

# Assessment of the Neuro Patient

Holly White RN, BSN, CCRN  
CAVHS – SICU – RRT  
[Holly.White2@va.gov](mailto:Holly.White2@va.gov)  
LRCCP – Basic Critical Care Class  
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## Objectives

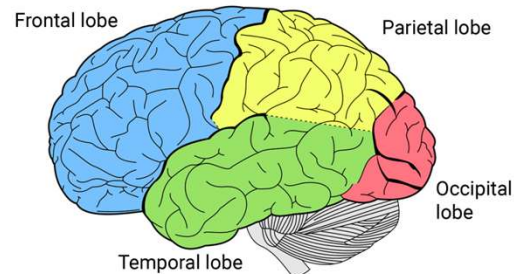
- Perform a neuro assessment.
- Recognize and report deviations in the neuro assessment.
- Modify assessment to patient specific needs.

[Chapter 6 Neurological Assessment - Nursing Skills - NCBI Bookshelf](#)

Open Resources for Nursing (Open RN); Ernstmeier K, Christman E, editors.  
Eau Claire (WI): Chippewa Valley Technical College; 2023.

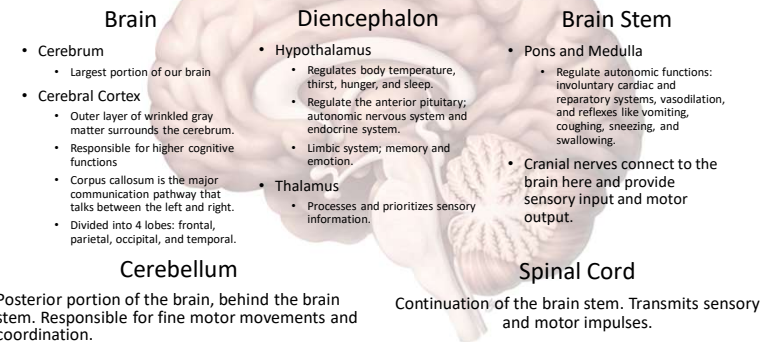
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## Anatomy and Physiology



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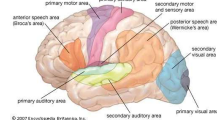
## Central Nervous System



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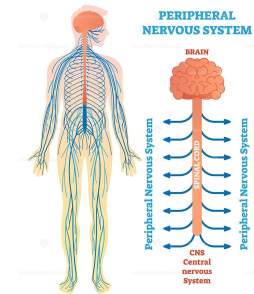
## Lobes of the Brain

- Frontal
  - Movement of skeletal muscles.
  - Cognitive functions like planning, problem solving, personality, short term memory, consciousness, Broca's area is responsible for language production and controlling movements responsible for speech.
- Parietal
  - Tactile senses, proprioception, and kinesthesia.
- Temporal
  - Limbic system: behavioral and emotional response for survival (Fight or Flight).
  - Wernicke's area is responsible comprehension of spoken and written language.
- Occipital
  - Process visual information.



## Peripheral Nervous System

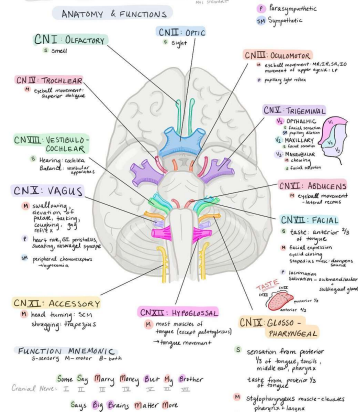
- Main function is to connect limbs and organs to the central nervous system. Consists of cranial nerves, spinal nerves, and autonomic nervous system.
- Peripheral nerves are classified as sensory, motor, or combination.



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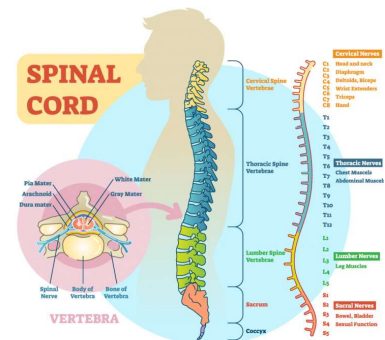
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## CRANIAL NERVES



- 12 cranial nerves.
- Primarily responsible for sensory and motor function of the head and neck.

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- 31 spinal nerves, named based on the level from where they emerge.
- All spinal nerves are combination sensory and motor.
- Paralysis can be predicted based on location of injury.
- Both motor and sensory do not have to be affected, paralyzed patients may still have sensation.

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## Assessment

- Begins upon first interaction.
- Should occur during bedside report.
- Important to note patient history.

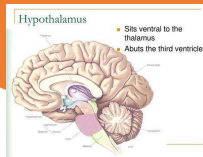
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## Vital Signs

Changes in vital signs in the neuro patient are late indicators of deterioration.

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## Temperature



Fever management should be aggressive in the first days after a severe brain injury like TBI, SAH, or stroke.

Fever can result in a secondary injury to the brain and increased risk of mortality.

Blood within the cerebral spinal fluid can stimulate the hypothalamic thermoregulatory center.

Mrozek S, Vardon F, Geeraerts T. Brain temperature: physiology and pathophysiology after brain injury. *Anesthesiol Res Pract*. 2012;2012:989487. doi: 10.1155/2012/989487. Epub 2012 Dec 26. PMID: 23326261; PMCID: PMC3541556.

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## Pulse and Blood Pressure

- Brain injuries can stimulate the sympathetic and parasympathetic nervous systems resulting in manifestations of cardiac and hemodynamic disturbances, cardiac failure and death.
- As intracranial pressure increases heart rate decreases and blood pressure increases. Once herniation occurs, heart rate increases, and blood pressure decreases.

Hrishi AP, Lionel KR, Prathapadas U. Head Rules Over the Heart: Cardiac Manifestations of Cerebral Disorders. *Indian J Crit Care Med* 2019;23(7):329–335.

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## Cerebral Perfusion Pressure (CPP)

- CPP is the net pressure gradient that drives oxygen delivery to the cerebral tissue.
- Normal CPP 60-80 mmHg
- $CPP = MAP - ICP$  (normal 0-15)
- Monro-Kellie doctrine: the sum of volumes of the brain, cerebrospinal fluid and intracerebral blood is constant. An increase in one should cause a reciprocal decrease in either one or both of the remaining two.

[Cerebral Perfusion Pressure - StatPearls - NCBI Bookshelf](#)

[Monro-Kellie doctrine • LITFL • Medical Eponym Library](#)

<https://youtu.be/DdtrJawi7zQ?si=cWRW7fVYwE5K9eea>

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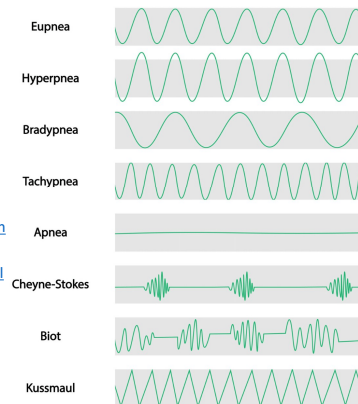
## Respiratory

- Dysfunction is common in brain injuries from either dysregulation of the breathing pattern or acute lung injury.
- Respiratory centers can be dysregulated from direct and indirect damage to the brain stem.
- Acute lung injury can occur from inflammatory response, aspiration, atelectasis, and lung contusion.

Frisvold, S., Coppola, S., Ehrmann, S. et al. Respiratory challenges and ventilatory management in different types of acute brain-injured patients. *Crit Care* 27, 247 (2023). <https://doi.org/10.1186/s13054-023-04532-4>

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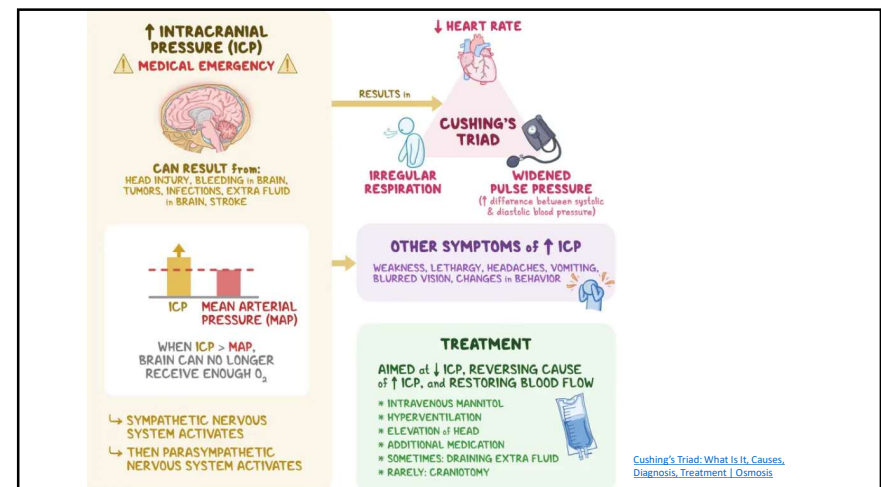
### Respiratory Patterns



[Abnormal Breathing Patterns: Types and What They Mean \(2025\)](#)

<https://youtu.be/91CH6NbsC74?si=KeVGahKACw05WVNI>

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## Pain

- Pain management is difficult in neuro patients due to the need to keep the patient comfortable but not suppress their LOC or mask deterioration.
- Pain perception and expression can be altered.
  - Perception: nociceptive pathway pathologies, sensory, autonomic, affective
  - Expression: impairment in language, motor, cognitive, and behavior
- Pain recognition is important to nurses.
  - Widened pupils, sweating, increased HR or BP, agitation
  - Unmanaged pain can cause increased anxiety, stress, and agitation.

Petzold, A., Girbes, A. Pain Management in Neurocritical Care. *Neurocrit Care* 19, 232–256 (2013). <https://doi.org/10.1007/s12028-013-9851-0>

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## Nonverbal Pain Scale

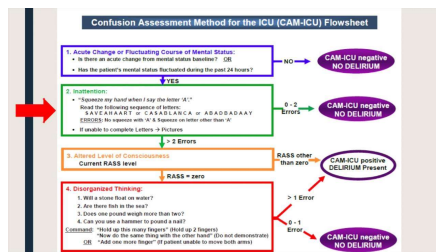
| Table 2.<br>Critical Care Pain Observation Tool (CPOT) |       |                                                          |           |
|--------------------------------------------------------|-------|----------------------------------------------------------|-----------|
| Term                                                   | Score | Description                                              | Indicator |
| Facial expression                                      | 1     | Relaxed                                                  | 0         |
|                                                        | 2     | Partially frowning (e.g., brow lowering)                 | 1         |
|                                                        | 3     | Fully frowning (e.g., eyelid closing)                    | 2         |
|                                                        | 4     | Grimacing                                                | 3         |
| Upper limbs                                            | 1     | No movement                                              | 0         |
|                                                        | 2     | Partially flexed                                         | 1         |
|                                                        | 3     | Fully flexed with finger flexion                         | 2         |
|                                                        | 4     | Permanently retracted                                    | 3         |
| Compliance with ventilation                            | 1     | Tolerating movement                                      | 0         |
|                                                        | 2     | Coughing but tolerating ventilation for most of the time | 1         |
|                                                        | 3     | Fighting ventilator                                      | 2         |
|                                                        | 4     | Unable to control ventilation                            | 3         |

From Gilman, C., Miller, L., Purtilo, K., Neri, C., & Forster, M. (2005). Validation of the critical care pain observation tool in adults. *American Journal of Critical Care*, 15(4), 41.

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## Delirium

Delirium can be especially difficult to identify in the neuro ICU. Most patients are admitted with some degree of brain dysfunction. Delirium or injury?



Delirium in the Neuro Intensive Care Unit - Critical Care Nursing Clinics

**INTENSIVE CARE DELIRIUM SCREENING CHECKLIST**

(i) Complete once a shift before afternoon rounds or towards the end of your N shift  
(ii) Score either 0 or 1 for each section: no more than 1 point per section  
(iii) Maximum score is 6

**Assessment: Date & Time**

| Shift                             | D | N | D | N | D | N | D | N | D | N | D | N | D | N |
|-----------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VAMASS                            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1. Altered LOC                    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2. Inattention                    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3. Altered Level of Consciousness |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4. Disorganized Thinking          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5. Sleep/Wake Cycle Disturbance   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 6. Symptom Fluctuation            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Total score (0-6)                 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

**Sheep**

| Shift                                                                                                | D | N | D | N | D | N | D | N | D | N | D | N | D | N |
|------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Altered LOC: What is the numerical score from your VAMASS assessment?                             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2. Inattention: If any are present score 1 point in total                                            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3. Altered Level of Consciousness: If either is present score 1 point                                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4. Disorganized Thinking: If either is present score 1 point                                         |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5. Sleep/Wake Cycle Disturbance: Score 1 point for ANY of the following                              |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 6. Symptom Fluctuation: Score 1 point for: Fluctuation of any of the above items (1-7) over 24 hours |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

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## Mental Status Assessment

- Level of Consciousness (LOC)
  - Refers to the patient's level of alertness and orientation to self, place, and time.
    - Alert: Awake and responsive
    - Somnolent: Sleepy
    - Lethargic: Very drowsy, falls asleep
    - Obtunded: Difficult to arouse
    - Stuporous: Very difficult to arouse
    - Comatose: Unarousable
- Glasgow Coma Scale
  - Standardized tool to assess LOC after injury.
    - Assess eye opening, verbal response, and motor response.

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LOC is the most sensitive indicator of neurological status!

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## GCS

| Category                                                |                        | Best Response |
|---------------------------------------------------------|------------------------|---------------|
| Eye opening                                             |                        |               |
| Spontaneous                                             |                        | 4             |
| To speech                                               |                        | 3             |
| To pain                                                 |                        | 2             |
| None                                                    |                        | 1             |
| Verbal                                                  | (Modified for Infants) |               |
|                                                         | Babbles                | 5             |
|                                                         | Irritable              | 4             |
|                                                         | Cries to pain          | 3             |
|                                                         | Moans                  | 2             |
| None                                                    |                        | 1             |
| Motor                                                   |                        |               |
| Follows commands                                        |                        | 6             |
| Localizes to pain                                       |                        | 5             |
| Withdraws to pain                                       |                        | 4             |
| Abnormal flexion                                        |                        | 3             |
| Abnormal extension                                      |                        | 2             |
| None                                                    |                        | 1             |
| Glasgow Coma Scale                                      |                        |               |
| Best possible score                                     |                        | 15            |
| Worst possible score                                    |                        | 3             |
| If tracheally intubated then verbal designated with "T" |                        |               |
| Best possible score while intubated                     |                        | 10T           |
| Worst possible score while intubated                    |                        | 2T            |

[https://youtu.be/h2SIN7Mn0YA?si=o9hQeyoRuDX\\_UJ14](https://youtu.be/h2SIN7Mn0YA?si=o9hQeyoRuDX_UJ14)

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## Painful Stimuli

- **Peripheral Painful Stimuli**
  - Used to elicit an eye-opening response.
  - Interphalangeal joint pressure
    - Apply pressure with a pencil or pen to the lateral outer aspect of the proximal or distal interphalangeal joint for 10 s–15 s to elicit a response.
    - A peripheral painful stimulus may elicit a spinal reflex, causing flexion of the tested limb; a spinal reflex is not an indication of intact brain function.
- **Central Painful Stimuli**
  - Used to elicit a motor response, Stimulates a cranial nerve to avoid a spinal reflex.
  - Trapezius squeeze
  - Supraorbital pressure
  - Jaw margin pressure
- **Sternal Rub**
  - Used to elicit any response if previous techniques have failed.

Zakaria Z, Abdullah MM, Halim SA, Ghani ARI, Idris Z, Abdullah JM. The Neurological Exam of a Comatose Patient: An Essential Practical Guide. Malays J Med Sci. 2020 Oct;27(5):108-123. doi: 10.21315/mjms2020.27.5.11. Epub 2020 Oct 27. PMID: 33154707; PMCID: PMC7605838.

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## Cranial Nerve Assessment

### Common cranial nerves assessed in critical care.

- Cranial Nerve 3
  - Pupillary response
- Cranial Nerve 5
  - Corneal Reflex
- Cranial Nerve 6
  - Eye Deviation
- Cranial Nerve 7
  - Facial Symmetry
- Cranial Nerves 9
  - Gag Reflex
- Cranial Nerve 10
  - Speech and Swallow

<https://youtu.be/kWEQouzHavq?si=clrPdLbG0G8q5cl1>

Zakaria Z, Abdullah MM, Halim SA, Ghani ARI, Idris Z, Abdullah JM. The Neurological Exam of a Comatose Patient: An Essential Practical Guide. Malays J Med Sci. 2020 Oct;27(5):108-123. doi: 10.21315/mjms2020.27.5.11. Epub 2020 Oct 27. PMID: 33154707; PMCID: PMC7605838.

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| Cranial Nerve                      | Expected Finding                                                                                                                 | Unexpected Finding (Dysfunction)                                                                                                                         |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| I. Olfactory                       | Patient is able to describe odor.                                                                                                | Patient has inability to identify odors ( <b>anosmia</b> ).                                                                                              |
| II. Optic                          | Patient has 20/20 near and far vision.                                                                                           | Patient has decreased visual acuity and visual fields.                                                                                                   |
| III. Oculomotor                    | Pupils are equal, round, and reactive to light and accommodation.                                                                | Patient has different sized or reactive pupils bilaterally.                                                                                              |
| IV. Trochlear                      | Both eyes move in the direction indicated as they follow the examiner's penlight.                                                | Patient has inability to look up, down, inward, outward, or diagonally. <b>Ptosis</b> refers to drooping of the eyelid and may be a sign of dysfunction. |
| V. Trigeminal                      | Patient feels touch on forehead, maxillary, and mandibular areas of face and chews without difficulty.                           | Patient has weakened muscles responsible for chewing; absent corneal reflex; and decreased sensation of forehead, maxillary, or mandibular area.         |
| VI. Abducens                       | Both eyes move in coordination.                                                                                                  | Patient has inability to look side to side (lateral); patient reports <b>diplopia</b> (double vision).                                                   |
| VII. Facial                        | Patient smiles, raises eyebrows, puffs out cheeks, and closes eyes without difficulty; patient can distinguish different tastes. | Patient has decreased ability to taste. Patient has facial <b>paralysis</b> or asymmetry of face such as facial droop.                                   |
| VIII. Vestibulocochlear (Acoustic) | Patient hears whispered words or finger snaps in both ears; patient can walk upright and maintain balance.                       | Patient has decreased hearing in one or both ears and decreased ability to walk upright or maintain balance.                                             |
| IX. Glossopharyngeal               | Gag reflex is present.                                                                                                           | Gag reflex is not present; patient has <b>dysphagia</b> .                                                                                                |
| X. Vagus                           | Patient swallows and speaks without difficulty.                                                                                  | Slurred speech or difficulty swallowing is present.                                                                                                      |
| XI. Spinal Accessory               | Patient shrugs shoulders and turns head side to side against resistance.                                                         | Patient has inability to shrug shoulders or turn head against resistance.                                                                                |
| XII. Hypoglossal                   | Tongue is midline and can be moved without difficulty.                                                                           | Tongue is not midline or is weak.                                                                                                                        |

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**Anisocoria - Unequal Pupil Size**

- Patient history is an important component to the pupil assessment.
- Pupil change is a late sign of neurological injury.
- Abnormal pupils with no change in mental status can be benign.
- Charting pupillary response note
  - Size/ Equal size/ Shape
  - Light reaction/ Equal response
  - Location or movement
    - Deviation
    - Roving
    - Nystagmus

[Neuro-ophthalmology Question of the Week: Neuro-ophthalmology Coma Eye Exam — Neuro-Ophthalmology](#)

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## Motor Assessment

- Motor strength should be performed bilateral.
- Tested by using:
  - Hand grip
  - Upper extremity push and pull
  - Lower extremity push toes down, pull toes up. Knee lifts.
  - Baseline mobility can be a hinderance.

| Muscle strength grading scale |                                                     |
|-------------------------------|-----------------------------------------------------|
| Grade                         | Description                                         |
| 0                             | No muscular contraction detected                    |
| 1                             | Barely detectable trace of contraction              |
| 2                             | Active movement with gravity eliminated             |
| 3                             | Active movement against gravity                     |
| 4                             | Active movement against gravity and some resistance |
| 5                             | Active movement against full resistance             |

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## Motor Response

- Follows Commands
  - Ask to follow 2 step question.
- Localizes to pain
  - Trapezius squeeze or similar, crosses midline and up toward painful stimuli.
- Withdraws to pains
  - Pulls away from painful stimuli.
- Abnormal flexion
  - Adduction of arm, pronation of forearm, decorticate response.
- Abnormal extension
  - Abduction of arm, supination of forearm, decerebrate response.
- No motor response

• Should be tested bilaterally.

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## Posturing

- Decerebrate
  - Arched neck
  - Straight extended arms
  - Bent wrist, curled fingers
  - Straight legs
  - Toes pointed downwards
- Decorticate
  - Closed hands
  - Internally rotated legs
  - Adducted arms that are flexed at the elbows and wrist
  - Inward turned feet

*Posturing After Brain Injury Explained: Decerebrate vs Decorticate*

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## POSTURING

DECORTICATE  
(Flexor)



Arms are like "C's"  
Moves in toward the "Cord"

Problems With Cervical Spinal Tract or Cerebral Hemisphere.

DECEREBRATE  
(Extensor)



Arms are like "E's"

Problems Within Midbrain or Pons.

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## Sensory Assessment

- Testing somatic senses, consciously perceiving touch.
- Touch should feel equal bilaterally.
- Sensory impairment is indicative of the level of injury.
- Diabetes, neuropathy, and vascular disease can hinder assessment.

