Neurologic Alterations
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Objectives
1. Describe common CNS tumors
2. Describe signs and symptoms of neurologic alterations
3. Review key assessment skills and nursing interventions

Disclosures
• none
Neuro Assessment

- Baseline assessment is essential and needs to be documented
- LOCATION and type of injury/insult
- Basic Assessment
  - Glasgow Coma Scale
  - Motor/Sensory Function
  - Cranial nerve dysfunction
  - Pupil

Glasgow Coma Scale

<table>
<thead>
<tr>
<th>Glasgow coma scale</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye opening</td>
<td></td>
</tr>
<tr>
<td>Spontaneously</td>
<td>5</td>
</tr>
<tr>
<td>in response to pain</td>
<td>4</td>
</tr>
<tr>
<td>to pain</td>
<td>3</td>
</tr>
<tr>
<td>to voice</td>
<td>2</td>
</tr>
<tr>
<td>to none</td>
<td>1</td>
</tr>
<tr>
<td>Verbal response</td>
<td></td>
</tr>
<tr>
<td>Oriented</td>
<td>5</td>
</tr>
<tr>
<td>Confused</td>
<td>4</td>
</tr>
<tr>
<td>Inappropriate</td>
<td>3</td>
</tr>
<tr>
<td>Incomprehensible</td>
<td>2</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
</tr>
<tr>
<td>Motor response</td>
<td></td>
</tr>
<tr>
<td>obeys commands</td>
<td>5</td>
</tr>
<tr>
<td>withdraws from pain</td>
<td>4</td>
</tr>
<tr>
<td>Extends to pain</td>
<td>3</td>
</tr>
<tr>
<td>reaction to pain</td>
<td>2</td>
</tr>
<tr>
<td>none</td>
<td>1</td>
</tr>
<tr>
<td>Maximum score</td>
<td>15</td>
</tr>
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</table>
Motor Strength

<table>
<thead>
<tr>
<th>Rating</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No muscle contraction is detected.</td>
</tr>
<tr>
<td>1</td>
<td>A trace contraction is noted in the muscle by palpating the muscle while the patient attempts to contract it.</td>
</tr>
<tr>
<td>2</td>
<td>The patient is able to actively move the muscle when gravity is eliminated.</td>
</tr>
<tr>
<td>3</td>
<td>The patient may move the muscle against gravity but not against resistance from the examiner.</td>
</tr>
<tr>
<td>4</td>
<td>The patient may move the muscle group against some resistance from the examiner.</td>
</tr>
<tr>
<td>5</td>
<td>The patient moves the muscle group and overcomes the resistance of the examiner. This is normal muscle strength.</td>
</tr>
</tbody>
</table>

Pupil Assessment

Common Terms in Neuro Assessment

Nystagmus - Rhythmic, oscillating motions of the eyes are called nystagmus

Anascoria - unequal pupils

Focal - impairments of nerve, spinal cord, or brain function that affects a specific region of the body
Neuro Changes

Types and signs of neuro change
• Change in LOC
• Pupil changes
• Motor or sensory changes
• Speech changes
• Vision changes
• Seizure activity
• Peripheral neuropathy

Seizures

• Definitions:
  – Seizure: a sudden, explosive, disorderly discharge of cerebral neurons
    • Motor, sensory, autonomic, or psychic
  – Tonic: excessive muscle tone
  – Clonic: alternating contraction, relaxation
  – Epilepsy: disease condition that causes seizures
• Types
  – Partial (focal), simple, complex, generalized

Seizure Classification
Post Ictal

Thought:
• Memory loss
• Writing difficulty
• Somnolence/Lethargy

Emotional:
• Confusion
• Depression and sadness
• Fear
• Frustration
• Shame/Embarrassment

At risk for:
– Aspiration
– Falls
– Bruising/self injury
– Airway
– Status Epilepticus

Guidelines for Seizure Care

Diagnosing Seizure Activity
• You first have to be looking for any potential seizures in your patient with a brain tumor.
• Report any Symptoms that could be seizure activity to a provider
• EEG is the definitive test to discover whether your patient is seizing or not.
Seizure Med Management

