NEUROLOGIC DYSFUNCTION

(CHAPTERS 30 AND 34)

QUESTION 1

Compare cerebral dysfunction and whole-brain death.

Remember the functions of the cerebrum and the brainstem:

the **cerebrum** controls the "higher functions" of the brain, such as motor control, perception, information processing, etc.

the **brainstem** controls the lower-level, basic functions that keep the body alive, such as breathing, controlling heart rate, etc.

Failure of part or all of the cerebrum (focal or diffuse dysfunction) causes loss of one or more **higher functions** of the brain.

This can affect anything from speech and language processing to facial recognition, or can be as severe as complete loss of conscious thought (coma.)

Even with **complete loss** of cerebral function, the body can **still survive** under its own autonomic processes, e.g. without mechanical ventilation, ECMO, etc.

When the **brainstem** is also nonfunctional (whole-brain death,) even basic autonomic processes cease and the body **will not** survive without continuous intervention.

QUESTION 2

Which neurotransmitter is involved in Alzheimer's disease?

Alzheimer's disease is the most common form of **dementia**, a neurodegenerative disease characterized by loss of memory and cognitive function.

It occurs most often in the elderly, with an average age at diagnosis of 80.

It is closely linked with a decline in **acetylcholine** production in the brain, and is commonly treated with acetylcholinesterase inhibitors which work to increase levels of ACh.

This treatment can improve the symptoms of Alzheimer's disease, but is **not a cure** and does not slow the progression of the disease.

Alzheimer's disease is the **sixth-leading** cause of death in the United States, just behind strokes.

The median survival for Alzheimer's patients is <10 years even in those diagnosed as early as 65, worsening as age at diagnosis increases.

QUESTION 3

Which two proteins have been implicated in Alzheimer's disease?

Two of the abnormalities noted in Alzheimer's disease involve the improper folding of **amyloid beta** (Aβ) and **tau** (τ) proteins.

Amyloid beta proteins form **amyloid plaques** (senile plaques,) clumps of misfolded protein that accumulate in the **extracellular** space.

Tau proteins, responsible for maintaining the structure of neurons, likewise misfold and clump together, leading to **tau tangles** inside the the neurons.

QUESTION 4

Name two other forms of dementia. Which has a genetic linkage?

Multi-infarct dementia, sometimes called **vascular dementia**, is the second most-common form of dementia after Alzheimer's disease.

It is seen in patients who have suffered a series of minor strokes, due to the accumulation of permanent damage due to cerebral infarction.

A rare cause of dementia is **Huntington's disease**, which is an autosomal dominant genetic disorder resulting in progressive loss of brain cells.

It typically manifests itself at a much younger age than other forms of dementia (30-50 years,) with some cases being diagnosed even in children.

There is currently no cure for Huntington's disease. Patients experience worsening loss of motor control, severely impacting independence and quality of life.

QUESTION 5

Describe the different types of seizures. Which is the most serious and represents a medical emergency?

Seizures are caused by **abnormal electrical activity** in the brain, and are typically categorized as either **focal** or **generalized**.

Focal seizures affect only one part of the brain, so the signs and symptoms tend to be confined to one aspect of brain function: twitching, abnormal perception, etc.

Generalized seizures affect both hemispheres of the brain, resulting in a wider variety of symptoms at once:

- **Absence** (petit mal) seizures result in a brief loss of motor activity and decreased level of consciousness, usually just for a few seconds.
- **Tonic-clonic** (grand mal) seizures are the most common type in adults and result in muscle rigidity (tonic phase) and followed by alternating spasm and flaccidity (clonic phase.)

The term **status epilepticus** refers to a single seizure or series of seizures lasting longer than 5 minutes. This is an emergent condition and requires immediate treatment.

Patients experiencing SE are at risk of losing **airway patency**, and can experience **severe exhaustion** as a result of persistent clonic activity.

SE is **usually** associated with a severe underlying problem such as an advanced brain tumor, rather than primary generalized epilepsy.

QUESTION 6

Compare decerebrate and decorticate posturing.

Decerebrate and **decorticate** posturing are very similar, and both are signs of **severe** brain damage.

Both involve whole-body rigidity with legs extended and plantar flexion at the ankles (toes pointed downward.)