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## Cerebellar Assessment

CEREBELLUM = "LITTLE BRAIN"



**CEREBELLUM**  
• COORDINATES MOVEMENTS  
• CONTROLS POSTURE, BALANCE & FINE MOTOR MOVEMENT  
• INVOLVED IN MOTOR LEARNING

- The cerebellum is responsible for equilibrium, coordination, and smoothness of movement.
- Gait and balance
  - Should be regular pace with arms swinging in coordination with walking.
    - Weakness, shuffling, jerky, loss of balance, and incoordination of arm swing indicate neurological dysfunction.
- Romberg test
  - Stand with feet together, eyes closed, arms out or crossed on chest. Swaying is allowed.
    - Loss of balance
- Pronator drift
  - Extend arms and hold with eyes closed and palms up. Proprioception!
    - Unequal position, pronation of hand.
- Finger to Nose test
  - Equilibrium and coordination, close eyes and touch finger to nose alternating hands.
    - Unable to touch nose, unable to alternate, jerky movements.
- Heel to Shin test
  - Place heel on opposite shin and slide from knee to ankle and back up. Should be smooth and straight.

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## Reflex Assessment

- Not typically performed by nursing, only on specialty units.
- Common locations
  - Brachioradial, Tricep, Patella
- Plantar Reflex is common in adult neuro ICU. Toe flexion is normal, toe extension is a positive Babinski.

[https://youtu.be/IV\\_a2WSbdM8?si=f2mswQeF7W8Cng8H](https://youtu.be/IV_a2WSbdM8?si=f2mswQeF7W8Cng8H)

| GRADE | ASSESSMENT ON PHYSICAL EXAMINATION |
|-------|------------------------------------|
| 0     | Reflexes absent                    |
| 1     | Reflexes diminished but present    |
| 2     | Normal reflexes                    |
| 3     | Reflexes increased                 |
| 4     | Clonus present                     |

## Speech and Swallowing

- Aphasia
  - Acquired disorder in the production or understanding of language
  - Expressive aphasia (Broca) difficulty producing language
  - Receptive aphasia (Wernicke) fluent but nonsensical or impaired understanding
- Agnosia
  - Difficulty processing sensory input
- Dysarthria
  - Garbled speech due to muscle weakness
- Dysphagia
  - Difficulty swallowing

|                 | BROCA                      | WERNICKE                    | CONDUCTION         | ISOLATION   | ANOMIC                      | GLOBAL                           |
|-----------------|----------------------------|-----------------------------|--------------------|-------------|-----------------------------|----------------------------------|
| Fluency         | +                          | +                           | +                  | +           | +                           | +                                |
| Comprehension   | OK                         | +                           | +                  | +           | OK                          | +                                |
| Repetition      | +                          | +                           | +                  | +           | OK                          | +                                |
| Naming          | +                          | +                           | +                  | +           | +                           | +                                |
| Reading         | +                          | +                           | OK                 | OK          | OK                          | +                                |
| Writing         | +                          | +                           | +                  | +           | OK                          | +                                |
| Lesion location | post inferior frontal lobe | post superior temporal lobe | arcuate fasciculus | border zone | post inferior temporal lobe | large portion of left hemisphere |

The Five-Minute Neurological Examination

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In most facilities nurses can perform bedside swallow evaluations IF the patient does not have facial droop or aphasia. These patients need formal swallow studies or FEES.

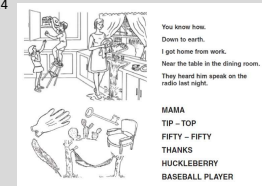
Fiberoptic endoscopic evaluation of swallow

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## National Institutes of Health Stroke Scale (NIHSS)

- Measures the severity of symptoms associated with cerebral infarcts
- Assess aphasia, behavior, cognition, dysarthria, vision and perception
- 15 items are assessed scoring on a 3- or 4-point scale
- Scores range 0-42
  - Very Severe > 25
  - Severe 15-24
  - Mild to Moderately Severe 5-14
  - Mild 1-5

[NIH Stroke Scale](#)



National Institutes of Health Stroke Scale | RehabMeasures Database

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## Meningeal Irritation Assessments

- Irritation of meninges can occur in meningitis and subarachnoid hemorrhage
  - Neck Stiffness/Nuchal Rigidity
    - Unable to flex neck toward chest but preserved lateral movements
  - Kernig's sign
    - Lying on back, with legs fully extended, one leg is flexed at the hip and knee.
    - Positive result is when there is resistance to the test and or involuntary flexion of the opposite hip.
  - Brudzinski's sign
    - Lying on back, with legs fully extended, one hand behind head, other on chest
    - Positive result is when the patient's neck is flexed towards the chest and there is involuntary flexion of the hips and knees.

Zakaria Z, Abdullah MM, Halim SA, Ghani ARI, Idris Z, Abdullah JM. The Neurological Exam of a Comatose Patient: An Essential Practical Guide. Malays J Med Sci. 2020 Oct;27(5):108-123. doi: 10.21315/mjms2020.27.5.11. Epub 2020 Oct 27. PMID: 33154707; PMCID: PMC7605838.

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## Brain Stem Reflexes

- Oculocephalic Reflex
  - When briskly turning the head from midline to the side, eyes should rotate to the opposite; and should gradually, smoothly, and conjugately return to the mid position.  
<https://youtu.be/380aAXo8V24?si=Bu3Fjf8ax5NdKyjb>
- Oculovestibular Reflex
  - Ice cold water is instilled into each ear canal separately and eye movement is observed. Eyes should have nystagmus or turn toward ear that water is instilled in meaning the brainstem is intact.  
<https://youtu.be/zk3r4XWt94A?si=hQqbt39uW8ty8Yu>

Oculocephalic and oculovestibular reflexes • UTLFL • CCC

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## Diagnosis of Brain Death

- Brain death implies permanent absence of cerebral and brainstem function.
  - Trauma and SAH are leading causes of brain death.
- Neuro exam includes absence of cerebral and brainstem functions
  - Including but not limited to; absence of motor response, pupillary response, corneal reflex, oculocephalic and oculovestibular reflexes, gag reflex, cough and presence of apnea.
- Apnea test and other ancillary test can be performed to confirm brain death.

[Diagnosis of brain death - UpToDate](#)

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### Ancillary Testing for brain death

- Cerebral Angiography
- Transcranial Doppler
- CTA
- MRA
- EEG

[Diagnosis of brain death - UpToDate](#)

**Table 3. Apnea Test Sequence** (Derived from reference 9 and UCI Declaration of Brain Death Policy and Form - see Figure 2)

1. Preoxygenate the patient with 100% FIO<sub>2</sub>
2. Ensure the patient is not hypocarbic via ABG
3. Disconnect the ventilator, but supply oropharyngeal oxygen
4. Monitor the patient for any signs of respiration
5. Obtain ABGs at selected intervals (q3-4 min)
6. Stop the test and return to mechanical ventilation if
  - hemodynamic instability occurs, or
  - the patient exhibits attempts to breathe, or
  - the pCO<sub>2</sub> is >60 mmHg or rises > 20 mmHg above baseline in the setting of an arterial pH < 7.3

\*FIO<sub>2</sub>, fraction of inspired oxygen; ABG, arterial blood gas; pCO<sub>2</sub>, partial pressure of arterial carbon dioxide

[Devastating Brain Injuries: Assessment and Management Part I: Overview of Brain Death - The Western Journal of Emergency Medicine](#)

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## Neurologic Diagnostics

- Laboratory testing
- Genetic testing
- CT scan
- MRI
- PET
- Angiography
- Biopsy
- Lumbar Puncture
- EEG
- Nerve Conduction
- Ultrasound
- X-rays

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Thank you

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# COMPLICATIONS OF THE NEURO PATIENT

HOLLY WHITE RN, BSN, CCRN

CAVHS – SICU – RRT

[HOLLY.WHITE2@VA.GOV](mailto:HOLLY.WHITE2@VA.GOV)

LRCCP – BASIC CRITICAL CARE CLASS

SEPTEMBER 2026

1

## OBJECTIVES

Review possible complications of the neuro patient

Review nursing interventions for those complications.

2

## HIGH RISK

- Neuro patients have some degree of neurological derangement, making them high risk for accidental line and/or tube removal.
- They are at high risk for the need for physical restraint usage to protect important lines and tubes like ETT, trach, NGT, DHT, EVD, Lumbar drains and JP/hemovacs.
- They are at high risks for falls as well.

3

## INCREASED INTRACRANIAL PRESSURE

- 3 components: brain, cerebrospinal fluid, and blood
- Rigid vault: skull
- Monro-Kellie Doctrine: An increase in one volume will cause a forced decrease in one or the other two.
- Increased ICP is caused by an increase in one of the volumes, most commonly CSF or brain volume via swelling. The body will try to maintain the balance and the most often ways to decrease are cerebral perfusion or herniation.

Increased Intracranial Pressure - StatPearls - NCBI Bookshelf

4

## CAUSES OF INCREASED ICP

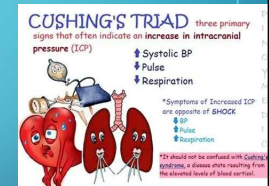
- Mass Effect/ Swelling
  - Hematoma
  - Tumor
  - Abscess
  - Infarct
- Increased CSF
  - Increased production
  - Choroid plexus tumor
- Decreased Reabsorption CSF
  - Obstructive hydrocephalus
  - Meningeal inflammation
- Increased Blood Volume
  - Increased blood flow, hypercarbia, aneurysm
  - Venous stasis
  - Venous sinus thromboses
  - Elevated CVP; CHF
- Other Causes
  - Idiopathic intracranial HTN
  - Skull deformities

Increased Intracranial Pressure - StatPearls - NCBI Bookshelf

## SIGNS AND SYMPTOMS

- Decreased LOC (#1 indicator something is wrong)
- Headaches
- Nausea and vomiting
- Vision changes
- Pupillary changes
- Muscle weakness
- Seizures

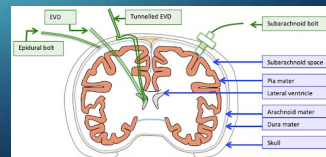
- Late Signs
- HTN
  - Bradycardia
  - Irregular Respirations.



Increased Intracranial Pressure (ICP): Symptoms & Treatment

## EVALUATION

- Identifying increased ICP early is crucial to preventing morbidity and mortality.
- CT scan can indicate this by revealing edema (loss of grey and white matter differentiation), compressed or enlarged ventricles, narrowed or compressed sulci.
- Tools of measurement include:
  - Opening pressure of a lumbar puncture. (CT scan first, a sudden change in ICP can cause herniation)
  - External Ventricular Device
  - Bolt
  - Eye Exam (Optic Nerve Sheath Diameter)



Increased Intracranial Pressure - StatPearls - NCBI Bookshelf

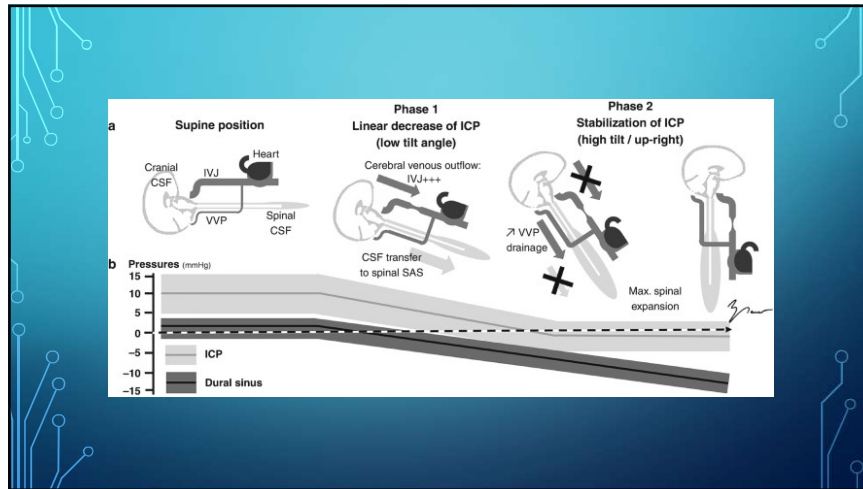
## TREATMENT

- Identify and treat the cause
- Maintain CPP
  - 70-100mmHg
- Lower ICP
  - 5-20 mmHg
- Elevate HOB
- Neck midline
- EVD/Lumbar Drain
- Osmotic Agents: Mannitol
- Hypertonic Saline: 1.5%, 3%, 26.3%
- Barbiturates: Pentobarbital
- Decompressive Craniectomy

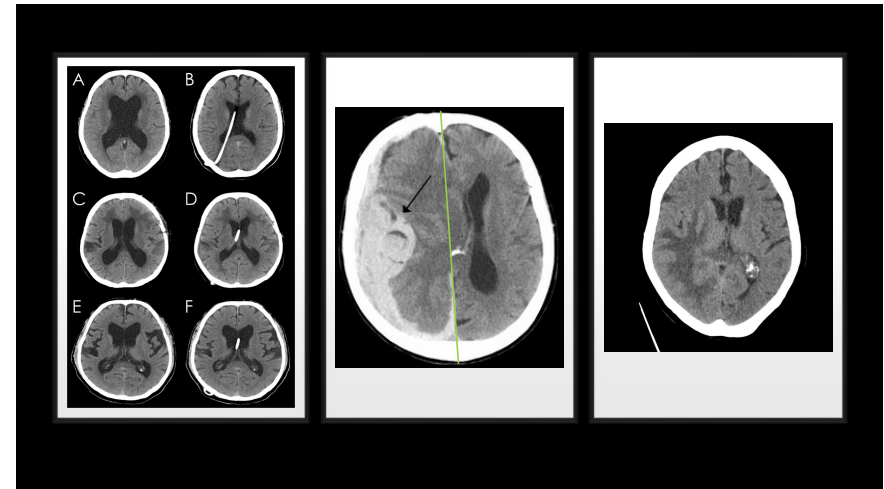
[https://youtu.be/E-pZ9FW-5bE?si=\\_GXPOQHfKL8gZhXB](https://youtu.be/E-pZ9FW-5bE?si=_GXPOQHfKL8gZhXB)

Increased Intracranial Pressure - StatPearls - NCBI Bookshelf





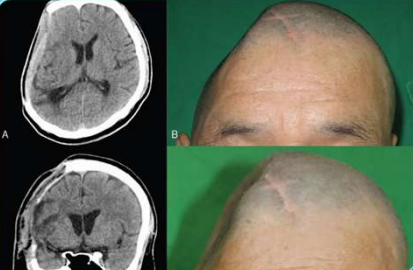
9



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### Nursing Interventions Post Craniectomy

- Monitor for S&S of infection
- Monitor for changes in neurological status
- Protect the cerebrum from injury
  - Positioning (use pillows, rolls, or other supportive devices to keep pressure off the craniectomy but also maintain neutral positioning.)
  - Falls (use helmets once mobilized)



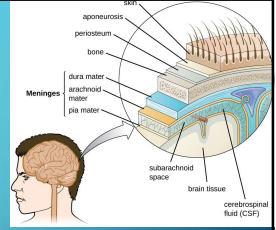
Evidence-Based Nursing Review of Craniectomy Care | Stroke

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### INTRACRANIAL HEMORRHAGE

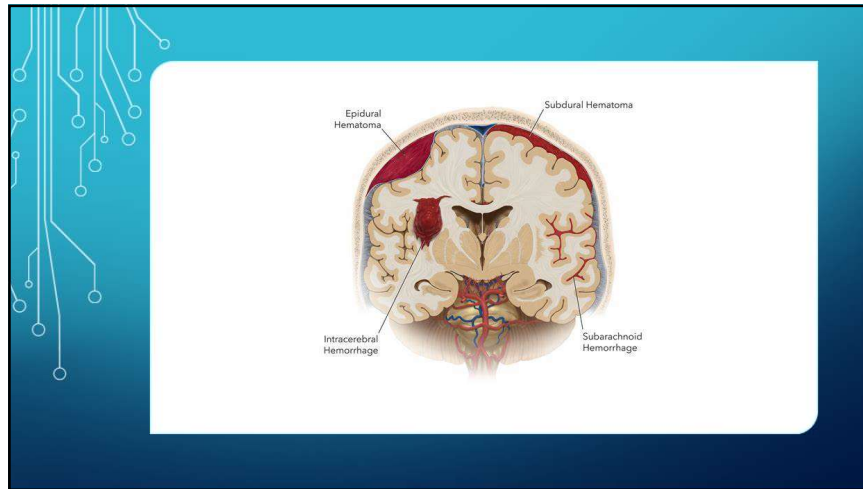
- A rupture of blood vessels within the brain.
- Presentation and treatment are dependent on location.
- Can be challenging to manage and requires frequent observation and assessment. Most often q1h neuro checks for an extended period.

<https://youtu.be/LxUCbyrYGKA?si=A2zLrKbr8y-Jm2cQ>

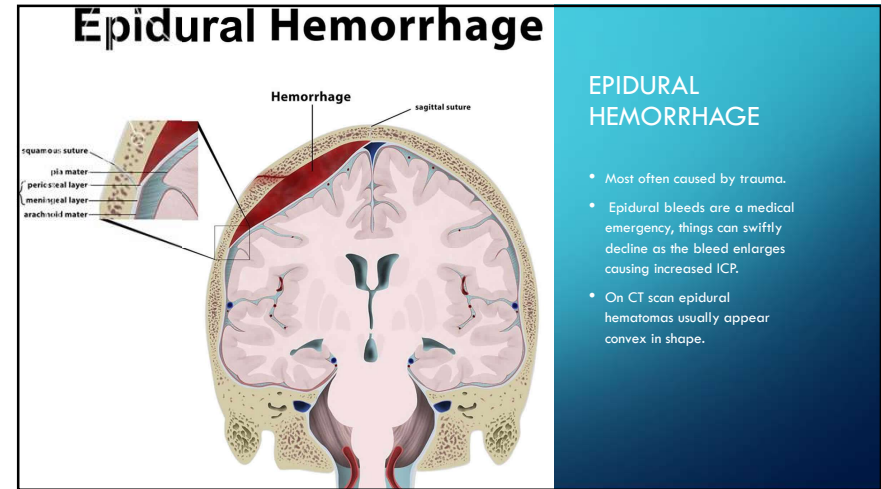


Brain Bleed Nursing Diagnosis Essential Care Strategies  
Intracranial Hemorrhage - StatPearls - NCBI Bookshelf

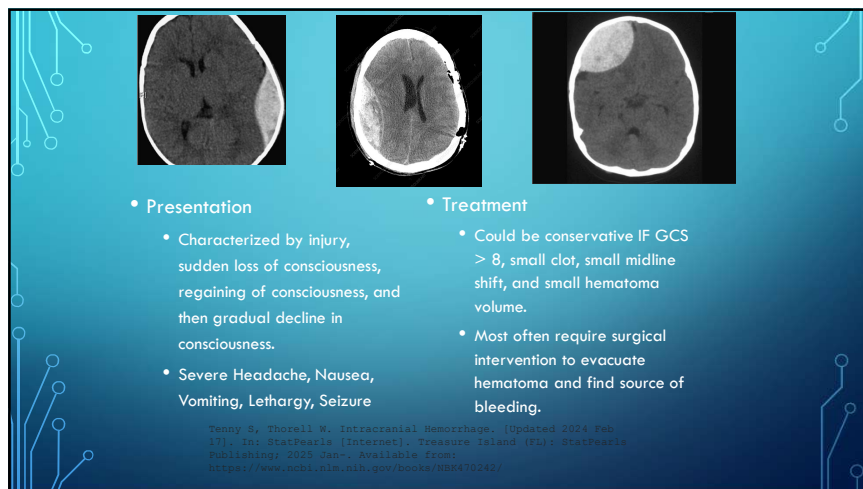
12



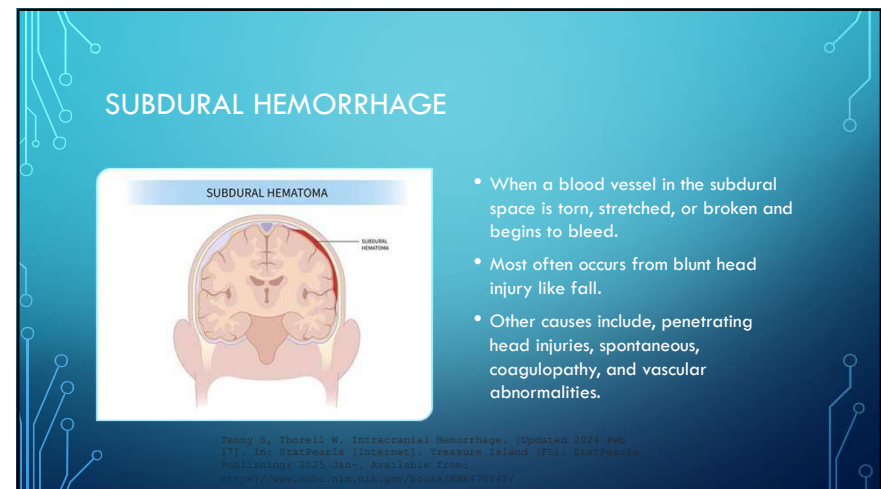
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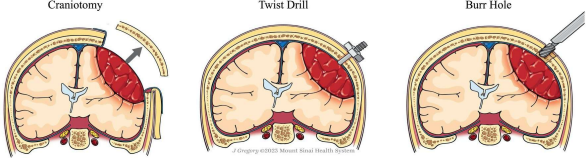
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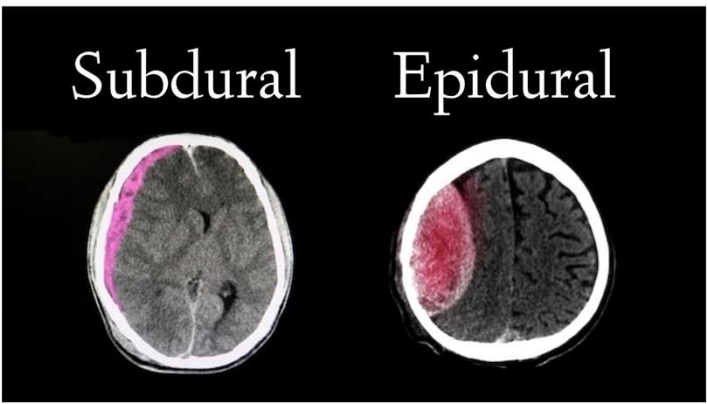
Craniotomy      Twist Drill      Burr Hole

- **Presentation**
  - Focal motor deficit, neurological deficit, lethargy, and altered level of consciousness.
  - May appear concave on CT scan.
- **Treatment**
  - Definitive: surgical intervention for evacuation. Twist drill, burr hole, or craniotomy.
  - Could be monitored via serial scans, anticoagulation reversal, platelet transfusion, and controlling HTN.