- Benzo’s for immediate control
  - Ativan/valium/versed
- Maintenance meds (may require a load)
  - Phenytoin/Fosphenytoin
  - Keppra
  - Depakote
  - Lacosamide

Common Types of CNS tumors

Breakdown of Brain Tumors

- There are more than 120 types of brain and central nervous system (CNS) tumors
- Brain metastases are about 10 times more common than primary tumors
- Classify brain tumors by cell origin and how the cells behave, from the least aggressive (benign) to the most aggressive (malignant)
Incidence of primary brain tumors
A. Incidence rate of all primary benign and malignant brain tumors,
14 cases per 100,000 person-years
   - 1. Benign tumors, 5.7 per 100,000 person-years
   - 2. Malignant tumors, 7.7 per 100,000 person-years
B. Incidence rate by sex
   - 1. Men, 14.2 per 100,000 person-years
   - 2. Women, 13.9 per 100,000 person-years
C. Median age at diagnosis, 57 years

How might the Patients present?
- SEIZURES
- Back/neck pain/headache
- Mental status changes
- Foot drop
- Gait disturbance
- Nausea/vomiting
- Incidental finding on MRI
Primary Brain Tumors

- Meningiomas
- Pituitary tumors
- Pineal tumors
- Choroid plexus tumors
- Other, more benign primary tumors
- Tumors of nerves and/or nerve sheaths

Primary Brain Tumor - Gliomas

- Lowest grade tumors
  - Pilocytic astrocytoma
  - Subependymal giant cell astrocytoma
  - Protoplasmic astrocytoma
  - Ganglioglioma
  - Xanthomatous astrocytoma
  - Subependymoma

- Lower grade malignancies
  - Fibrillary (gemistocytic, protoplasmic) astrocytoma
  - Ependymoma
  - Oligodendroglioma
  - Mixed oligo-astrocytoma
  - Optic nerve glioma

- Higher-grade malignancies
  - Anaplastic astrocytoma
  - Anaplastic oligodendroglioma
  - Anaplastic mixed glioma

- Highest-grade malignancies
  - Glioblastoma multiforme
  - Gliosarcoma
  - Gliomatosis cerebri

http://www.aans.org/media/fact%20sheets/classification%20of%20brain%20tumors.aspx#Pilocytic_astrocytoma

Grades of Gliomas

<table>
<thead>
<tr>
<th>Grade</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Benign, slow-growing tumor; usually associated with longer survival; least likely to recur; less prone to invasion; no necrosis; no vascular proliferation; no seizures; can occur as a high-grade tumor</td>
</tr>
<tr>
<td>II</td>
<td>High grade of malignancy; high rate of recurrence; high rate of malignant behavior; high rate of tumor recurrence; progressive course</td>
</tr>
<tr>
<td>III</td>
<td>Very high-grade malignant tumor; high rate of mortality; high rate of infiltration; presence of vascular proliferation; presence of necrosis</td>
</tr>
</tbody>
</table>

Meningioma
- Slow growing
- Usually benign
- Usually adults (women > men)
- Cause pressure on brain tissue

Metastatic Tumors
- Often necrotic center/spherical
- Severity of disease often related to type/location/radiosensitivity, presence of other systemic metastasis
- Most common sites are
  - Lung 35-48%
  - Breast 10-30%
  - Melanoma (30-40%)
  - Kidney (10-15%)

Leptomeningeal Disease
- Tumor Cells throughout the CSF
- Other names are carcinomatosis or lymphomatous meningitis
- Most common cause
  - Lymphoma
  - Breast
  - Lung
  - Can occur from Primary brain tumors
Teratoma

Anti-N-methyl-D-aspartate (NMDA)

- Anti-N-methyl-D-aspartate (NMDA) receptor encephalitis often instigated by ovarian or testicular teratoma
- Acute onset.
- The typical clinical features include: severe psychiatric symptoms
  - memory loss
  - seizures
  - decreased consciousness
  - autonomic dysregulation
  - dyskinesias
Nerve Sheath Tumors

