

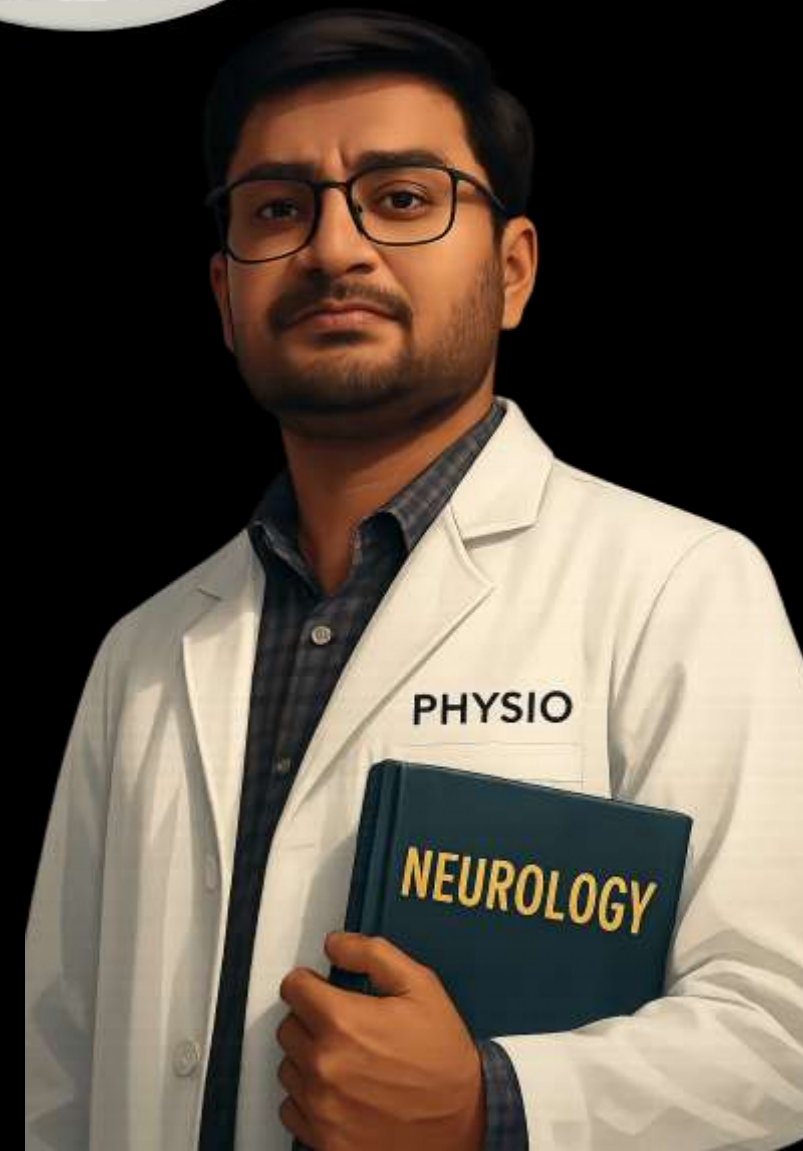


NEUROFLIX
X
PHYSIOCITY

PRESENTS

Stroke

Dr. Preetkumar Mehta (PT)



Ischemic (80% of strokes)

Interruption of blood flow depriving brain of O₂ and glucose.

Atherothrombotic: Clot forms locally on atherosclerotic plaque.

Embolic: Clot travels from heart/systemic circulation (linked to Atrial Fibrillation).

Systemic Hypoperfusion: Low global flow (cardiac failure) causing bilateral deficits.

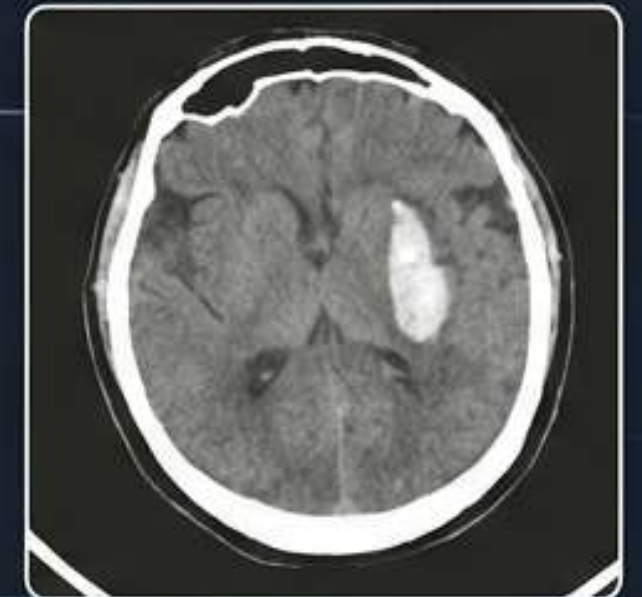


Hemorrhagic (~20% of strokes, higher mortality)

Rupture causing bleeding, increased intracranial pressure, and mass effect.

Intracerebral: Rupture of small vessels, strongly linked to chronic hypertension.

Subarachnoid: Rupture of large vessels, often from saccular (berry) aneurysms or Arteriovenous Malformations (AVMs).

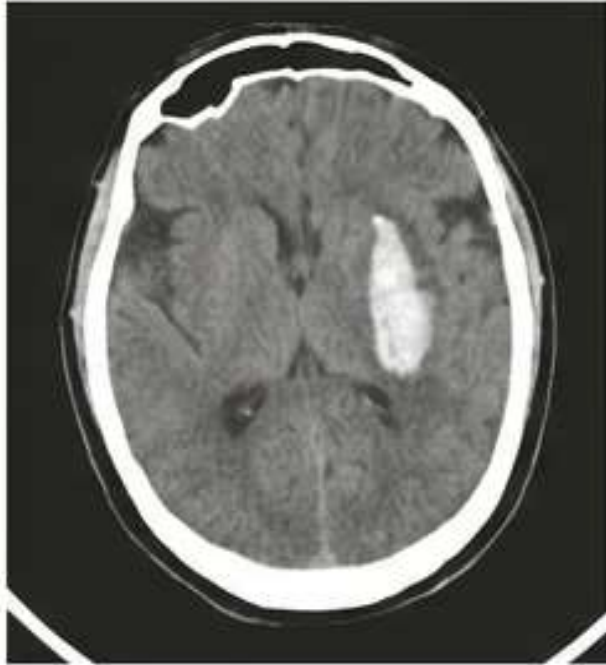


The Ischemic Cascade



Diagnostic Toolkit: Cerebrovascular Imaging Modalities

Computed Tomography (CT)



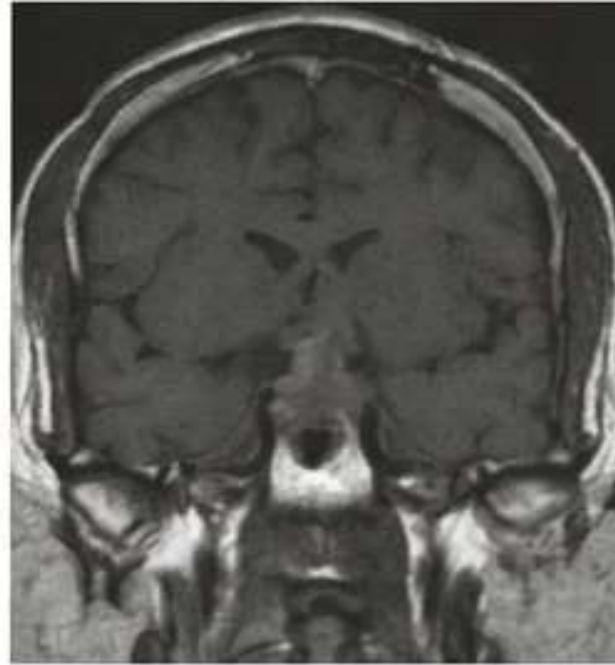
Primary Use:

The acute standard. Rapid differentiation between atherothrombotic and hemorrhagic stroke.