Tenny S, Thorell M. Intracranial Hemorrhage. [Updated 2024 Feb 17]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/BSK470242/>

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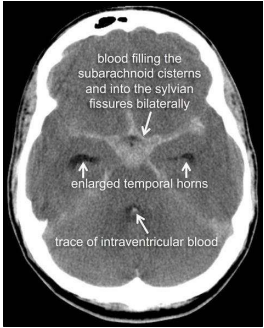
# Subdural      Epidural



Banana vs. Lemon

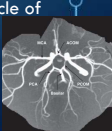
18

## SUBARACHNOID HEMORRHAGE

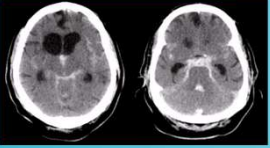


- Bleeding within the subarachnoid space
- Non-traumatic: aneurysm, AVM, coagulopathy, and idiopathic
- Traumatic: Blunt head trauma, sudden acceleration changes (shearing)
- Most often located within the Circle of Willis

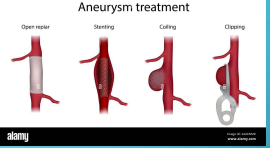
Tenny S, Thorell M. Intracranial Hemorrhage. [Updated 2024 Feb 17]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/BSK470242/>



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### Aneurysm treatment



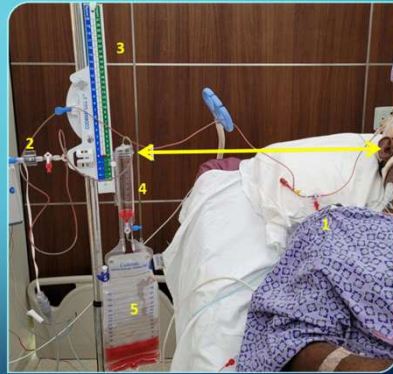
- **Presentation**
  - Thunderclap/ Worst headache of life
  - Dizziness, N/V, diplopia, seizures, nuchal rigidity, altered consciousness, focal neuro deficits, and cranial nerve palsies.
  - Noncontrast CT, contrast can spill into the subarachnoid space. CTA, MRA are necessary to identify source.
  - LP can be used if CT negative to confirm blood in CSF.
- **Treatment**
  - Conservative with watching and waiting.
  - If neuro deficits, could require EVD, lumbar drain, surgical intervention.
  - AVM or aneurysm can be treated in either interventional radiology (coiling/stenting) or OR (clipping).
  - Reverse coagulopathy, treat HTN

[https://youtu.be/MjOc3Zpv2K8?si=OwWZBsAhj\\_3NHn37](https://youtu.be/MjOc3Zpv2K8?si=OwWZBsAhj_3NHn37)

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## INTRACRANIAL ANEURYSM INTERVENTIONS

- Minimum stimulation, lights off, quiet
- Q1h neuro checks x 14 days (4-12 days vasospasms most frequent after initial hemorrhage)
- Monitor BP
- Monitor for seizures
- Administer calcium channel blocker, Nimodipine, relaxes vessels (21 days)
- Manage drains
  - EVD (0-20 cm H<sub>2</sub>O)
  - Lumbar drain (set amount every hr; 5 – 7mls)



Keyrouz SG, Dinger MN. Clinical review. Prevention and therapy of vasospasm in subarachnoid hemorrhage. Crit Care. 2007;11(4):230. doi: 10.1186/cc20652. PMID: 17705983. PMCID: PMC2206512

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## VASOSPASM

- Vasospasms occur due to the blood breaking down in the subarachnoid space and irritating vessels, thus making them spasm. Then causing delayed ischemic deficits.
- Evidence of spasm could be, change in LOC and/or focal neuro deficits.
- Can also be asymptomatic.
- Can be diagnosed via CTA
- Most often treated by IR with intraarterial calcium channel blockers like nicardipine or verapamil.
- Hypervolemia, hemodilution, hypertensive therapy

Keyrouz SG, Dinger MN. Clinical review. Prevention and therapy of vasospasm in subarachnoid hemorrhage. Crit Care. 2007;11(4):230. doi: 10.1186/cc20652. PMID: 17705983. PMCID: PMC2206512

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## TRIPLE H THERAPY

- Used in extreme circumstances for treatment and prevention of vasospasm.

Hypertension: SBP >150 usually closer to 180, or MAP > 100. May have to use vasopressors to maintain. Arterial line essential! Aneurysm should be secured meaning coiled, stented, or clipped.

Hypervolemia: Give fluid to achieve a CVP 8-12 or SVV < 5

Hemodilution: Hand in hand with hypervolemia, decreases viscosity of blood.

ALL THIS TO ATTEMPT TO MAINTAIN AN ADEQUATE CPP > 70

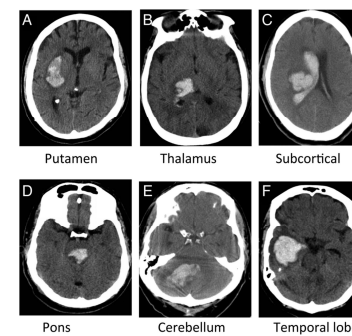
Many complications are associated with this to include, rebleed, pulmonary edema, cerebral edema, cardiac failure, renal medullary washout.

[Triple-H-Therapy.pdf](#)

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## INTRAPARENCHYMAL/ INTRACEREBRAL HEMORRHAGE

- Bleeding within the brain parenchyma
- Most often caused by HTN
- Other causes include AVM, aneurysm, tumor, coagulopathy, infection, vasculitis, and trauma.
- Most common location is the putamen.



Samy S, Shorrell W. Intracranial Hemorrhage. [Updated 2024 Feb 17]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK470242/>

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**Presentation**

- Sudden onset of stroke-like symptoms
- Headache, N/V, lethargy, slurred speech, syncope, vertigo, weakness, focal neurological deficits
- CT scan with hyper density within parenchyma

**Treatment**

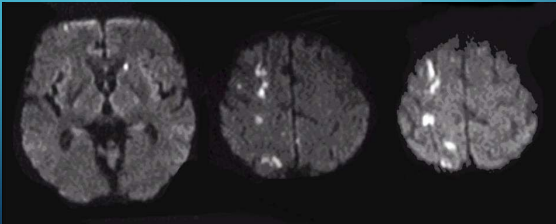
- Conservative with watching and waiting.
- May require surgical evacuation, dependent on location.
- May require craniectomy if evacuation is not a viable option.

Henry B, Thorrell W. Intracerebral Hemorrhage. [updated 2024 Feb 17]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/BOOK470242/>

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## ISCHEMIA OR EMBOLIC STROKE

There is a sudden interruption of blood flow due to an embolus moving from its point of origin.



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## TYPES OF EMBOLI

- Blood clot
  - Most often origin is heart from arrhythmia
- Air or gas
  - Can occur during procedure like line insertion, surgery, hemodialysis
- Fat
  - Fracture of long bone
- Tumor
  - Happens during migration of malignant cells
- Septic
  - Purulent Tissue from infection
- Amniotic Fluid
  - Amniotic fluid enters mother vasculature during or immediately after childbirth
- Foreign Body
  - Everything else: catheter, bone, threads, or patches (cotton fibers during angiography)

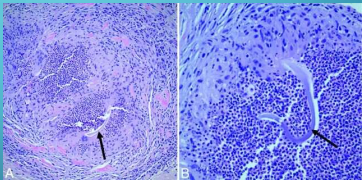
> The 7 types of embolism (and their characteristics) | [ 2024 ]

27

## TREATMENT AND MANAGEMENT

Determine and treat the cause and/or symptoms

- Thrombolysis
- Anticoagulation
- Thrombectomy
- O2 therapy
- Antibiotics
- Supportive
- Removal of foreign body
- Steroid taper

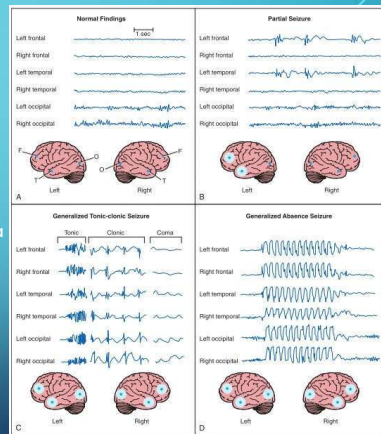


[Embolus Stroke - StatPearls - NCBI Bookshelf](#)  
[Air Embolism: Types, Symptoms, Treatment, and More](#)  
[Amniotic Fluid Embolism - StatPearls - NCBI Bookshelf](#)  
[Foreign Body Emboli following Cerebrovascular Interventions: Clinical, Radiographic, and Histopathologic Features - PubMed](#)

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## SEIZURES

- A sudden burst of electrical activity in the brain.
- A seizure lasting longer than 5 minutes is a medical emergency.
- Symptoms are based on type.



Seizures - Symptoms and causes - Mayo Clinic

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## TYPES OF SEIZURES

- **Focal seizures**  
Electrical activity in 1 area of the brain.  
Do not pass out, but may have altered level of consciousness, repeated movements or words, changes in emotions, or senses.
- **Generalized Seizures**  
Involve all areas of the brain.  
Absence: Stare into space, slight body movements like blinking or lip smacking, can happen hundreds of times during the day, can be clustered.  
Tonic: Muscles stiffen, pass out, falls.  
Atonic: Sudden loss of muscle use, "drop seizures", falls.
- **Clonic:** Jerking muscle movements. Affect neck, face, and arms on both sides.  
• **Myoclonic:** Brief sudden jerks of arms and legs, do not pass out.  
• **Tonic-clonic:** Most common type, body stiffness and shaking, loss of consciousness, can start as focal and then spread to all of the brain.

<https://www.mayoclinic.org/diseases-conditions/seizure/symptoms-causes/syc-20365711>

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## STAGES OF A SEIZURE

- **Prodrome:**  
Beginning phase, an impending since that a seizure may occur. Feeling, aura, behavioral change.
- **Ictal:**  
Middle phase, includes the aura until the end of the seizure.
- **Postictal**  
End/Recovery phase, can last minutes to hours, dependent on type and area of brain affected. Symptoms can include drowsy, confused, anxious, scared, nausea, headache, weakness, slow to respond, loss of memory.

<https://www.mayoclinic.org/diseases-conditions/seizure/symptoms-causes/syc-20365711>

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## SEIZURE DIAGNOSIS AND MANAGEMENT

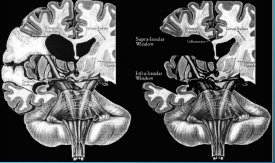
- **Diagnosis**
  - Electroencephalogram (EEG)
  - High density EEG
  - Stereoelectroencephalography (SEEG)
  - CT scan
  - SPECT/MRI to pinpoint location
    - Dependent on seizure occurring during SPECT
  - Neuro Exam
  - Lab tests like glucose and sodium
  - LP

<https://www.mayoclinic.org/diseases-conditions/seizure/symptoms-causes/syc-20365711>

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## Treatment

- GOAL: Stop seizures with fewest side effects
- Medications
- Dietary changes (keto)
- Surgical
  - Lobectomy
  - Thermal ablation
  - Multiple subpial transection
  - Corpus callosotomy
  - Hemispherotomy (for children)
- Electrical stimulation
  - Vagus nerve stimulator
  - Responsive neurostimulation
  - Deep brain stimulation



<https://www.mayoclinic.org/diseases-conditions/seizure/symptoms-causes/syc-20365711>

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## STATUS EPILEPTICUS

### Medical Emergency

Defined as a convulsive seizure lasting more than 5 minutes, or multiple seizures without return to baseline level of consciousness

### Management

Rapid assessment and supportive care (ABCs), urgent pharmacologic therapy with a benzodiazepine, urgent therapy with a nonbenzodiazepine (antiseizure medication), and postictal recovery and evaluation (neuro exam, EEG, imaging)

Expect a prolonged postictal phase due to sedation from medication, and the nature of multiple seizures and the brains recovery.

<https://www.uptodate.com/contents/convulsive-status-epilepticus-in-adults-management#H2329061469>

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## MENINGITIS

Inflammation of membranes surrounding the brain and spinal cord.

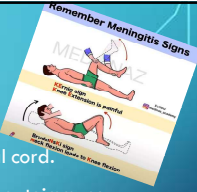
Can be bacterial, viral, fungal, parasitic, or caused by cancer and autoimmune.

Symptoms: fever, vomiting, headache, stiff neck, rash, light sensitivity; rapidly worsen.

Diagnosis: history, physical exam, lab, CT, MRI, LP

Treatment: Viral, usually self limiting, fluids and rest; Bacterial, hospitalization, IV antibiotics, steroids; Fungal, IV antifungals

Darkened room and control fever and pain.



<https://www.americanbrainfoundation.org/diseases/meningitis/>

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## ENCEPHALITIS

Inflammation of the brain tissue.

Caused most often by viruses. Can be infectious (bacterial, fungal, parasitic) or autoimmune.

Symptoms: Headache, flu-like symptoms, light and sound sensitivity, nausea, difficulty moving, changes in LOC, psychosis, seizures.

Worsens over days to weeks.

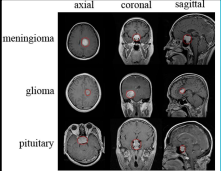
Diagnosis: Medical history, recent bug bites, travel, illnesses, vaccine history, neuroimaging, lab test, LP, EEG, ICP monitoring.

Treatment: Targets cause first, antibiotics, immunoglobulin therapy, plasma exchange. Symptom management, steroids, surgical intervention.



<https://www.americanbrainfoundation.org/diseases/encephalitis/>

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## TUMORS

Growth of abnormal cells. Most common types glioblastoma, schwannoma, neurofibroma, and neurofibrosarcoma.

Can be primary, originating from the brain or spinal cord. Or secondary, originating from another body part and spreading. Can be benign and malignant.

Symptoms depend on location, size, and type. Can range from headaches, to stroke like symptoms.

Diagnosis occurs through exam, imaging, and sometimes biopsy.

Treatment is dependent on tumor. Surgical intervention, chemotherapy, radiation therapy, and rehabilitation.

<https://www.americanbrainfoundation.org/diseases/brain-and-nerve-tumors/>

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## BRAIN AND ELECTROLYTES

Electrolyte abnormalities can present as neurological symptoms.

**Sodium: Hypo (Serum  $< 135\text{mmol/L}$ )** Common in neuro patients.

Acute hyponatremia develops in less than 48 hours, can cause cerebral edema, needs more aggressive treatment. Chronic develop over more than 48 hours, often times in an unknown timeframe and requires a slow repletion.

Symptoms: nausea, malaise, weakness, lethargy, forgetfulness, confusion, coma, hypotension, seizures, and arrest

Treatment: Identify the cause, acutely can be given hypertonic saline, can be placed on a fluid restriction.

Most standard goals of treatment is to increase the serum sodium by 6-10 mmol/L in a 24-hour period. This patient needs constant monitoring and frequent serum sodium (4-6 hours).

SIAD: syndrome of inappropriate antidiuresis, hyponatremia, low plasma osmolality, inappropriately elevated urine osmolality, sodium excretion (urinary  $> 30\text{mOsm/kg}$ ), normovolemia, tx fluid restriction, hypertonic saline.

CSW: cerebral salt wasting, resembles SIAD, but with much higher urine sodium, common after neuro injury, unsafe to restrict fluid in this patient, treated with hypertonic saline and sodium supplements.

Osmotic demyelination syndrome: Central pontine myelinolysis, caused from over correction of chronic hyponatremia, damaging the myelin sheath from rapid fluid shifting, symptoms: seizures, spastic tetraparesis, encephalopathy, coma and death.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC3474650/>  
<https://pn.bmj.com/content/25/4/303>

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## BRAIN AND ELECTROLYTES

**Sodium: hyper  $> 145\text{mmol/L}$**  associated with traumatic brain injuries.

Neurologically can lead to cell shrinking, due to water shift, shrinking brain parenchyma, causing tearing of blood vessels, which may lead to intracerebral and subarachnoid hemorrhage.

Symptoms: thirst, lethargy, confusion, coma, seizures, rigidity, tremors, myoclonus, asterixis, and chorea.

Treatment: Identifying and treating underlying cause and hypotonic fluids. Rapid correction can cause similar symptoms as rapid replacement of sodium. The goal is 0.5-1 mmol/L/hr

DI: diabetes insipidus, loss ability to concentrate urine and pass large volumes of dilute urine, treatment is volume repletion and DDAVP.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC4519799/>  
<https://pn.bmj.com/content/25/4/303>

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## SPINAL CORD INJURIES

Spinal injuries can devastatingly affect motor and sensory function, but can also cause cardiovascular collapse, ventilatory failure, and bowel and bladder dysfunction.

Primary trauma can lead to secondary injury related to inflammation. All functions below the site of injury can be affected for up to 12 weeks.

Cardiovascular: Neurogenic shock (spinal shock); fluid, vasopressors, MAP  $> 85\text{mmHg}$ . Autonomic dysregulation, usually chronic but can be acute, extreme elevation in BP, flushing, sweating from sensory stimuli. Remove stimuli.

Respiratory: Cervical and thoracic injuries can cause respiratory insufficiency immediately or over time. Early tracheostomy has been found to improve outcomes.

GI, GU, ID: Spinal shock and treatment can lead to all kinds of GI complications ileus, ulceration and hemorrhage, pancreatitis, cholecystitis; manual removal of stool may be necessary. Urinary retention is common requiring catheterization. Infections are common UTI, aspiration, decubitus, leading to sepsis.

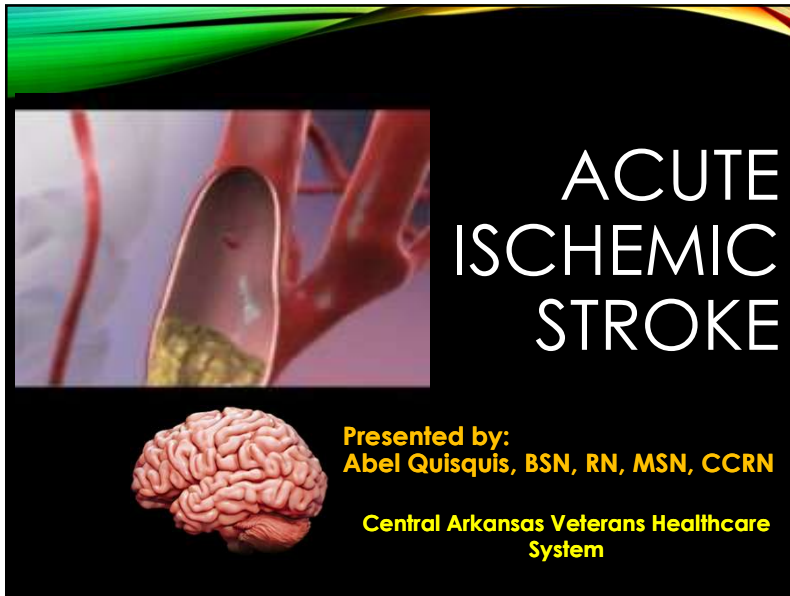
May also have trouble thermoregulating.

Pain management is key. Quality of life, mood, and ability to participate in rehab are all affected.