A. Schwannoma
   • Benign/derived from Schwan Cells
   • Often Sensory nerves (often CN VIII) – AKA Vestibular Schwannoma
   • Nerve Compression will cause the symptoms

B. Neurofibroma
   • Benign - peripheral nerve tumor
   • Multiple lesions = Neurofibromatosis Type 1
   • Bilateral vestibular Schwannoma = neurofibromatosis Type 2

Vestibular Schwannoma

Treatment

• Surgical Options
  – Translabyrinthine
  – Retrosigmoid
Translabyrinthine

- **Pros:**
  - Safer for facial nerve
  - Less long term headache
  - Less invasive
    - Cranial nerves
    - Cerebellum
- **Cons**
  - Hearing loss
  - Longer surgery

Retrosigmoid / Suboccipital

- **Pros**
  - Safer for hearing
- **Cons**
  - Risk of facial nerve damage
  - Headaches

Post Op Complications

- Vestibular Nerve Dysfunction
- Facial Nerve Dysfunction
- CSF Leak
- CVA
- Meningitis
Hematopoietic Tumors

CNS Lymphoma

- **Primary central nervous system lymphoma** (PCNSL) is a high-grade non-Hodgkin B-cell neoplasm, usually large cell or immunoblastic type.

- **Secondary CNS**: Lymphomas can sometimes migrate to the central nervous system. This secondary form of CNS lymphoma is not common.

CNS Lymphoma

- Systemic chemotherapy with or without stem cell rescue:
  - High dose methotrexate, high dose Cytarabine
  - Intra-thecal chemotherapy: methotrexate (e.g. 12 mg)
  - Rituxan for CD 20+ lymphoma – role in treatment unclear
  - Corticosteroids – for edema, ICP, and its role in chemotherapy (potentiates action)
  - Anticonvulsants – seizures prophylaxis
  - Radiation therapy – may have a role (whole brain for primary, or to specific sites for secondary CNS lymphoma)
Blood Brain Barrier

- A filtering mechanism of the capillaries that carry blood to the brain and spinal cord tissue, blocking the passage of certain substances.

High Dose Methotrexate for CNS Tumors

- HDMTX therapy can cause significant toxicity, which not only leads to morbidity and occasional mortality, but also disrupts therapy, resulting in dose reductions that can adversely affect control of the cancer.
- **Hydration** - flushes kidneys
- **Urine alkalinization** - Sodium bicarb
- **Leucovorin Rescue** - is particularly effective in the prevention of myelosuppression, GI toxicity, and neurotoxicity during treatment with HDMTX.

Hemangioblastoma

- Tumors of Blood Vessel Origin
- HIGHLY vascular tumors
- Often found in cerebellum, brain stem, and cervical spine
- Common age 20-40 years old
- Genetic component of Hippel-Landau Syndrome
- Often have them in other body organs
- Dangerous if they impede CSF flow
Neuroendocrine Tumors

Pineal Tumors
- Arise from Pinocytes
- Often 20-50 years of age
- Often cause obstruction of CSF flow or pressure on adjacent structures
- Look for signs and symptoms of hydrocephalus and visual issues

Pineal Gland
- The gland produces melatonin
- This hormone helps regulate circadian rhythm
Let's talk Pituitary!

Where Is The Pituitary Gland?

Types of pituitary tumors:

- Adenomas
- Craniopharyngiomas
- Rathke's cleft cysts
Craniopharyngiomas

Location
Craniopharyngiomas occur in the sellar region of the brain, near the pituitary gland. They often involve the third ventricle, optic nerve, and pituitary gland.

Description
Craniopharyngiomas are localized tumors and become large before they are diagnosed. How malignant they are and how quickly they are likely to spread are unknown.

Symptoms
Increased pressure within the brain causes many of the symptoms associated with this tumor. Other symptoms result from pressure on the optic tract and pituitary gland. Obesity, delayed development, impaired vision, and a swollen optic nerve are common.