Detection Window:

Clearly identifies acute bleeding; highly insensitive to early ischemic small infarcts. Shows cerebral edema development within 3 days.

Magnetic Resonance Imaging (MRI)



Primary Use:

High-resolution structural detail.

Detection Window:

Diffusion/perfusion MRI detects cerebral ischemia as early as 30 minutes post-occlusion, and infarction within 2 to 6 hours.

Doppler Ultrasound & MRA



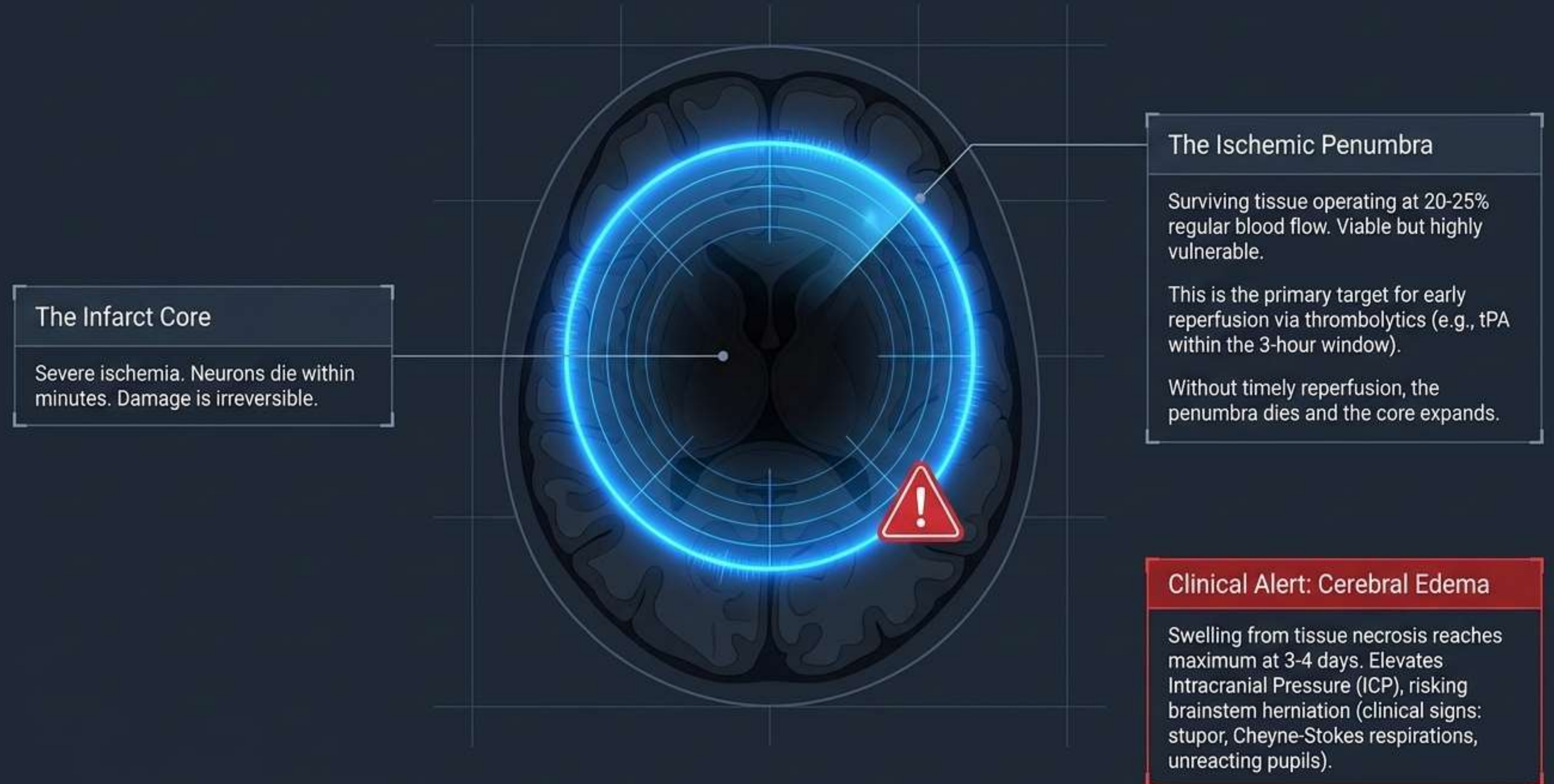
Primary Use:

Vascular mapping.

Detection Window:

Transcranial Doppler isolates posterior circulation. MRA creates software-rendered models of arterial stenosis or embolic occlusion.

Time is Brain: Core vs. Penumbra



Cortical Localization: The Processing Districts

Frontal Lobe:

Precentral gyrus (Motor control/Ms I), Premotor orientation, Prefrontal area (higher intelligence, inhibitory control, personality).

Parietal Lobe:

Postcentral gyrus (Sensory analysis/Sm I), integrating somatic information.

Occipital Lobe:

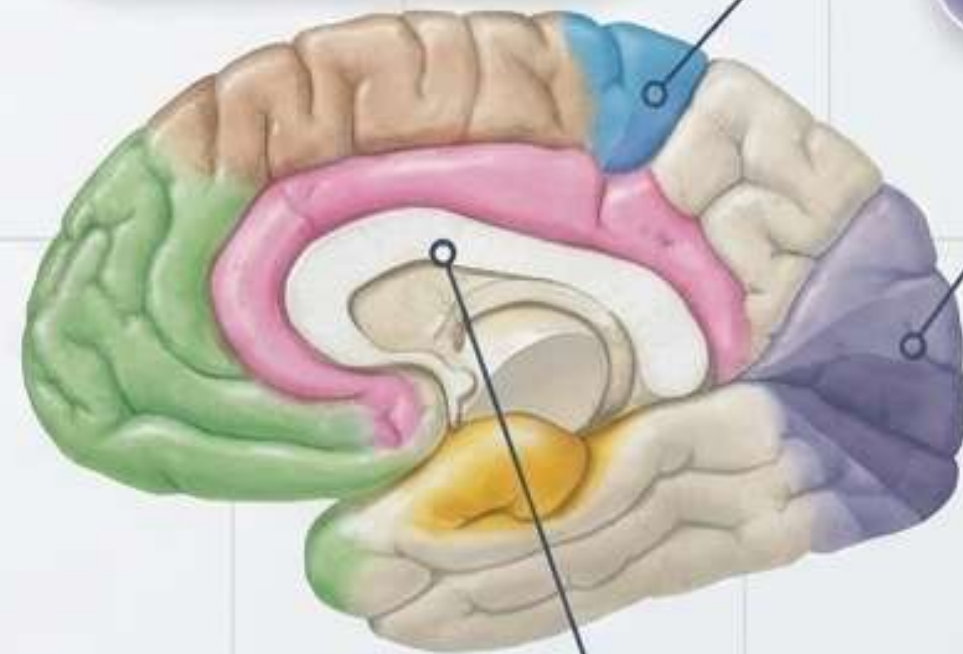
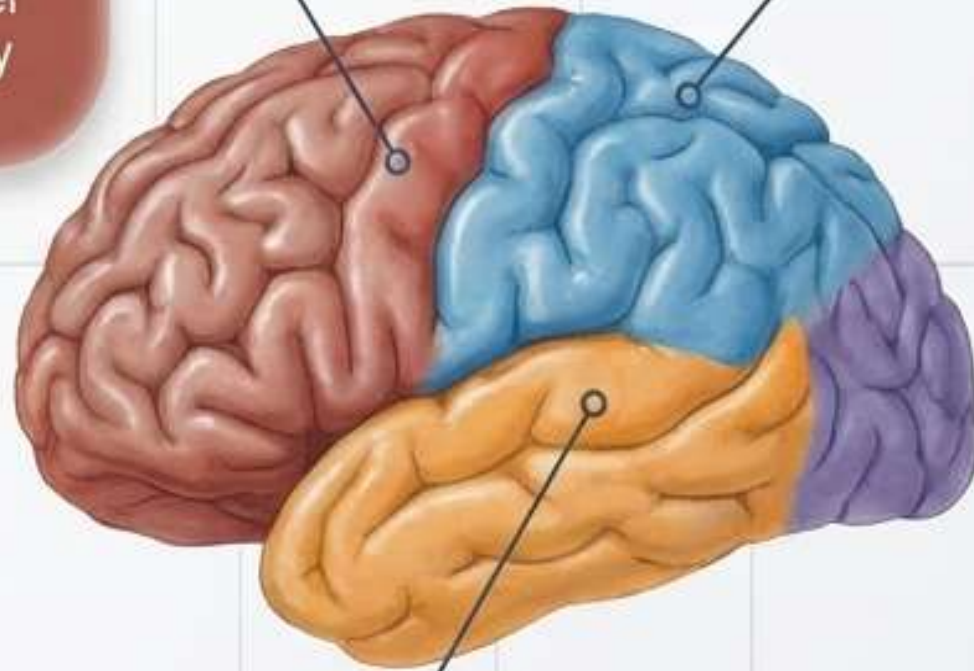
Visual areas I, II, and III.

Temporal Lobe:

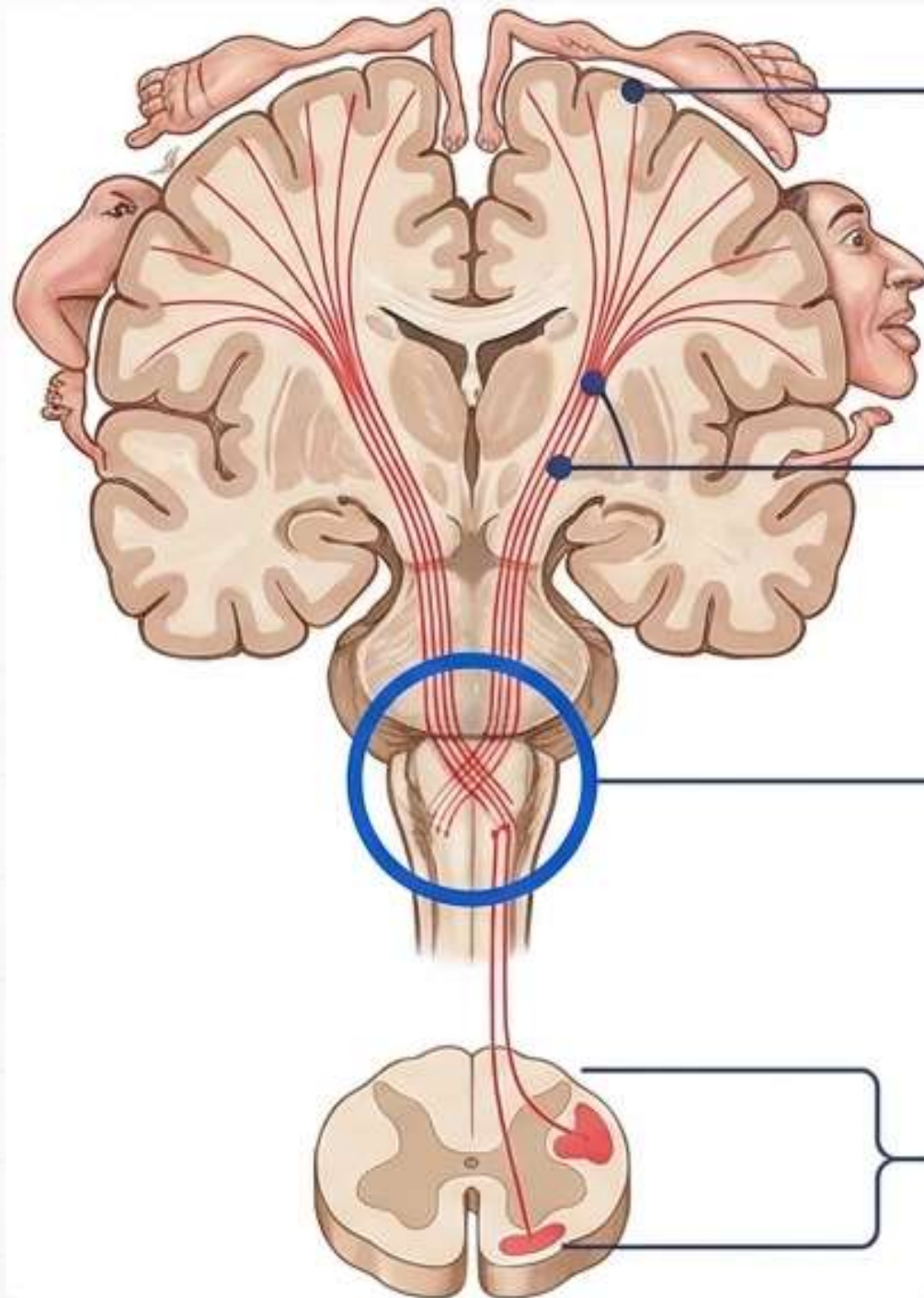
Auditory areas I and II, memory processing.