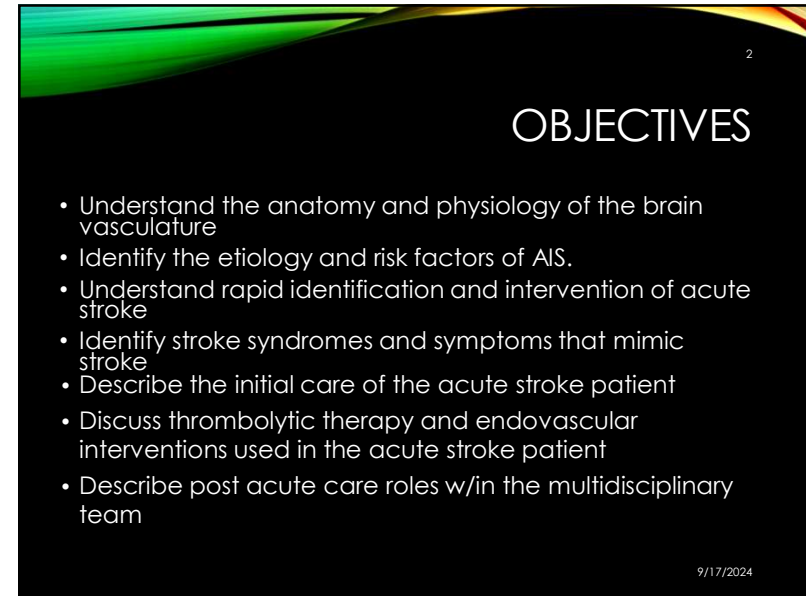
<https://pmc.ncbi.nlm.nih.gov/articles/PMC8074850/>

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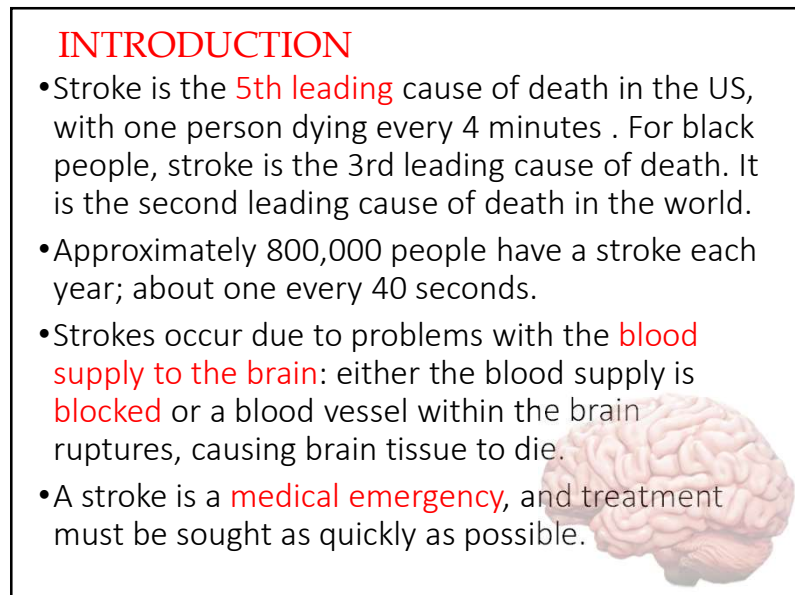




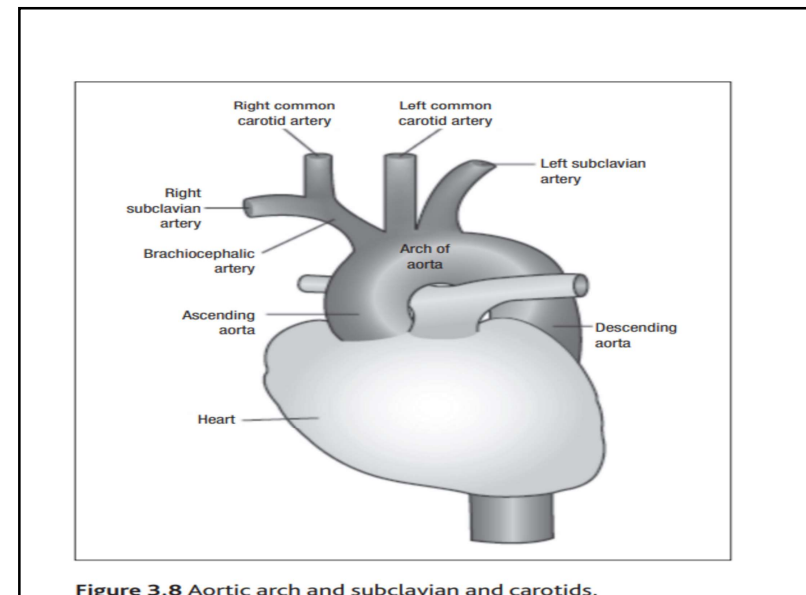
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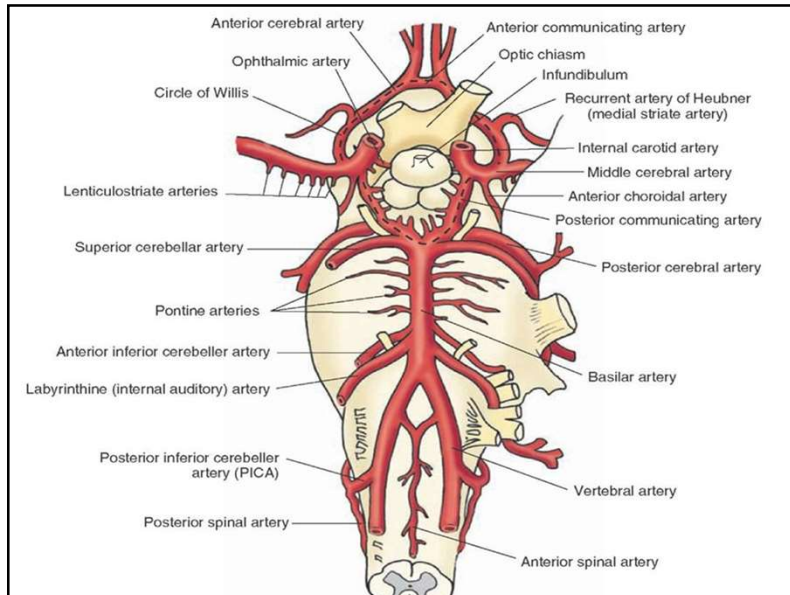
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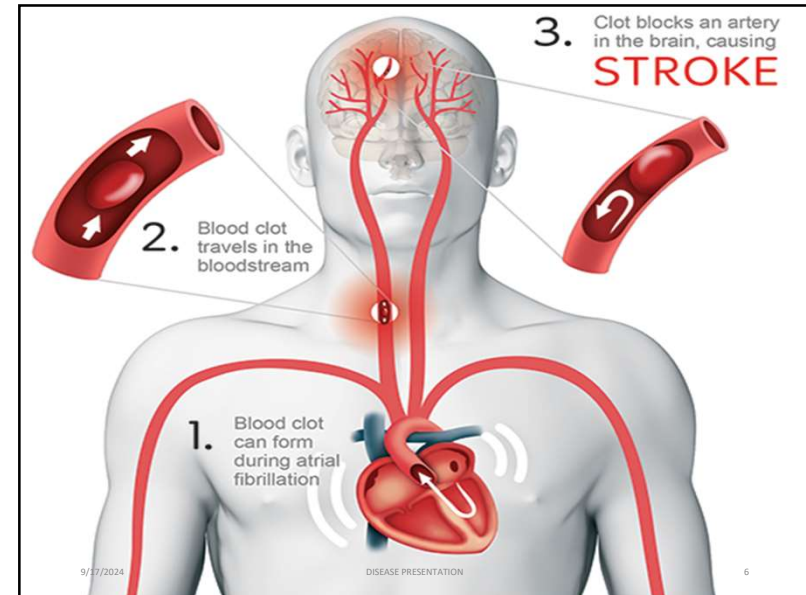
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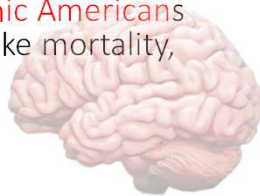


6

## TIA & Ischemic Stroke Risk Factors

### •Non-modifiable

- Age (after age 55, the stroke risk doubles with each successive decade)
- Sex (men increased rate of strokes except for SAH)
- Low birth weight, birth weight below 2,500 g (5 lb., 8 oz)
- Ethnicity (Black and some Hispanic Americans have higher stroke rates and stroke mortality, namely for ICH and SAH)
- Genetics



7

## TIA & Ischemic Stroke Risk Factors

- Modifiable (91%)
  - Carotid artery disease
  - Hypertension: target <130/80 mmHg
  - Diabetes (maintain HgbA1c < 7.0%)
  - High BMI, weight reduction w/goal BMI<25kg/m<sup>2</sup>
  - Hyperlipidemia, LDL<160mg/dL
  - Atrial Fibrillation
- Modifiable-Behavioral (74%)
  - Unhealthy diet
  - Cigarette smoking
  - Physical inactivity



8

## ADDITIONAL MODIFIABLE RISK FACTORS

- Sleep-disordered breathing
- Hormone therapy
- Migraine with aura- Young women with **migraines** who also **smoke** and take **oral contraception** have nine-fold increased risk of stroke.
- Alcohol consumption
- Drug abuse
- Hypercoagulability
- Inflammation
- Metabolic syndrome



9

## TIA & Ischemic Stroke Risk Factors

- **Cigarette smoking**  
(ischemic stroke risks doubles for smokers & for hemorrhagic stroke increases 2-4 x that of a non-smoker, **quit smoking to lower risk**).
- **Smoking & oral contraceptives**  
(increased synergistic effect—**quit smoking or OC**).

Researchers: 'The more you smoke, the more you stroke'

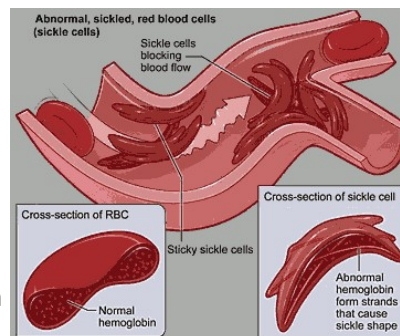
Subrata Thakur | April 19, 2018 | Vascular & Endovascular



10

## TIA & Ischemic Stroke Risk Factors

- Sickle cell anemia in adults should be evaluated for stroke risk
- Sodium intake (less than 2.3 grams/day)
- Potassium intake (more than 4.7 grams/day)



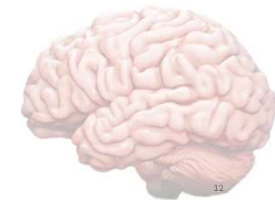
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## TYPES

There are three main kinds of stroke:

- **Ischemic strokes**
  - Hemorrhagic strokes
  - Transient ischemic attacks (TIAs), also referred to as mini-strokes



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## Typical Presentation of Stroke

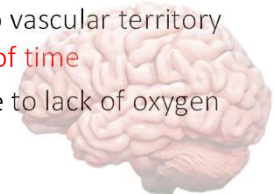
- Thrombotic strokes: progress **over seconds to minutes**, rarely hours—caused by increasing size of thrombus
- Embolic strokes: occurs **suddenly** and often without warning
- Hemorrhagic stroke: occurs rapidly, **over minutes**; headache. Hemorrhages can grow in the first 24 hours.



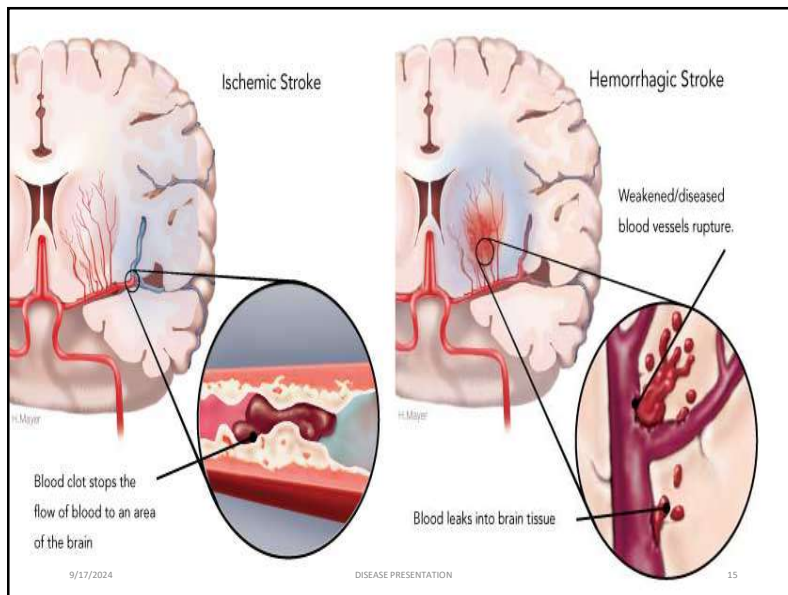
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## ISCHEMIC STROKE

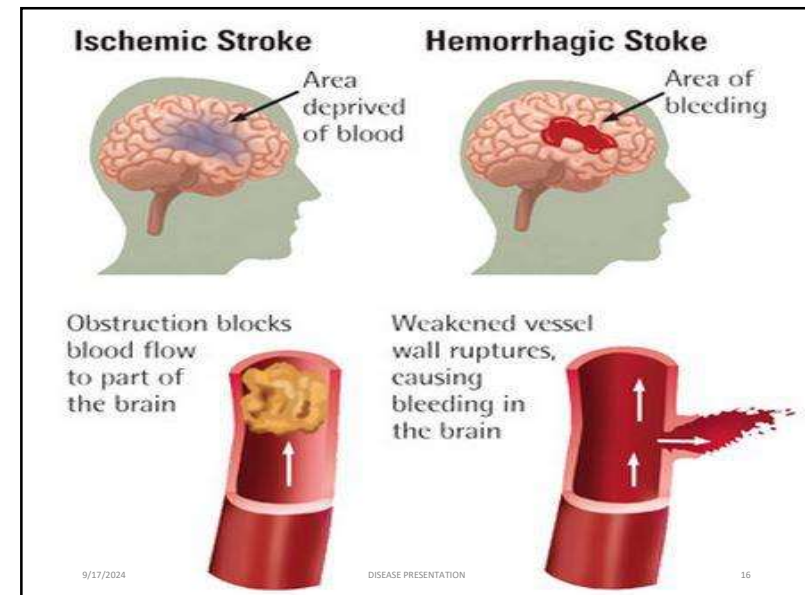
- most common form of stroke, accounting for around **80% of strokes**.
- caused by **blockages** or **narrowing** of the arteries that provide blood to the brain, resulting in ischemia
- These blockages are often caused by blood clots. Clots can be caused by fatty deposits within the arteries called **plaque**.
- **Acute vascular event with a sudden onset of focal neurological deficits** which relate to vascular territory and that last for **prolonged period of time**
- Progressive death of brain cells due to lack of oxygen and glucose



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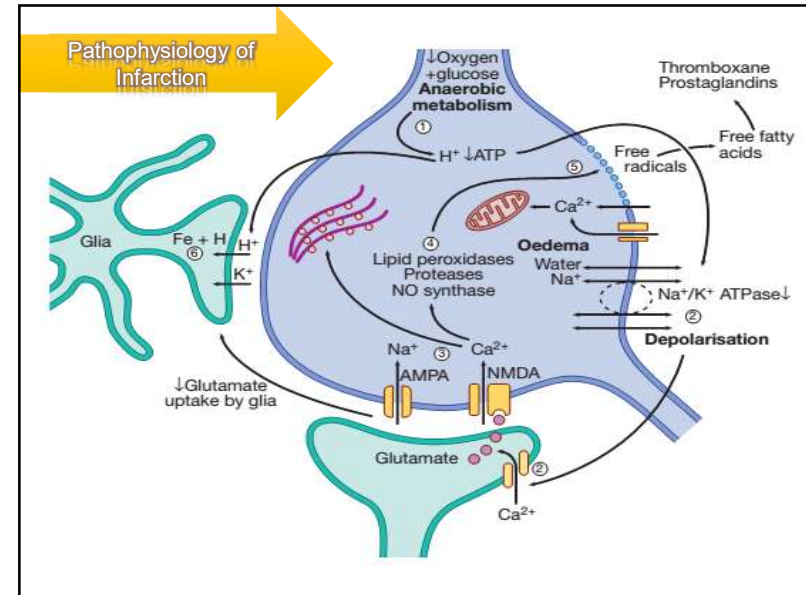
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## PHYSIOLOGY OF CEREBRAL ISCHEMIA

- Normal cerebral blood flow is 45 to 60 mL/100 g/min. When it drops below 18 mL/100 g/min, brain tissue infarction can occur if cerebral blood flow is unresolved for up to 4 hours. This process is known as the *ischemic cascade*.



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## ISCHEMIC PENUMBRA

- The area surrounding the infarcted tissue.
- The area is still viable, often supported by collateral circulation, but is at risk of proceeding to infarction, like the core of the stroke (original area of infarcted tissue).
- Resolution of edema generally occurs within 72 hours, as demonstrated by improvement of some deficits and by patients being more awake and alert



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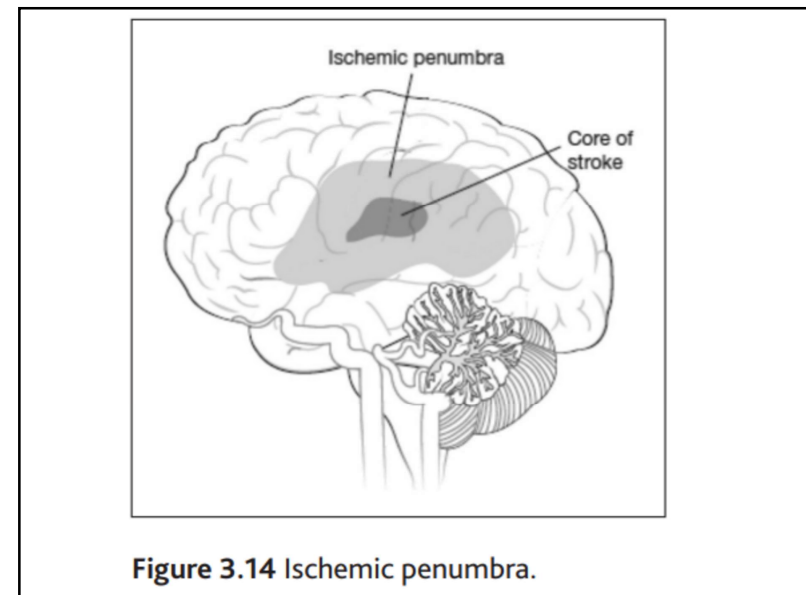
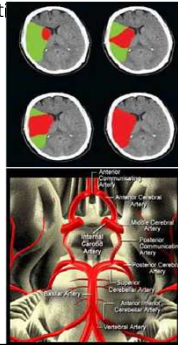


Figure 3.14 Ischemic penumbra.

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## Save the Penumbra!

- The **zone of salvageable tissue**, neuronal cells unable to function but remain viable
- Located around the area of the core infarct
- Reversible if flow is established to the stunned area
- **Variables affecting the penumbra:**
  - Time to IV- thrombolytic or endovascular delivery/intervention
  - Site occlusion location (clot burden)
  - Collateral flow
  - BP control (tight and slow)
- **Decrease Complications by avoiding:**
  - Seizures
  - Hypotension
  - Hyperglycemia
  - Fever



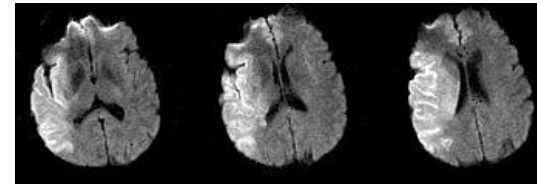
21

## Acute Infarction: CT and MRI

NCHCT



DWI



**AIS evident within 15 minutes to 2 weeks on MRI**

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- In an adult, CBF is typically
  - ✓ 750 ml/min or
  - ✓ 45-50ml/100g/min or
  - ✓ 15 % of the cardiac output (CO)

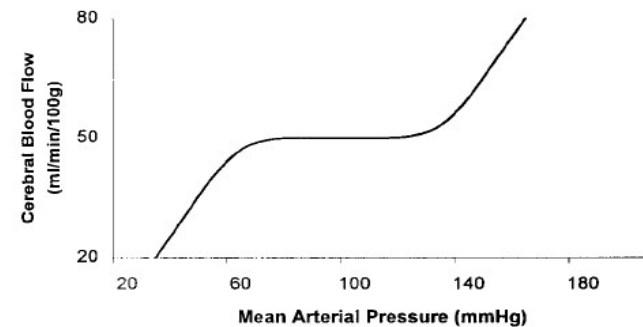
In normal individuals, CBF remains constant when the mean arterial pressure varies between

**"60 and 160 mmHg"**



23

## Ideal Cerebral Auto Regulation



Lassen NA. *Physiol Rev.* 1959;39:183-238  
Strandgaard S, Paulson OB. *Stroke.* 1984;15:413-416

24

### Cerebral Blood Flow (CBF) :

- Less than 23ml/100g/min, physiological electrical function of the cell begins to fail- “**ischemic penumbra**”.
- Below 10 ml/100g/min, ionic membrane transport failure, Irreversible cell death- which leads to- “**infarction**”.