Adenoma

Microadenomas are smaller than 10 millimeters.
Macroadenomas are 10 millimeters or larger.
Can be Functioning or Non-functioning
Examples of functioning pituitary tumors include:

- Prolactin - 43 %
- ACTH - 7 %
- Growth hormone 17 %
- Thyroid hormone 3 %
Rathke's cleft cysts

- Rathke cleft cysts (RCCs) are benign (non-cancerous) fluid-filled growths that develop between the parts of the pituitary gland at the base of the brain.
- Congenital deformities,
- RCC develops from a piece of the fetus’ developing Rathke pouch, which ultimately becomes part of the pituitary gland
- Rarely cause problems during childhood. Show up in adults
Brain Tumor TX

- Stereotactic biopsy
- Surgical Debulking
- Radiosurgery
- Chemo/Radiation
  - Temozolomide – oral/IV agent that crosses BBB
- Gliadel wafers
- Novel treatments

AANS - Classification of Brain Tumors

Stereotactic Biopsy
Types of stereotactic radiosurgery

Doctors use three types of technology to deliver radiation during stereotactic radiosurgery:

- **Linear accelerator (LINAC)** machines use x-rays (photons) to treat cancerous and noncancerous abnormalities in the brain and other parts of the body. LINAC machines are also known by the brand name of the manufacturer, such as CyberKnife, Accuray, Novadaq Tx, TruBeam and XXKnife. These machines can perform SRS in a single session or over three to five sessions for larger tumors, which is called fractionated stereotactic radiotherapy.

- **Gamma Knife** machines use 192 or 201 small beams of gamma rays to target and treat cancerous and noncancerous brain abnormalities. Gamma Knife machines are less common than LINAC machines and are used primarily for small to medium tumors and lesions in the brain associated with a variety of conditions.

- **Proton beam** (charged particle radiotherapy) is the newest type of stereotactic radiosurgery and is available in only a handful of research centers in the U.S. It can treat brain cancers in a single session using stereotactic radiosurgery or use fractionated stereotactic radiotherapy to treat body tumors over several sessions.

www.mayoclinic.org
Complications of Radiation to the Brain

- Can be direct damage at time or occur months later
  - Increased ICP (cerebral edema)
  - Disruption of BBB
  - Cognitive deficits
  - Seizures
  - Headaches

Intrathecal Chemo

Nurse Role Post lumbar puncture
- Monitor for S/S of CSF leak
  - Nausea
  - Vomiting
  - Headache
  - Fluid leaking
- Monitor for S/S of CNS irritation
  - Pain
  - Hypotension
  - Infection

Ommaya Reservoir
Some Novel Immunotherapy Treatments in Trial

- Chimeric Antigen Receptor (Car T) Cells

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Regression of Glioblastoma after Chimeric Antigen Receptor T-Cell Therapy

Christine E. Brown, Ph.D., Darya Aksakal, Ph.D., Renate Starr, M.S., Lihong Wang, M.D., Jamie R. Wagner, B.A., Araceli Narajo, B.A., Julie R. Ostberg, Ph.D., Monette Rambaud, Ph.D., Julie Kilpatrick, M.S.N., Jennifer Simpson, B.A., Anita Kiven, M.B.B.S., Sadi J. Priceman, Ph.D., Xuji Wang, M.D., Ph.D., Todd I. Hershberger, M.D., Marcella D’Aquino, M.D., Julie A. Resler, M.D., Michael C. Jensen, M.D., Michael E. Banih, Ph.D., Mike Chen, M.D., Ph.D, Jane Peterson, M.D., Stephen J. Forman, M.D., and Betham Badie, M.D.