Cingulate Gyrus:

Emotional behavior integration.



The Corticospinal Tract: Executing Voluntary Movement



1. Origin

Motor cortex (Precentral gyrus), exhibiting a topographic projection of motor centers (leg positioned medially, face/hand laterally).

2. Transit

Descent through the Internal capsule and the Basis pedunculi of the midbrain.

3. The Crossing

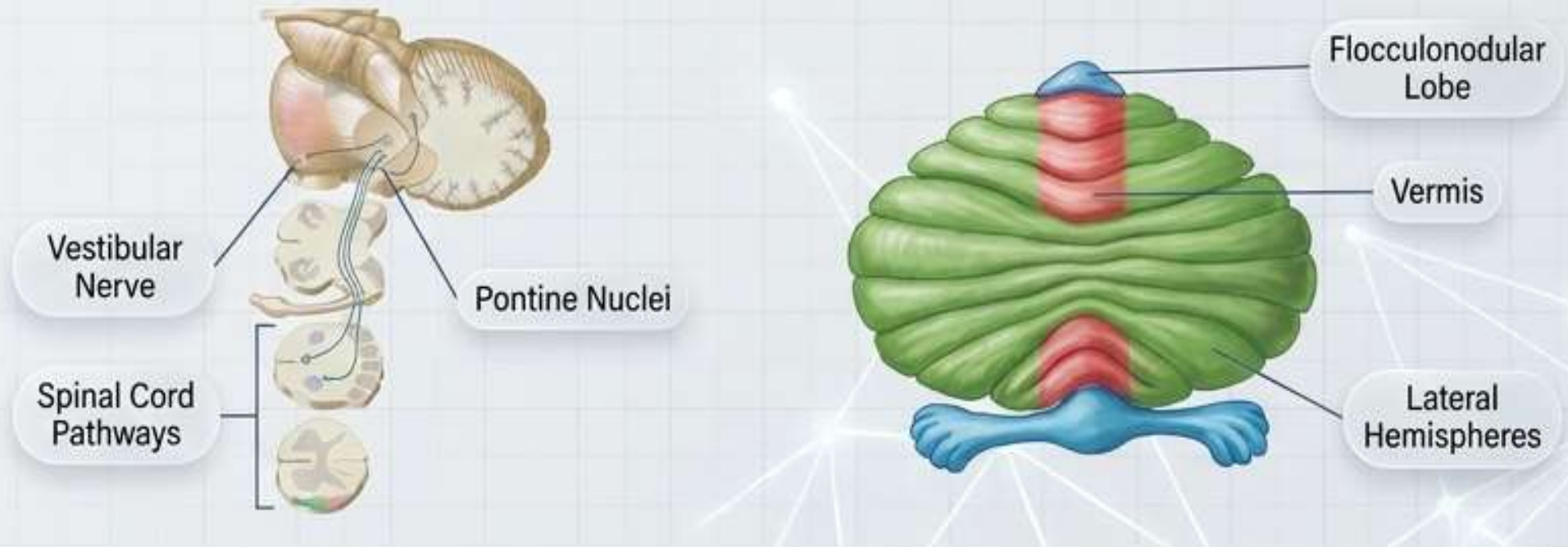
Crossing over visually explains why the left hemisphere controls the right side of the body.

Decussation of Pyramids in the Medulla Oblongata.

4. Destination

Splits into the Lateral corticospinal tract (synapsing on ipsilateral anterior horn cells) and Anterior corticospinal tract.

Cerebellar Physiology: The Coordination Matrix



Archicerebellum (Vestibulocerebellum)

Structure: Flocculonodular lobe

Input: Vestibular nerve

Output: Posture, balance, head/eye movement

Paleocerebellum (Spinocerebellum)

Structure: Vermis / Paravermis

Input: Muscle spindles, Golgi tendon organs

Output: Proximal limb movement and muscle tone modification

Neocerebellum (Cerebrocerebellum)

Structure: Lateral Hemispheres

Input: Cerebral cortex via pontine nuclei

Output: Planning and coordination of fine, distal limb movements

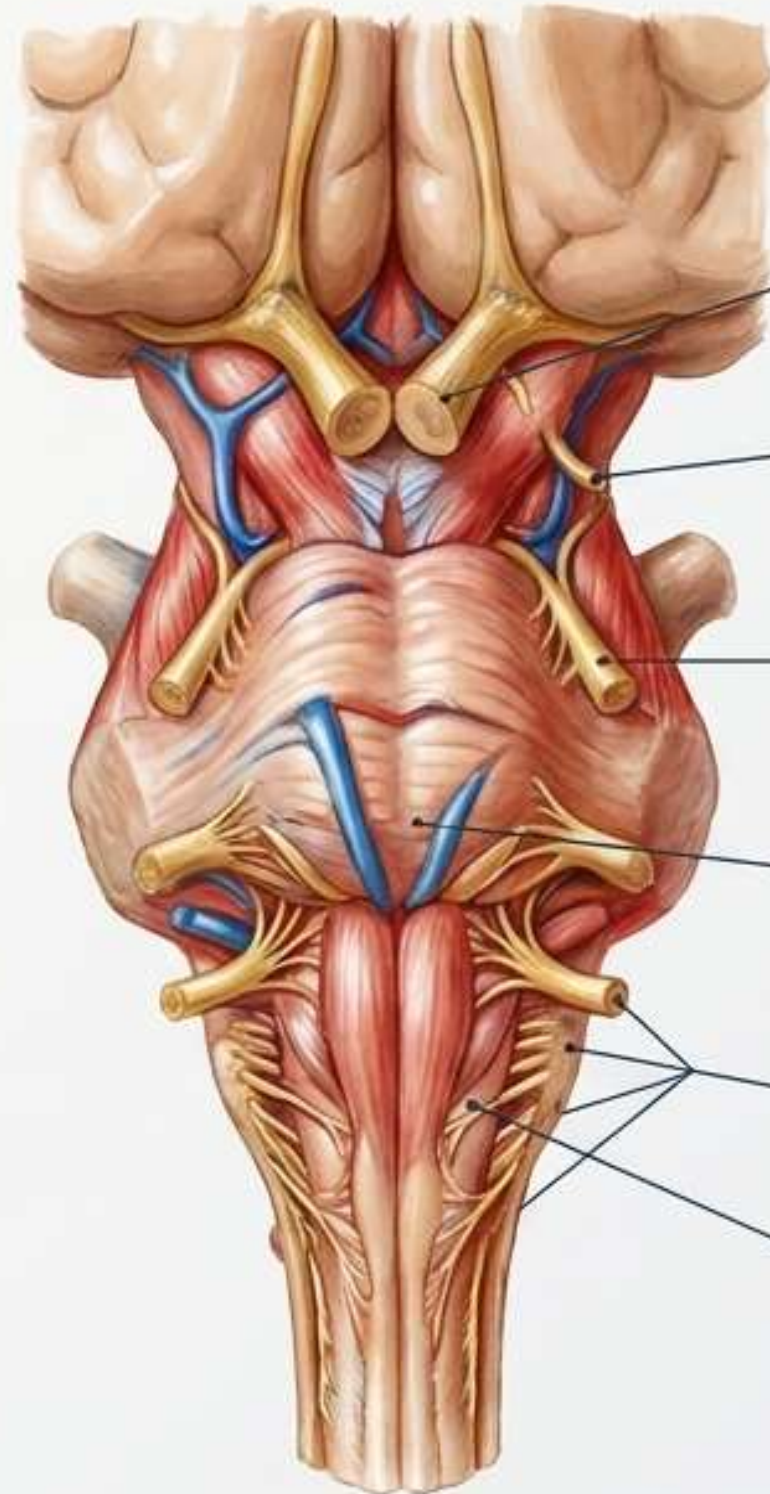
Sensory Input (Limb Position)

