin on each side of the body lateral to the dorsal spinous process, starting at the level of the ilial wings, should elicit a bilateral contraction of the cutaneous trunci muscle, regardless of testing side. If no contraction is elicited, continue cranially until the reflex is present to identify a “cutoff.” This evaluates the spinal cord from the levels of C8 through L3, as well as the lateral thoracic nerve.

Abnormalities noted in these reflexes indicate a neurologic problem with the associated nerves and/or spinal cord segments. Evaluation of muscle mass and tone provides additional information, as low muscle tone or atrophy also reflects nerve or segmental spinal cord dysfunction. It is important to note that intact reflex pathways in the limb do not correlate to intact perception of pain sensation. Observing intact perception of pain sensation in a limb requires the patient to display a conscious reaction to the stimulation, such as biting, whining, or looking toward the stimulation source. For example, a patient can have a normal withdrawal reflex in a limb but be unable to perceive painful stimulation applied to that same limb.

**Spinal Palpation**

The final part of the neurologic examination involves palpation of the spine. While the patient’s chest and abdomen are supported, mild to moderate pressure is placed on each spinous process to locate any area of discomfort. In the cervical spine, it is best to palpate the transverse processes of each vertebra for a more accurate reaction, as the dorsal musculature can mask any sensitivity. Cervical and tail range of motion may also be performed for additional information. This is a nonspecific evaluation and may have false-positive results due to patient temperament or other pain (e.g., abdominal, muscular).

**THE NEUROLOGIC EXAMINATION IN CLINICAL PRACTICE**

Synthesis of the neurologic examination information allows for focused localization of neuroanatomic deficits and identification of more specific diagnostic differentials to investigate. It is easy to conflate performing neurologic evaluations with diagnosis and assume that neurologic examination is outside of a credentialed veterinary nurse’s scope of practice. However, in clinical practice, knowledge of the nervous system and familiarity in performing the neurologic examination allows for creation of a more comprehensive care plan and rapid detection of concerning findings, as well as proving advantageous in emergency situations. In this way, the neurologic examination should be considered a patient assessment tool, as demonstrated in the following examples.

**Example 1: Patient Unable to Walk**

**Presentation and Assessment**

A patient presents for an inability to walk. The neurologic examination reveals the following:

- Nonambulatory paraplegia with intact pain perception; normal mentation
- Absent proprioception in the pelvic limbs; normal thoracic limbs
- Normal cranial nerve evaluation
- Absent withdrawal reflex in the pelvic limbs; normal thoracic limbs
- No discomfort on spinal palpation

The combination of absent pelvic limb withdrawal reflexes and absent proprioception in the pelvic limbs in a nonambulatory patient with normal mentation localizes neurologic concerns to the L4 through S3 region of the spinal cord.

**Considerations for Care**

Owing to the inability to contract the muscles in the
pelvic limbs, regardless of diagnosis, this patient should be protected from developing decubital ulcers with thick bedding, padding around bony prominences, and frequent rotation of position.

Disease affecting this area of the spinal cord can also affect urinary and fecal continence. Either urinary catheterization or manual expression should be used to carefully manage the urinary bladder to prevent overdistention. Urinary catheterization has the additional benefit of protecting the patient’s skin from urine scalding that can occur with urine leakage. This patient will be at an increased risk of urinary tract infection regardless of intervention strategy; therefore, it is important to monitor the color and odor of urine for changes. The patient should also be kept clean and dry of feces to protect the integrity of the skin.

Lack of air movement between the toes due to the patient’s inability to walk can lead to interdigital dermatitis that can be addressed with cleaning and drying the toes periodically. To improve circulation and maintain joint health, massage of the affected limbs and passive range of motion of all affected joints should be performed while the patient is recovering.

As the patient recovers and pelvic limb withdrawal reflexes return, the care plan should be updated to reflect the decreasing risk of decubital ulcers, urinary incontinence, and skin damage.

Example 2: Patient With Head Trauma

Presentation and Assessment
A patient presents with head trauma. The neurologic examination reveals the following:
- Stuporous mentation, difficult to rouse, recumbent
- Delayed proprioception in thoracic and pelvic limbs
- Anisocoria, slow but present pupillary light reflex, slowed oculocephalic reflex and reduced gag reflex
- Normal spinal reflexes
- No discomfort on spinal palpation

The presence of multiple abnormalities on the cranial nerve evaluation, delayed proprioception in all limbs, and reduced mental status localize neurologic concerns to the brainstem.