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CAR T Cell Neurologic Toxicities:

Overview

- Neurologic toxicities previously reported with therapies that increase serum cytokine levels:
  - High-Dose Interleukin-2 (IL-2): Can cause global encephalopathy
  - Blinatumomab (Blinco®):
    - Bi-specific antibody targets CD-19 & activates T-lymphocytes
    - May cause global encephalopathy, as well as more localized defects including aphasia, tremor, ataxia, hemiparesis, and cranial nerve palsies

Brudno & Kichenderfer, 2016.
CAR T Cell Neurologic Toxicities: Overview

• Neurologic toxicities associated with anti-CD 19 CAR T cells are similar to neurologic toxicities of blinatumomab
• Can be diverse
• Do not localize to one specific area of neuroanatomy

Brudno & Kochenderfer, 2016.

Pathophysiology

• Not well understood
• May occur at different times than Cytokine Release Syndrome (CRS) or in absence of CRS (suggests different mechanism)
• Central nervous system (CNS) involvement of leukemia shown NOT to be associated with CAR T cell neurologic toxicity
• Modified T-cells have been found in CSF of patients with neurologic toxicities, but also in patients without neurologic toxicities (Maude, et al, 2014).

Brudno & Kochenderfer, 2016.

Onset & Duration

• Published studies: (Brudno & Kochenderfer, 2016)
  – May occur concurrently with Cytokine Release Syndrome (CRS), following resolution of CRS, or in absence of CRS toxicities

Brudno & Kochenderfer, 2016.
Clinical Manifestations

- Can be diverse, do not localize to one specific area of neuroanatomy
  - Aphasia/dysphagia
  - Confusion
  - Motor neuropathy
  - Somnolence

INCREASED ICP

Monroe Kellie Hypothesis

The Monroe Kellie Doctrine describes the interrelation of the various volume compartments of the CNS:
- Ventricles w/CSF
- Brain (white and gray matter)
- Subarachnoid space (SAS) w/CSF
- Volume of the blood in vessels

- The Monroe Kellie Doctrine suggests that when the volume of one compartment increases, there must be a corresponding and compensatory decrease in the volume of the other spaces.
Increased ICP

1. altered levels of consciousness
2. changes in sensory and motor function
3. changes in pupil size, equality, and reaction to light, and extraocular movements
4. changes in vital signs and patterns of respiration.

Types of Herniation

a) Subfalcial herniation
b) uncal herniation
c) central transtentorial herniation
d) external herniation
e) tonsillar herniation
Treatment of ICP

- Medication
  - Corticosteroids
  - Hypertonic saline 23.4%
  - Mannitol
- Surgery
- Nursing interventions
  - Increase HOB (30-45 degrees)
  - Keep body in alignment
  - Head/neck straight

Spinal Tumors

- Primary Spinal tumors are relatively rare and affect only a minority of the population.
- Cause significant morbidity in terms of pain and limb dysfunction
- Associated with mortality as well
- Early diagnosis and prompt treatment is important.
- MR imaging
- Tumors to be classified as
  - Extradural
  - Intradural-extramedullary
  - Intradural-intramedullary
A. Intradural, Intramedullary: astrocytoma, ependymoma, hemangioma, cavernoma, dermoid/epidermoid
B. Intradural, Extramedullary: nerve sheath tumors, meningioma
C. Extradural: bone neoplasm, mets

How do the Tumors get Identified?

- Non-malignant
  - Often an incidental finding
  - Sometimes weakness/numbness
- Malignant/mets
  - Pain
  - Weakness/numbness
  - Bowel/bladder dysfunction

Mets to the Spine

- Most common source of bone metastasis
- 3rd overall most common site after lung and liver
- Bowel/Bladder dysfunction
- Treatment
  - Palliative VERSUS cure
  - Surgery- who qualifies?
  - Radiation
  - Embolization
  - Biphosphonates
  - Steroids
Spinal Cord Injury

- When there is injury to the actual spinal cord
- Goal is to relieve pressure on the cord and promote function
- "complete" spinal cord injury results in permanent injury. Goal is to prevent complications and to strengthen current function

Neuro Complications of chemotherapy
Neuro Complications of Chemo Therapy

Peripheral Neuropathy
- Vincristine
- Cisplatin
- Taxanes
  - Paclitaxel
  - Docetaxel