Cerebellar Processing

Efferent Modification

Motor Output Coordination

Cranial Nerves: The Brainstem Interface



Diagnostic Matrix

CN III (Oculomotor)

Origin:
Midbrain

Function:
Motor to most eye muscles,
parasympathetic pupillary constriction

CN IV (Trochlear)

Origin:
Midbrain (posterior)

Function:
Motor to superior oblique

CN VI (Abducent)

Origin:
Pons

Function:
Motor to lateral rectus

CN VII (Facial)

Origin:
Pons

Function:
Facial expression, taste (anterior
2/3), salivatory glands

CN XI (Accessory)

Origin:
Medulla/Spinal Cord

Function:
Motor to Sternocleidomastoid &
Trapezius

CN XII (Hypoglossal)

Origin:
Medulla

Function:
Motor to intrinsic/extrinsic tongue
muscles

Mapping the Cerebrovascular System

Anterior Circulation

- Supplied by the Internal Carotid Arteries.
- Branches into the Anterior Cerebral Artery (ACA) and Middle Cerebral Artery (MCA).



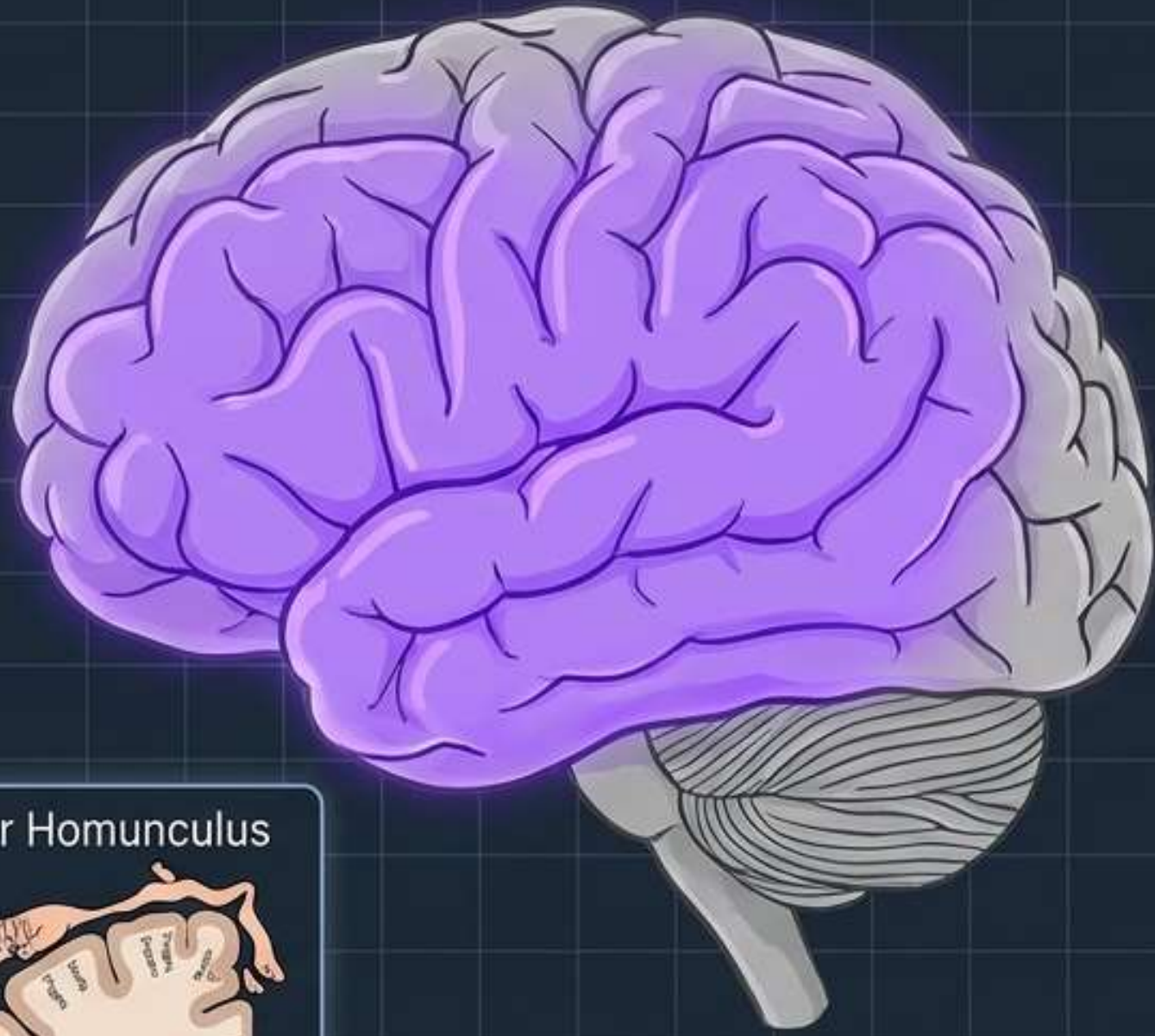
Posterior Circulation

- Supplied by the Vertebral Arteries merging into the Basilar Artery.
- Branches into the Posterior Cerebral Artery (PCA) and cerebellar arteries.



Note: The Anterior Communicating Artery and Posterior Communicating Arteries form the 'Circle,' providing critical collateral blood flow.

Middle Cerebral Artery (MCA) Syndrome



Motor Homunculus



Pathophysiology

Most common site of stroke occlusion. Infarct of lateral cerebral hemisphere & internal capsule.

Motor/Sensory Profile

Contralateral spastic hemiparesis and hemisensory loss.

Key Distinction

The Face and Upper Extremity (UE) are significantly MORE involved than the Lower Extremity (LE) due to lateral cortical mapping.