The major difference between the two can be observed in the positioning of the arms:

Decerebrate posturing features **extension** of the arms and neck, with the head thrown backwards and the arms held stiffly at the sides.

Decorticate posturing features **flexion** of the arms, with the hands held over the chest (decorticate → arms "towards the core")

QUESTION 7

Compare intentional tremor and tremor at rest. Which is characteristic of Parkinson's disease?

Intentional tremor is shaking that emerges when a person attempts to make an **intentional** movement, such as picking up an object.

This is contrasted with **tremor at rest**, which is present even when a person is meaning to stay still.

Tremor at rest is commonly associated with Parkinson's disease, whereas intentional tremor is more commonly idiopathic (essential tremor) or secondary to multiple sclerosis or stroke.

QUESTION 8

Describe athetosis and chorea. Which is associated with Huntington's disease?

Athetosis and chorea are both forms of **dyskinesia**, or involuntary muscle movement, which are caused by several forms of neurological disorder and can occur either together (choreoathetosis) or separately.

Athetosis primarily affects the hands (and sometimes the feet) and is commonly associated with **cerebral palsy**.

It is usually described as a "**slow, writhing movement**" of the affected extremities, particularly the **fingers**.

Chorea, on the other hand, consists of **larger** "dance-like" movements that tend to affect the arms and legs, and is a major sign of **Huntington's disease**.

QUESTION 9

Describe an upper motor neuron lesion (UMNL.)

First, let's review the anatomy of the motor nerves:

Motor signals originate in the **primary motor cortex** of the frontal lobe, anterior to the central sulcus.

The **upper motor neurons** carry the signal through the brainstem and down the **corticospinal tracts** of the spinal cord white matter.

The upper motor neuron travels down the spinal cord until it reaches the appropriate level, then synapses with a **lower motor neuron** in the ventral gray horn.

The lower motor neuron then carries the signal out the ventral root and to the skeletal muscle, synapsing with the muscle at the **neuromuscular junction**.

In an **upper motor neuron lesion**, the damage is either in the brain or in the upper spinal cord, **above** where the two neurons synapse in the ventral gray horn.

This means that the **brain** is cut off from the muscle, but the spine and the muscle are **still communicating normally**.

So how does this type of injury manifest itself?

- **hyperreflexia** – spinal reflexes are still intact but no longer regulated by the brain, leading to more pronounced reflexive responses
- **hypertonia** and **spastic paralysis** – muscles become stiff and difficult to move due to lack of impulse regulation from the brain
- positive **Babinski's sign** – dorsiflexion and toe fanning in response to plantar stimulation (normal in babies, abnormal in adults)
- typically **no atrophy** because the muscle is still innervated by the spine

QUESTION 10

Describe a lower motor neuron lesion (LMNL.)

In contrast to an UMNL, lower motor neuron lesions result from damage to the nerves **between the spine and the muscle**.

This means that the muscle is cut off from the entire central nervous system and receives diminished or completely absent stimulus from the CNS.

So how does this type of injury manifest itself?

- **hyporeflexia** – spinal reflexes are diminished or absent due to lack of communication between the muscle and the spine
- **hypotonia** and **flaccid paralysis** – muscles become permanently limp due to lack of innervation of the muscle
- negative **Babinski's sign** – no dorsiflexion in response to plantar stimulation
- **denervation atrophy** because the muscle is receiving diminished signals from the entire CNS

QUESTION 11

What is the hallmark of a basal ganglion lesion?

Lesions to the basal ganglia (in the midbrain) typically manifest in the form of **dyskinesias**, or involuntary muscle movement.

The basal ganglia contain synapses related to motor control, among several other functions, so damage here can cause signals to be sent down the spinal cord without any intentional stimulus in the motor cortex.

This can result in **athetosis** and **chorea**, which we've talked about, as well as the tremors seen in **Parkinson's disease**.

QUESTION 12

What is the hallmark of cerebellar syndrome?

The primary manifestation of cerebellar damage is **ataxia**, or loss of voluntary muscle coordination.

This can result in many abnormalities, from slurred speech and tremors to trouble eating or swallowing.

In can also cause an **ataxic gait**, where cerebellar damage leads to extreme difficulty walking and a wide, shuffling stance when trying to walk.