Cyclosporin/tacrolimus
- Confusion
- Cortical blindness
- Brain hemorrhage
- Peripheral neuropathy
- Aphasia
- Cerebellar changes

Peripheral neuropathy describes damage to the peripheral nervous system
- numbness
- tingling
- pricking sensations (paresthesia)
- sensitivity to touch
- muscle weakness
- burning pain (especially at night)
- muscle wasting
- paralysis
- organ or gland dysfunction
“Chemo or Radiation” Brain

- "Chemo brain" is a common term used by cancer survivors to describe thinking and memory problems that can occur after cancer treatment. Chemo brain can also be called chemo fog, chemotherapy-related cognitive impairment or cognitive dysfunction" - Mayo Clinic

Radiation and Supportive Care, Volume 13, Issue 4

Chemotherapeutic drugs that penetrate the blood-brain barrier affect the development of hyperactive delirium in cancer patients

Published online: 20 June 2014

Nursing Interventions for Neuro Patients
General Neuro Patient Care needs

- Neuro changes/seizure identification
- Respiratory/Airway Protection
- Cardiovascular
- GI/GU
- Delirium
- SAFETY
- Pain Assessment
- Communication

Normothermia

- Goal of Normothermia
  - varies in the literature but typically try for 36-37.5
- Patients neuro exam will worsen if they are warm
- Hyperthermia in neuro = worse outcomes
- Rule out infectious origin(culture blood/any drains or tubes, chest x-ray)
- Strategies
  - PRN or scheduled tylenol
  - ibuprofen in some cases(must have NS approval as can extend bleeding time)
  - Ice Packs to Groin/axilla

Respiratory Care

Lungs/Vitals
- Monitor RR/ O2 Sats
- Pay close attention to the respiratory rhythm and any abnormal pauses or cycling of breathes

Airway
- What kind of airway does your patient have?
- Do they have control of their airway?
- Can they manage their secretions?
- Do they have a cough/gag reflex?
- Are they aware enough that they could turn over if they vomited?

HOOK UP SUCTION IN ALL NEURO PATIENTS ROOMS!
Altered Breathing Patterns

- Abdominal (Diaphragmatic) Breathing
- Apneustic Breathing
- CHEST-INDIRECT BREATHING

Airway Management

- Side lying in patients without airway control
- HOB > 30 degrees
- Position pillow under shoulders/neck to prevent airway obstruction from tongue
- Suction set up in the room and active
- Frequent Mouth care

**BEFORE YOU PUT THE HEAD OF BED DOWN TO REPOSITION THE PATIENT, YOU MUST SUCTION OUT THEIR MOUTH!**
GI
- Evaluate their ability to swallow prior to med and food intake
- Spinal cord Mets- may need a bowel program to facilitate bowel movement.

GU
Voiding
- Need for PVR and bladder ultrasounds
- Complex, requires intact nerves and control.
- Requires uninjured muscles
>350 cc of urine shown to cause damage in neuro patients bladders

NEVER TRUST A NEURO PATIENT!
- Almost all neuro patients are at risk for injury
- Identify patients at risk to fall
- Bed Alarms on all at risk patients- make sure they are on and working
Red Flags of Neurological Emergency

Stroke
- Facial droop
- Motor weakness
- Pronator drift
- Ataxia
- Speech dysfunction

Seizure
- Starring spells
- Eye deviation and unresponsive
  Periods of loss of consciousness
- Muscle Twitching
- Periods of stuttering

Pain Evaluation

<table>
<thead>
<tr>
<th>Category</th>
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<th>2</th>
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</thead>
<tbody>
<tr>
<td>Face</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiology (still lying)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
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Conditions:
- Change in any of the following:
  - BP: > 20 mm Hg
  - HR: < 60 beats/min
  - SpO2: < 90%
  - RR: > 30 breaths/min

Note: Typical pain needs to be evaluated before intervention.

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I am here to speak for the neuro patients, who often can not speak for themselves……

Questions?

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