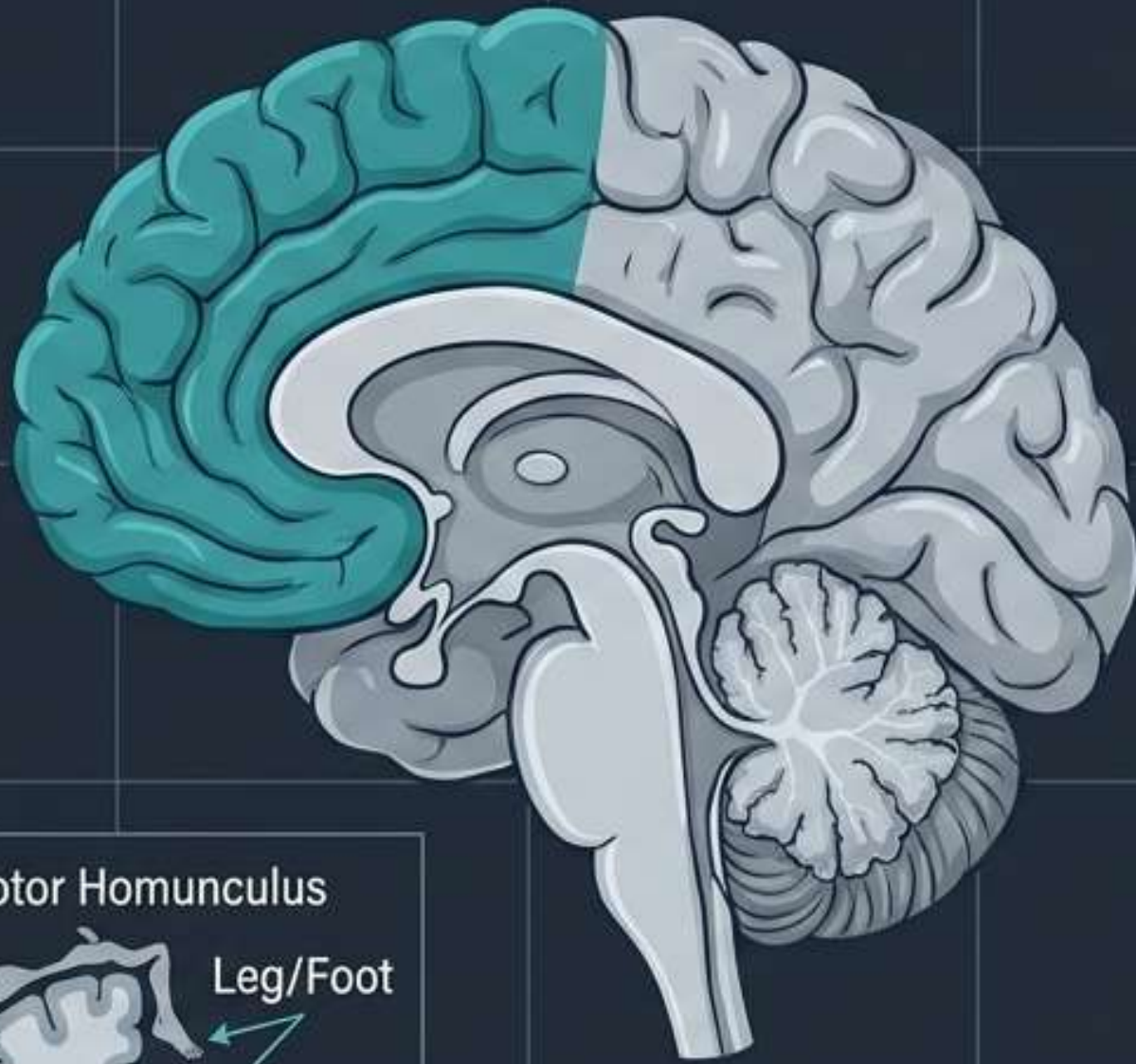
Cortical Deficits

Dominant Hemisphere (usually Left): Broca's or Wernicke's Aphasia.

Nondominant Hemisphere (usually Right): Unilateral neglect, spatial agnosia, apraxia.

Visual: Contralateral homonymous hemianopsia (optic radiation involvement).

Anterior Cerebral Artery (ACA) Syndrome



Pathophysiology

Infarct of the medial aspect of the frontal/parietal lobes and anterior basal ganglia.

Motor/Sensory Profile

Contralateral hemiparesis and hemisensory loss.

Key Distinction

The Lower Extremity (LE) is significantly MORE involved than the Upper Extremity (UE).

Cortical & Behavioral Deficits

- Abulia: Akinetic mutism, slowness, lack of spontaneity.
- Other Signs: Urinary incontinence, contralateral grasp reflex, sucking reflex, apraxia (bimanual tasks).

Motor Homunculus



Posterior Cerebral Artery (PCA) Syndrome



Pathophysiology

Terminal branches of the basilar artery; infarct of visual cortex and thalamic structures.

Visual Deficits (Occipital Lobe)

Contralateral homonymous hemianopsia (often with macular sparing due to MCA collateral supply).

Visual agnosia and Prosopagnosia (difficulty naming faces).

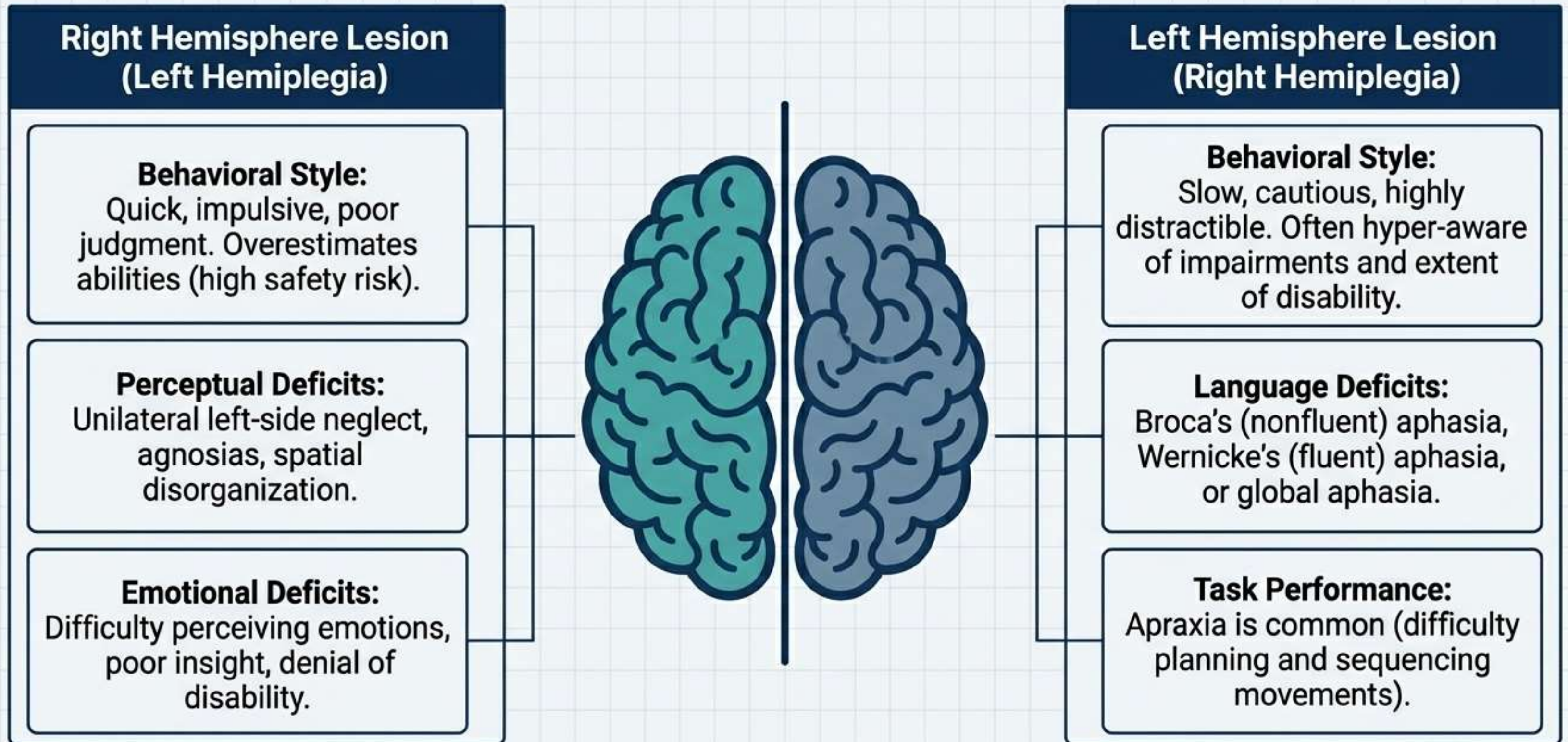
Cognitive Deficits (Temporal Lobe)