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### Factors Influence Ischemic Stroke

- Rate and onset of duration
- Collateral circulation
- Systemic circulation
- Hypercoagulable states
- Increased temperature
- Hyper/hypo glycemia



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### Ischemic Stroke Subtypes

- Thrombotic stroke
- Embolic stroke
- Lacunar stroke -77% of ischemic strokes
  - occlusion of smaller, penetrating arteries, blocking blood flow to small portions of the brain.
  - referred to as **pure motor or pure sensory** stroke



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### Transient Ischemic Attack- TIA

- **Brief episode** of neurological dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting < one hour and without evidence of acute infarction
- **90% clear within 10 minutes**
- Most common cause is **thromboembolism**
- **Crescendo TIA**
- Find the cause and treat – prevent future strokes
  - 10% have a stroke w/in 2 days
  - 15% have a stroke w/in 7 days
  - 25% have a recurrent “event” w/in 3 months
  - 25% expire at one year



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## ABCD<sup>2</sup> Score

### Risk Assessment Scale Predictor 2 – 90 Day Risk of STROKE after TIA

| Risk Factor          | Value                                                     | Score | Score 0-3: 1% risk of stroke in 2 days 5% in 90 days               |
|----------------------|-----------------------------------------------------------|-------|--------------------------------------------------------------------|
| Age                  | >= 60 years                                               | 1     |                                                                    |
| Blood Pressure       | SBP > 140 or DBP > 90                                     | 1     |                                                                    |
| Clinical Symptoms    | Unilateral Weakness<br>Speech disturbance<br>w/o weakness | 2     | Score 4-5:<br>4% risk of stroke in 4 days 8-12 % risk in 90 days   |
|                      |                                                           | 1     | Score 6-7:<br>8% risk for stroke in 2 days<br>17 – 22 % in 90 days |
| Duration of Symptoms | > 60 min                                                  | 2     | Score 4-7:<br>Consider for hospital admission                      |
|                      | > 10-59 min                                               | 1     |                                                                    |
| Diabetes             | Oral Medication or insulin                                | 1     |                                                                    |

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## TIA & Ischemic Stroke Etiology

- Atrial fibrillation
- Atherosclerosis
- Coronary artery disease (CAD)
- Hypercoagulable states
- Drug use

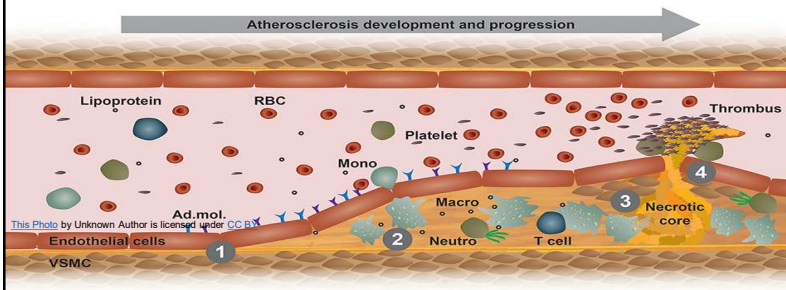


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## Stroke Etiology

### • Atherosclerosis

- In the carotid artery, a roughening of the intima, causing plaque formation along the injured vessel
- Endothelial injury permits platelets to aggregate and adhere
- Coagulation is activated and a thrombus develops at the site
- Blood flow is reduced

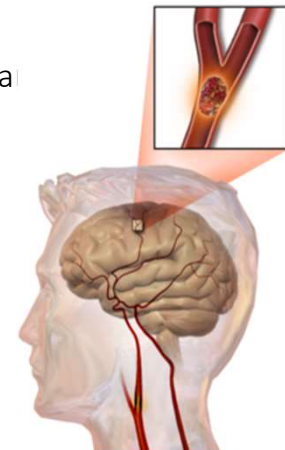


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## Stroke Etiology

- **Ischemic:** Embolic formation, emboli travel from other areas and lodge in cerebral vessels

- Carotid plaques
- Cardiac disease (atrial fib)
- Foreign substances
- Air emboli (OR procedure, pulling central line in sitting position)
- Fat emboli (long bone)
- Hypercoagulable state
- Carotid dissection (trauma)



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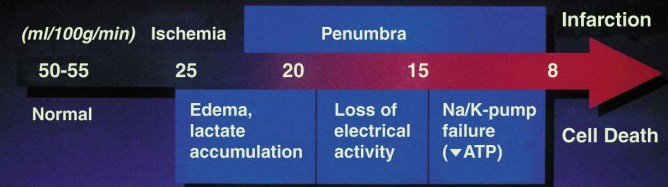
## Stroke Etiology

- **Lacunar:** Thrombosis of small penetrating arteries
  - Caused by **HTN** (frequently) and lipohyalinosis (small tissue sloughing in gray & white matter)
  - Affects arm, leg, face; deficits are **EQUAL** in lacunar strokes
- **Other**
  - Inflammation of walls (giant cell arteritis, polyarteritis nodosa)
  - Mechanical constriction of vessel
  - Hypotension
  - Sickle cell
  - Polycythemia vera



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## Effects of Reduced Cerebral Blood Flow



From National Stroke Association, 1997

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## What are the signs of Stroke?



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DISEASE PRESENTATION

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## STROKE KNOW THE WARNING SIGNS

If you experience any of these symptoms, CALL 9-1-1 or your local emergency number immediately.



### Weakness

Sudden loss of strength or sudden numbness in the face, arm or leg, even if temporary.



### Trouble speaking

Sudden difficulty speaking or understanding or sudden confusion, even if temporary.



### Vision problems

Sudden trouble with vision, even if temporary.



### Headache

Sudden severe and unusual headache.



### Dizziness

Sudden loss of balance, especially with any of the above signs.

SEE WHAT HAPPENS WHEN  
YOU PUT YOUR HEART INTO IT.™

heartandstroke.ca

HEART & STROKE  
FOUNDATION  
Finding answers. For life.

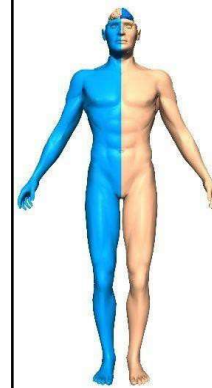
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### Effects of a Left hemispheric stroke:

#### Left Middle Cerebral Artery (MCA)

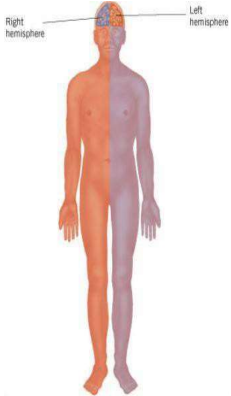


- Right visual field loss: **homonymous hemianopia**
- Left gaze deviation
- Poor right conjugate gaze: palsy,
- Aphasia: difficulty with language
  - expressive, receptive, global
- Right sided weakness: hemiparesis, effects the face and arm > leg
- Right sided paralysis: hemiplegia
- Right sided sensory impairment
- Dysarthria (motor disorder)
- Difficulty reading, writing or calculating

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### Effects of a Right hemispheric stroke:

#### Right Middle Cerebral Artery (MCA)



- Left visual field loss: homonymous hemianopia
- Right gaze deviation
- Poor left conjugate gaze: palsy, inability to move both eyes in the same direction
- Left sided weakness: hemiparesis
- Left sided paralysis: hemiplegia
- Left sided sensory impairment
- Anosognosia: impaired body part recognition
- Inattention: neglect/denial

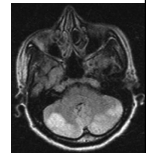
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### Effects of a Posterior Stroke:

#### Brainstem and Cerebellum

#### Overview Typical Signs:

- **D**izziness, ataxia, vertigo (spinning)
- **D**ysphagia, **D**ysarthria
- **D**iplopia, **D**ecreased LOC, amnesia
- **D**ysconjugate gaze, gaze deviation, nystagmus
- Bilateral visual field deficits, ptosis
- Abnormal respirations, nausea, vomiting
- Hiccups, tinnitus (ringing in the ear)
- Motor and sensory loss in all four limbs
- Crossed sensory or motor findings: ipsilateral face, contralateral body

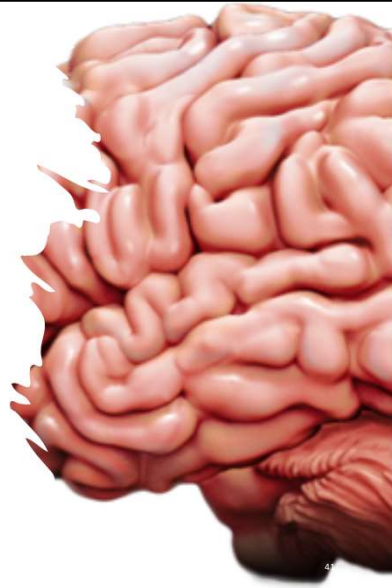


***"DIZZY PLUS"***  
***Most misdiagnosed Stroke***



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# STROKE- ALERT PROCESS



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DISEASE PRESENTATION

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## Chain of Survival & Recovery 8 D's

- Detection: Stroke Onset
- Dispatch: EMS Activation & Response
- Delivery: Prehospital Care
- Door: ED Triage
- Data: ED Evaluation (CT, Glucose, INR if on Coumadin)
- Decision: Potential Therapies (identify time windows)
- Drug or Device: Inclusion/Exclusion Criteria Alteplase
- Disposition: Rapid admission to stroke unit or ICU

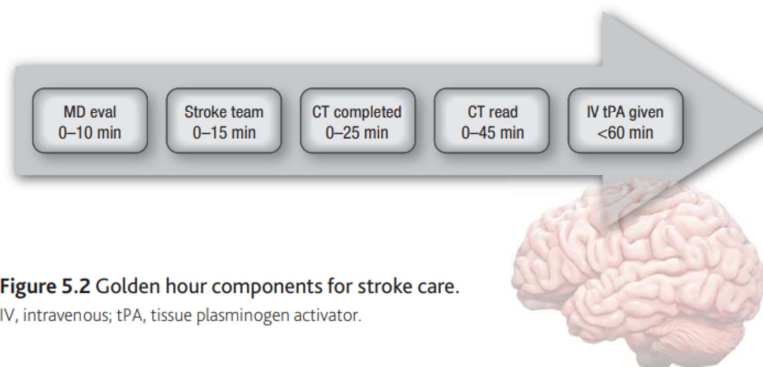
-Activation of EMS is the most important to emphasize in community education that directly improves outcomes and disability.

-The greatest time delay occurs from symptom onset to ED arrival.

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## THE GOLDEN HOUR

- This refers to the time from patient arrival until IV tPA is administered



**Figure 5.2** Golden hour components for stroke care.

IV, intravenous; tPA, tissue plasminogen activator.

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## PHASE III TARGET: STROKE<sup>SM</sup> SUGGESTED TIME INTERVAL GOALS



Current VA Goal DTN < 60 minutes Time Targets:

### ACTION TIME

Door to physician ≤10 minutes

Door to stroke team ≤15 minutes

Door to CT/MRI initiation ≤25 minutes

Door to CT/MRI interpretation ≤45 minutes

Door to needle time ≤60 minutes

Future VA Goal DTN < 45 minutes Time Targets:

### ACTION TIME

Door to physician ≤5 minutes

Door to stroke team ≤10 minutes

Door to CT/MRI initiation ≤20 minutes

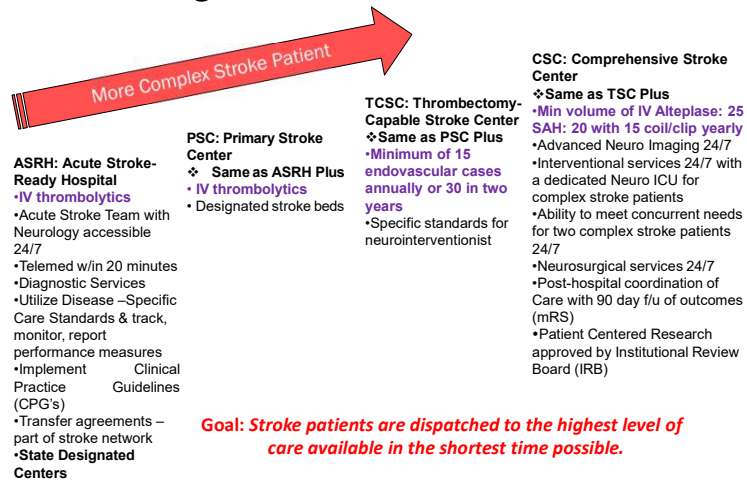
Door to CT/MRI interpretation ≤35 minutes

Door to needle time ≤45 minutes

Target: Stroke phase III, [www.heart.org](http://www.heart.org), (2022, June 2), <https://www.heart.org/en/professional/quality-improvement/target-stroke/introducing-target-stroke-phase-iii>

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## Designation of Stroke Centers



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## ED Acute Stroke Management

- The primary goal is to identify patients with possible stroke as well as to **exclude stroke mimics**.
- ABCs
- Stroke team notification (Telestroke)
- Stat head CT
- Hand-off report from EMS
- Patient history—confirm LKW time, review medical history, particularly related to eligibility for therapeutic interventions



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- Neurological assessment using a standardized tool such as National Institutes of Health Stroke Scale (NIHSS)
- ECG to assess for concurrent myocardial ischemia or arrhythmias
- Oxygen saturation to assess for hypoxia and treatment if <94%
- Blood tests are ideally drawn by EMS shortly before arrival to ED; otherwise, blood is drawn as early as possible in the ED without delaying treatment decisions (see Chapter 6 for the standard list of the blood tests)
- Determine etiology
- Appropriate treatment



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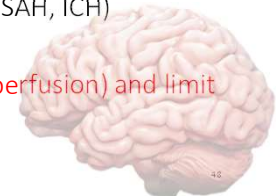
DISEASE PRESENTATION

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## Decrease medical complications:

- Glucose management: Goal **140-180 mg/dl**
- BP management: if fibrinolytic candidate **< 185/110**
  - Treat > 220/120 mm Hg
- Avoid **aspiration** (dysphagia screen follow protocol)
- Provide oxygen to maintain **O<sub>2</sub> saturation > 94%**
- **Euvolemia**: IVF's: isotonic saline x 72 hours
- **Temp control**: one degree increases cerebral metabolism by 7%
- Cardiac monitoring (minimum first 24 hours)
- Standardized stroke protocols (AIS, SAH, ICH)
- **Goal: Restore cerebral blood flow (reperfusion) and limit neuronal injury**



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## Nursing Considerations

- High and low alarm limits in bedside monitoring equipment should be set to patient-specific goals
- Do not treat an isolated BP
- Consider other causes for increased BP
- If antihypertensives are administered, BP is reassessed in 15 to 30 minutes



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DISEASE PRESENTATION

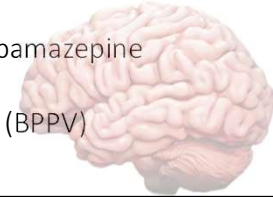
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## Stroke Mimics

Approximately 6-20% of suspected strokes are mimics, rates increase when clinician has less information

- Toxic metabolic syndromes:
  - Hypo or Hypernatremia
  - Hypo or Hyperglycemia
  - Wernicke's or Hepatic encephalopathy
- **Seizure disorder with postictal Todd's paralysis**
- Migraine headaches
- CNS abscess/Systemic infections
- CNS Tumor with bleed or seizure
- Drug toxicity: lithium, phenytoin, carbamazepine
- Psychogenic/Conversion Disorder
- Benign paroxysmal positional vertigo (BPPV)
- Syncope



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## Last Known Normal (LKN)

- Patient's baseline
  - Previous stroke deficits, normal mental status
- Identifiers of LKN
  - State actual time and day
  - Meals, TV shows, phone calls, texting, etc
  - Symptom Discovery vs LKN – not always the same
  - Obtain Family or Witness contact information
- Wake up Strokes
  - Time patient went to bed
  - Getting up during the night
  - How patient is dressed



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DISEASE PRESENTATION

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## USE OF TELESTROKE (TELEMEDICINE)

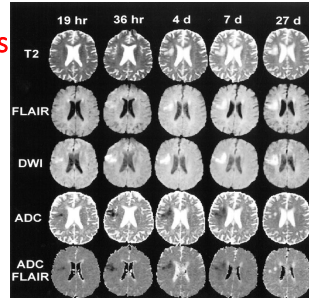
- Telestroke is recommended to increase access to acute stroke care in underserved areas.
- This technology provides expert consultation without “being there.”
- also facilitates initiation of interventions proven to reduce complications and stroke recurrence.
- It is proven to shorten DTN time in patients receiving IV thrombolytic.

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## Defining the Stroke Timeline

### ○ Acute Ischemic Stroke (AIS)

- **Hyperacute stroke: first 24 hours**
- Acute stroke: first 24 – 72 hours
- Subacute stroke: after 72 hours
- Chronic stroke: 6 weeks or greater



**Priority first 24 hours frequent assessment of neurological status**

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## DIAGNOSIS

- Strokes happen fast and will often occur before an individual can be seen by a doctor for a proper diagnosis.
- The acronym **B.E.F.A.S.T.** is a way to remember the signs of stroke, and can help identify the onset of stroke more quickly:



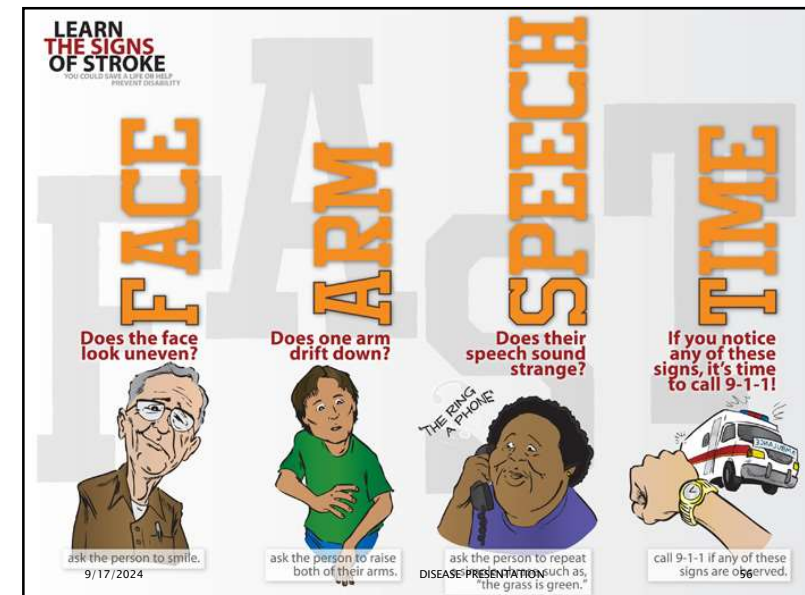
54

## Typical Presentation of Stroke

- Thrombotic strokes: progress **over seconds to minutes**, rarely hours—caused by increasing size of thrombus
- Embolic strokes: occurs **suddenly** and often without warning
- Hemorrhagic stroke: occurs rapidly, **over minutes**; headache. Hemorrhages can grow in the first 24 hours.



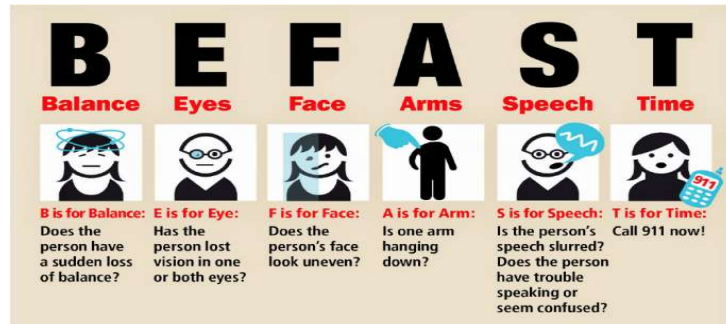
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## Ischemic Stroke

- Focal neurological deficit caused by the interruption of blood flow to the brain lasting longer than 24 hours.



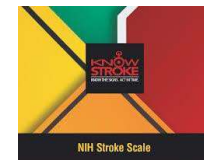
[https://www.healthy.arkansas.gov/images/uploads/pdf/Arkansas\\_EMS\\_-\\_Stroke\\_Best\\_Practices\\_Toolkit\\_2-19\\_locked.pdf](https://www.healthy.arkansas.gov/images/uploads/pdf/Arkansas_EMS_-_Stroke_Best_Practices_Toolkit_2-19_locked.pdf)

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## NIH Stroke Scale (NIHSS)

- Validated tool and best practice
- Predictor of long-term outcome
  - NIHSS > 25 high probability for morbidity and mortality
- Communication tool between providers
- May not be feasible to perform in prehospital setting
- Measures neurological functional improvement over time
- Providers certified a minimum of every 2 years

| NIH Stroke Scale Score | Stroke Severity           |
|------------------------|---------------------------|
| 0                      | No stroke symptoms        |
| 1-4                    | Minor stroke              |
| 5-15                   | Moderate stroke           |
| 16-20                  | Moderate to severe stroke |
| 21-42                  | Severe stroke             |



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## Immediate Diagnostic Studies: Evaluation of a Patient With Suspected Acute Ischemic Stroke

### All patients

- Noncontrast brain CT or MRI
- Blood glucose
- Serum electrolytes/renal function tests
- ECG
- Markers of cardiac ischemia
- CBC, including platelet count\*
- PT/INR\*
- aPPT\*
- Oxygen saturation

### Selected patients

- Hepatic function tests
- Toxicology screen
- Blood alcohol level
- Pregnancy test
- ABG (if hypoxia is suspected)
- CXR (if lung disease is suspected)
- Lumbar puncture (if SAH is suspected and CT scan is negative for blood)
- EEG (if seizures are suspected)

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## Artificial Intelligence (AI)



**Advanced Imaging should NEVER delay IV thrombolysis therapy**



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## Acute Ischemic Stroke Treatments

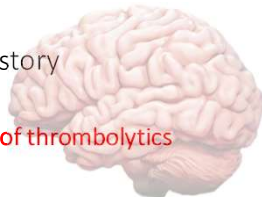
### Time sensitive

- Thrombolytic therapy
  - **0-4.5 hour window**
- Endovascular intervention
  - **0-24 hour window**



- Arrival to the appropriate healthcare facility
- Last known well and symptom onset
- Witness information
- Accurate healthcare and medication history

**Patients need to Walk and Talk themselves out of thrombolytics**

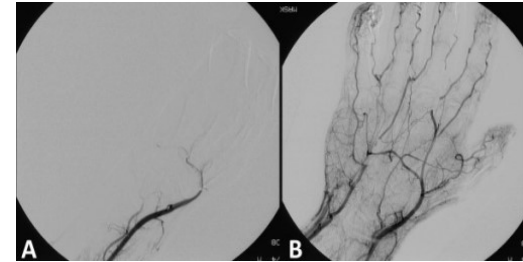


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## Medical Interventions

### • Thrombolytic therapy

- An attempt to restore perfusion to the affected area
- Patient must meet certain criteria
- Contraindications exist



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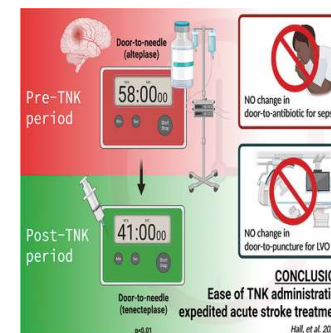
## Criteria for Thrombolytic Therapy

- Patient characteristics
  - CT of head must be **negative** for hemorrhage
  - Older than 18 years
  - Time of **onset < 3 hours**
  - No history of **intra-cranial surgery**, head trauma, or stroke **within 3 months**
  - No major surgeries within 2 weeks
  - No arterial punctures at a non-compressible site in the last one week
  - SBP < 185 mm Hg
  - DBP < 110 mm Hg
  - No AMI in the last 3 months