Considerations for Care
The history of head trauma and reduced mental status raise concern for increased intracranial pressure. Measures should be taken to reduce the risk of increasing intracranial pressure, such as positioning the patient with the head elevated, avoiding jugular compression, and alleviating pain and/or anxiety to keep the patient calm. Careful monitoring of the patient’s heart rate, blood pressure, and respiratory pattern can identify hypertension and bradycardia, components of the Cushing reflex. These findings raise alarm for imminent brain herniation due to increased intracranial pressure.

Supplemental oxygen should be considered for this patient to maintain tissue perfusion.

Patients with head trauma may be at an increased risk for seizure; therefore, close monitoring is critical for rapid intervention.

Aspiration pneumonia can be a devastating complication. Maintaining sternal recumbency with head elevation is a simple strategy to reduce the risk of aspiration. The reduced gag reflex indicates the patient should receive nothing it is unable to willingly ingest. Nutrition and medications may need to be provided by an alternative route to prevent aspiration.

Like the patient in the first example, this patient is recumbent and will need similar interventions to prevent decubital ulceration, urine and fecal scalding, and joint contracture.

At the next treatment time, the patient is observed to be nonresponsive with bilateral mydriasis and absent pupillary light reflex. The ability to identify and raise concern for this potentially life-threatening decline in status will expedite medical interventions that may improve outcome.
CONCLUSION

For veterinary nurses, using the neurologic examination as an assessment tool provides objective information about a patient’s status. This information can set a baseline of patient status to which positive or negative changes in neurologic status can be compared. Understanding neurologic examination findings can also aid in anticipating potential complications when developing a care plan for an individual patient. Neurologic examination information can be used to communicate current status as well as potential concerns or complications to other team members for continuity of care and improvement of patient outcomes.

References


Brittany Laflen

Brittany earned her associate of science degree in veterinary technology from Purdue University in 2010. After graduation, she joined the neurology department at the Purdue University Veterinary Hospital, where she provides clinical case support and patient care and teaches the fundamentals of neurology and neurologic diseases to students in the veterinary nursing program at Purdue. In 2019, she achieved her Veterinary Technician Specialist designation in neurology. In 2022, Brittany began serving as President for the Academy of Internal Medicine for Veterinary Technicians (AIMVT). Brittany also speaks on a wide variety of neurology topics.
Firing on All Cylinders: A Guide to the Neurologic Examination

TOPIC OVERVIEW
The neurologic examination, joined with patient history and physical examination, is an important diagnostic and monitoring tool in veterinary medicine that enables the healthcare team to identify potential issues with the brainstem, cerebellum, spine, and more. The veterinary nurse plays a role by understanding the tests and communicating the findings to other team members to ensure continuity of care and improve patient outcomes.

LEARNING OBJECTIVES
This article will enable the reader to become familiar with the basic anatomy of the nervous system, the 5 phases of a neurologic examination, potential findings of a neurologic examination and their significance, and the veterinary nurse’s role in utilizing a neurologic examination in practice.

1. The components of the central nervous system are the:
   a. brain and peripheral nerves
   b. spinal cord and peripheral nerves
   c. forebrain and brainstem
   d. brain and spinal cord

2. Autonomic functions of the body, such as heart rate and blood pressure, are mediated by the _________.
   a. brainstem
   b. forebrain
   c. cerebellum
   d. peripheral nerves

3. A stuporous level of consciousness is clinically described as:
   a. Asleep but reactive to mild stimulus
   b. Unconscious but reactive to mild stimulus
   c. Asleep; requires strong stimulation to elicit reaction
   d. Unconscious; unable to elicit reaction

4. True or False: A loss of proprioception is always the result of spinal cord disease.
   a. True
   b. False

5. Carrying a patient toward a table and expecting the patient to reach and place limbs on the surface is a test of proprioception called ____________.
   a. Visual placing
   b. Tactile placing
   c. Extensor postural thrust
   d. Paw placing

6. The pupillary light reflex evaluates the function of which nerves?
   a. Optic and facial
   b. Optic and oculomotor
   c. Oculomotor and facial
   d. Trigeminal and facial

7. Unilateral drooping of the lip and ear may indicate a problem with which cranial nerve?
   a. Trigeminal
   b. Spinal accessory
   c. Vestibulocochlear
   d. Facial

8. Testing the withdrawal reflex in the thoracic limb gives information about which spinal segment?
   a. C1–C5
   b. C6–T2
   c. T3–L3
   d. L4–S3

9. True or False: An intact withdrawal reflex means the patient can perceive painful stimulation in that limb.
   a. True
   b. False

10. The neurologic examination should be considered a patient assessment tool for veterinary nurses because:
    a. The veterinary nurse can diagnose the problem
    b. It allows for more comprehensive and dynamic nursing care plans
    c. It determines the prognosis for the patient
    d. It should not be used by veterinary nurses because it is outside of the scope of practice