Memory defects (amnesia) and topographical disorientation.

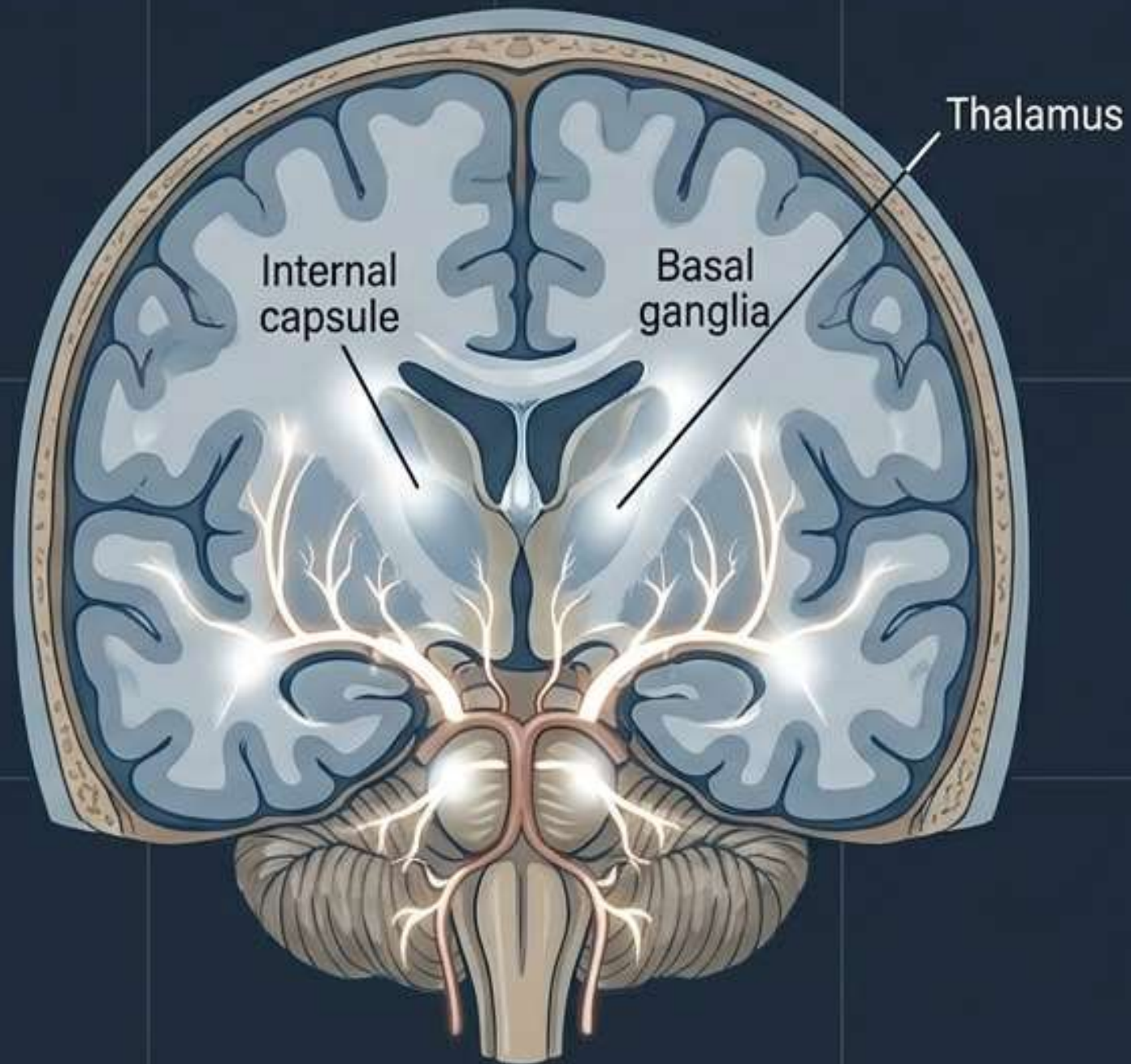
Sensory Deficits (Thalamic Branches)

Central Post-Stroke (Thalamic) Pain. Intense, persistent burning or aching pain, often evoked by mechanical touch or temperature (dysesthesia).

Behavioral Phenotypes: Hemispheric Lateralization



Lacunar Strokes (Deep Penetrating Arteries)



Pathophysiology

Small vessel disease linked to chronic hypertension and diabetic microvascular disease.

The Key Differentiator

Because lesions are deep in the white matter, higher cortical areas are completely preserved.

- NO aphasia
- NO visual field loss
- NO cognitive neglect

Classic Syndromes

- Pure Motor Hemiplegia: Involvement of the posterior limb of the internal capsule or pons.
- Pure Sensory Stroke: Involvement of the ventrolateral thalamus.
- Dysarthria/Clumsy Hand Syndrome: Base of the pons / internal capsule.

Vertebrobasilar Artery Syndrome



Pathophysiology

Occlusion of the posterior circulation. Symptoms are highly variable due to crossed and uncrossed tracts.

Hallmark Features

Crossed Signs: Ipsilateral cranial nerve deficits combined with contralateral motor/sensory deficits.

Cerebellar Signs: Ataxia, vertigo, nausea, nystagmus.