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## TNK vs TPA



### Tenecteplase (TNK)

Not FDA approved for stroke – recent literature suggest can be effective alternative to alteplase in pt's without contraindications  
Indication for AIS must be given within 4.5 hours of symptom onset  
Promotes fibrinolysis of fibrin clot  
More fibrin specific with longer half-life than alteplase; 20-24 minutes  
Dosing: 0.25 mg/kg for pt's weighing > 100 kg  
Vial is not shaken. Max dose 25mg

Consider repackaging for stroke



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### Lab Data for Thrombolytic Therapy

- Prothrombin time (PT) < 15 seconds
- Platelet count > 100,000 mm<sup>3</sup>
- Blood glucose > 50 & < 400
- No prolonged PTT or INR (INR ratio < 1.5)
- Pt cannot be pregnant or lactating



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### Tissue Plasminogen Activator (t-PA)

- Must be given within 3 hours of symptom onset
- Administer 0.9 mg/kg, 10% of bolus over 1-2 minutes followed by a 90% dose given by IV drip over 1 hour
- The maximum total dose is 90 mg, regardless of patient's weight



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### Thrombolytics-Nursing Considerations

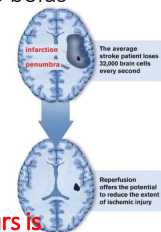
- Monitor vital signs & neurological status
- Treat BP if systolic > 180 or diastolic > 105
- Monitor CBC, Pt/Ptt, INR, fibrinogen
- Monitor for bleeding precautions
  - Do not insert foley 30 minutes before or after TPA
  - Do not place central line or NGT for 24 hours
  - Monitor puncture sites
- Other nursing considerations
  - Manage blood pressure, glucose, I/O
  - Pt & family education



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### Thrombolytic Complications

- Monitoring for neurological decline or worsening symptoms
  - Agitation, Restlessness
  - Spike in blood pressure
  - Nausea/vomiting
  - Headache: document baseline pain score prior to bolus
- If Neurological Decline occurs
  - **First Priority Stop the Infusion**
  - Re-check BP to goal 180/105
  - Contact physician
  - Obtain Stat NCHCT head scan
  - Complete NIHSS: **≥4-point increase within 36 hours is considered a complication from the fibrinolytic**



Alteplase Infusion may be restarted at same rate (no bolus) if NCCT head is negative for hemorrhage per MD order

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## Complication: Angioedema

- Reported in 1-2 % of patients
- **Associated with previous ACE inhibitor allergy**
- Baseline assessment of tongue
- Observe for facial, tongue, or pharyngeal angioedema 30-75 min post infusion up to 24 hours
  - Histamine antagonists: Benadryl
  - Corticosteroids: hydrocortisone or methylprednisolone
  - H<sub>2</sub> Blocker: ranitidine or famotidine

**Avoid epinephrine due to increasing BP**



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## Complication: Hemorrhagic Conversion

- May occur up to 36 hours post infusion
- **Sudden change:**
  - **LOC/ Neurological deterioration**
  - Agitation/Restlessness
  - Acute Hypertension
  - Severe H/A
  - Nausea or vomiting
- Follow protocol:
  - Stat Labs: Coag panel, fibrinogen level, CBC, TXM
  - Kcentra/PCC (Prothrombin Complex Concentrate/4 factors)
  - Platelets 6-8 units (Volume)
  - Cryoprecipitate containing factor VIII (6-8 units)
  - Tranexamic acid 1k mg IV over 10 minutes
  - Neurosurgery and Hematology consults



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## Anti-coagulants

- **Heparin** (or low molecular weight heparin)
  - Prevent recurrent embolus
  - Assist collateral blood flow
  - Slow progression of a thrombus
  - Not used anymore. Studies showed no beneficial effect on patient outcome



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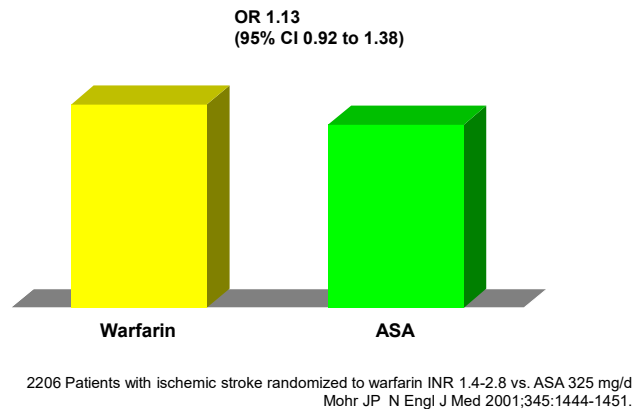
## Anti-platelet

- Inhibit platelet aggregation
  - ASA 80-325 mg PO, QD
  - Extended-release dipyridamole (200mg) plus ASA 25 mg (Aggrenox) BID, PO
  - Clopidogrel (Plavix) 75 mg PO, QD
  - IIb/IIIa receptor antagonist (Integrilin)
  - Ticlopidine (Ticlid) 500 mg PO, QD



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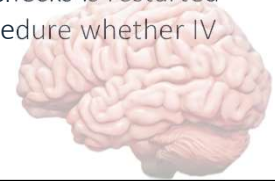
### Comparison of Warfarin & Aspirin for the Prevention of Recurrent Ischemic Stroke



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### ACUTE ENDOVASCULAR INTERVENTION

- Mechanical Thrombectomy (MT) for AIS patients with LVO
- Informed consent is needed
- Time frame to begin the start of the procedure is within 24 hours from LKW
- After an endovascular intervention, the schedule for frequent neurological and vital sign checks is restarted from the time of the end of the procedure whether IV thrombolytic had been given or not



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### Endovascular Therapy

#### 2019 Clinical Practice Guidelines (CPGs)

- Evidence of a large vessel occlusion (LVO): CTA/CTP
- NIHSS score  $\geq$  than 6
- ASPECTS score  $\geq$  than 6
- Clinical exam, pre-morbid condition (mRS 0-2)
  - Adequate life expectancy
- Collateral blood flow imaging
- LKN within the last 6 hours
- Patient may or may not have received IV fibrinolytic
- DEFUSE3 and DAWN Trails extended eligibility from 6 hours to 24 hours for anterior circulation strokes
- Consent and 18 years or older
  - No upper age limit



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### MECHANICAL RETRIEVAL DEVICES

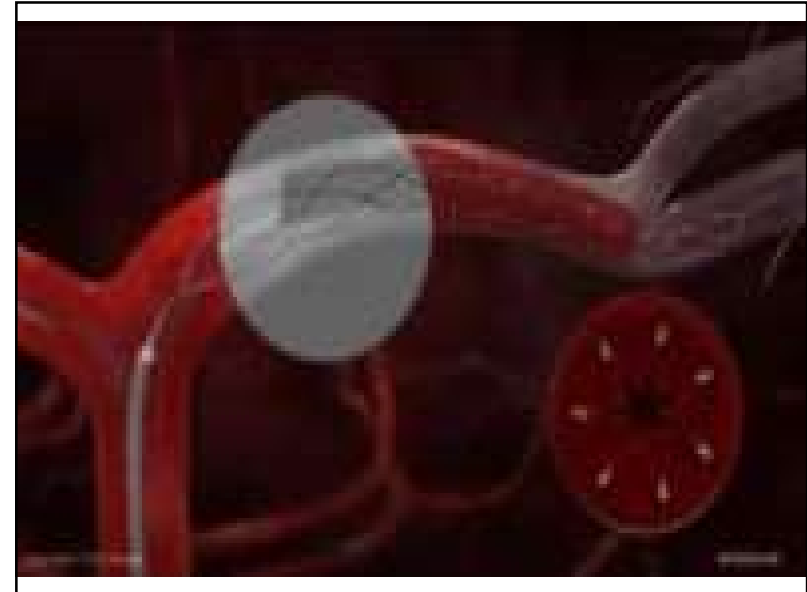


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## Penumbra system



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## Therapies NOT approved by the FDA

### • Intra-arterial t-PA

- Insert a femoral arterial line, insert catheter into thrombus and deliver t-PA
- t-PA within **6 hrs** in anterior circulation
- t-PA within **12 hrs** in posterior circulation
- Adjunct therapy (Heparin, Integrilin)



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## REHABILITATION

- Strokes are **life-changing events** that can affect a person both physically and emotionally, **temporarily or permanently**. After a stroke, successful recovery will often involve specific rehabilitative activities such as:
- **Speech therapy** - to help with problems producing or understanding speech. Practice, relaxation and changing communication style, using gestures or different tones for example, all help
- **Physical therapy** - to help a person relearn movement and co-ordination. It is important to get out and about, even if it is difficult at first



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- **Occupational therapy** - to help a person to improve their ability to carry out routine daily activities, such as bathing, cooking, dressing, eating, reading and writing
- **Joining a support group** - to help with common mental health problems such as depression that can occur after a stroke. Many find it useful to share common experiences and exchange information
- **Support from friends and family** - to provide practical support and comfort. Letting friends and family know what can be done to help is very important.



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## Burden of Stroke in the US

- Affects 795,000 people annually
- First time Strokes 610,000
- Recurrent Strokes 185,000 (nearly 1:4)
- *Number one cause of Disability*
- Fifth leading cause of Death
- Occurs every 40 seconds
- Someone dies every 3-4 minutes
- 80% of Strokes are preventable



AHA Heart and Stroke Statistical Update 2020

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# STROKE

A stroke aka. cerebrovascular attack is the loss of brain function due to a disturbance in the blood supply to the brain.

Stroke is the fourth leading cause of death in the United States.

On average, one American dies from stroke every 4 minutes.

Stroke is a leading cause of serious long-term disability.

In 2009, 34% of people hospitalized for stroke were younger than 65 years.

Stroke kills almost 130,000 Americans each year (1 out of every 19 deaths).

### Ischemic stroke

— blood supply to part of the brain is decreased, leading to dysfunction of the brain tissue in that area. There are four reasons why this might happen:

1. Thrombosis (obstruction of a blood vessel by a blood clot forming locally)
2. Embolism (obstruction due to an embolus from elsewhere in the body; see below)
3. Systemic hypoperfusion (general decrease in blood supply, e.g., in shock)
4. Venous thrombosis.

About 87% of all strokes are ischemic strokes.

### Hemorrhagic stroke

Intracranial hemorrhage is the accumulation of blood anywhere within the skull vault. A distinction is made between intra-axial hemorrhage (blood inside the brain) and extra-axial hemorrhage (blood inside the skull but outside the brain).

### Risk Reduction Tips:

- \*Eating a healthy diet.
- \*Maintaining a healthy weight.
- \*Getting enough exercise.
- \*Not smoking.
- \*Limiting alcohol use.
- \*Check Cholesterol
- \*Control Blood Pressure
- \*Manage Diabetes
- \*Manage Heart Disease
- \*Take Your Medicine
- \*Talk with Your Health Care Team

### Major Risk Factors:

- \*high blood pressure
- \*smoking
- \*high cholesterol

### Top Foods Thought To Help Prevent Stroke

|              |         |        |            |              |
|--------------|---------|--------|------------|--------------|
|              |         |        |            |              |
| Oats         | Almonds | Soy    | Strawberry | Low Fat Milk |
|              |         |        |            |              |
| Blackberries | Banana  | Barley | Cornmeal   | Salmon       |

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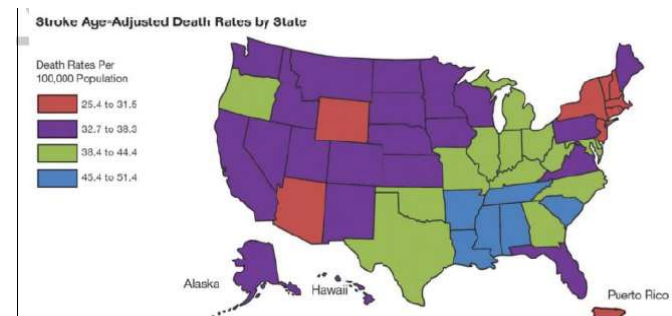
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## Stroke 2020

- Stroke prevalence in adults is 3.0% (median) in the US, with the lowest prevalence in Wisconsin (1.9%) and the highest prevalence in **Arkansas (4.5%)**.



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## PREVENTION

The best way to prevent a stroke is to address the underlying causes. This is best done by living healthily, which means:

- Eating a healthy diet
- Maintaining a healthy weight
- Exercise regularly
- Not smoking
- Avoiding alcohol or moderating consumption.



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Other measures taken to help reduce the risk of stroke include:

- Keeping blood pressure under control
- Managing diabetes well
- Treating obstructive sleep apnea (if present).
- As well as these lifestyle changes, a health care provider can help to reduce the risk of future strokes through prescribing anti-coagulant and anti-platelet medication. In addition to this, the arterial surgery previously mentioned can also be used to lower the risk of repeat strokes.



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Tenecteplase has gained favor over alteplase among some stroke centers for what reason?

- It simplifies and expedites transfer to higher level of care
- It has demonstrated no side effects or complications
- It is more cost-effective due to saving the cost of tubing and intravenous (IV) pump
- It is reimbursed at twice the amount of alteplase

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In reviewing a patient's progress notes, the nurse knows that they must have had a CT angiogram (CTA) by which statement?

- Evidence of uncal herniation
- Evidence of hemorrhage in left basal ganglia
- Evidence of hypodensity involving 40% of the right frontal lobe
- Evidence of 70% stenosis distal left internal carotid

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For community members with a family history of atrial fibrillation, what advice should be included regarding self-assessment?

- A. The value of purchasing a blood pressure (BP) cuff to monitor for hypotension
- B. Demonstration of radial pulse assessment for rate and rhythm regularity
- C. Deep breathing strategies to regulate heart rhythm
- D. YouTube instructions for monitoring for palpitations and dyspnea

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## It's a New Normal!

- Maintain and sustain a healthy lifestyle
- Strive to attain maximum functional ability
- Adapt to a new lifestyle
- Learn ways to maintain optimal health and wellness

### A lifelong dynamic plan



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QUESTIONS?

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## References

- [www.aann.org](http://www.aann.org)
- [www.aacn.org](http://www.aacn.org)
- [www.americanheart.org](http://www.americanheart.org)
- [www.americanstroke.org](http://www.americanstroke.org)
- <http://www.cdc.gov/stroke/faqs.htm>
- Sacco, R.L, et al, Guidelines for Prevention of Stroke in Patients with Ischemic Stroke or Transient Ischemic Attack, A Statement for Healthcare Professionals From the American Heart Association/American Stroke Association Council on Stroke, Co-Sponsored by the Council on Cardiovascular Radiology and Intervention. Stroke, 577-617, downloaded [www.strokeaha.org](http://www.strokeaha.org)

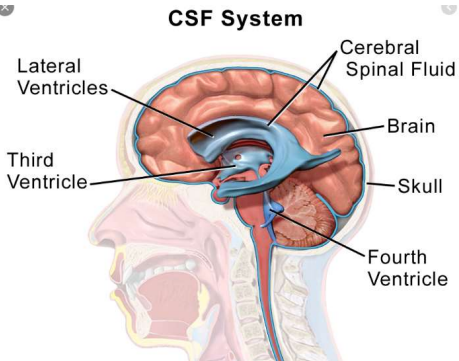


92

- Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, Biller J, Brown M, Demaerschalk BM, Hoh B, Jauch EC, Kidwell CS, Leslie-Mazwi TM, Ovbiagele B, Scott PA, Sheth KN, Southerland AM, Summers DV, Tirschwell DL; on behalf of the American Heart Association Stroke Council. [Guidelines for the early management of patients with acute ischemic stroke: 2019 update to the 2018 guidelines for the early management of acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association](#) [published online ahead of print October 30, 2019]. *Stroke*. doi: 10.1161/STR.0000000000000211.
- Stroke: Causes, Symptoms, Diagnosis and Treatment. Available at <http://www.medicalnewstoday.com/articles/7624.php?page=3>
- <https://www.cdc.gov/>
- National stroke association  
Available at: [www.stroke.org](http://www.stroke.org)  
➤ [http://www.who.int/topics/cerebrovascular\\_accident/en/](http://www.who.int/topics/cerebrovascular_accident/en/)
- Stroke health center. Available at: [www.webmd.com/stroke](http://www.webmd.com/stroke)
- The global stroke burden by Sarah Song MD, MPH  
available at <https://worldneurologyonline.com/article/the-global-stroke-burden>



**CSF System**



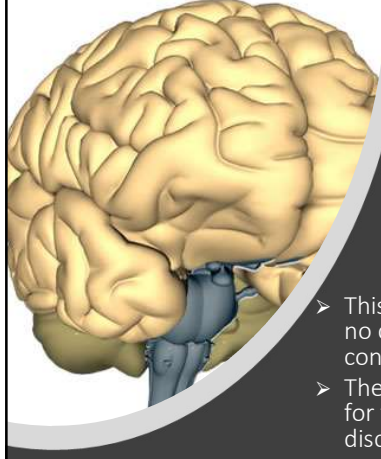
Lateral Ventricles  
Third Ventricle  
Cerebral Spinal Fluid  
Brain  
Skull  
Fourth Ventricle

Mary Jane Willard, PhD, MBA, MA, RN, CCRN, CNRN  
Reviewed and presented by:  
**Abel Quisquis, BSN, RN, CCRN**  
Central Arkansas Veterans Healthcare System  
Little Rock Critical Care Program Basic Critical Care Class

**Increased Intracranial Pressure**

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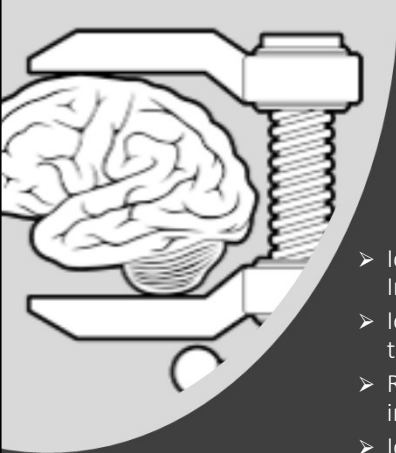
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- Participants must attend entire event and complete evaluation to be awarded CE.

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**Objectives**

- Identify different causes of Increased ICP
- Identify different medical treatments to decrease ICP
- Recognize appropriate nursing interventions to decrease ICP
- Identify, prevent, and treat secondary injuries and avoid adverse effects.

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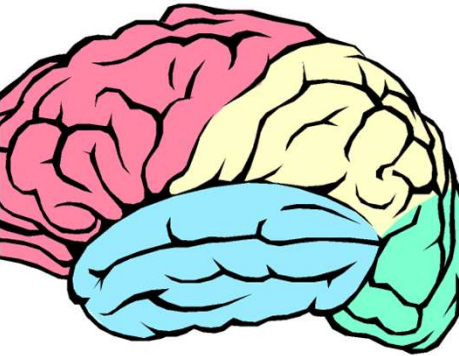
**Skull/Cranial Vault**

- Non-compressible and is filled with essential components.
  - Brain Tissue
  - Blood Volume
  - Cerebral Spinal Fluid



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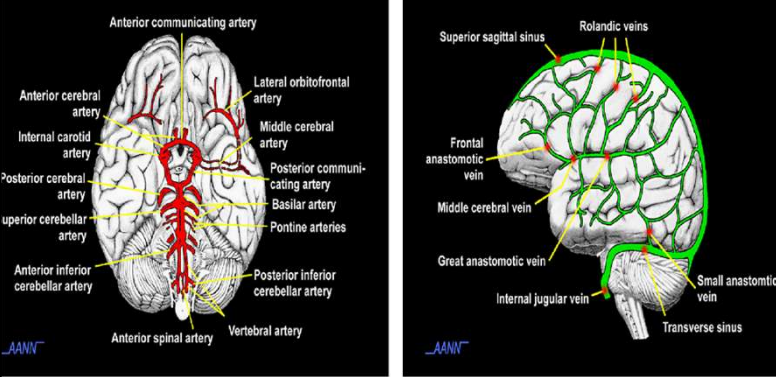


Brain Tissue (80%)

- Neurons & Glial Cells-which make up the white/gray matter
- Consumes 20% - 25% of the total body energy expenditure.
- Limited ability to store fuel (oxygen, glucose)

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Intravascular Blood (10%)

Capacity of Arteries, Veins, Venous Sinus, Capillary Bed

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Cerebral Spinal Fluid (CSF)

- 10%
- CSF - colorless, odorless fluid that fills the cerebral ventricle and arachnoid spaces
- Provide **cushion** for the central nervous system
- Approximately **150 ml** circulating in the adult (**25-30 ml/hr excreted**)
- Formed primarily in the choroid plexus of the lateral ventricles

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## Normal ICP

5-15 mm Hg

Figure 8. Anatomical location of tragus



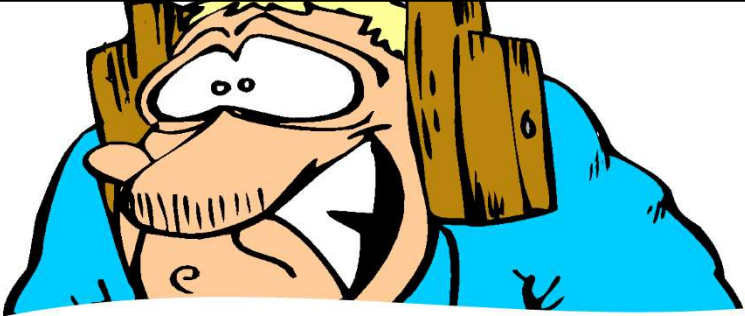
Figure 9. Transducer leveled with the tragus



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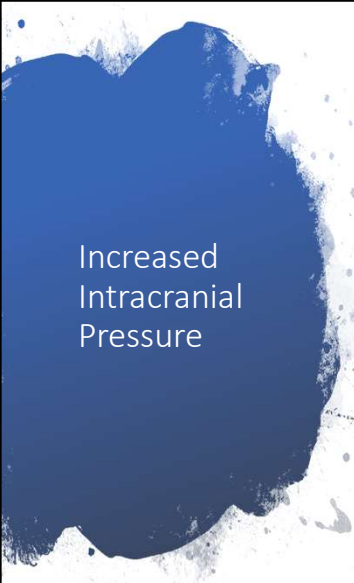


ICP Values

- Normal range: **5 -15 mm Hg**
- Moderate elevation: **15 - 40 mm Hg**
- Greater than 40 mm Hg - markedly elevated
- **40 - 50 mm Hg** - Ischemic
- Greater than **50** - Irreversible (**Infarct**)

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Increased Intracranial Pressure

- Intracranial Pressure is the pressure exerted within the cranial cavity by its contents
  - Brain, Blood, and CSF
- Transient increases in pressure are benign, sustained increases in ICP can be life-threatening (over 20 can be life threatening).