QUESTION 13

Describe some of the effects of unifocal cortical lesions.

Remember that **focal** lesions to the cerebral cortex are typically going to affect **one form** of higher information processing.

agnosia – inability to process sensory stimuli, e.g. recognizing objects, smells (umbrella term)

asterognosis – inability to recognize shapes by tactile stimulus

prosopagnosia – "face blindness," inability to recognize faces

acalculia – inability to do simple mathematical calculations

agraphia – inability to write

alexia – complete inability to read or understand written text

apraxia – loss of "skilled movement," can affect speech or ADLs

dysphasia/aphasia – difficulty speaking or understanding spoken language

QUESTION 14

Compare coup vs. contrecoup injuries.

A **coup** injury is an injury to the brain due to head trauma, which occurs **directly** from the source of the trauma.

For example, if you hit the **front** of your head, a coup injury will result in damage to the **front** of the brain.

A **contrecoup** injury is a secondary injury which can occur due to the momentum from the blow slamming the brain against the **opposite side** of the skull.

For example, if you hit the **front** of your head, a contrecoup injury will result in damage to the **back** of the brain.

QUESTION 15

Define concussion, contusion, and laceration.

concussion – a **mild** brain injury due to blunt trauma, which can result in loss of consciousness but does **not** cause severe, permanent brain damage

contusion – a more **severe** form of injury in which there is bruising (internal bleeding) of the brain tissue due to small blood vessel rupture

laceration – an even **more severe** form of brain injury in which the **meninges** are torn or ruptured, often due to a skull fracture

QUESTION 16

Describe thrombotic, embolic, and hemorrhagic strokes. Which type is most common?

thrombotic stroke – a type of **ischemic** infarction caused by "**stationary**" clotting within the brain's vascular system

embolic stroke – a type of **ischemic** infarction caused by a **moving** vascular obstruction from elsewhere

(includes **thromboembolic** strokes due to traveling clots, e.g. PE)

hemorrhagic stroke – the **most serious** form of stroke, caused by bleeding in the brain, e.g. subarachnoid or intracranial hemorrhage

QUESTION 17

When is fungal meningitis normally seen? Which is more serious, bacterial or viral meningitis?

Meningitis—inflammation of the meninges surrounding the brain and spinal cord—can be caused by several forms of infection, but fungal meningitis is particularly **rare**.

It is usually observed as an **opportunistic** infection in patients who are **already immunocompromised**, such as those with AIDS.

The most serious form of meningitis is **bacterial** (hence why we vaccinate against *Neisseria meningitidis*, one common pathogen causing bacterial meningitis.)

QUESTION 18

What part of the brain is involved in Parkinson's disease? Which neurotransmitter is involved?

The motor symptoms of Parkinson's disease are caused by the death of neurons in part of the **substantia nigra**, an area of the basal ganglia in the midbrain.

These are largely **dopaminergic** neurons, meaning that the primary neurotransmitter that they emit is **dopamine**.

The deficiency of dopamine caused by the death of these neurons is often treated with **L-DOPA**, a precursor to dopamine that makes it easier for the brain to produce it.

QUESTION 19

What process leads to the progression of multiple sclerosis (MS?) What is the hallmark of this disease?

Multiple sclerosis is characterized by the loss of **oligodendrocytes** and the **demyelination** (destruction of the **myelin sheath**) of neurons in the central nervous system.

It is believed to be at least partially autoimmune (type IV hypersensitivity,) caused by T cells attacking myelin and causing inflammation and scarring of the neuronal axons.

MS has many varied symptoms, but one telltale sign is impaired eye movement, particularly paralysis of the **medial rectus** muscle.

This causes the eyes to no longer be parallel when looking to the sides; when looking right, for example, the right eye will face right but the left eye will face forward.

QUESTION 20

In which sex is amyotrophic lateral sclerosis (ALS) is more common? What causes the deterioration that patients experience?

ALS is caused by the progressive death of **motor neurons**, resulting in spasticity, twitching, and over time, denervation atrophy.

This loss of motor function is eventually fatal as the worsening nerve damage begins to cause respiratory failure. Most ALS patients die within 3-4 years of diagnosis.

ALS is **slightly** more common in men than in women (about 20%,) particularly among those diagnosed at a young age.