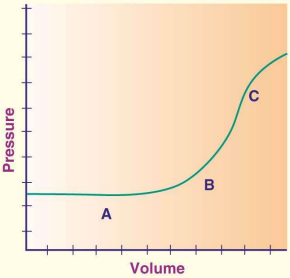
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**Monroe-Kellie Hypothesis**

ICV = H<sub>2</sub>O + CSF + CBV

ICV = Intracranial volume  
 H<sub>2</sub>O = Water in the cells/tissues = 80%  
 CSF = Cerebrospinal fluid = 10%  
 CBV = Cerebral blood volume = 10%



Compliance Curve

Pressure

Volume

A = Flat portion of compliance curve  
 B = Upward/Ascending portion of curve  
 C = Steep portion of curve

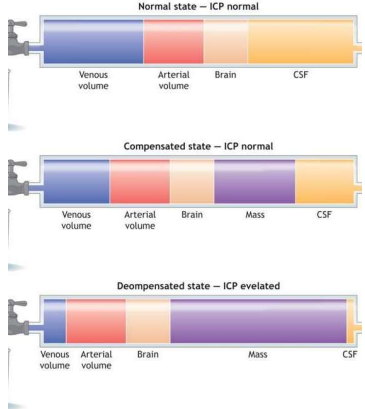
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**Monro-Kellie Hypothesis**

- If volume of one constituent of intracranial cavity increases, a reciprocal decrease in volume of one or both of the others must occur or an overall increase in ICP will result.



Normal state — ICP normal

Compensated state — ICP normal

Decompensated state — ICP elevated

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Which of the following is an accurate restatement of the Monro-Kellie hypothesis?

- If one of the three intracranial volumes goes down, one of the other two intracranial volumes will go up to prevent a decrease in intracranial pressure (ICP).
- If one of the three intracranial volumes goes up, one of the other two intracranial volumes will go down to prevent an increase in ICP.
- If one of the three intracranial volumes goes up, there will be a resultant vasoconstriction to normalize blood flow.
- If one of the three intracranial volumes goes down, there will be a resultant vasodilation to normalize blood flow.

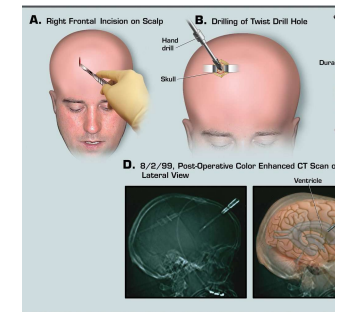
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## Common Causes of Increased ICP

- Space occupying lesions, brain tumor, abscess
- Hemorrhage, epidural & subdural hematoma
- Trauma, infarction, HTN, Hydrocephalus



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## Common Causes of Increased ICP

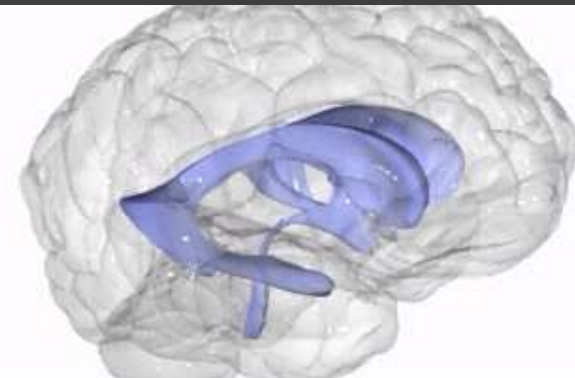
Metabolic disorders & diffuse lesions such as the following:

- Infections (Meningitis, Encephalitis, Ventriculitis, Intracranial abscess)
- Diseases of other organs
- Ingested or accumulated toxins
- Drugs
- Electrolyte imbalances
- Concussion
- Hypoglycemia
- Anoxia
- Ischemia
- Encephalopathy

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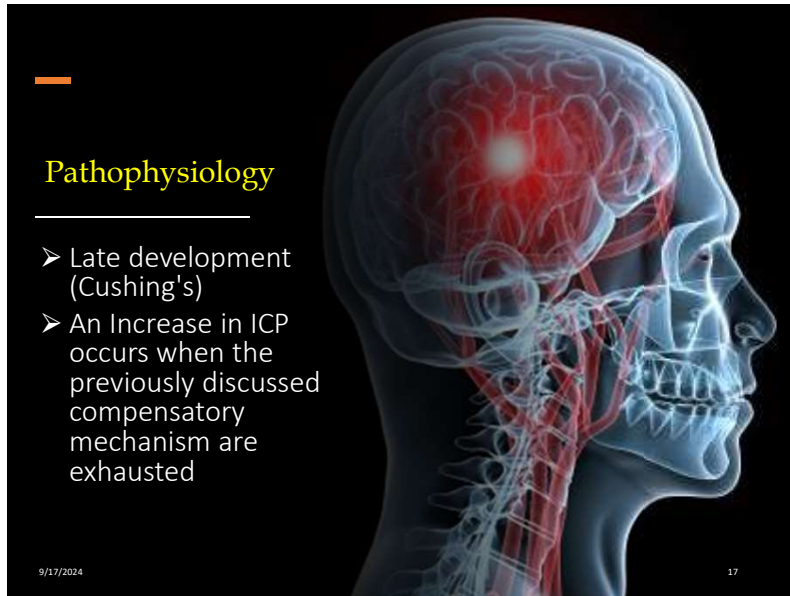
### Volume-Pressure Relationship within the Intracranial Cavity

- Displacement of some CSF (from Intracranial space to subarachnoid space)
- Compression of the low-pressure venous system
- Decreased production of CSF
- Vasoconstriction (increased RR)
- Increased absorption of CSF

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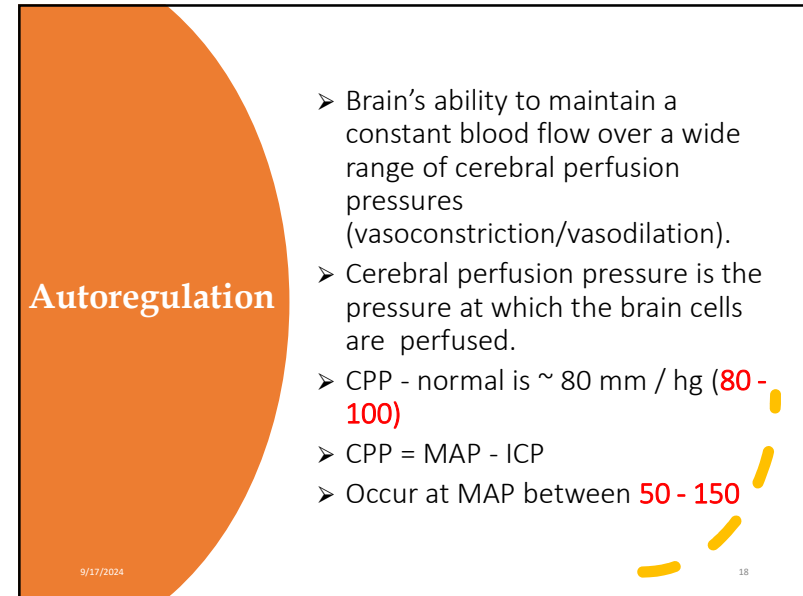
## Pathophysiology

- Late development (Cushing's)
- An Increase in ICP occurs when the previously discussed compensatory mechanism are exhausted

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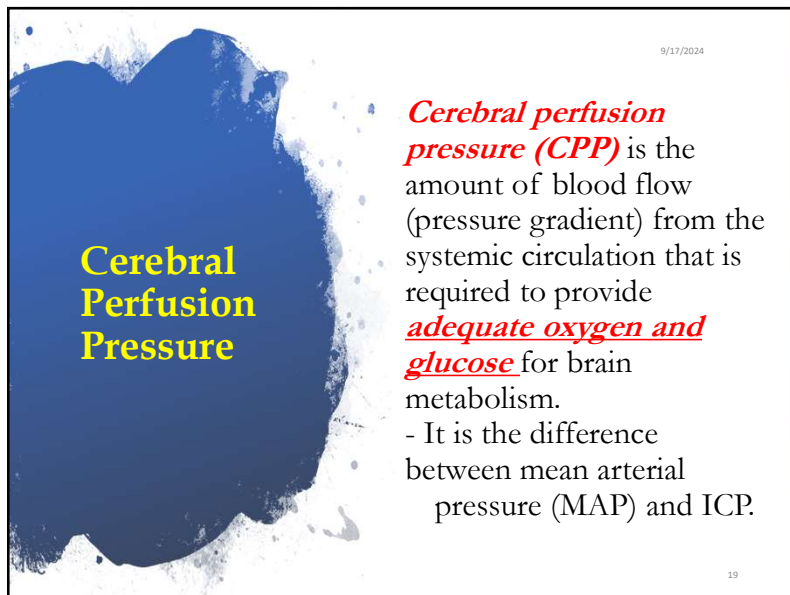
## Autoregulation

- Brain's ability to maintain a constant blood flow over a wide range of cerebral perfusion pressures (vasoconstriction/vasodilation).
- Cerebral perfusion pressure is the pressure at which the brain cells are perfused.
- CPP - normal is ~ 80 mm / hg (80 - 100)
- $CPP = MAP - ICP$
- Occur at MAP between 50 - 150

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## Cerebral Perfusion Pressure

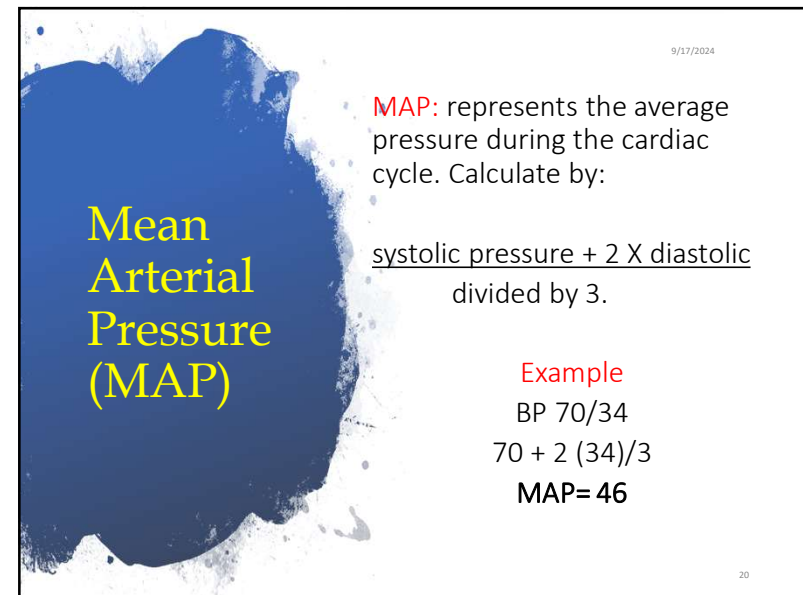
**Cerebral perfusion pressure (CPP)** is the amount of blood flow (pressure gradient) from the systemic circulation that is required to provide adequate oxygen and glucose for brain metabolism.

- It is the difference between mean arterial pressure (MAP) and ICP.

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## Mean Arterial Pressure (MAP)

**MAP:** represents the average pressure during the cardiac cycle. Calculate by:

$\frac{\text{systolic pressure} + 2 \times \text{diastolic}}{3}$

**Example**

BP 70/34

$70 + 2 (34)/3$

**MAP= 46**

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## Mean Arterial Pressure

- MAP < 50
  - Passive increase in CBF
  - Decreased cerebral perfusion pressure
  - Hypoxia
  - Vascular Collapse
  - Cell Death
- MAP > 150
  - Increased cerebral blood flow
  - Disruption of the blood brain barrier
  - Progressive cerebral edema
  - Petechial bleeding

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## Autoregulation

- Autoregulation can be mechanical (BP) or chemical (PaCO<sub>2</sub>, PaO<sub>2</sub>, Ph).
1. Hypotension causes vasodilation
  2. Hypertension causes vasoconstriction
  3. PaCO<sub>2</sub> is a potent vasodilator
  4. Hypoxia/acidosis causes vasodilation

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To maintain autoregulation, the cerebral perfusion pressure (CPP) must be maintained above which level?

- a. 150 mm Hg
- b. 100 mm Hg
- c. 50 mm Hg
- d. 30 mm Hg

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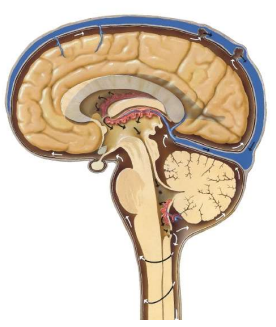
A patient with which of the following sets of mean arterial pressure (MAP) and intracranial pressure (ICP) would have impairment in autoregulation?

- a. MAP 70 mm Hg; ICP 10 mm Hg
- b. MAP 80 mm Hg; ICP 20 mm Hg
- c. MAP 75 mm Hg; ICP 30 mm Hg
- d. MAP 100 mm Hg; ICP 15 mm Hg

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Circulation of Cerebrospinal Fluid



Factors that influence the ability to compensate

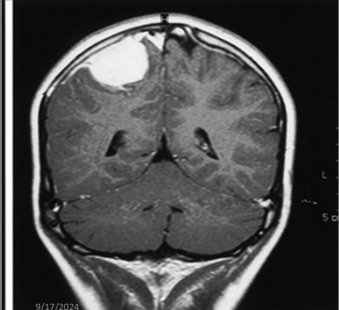
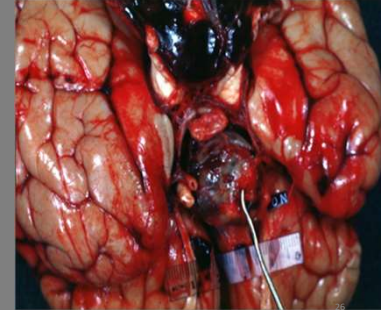
- Lesion location
- Rate of expansion (subdural/epidural)
- Impaired CSF drainage (hydrocephalus)

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Which is typically worse and requires immediate intervention?

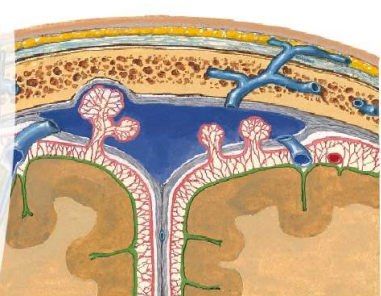
**Meningioma**      **Ruptured Cerebral Aneurysm**

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Meninges and Superficial Cerebral Veins  
Frontal Section

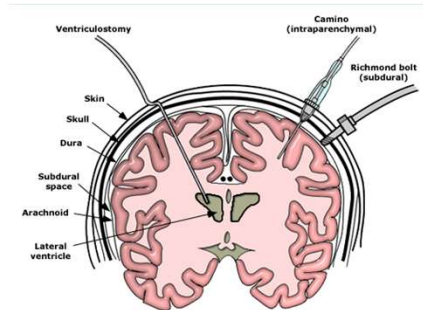


**CSF Reabsorption**

- Is reabsorbed constantly into the body's venous system
- Passes from the arachnoid villi into the venous sinuses into the venous system

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Ventriculostomy allows both ICP monitoring and therapeutic drainage of cerebrospinal fluid (CSF). Subdural and intraparenchymal monitors cannot be used to drain CSF.

**Cerebral Blood Volume**

- The amount of blood in the brain at a given time.
- $CBF = MAP - CVP$

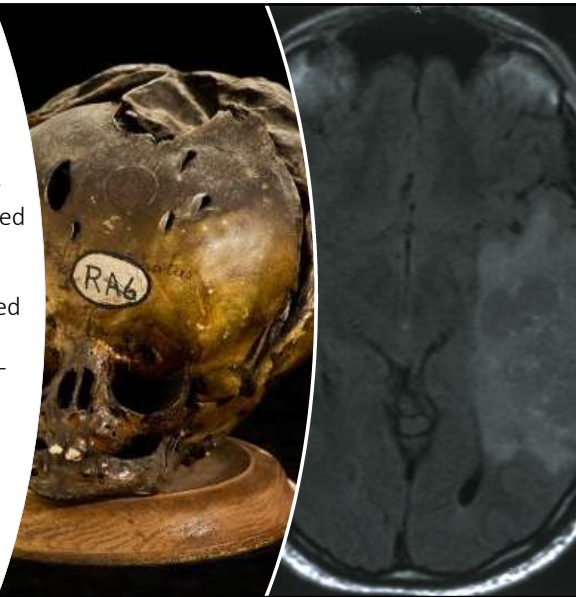
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### Reasons for Increased Volume

- Edema—increased interstitial fluid volume
- Tumor—increased tissue volume
- Hydrocephalus—increased CSF volume
- Hemorrhage, vasodilation—increased blood volume

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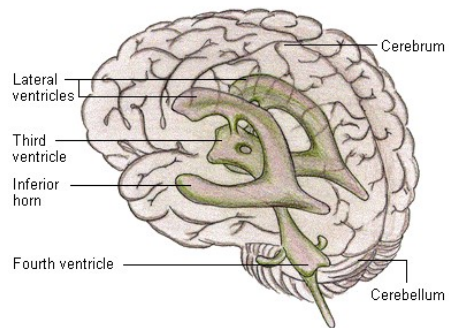
### Factors that Modify CBF

- Blood Pressure (main force that maintains cerebral circulation)
- Cardiac Function (BP, CO)
- Blood Viscosity (Anemia may increase blood flow up to 30%, Polycythemia may decrease blood flow by more than 50%)

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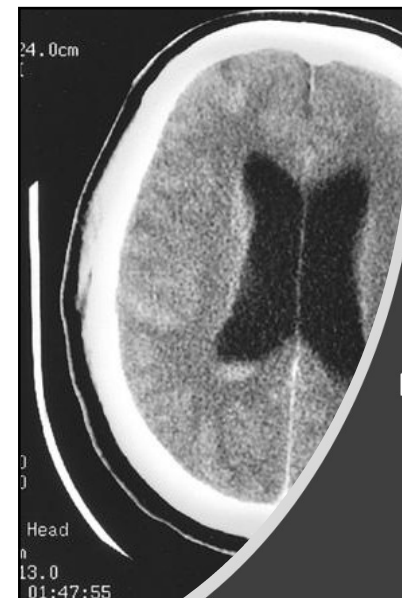
How does the body compensate for changes in ICP?

1. Compliance
2. Reduce Blood Volume
3. Herniation

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### Compliance

Displacement of CSF into the spinal canal

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## Decrease Blood Volume

Reduction of blood volume in the brain. This stage of compensation alters cerebral metabolism, eventually leading to brain tissue hypoxia and areas of ischemia.

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## Herniation with an Epidural Hematoma

Herniation - displacement of brain tissue. Most **lethal** stage of compensation. Process often results in death from brain stem compression.

**Always an emergency!**

## Herniation

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## Hypercapnia & Hypoxia

- Any systemic process that affects blood levels of carbon dioxide will affect CBF, CPP and CBV. Therefore, conditions that produce hypercapnia and hypoxemia will result in cerebral vasodilatation, increased blood volume, and increased ICP.
- These conditions include respiratory inadequacy, poor ventilation, hyperventilation, drugs, and inadequate amounts of oxygen.

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## Manifestations of Increasing Intracranial Pressure

*Manifestations include any alteration in level of consciousness (restlessness, irritability, confusion) and a decrease in Glasgow Coma Scale (GCS).*

- Any process that results in increased ICP will produce impairment of content and arousal. Clinical manifestations of increased ICP are subtle!!!

*Diligent observation for changes in client's condition.*

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## In addition, may have:

- |                                  |                                     |
|----------------------------------|-------------------------------------|
| Decreased level of consciousness | Change in sensorimotor status       |
| Behavioral changes               | Blurred or double vision (diplopia) |
| Headache                         | Changes in cardiac rate & rhythm    |
| Nausea & Vomiting                | Ataxia                              |
| Change in speech pattern         | Seizures                            |
| Abnormal pupillary reactions     | Cushing's triad                     |
| Changes in body temperature      | Abnormal posturing                  |

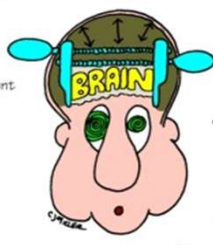
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## Signs & Symptoms of ↑ ICP

### INCREASED INTRACRANIAL PRESSURE

- 
- Changes in LOC
  - Eyes
    - Papilledema
    - Pupillary Changes
    - Impaired Eye Movement
  - Posturing
    - Decerebrate
    - Decorticate
    - Flaccid
  - Decreased Motor Function
    - Change in Motor Ability
    - Posturing
  - Headache
  - Seizures
    - Impaired Sensory & Motor Function
  - Changes in Vital Signs:
    - Cushing's Triad:
      - ↑ Systolic B/P
      - ↓ Pulse
      - Altered Resp Pattern
  - Vomiting
  - Changes in Speech
  - Infants:
    - Bulging Fontanels
    - Cranial Suture Separation
    - ↑ Head Circumference
    - High Pitched Cry

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## Cushing's Triad

- Widening pulse pressure, Increased BP
- Bradycardia
- Changes in Respirations (irregular)

*Cushing's triad indicates increased severe ICP (Late Sign)*

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### Emergency care includes:

- Airway maintenance, intubation with oxygenation ( $PO_2 > 90$  mm Hg), hyperventilation.
- Osmotic diuretics (mannitol IV)
- Steroids (dexamethasone IV) (brain tumors)
- Vasoactive medication (100-150 mmHg systolic)
- Elevate HOB (30 degrees)
- Sedate prn (midazolam IV)
- Drain CSF (keep ICP < 20)
  - Maintain fluid status (normal serum Na & osmolality)

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## Nursing Management in Controlling ICP

Elevate HOB

Monitor vital signs & maintain body temp

Maintain head & neck in neutral alignment

Prevent Valsalva maneuver

Administer prescribed meds to reduce ICP

Maintain fluid balance with 0.5% NaCl solution

Avoid noxious stimuli

Administer sedation to reduce metabolic demand

Maintain cerebral perfusion pressure >70mmHg

Serum Na levels should be elevated (may treat with 3% IV infusion or 23% IVPB)

Serum OSM may be elevated (may treat with mannitol 20% IVPB or 25% IVP)

Barbiturate coma with burst suppression (pentobarbital)

Surgery (craniotomy and/or decompressive craniectomy)

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A patient is admitted with subarachnoid hemorrhage. In order to maximize venous return and reduce intracranial pressure (ICP), the patient should be positioned:

- flat with a pillow.
- prone with the head turned to the side.
- with the head of the bed elevated 30 degrees.
- in high Fowler's with the knees raised.

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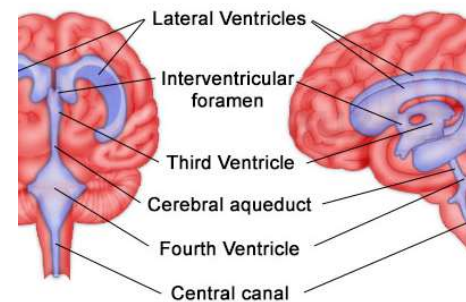
Which of the following can increase intracranial pressure?

- Hypoxia
- Hypocapnia
- Hypokalemia
- Dehydration

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## Ventricles of the Brain

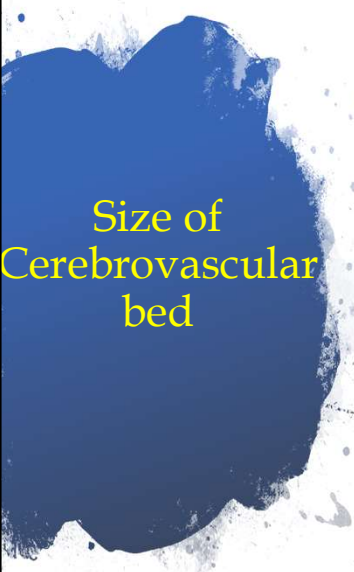


Ventricular System

- Composed of 4 cavities containing CSF
- Lateral ventricles – largest of the ventricles
- Third Ventricle – midline between the lateral ventricles
- Fourth – lies in the posterior fossa and is continuous with the aqueduct of Sylvia

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Size of Cerebrovascular bed

- Autoregulation is possible because there is a mechanism present in cerebral arterioles that causes vasoconstriction when the arterial pressure rises and vasodilation when it falls.
- Increase in PaCO<sub>2</sub> causes vasodilation
- Decrease in PaCO<sub>2</sub> causes vasoconstriction

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### Hydrocephalus Following SAH

- **Acute**
  - Usually within 24 hours of the bleed
  - Abrupt onset of coma
- **Subacute**
  - Develops a few days to a week after SAH
  - Usually a gradual and steady decline in consciousness
  - Headache, incontinence, nausea and vomiting
  - Loss of upward gaze ability
- **Chronic**
  - 10 or more days after SAH
  - Gradual onset
  - Impaired cognition, gait

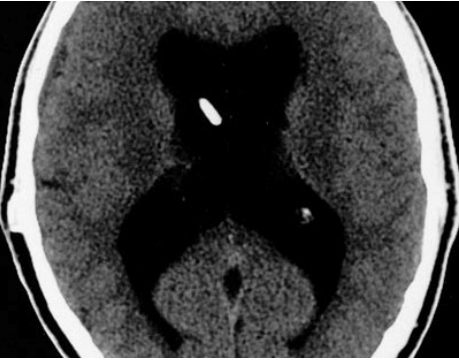
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Hydrocephalus (Causes)

- Obstruction of the CSF pathways (non-communicating)
- Deficient CSF absorption from the SA space – meningitis (communicating)
- Overproduction of CSF (rare in adults)

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## Diagnosis

- Patient presenting sign, symptoms & hx
- Diagnostic studies
- ICP monitoring
- Visual field testing
- CT scan – diffuse edema, shifts, bleeds
- Cerebral angiogram – vasospasms, tumors, stenosis, etc
- EEG

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## Late signs of Increased ICP

- Coma
- Apnea
- Unilateral pupil changes
- Hypertension
- Slow Pulse
- LOC changes are the most sensitive indicator of Increased Intracranial Pressure

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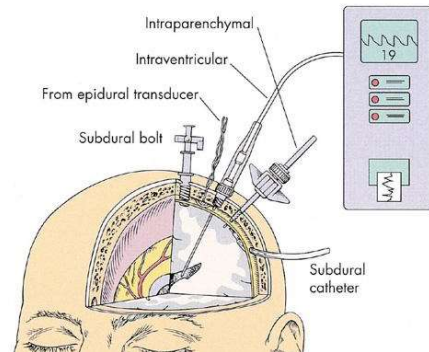
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## Indications for measuring ICP

- $GCS \leq 8$
- Closed Head Injury
- Cerebral Edema, TBI
- Deterioration of Neurological condition
- Extensive Surgical manipulation
- Hydrocephalus, SAH,
- Mass (Tumor)
- Infection (meningitis)

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## Purpose of ICP Monitoring

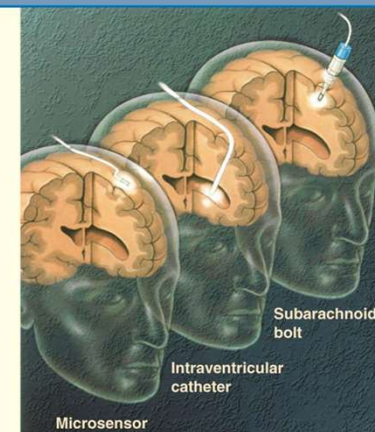
- Diagnosis of Increased ICP
- Monitor treatment of ICP
- Treat Increased ICP
- Monitor effect of nursing interventions

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## Intracranial Pressure Monitoring



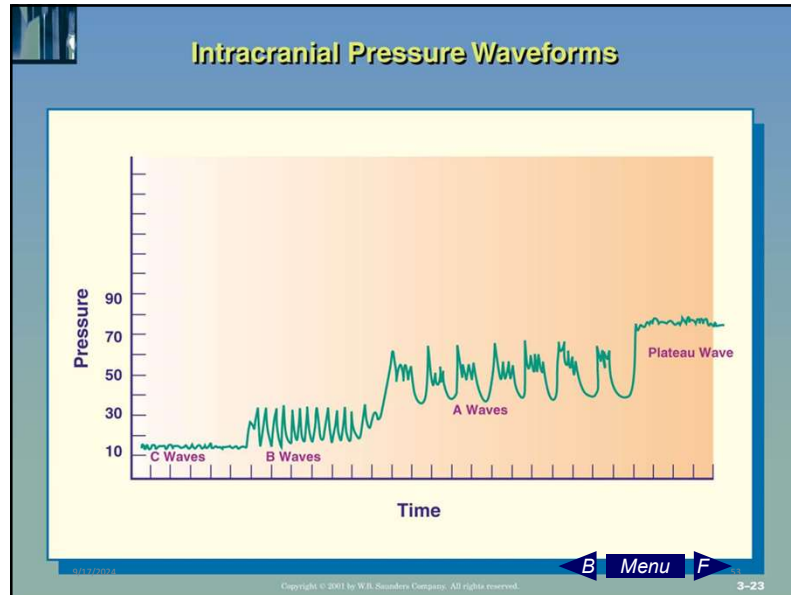
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## Monitoring Devices

- **Intraventricular Catheter** - inserted into lateral ventricle via a twist drill- connects to a fluid filled transducer with the transducer zero and leveled at the foramen of Monro (**tragus**) (EAM)
- **Subarachnoid Screw** - Hollow bolt inserted through a twist drill hole into the subarachnoid or subdural space - **fluid filled transducer**
- **Epidural Sensor**-inserted in the epidural space beneath the skin above the Dura via burr hole
- **Subdural Catheter**- inserted into the subdural space (**does not drain CSF**)

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### Intraventricular Catheter

- Advantages
  - Ability to measure CSF directly - **most accurate**
  - Access for CSF drainage therapeutically
  - Decrease intracranial volume
  - Access to administer intrathecal medications

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### Intraventricular Catheter

- **Disadvantages**
  - Difficulty locating the lateral Ventricle
  - Risk of bleeding and edema formation
  - Risk of ventricular collapse
  - Risk of infection
  - Risk of ventricular air entry
  - Dampened recording due to compression of cannula
  - Recalibrate with change in head position
  - May develop CSF leak
  - Catheter occlusion (brain tissue)

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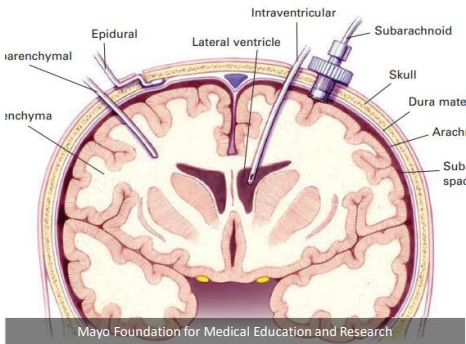
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**Which of the following descriptions about intracranial pressure (ICP) monitoring systems is incorrect?**

- Intermittent flush devices are not used.
- Heparin is not added to the solution used to prime the tubing.
- Only preservative-free saline is used to prime the tubing.
- The transducer is leveled to the phlebostatic axis.

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**Intraparenchymal Catheter**

**Advantages (Subdural or subarachnoid bolt)**

- Useful with small distorted ventricles
- Quick and easy to insert
- Catheter is placed in Subarachnoid space via burr hole in the frontal lobe (dura entered)
- No disruption of brain parenchyma
- Accurate readings

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**Intraparenchymal Catheter Subdural / Subarachnoid Bolt**

➤ Disadvantages

- Unable to withdraw CSF (treat or diagnosis)
- Risk of CSF infection / CSF leak
- Unreliable with high ICP
- Risk for infection
- Risk for brain injury - hematoma
- Recalibrate with change in head position

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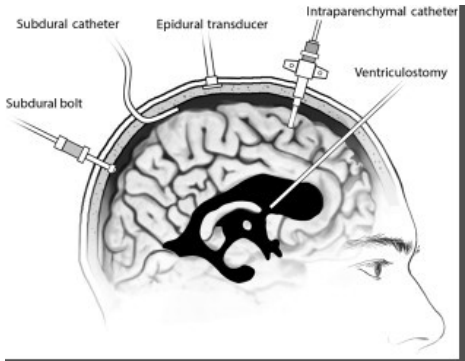
**Epidural Sensor**

**Advantages**

- Easy and safe to insert
- Less risk of infection
- Less risk of brain tissue damage

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**Epidural Sensor**

**Disadvantages**

- Most unreliable - pressure is not measured directly but is measured by a fiberoptic sensor placed in the epidural space
- May produce a wedge effect
- Cannot obtain or drain CSF for diagnosis or treatment

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**Report to Physician**

- ICP > 20
- CPP < 70
- Signs of infection at insertion site
- CSF leak around insertion site
- Appearance of new blood in CSF drainage
- CSF drainage > 500/24 hrs

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**Medical Management**

- **Drug Therapy**
  - Osmotic diuretics
  - Glucocorticoids (tumor)
  - Anticonvulsant
- **Supportive Therapy**
  - Hob 30 - 40
  - Hyperventilation - mechanical ventilation (acutely)
  - Surgery - burr hole drain, decompression, craniotomy

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**Mannitol (Osmitol)**

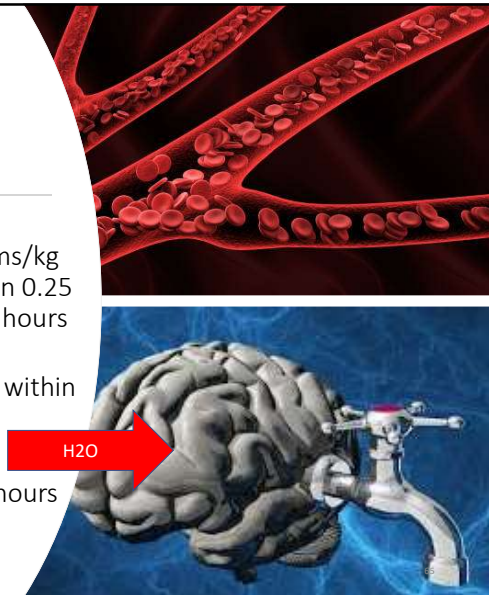
- An electrolyte and osmotic diuretic
- Promote diuresis in acute phase of renal failure, severe trauma, or surgery
- Reduce Acute increases in Intracranial pressure (ICP)



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## Mannitol (Osmitol)

- For ICP: 0.5-1.0 grams/kg over 15 minutes then 0.25 – 0.50 grams/kg q 4 hours
- Expect effect on ICP within 15 minutes
- Effects last about 4 hours



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## Mannitol (Osmitol)

- Adverse Effects: Headache, tremor, hypo/hypertension, Hypernatremia, acidosis, Rebound increase in ICP, **Toxic at 100-200 grams**
- Contraindications: Shock, Severe dehydration, Intracranial bleeding, Serum osmolality > 320 (normal 278-298)
- **Filter required**
  - Risk of crystallization

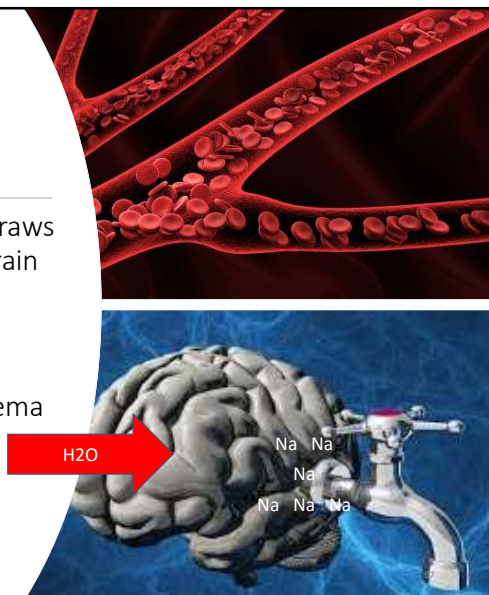


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## Hypertonic NaCL

- ❑ Hypertonic NaCL draws water out of the brain moving it to the bloodstream.
- ❑ Decreases ICP
- ❑ Decrease Brain Edema



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## Pentobarbital (Nembutal)

- Short acting barbiturate used as sedative, hypnotic, anticonvulsant
- Used following stroke, head injury to induce coma to reduce cerebral O2 demand and to treat refractory increased ICP, Refractory Status Epilepticus



This is a typical burst suppression pattern. This reflects severe diffuse cerebral dysfunction and is generally seen with comatose patients that are minimally reactive to stimuli. This pattern can be seen

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## Nursing Intervention



Maintain Patent Airway - LOC decreased



Monitor Fluid / Electrolytes - diuretics



Assess for decreased cerebral perfusion



Implement measures to avoid skin breakdown

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## F A - o s N c s e u e u s s r e s o d m e n t

- Early
- Decreased LOC
- Pupillary changes
- Visual disturbances
- Motor Weakness

- Later
- Coma
- Ipsilateral pupils
- Pupils nonreactive
- Motor weakness
- Posturing
- Hyperthermic
- Loss of brainstem reflexes

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## Diagnostic studies

- Arterial Blood Gas
- Complete blood Count
- Electrolyte Panel
- BUN /CR
- Osmolality
- CT scan

- Skull X rays
- MRI
- EEG
- Cerebral angio
- EKG

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## Hunt & Hess Classification of SAH

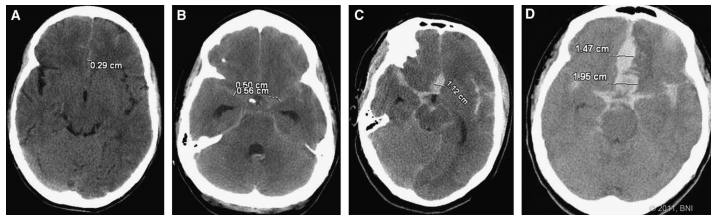
- **Grade I:** Asymptomatic, or mild headache, slight nuchal rigidity
- **Grade II:** Moderate to severe headache, nuchal rigidity, Cranial nerve palsy (3, 6)
- **Grade III:** Mild Focal deficit, lethargy, confusion
- **Grade IV:** Stupor, moderate to severe hemiparesis, early decerebrate, rigidity
- **Grade V:** Deep coma, decerebrate, rigidity moribund appearance
- **Grade O:** Unruptured Aneurysm
- **Grade 1a:** No acute meningeal or brain reaction but with significant fixed deficits

Hickey, J.V., Clinical Nursing Procedures, 10th ed, 2008, Lippincott Williams & Wilkins

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### Fisher Grading Scale

The Fisher Grading Scale is used to identify the amount of blood on the CT Scan and is a predictor of Vasospasm.

- I: No subarachnoid blood detected
- II: Diffuse or vertical layers < 1 mm thick
- III: Localized and/or vertical layers ≥ 1 mm thick
- IV: Intracerebral or intraventricular clot with diffuse or no SAH

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A 22-year-old woman had a craniotomy 5 days ago and has an intracranial pressure (ICP) catheter in place that was inserted during the craniotomy. Her temperature spikes to 39.4° C.

The most likely cause is:

- A. increased ICP.
- B. pressure on the hypothalamus.
- C. Infection.
- D. intracranial bleeding.

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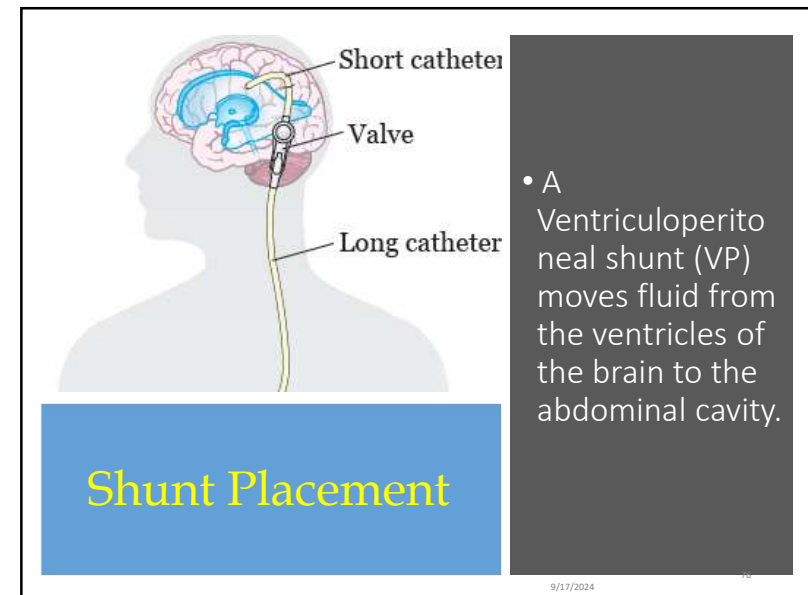
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A 32-year-old man is admitted with raccoon eyes. You notice clear fluid dripping from his nose. What would be an appropriate nursing intervention?

- A. Insert a nasogastric tube to prevent vomiting.
- B. Suction the nasopharynx as needed.
- C. Insert nasal packing until the physician arrives.
- D. Tape rolled sterile gauze under the nose.

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### Shunt Placement

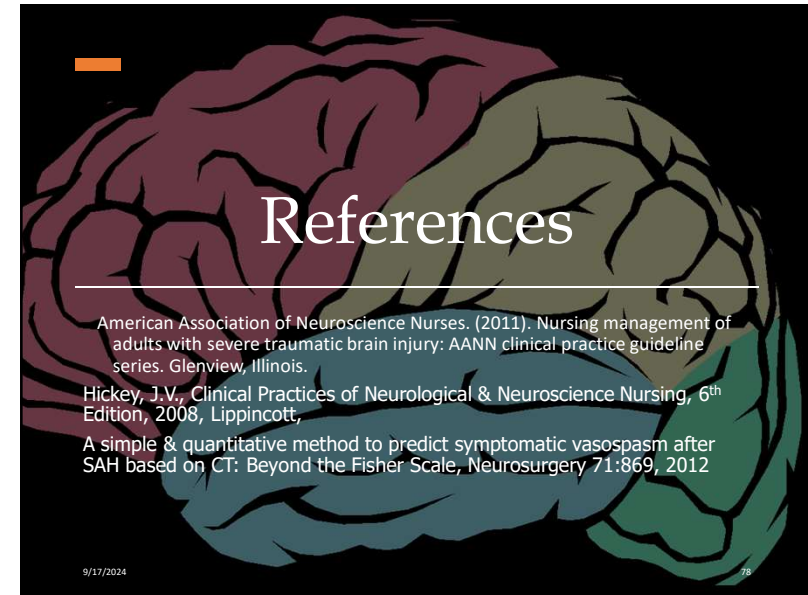
- A Ventriculoperitoneal shunt (VP) moves fluid from the ventricles of the brain to the abdominal cavity.

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