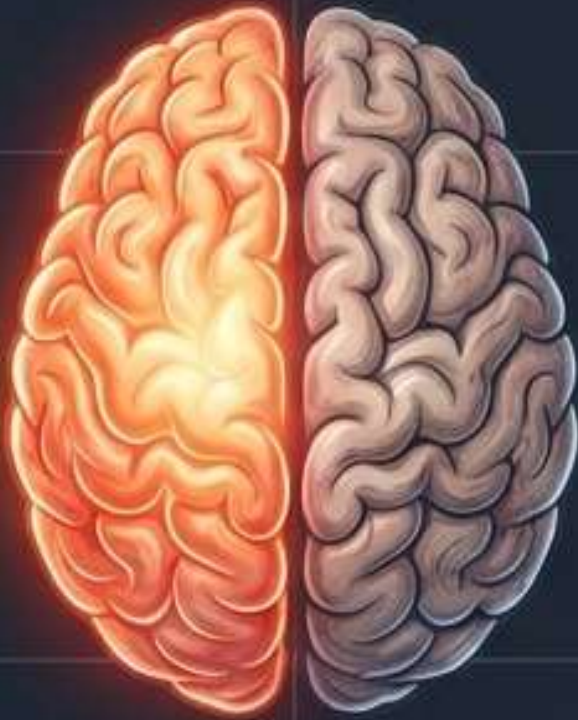
Locked-In Syndrome (LIS)

Catastrophic basilar artery thrombosis causing bilateral ventral pons infarction.

Presentation: Sudden acute hemiparesis progressing to tetraplegia and lower bulbar paralysis (mutism/anarthria).

Preserved: Sensation and consciousness remain intact. Communication is limited exclusively to vertical eye movements and blinking.

Clinical Synthesis: The Hemispheric Divide



Left Hemisphere Lesion (Right Hemiplegia)

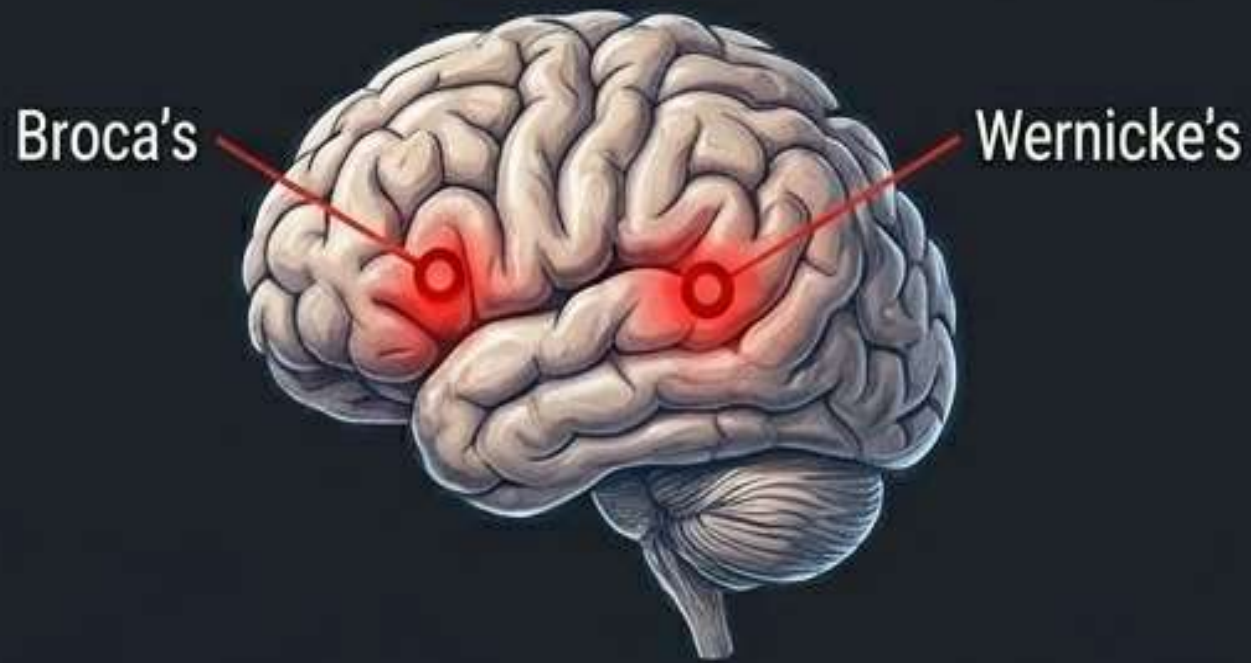
- **Behavior:** Cautious, slow, anxious, and highly disorganized.
- **Insight:** Highly aware of impairments and disability; prone to frustration and post-stroke depression.
- **Cognition:** Fluent, nonfluent, or global aphasia. Difficulty processing sequential verbal cues.
- **Rehab Need:** Requires slow pacing, step-by-step feedback, and support.



Right Hemisphere Lesion (Left Hemiplegia)

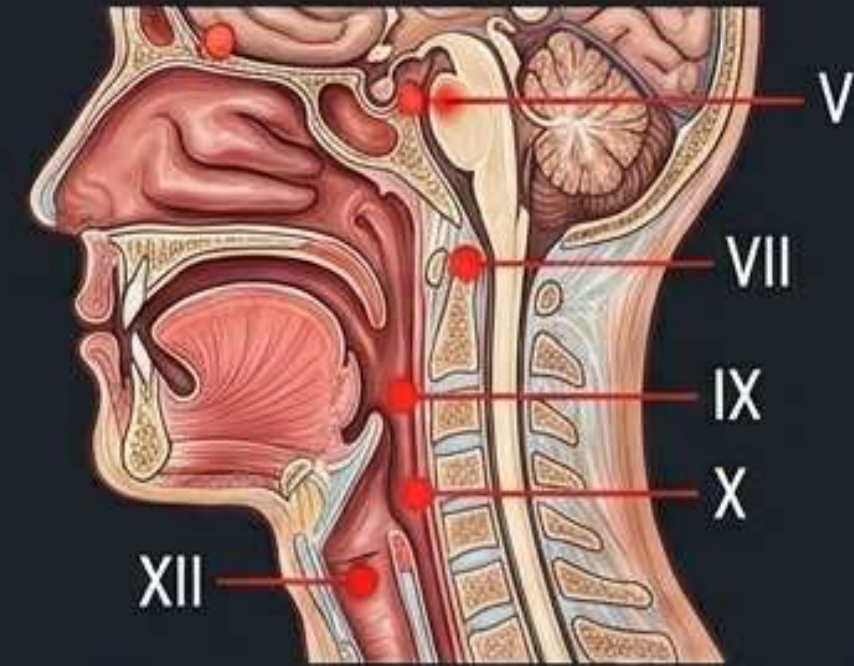
- **Behavior:** Impulsive, quick, and overestimates abilities.
- **Insight:** Poor insight, denial of disability (anosognosia). Creates a severe safety risk for falls.
- **Cognition:** Visuospatial disorders, left-side unilateral neglect, difficulty grasping the whole idea of a task.
- **Rehab Need:** Requires focus on slowing down, spatial cues, and checking sequential steps.

Neurological Complications: Speech & Swallowing



Disorders of Language (Aphasia)

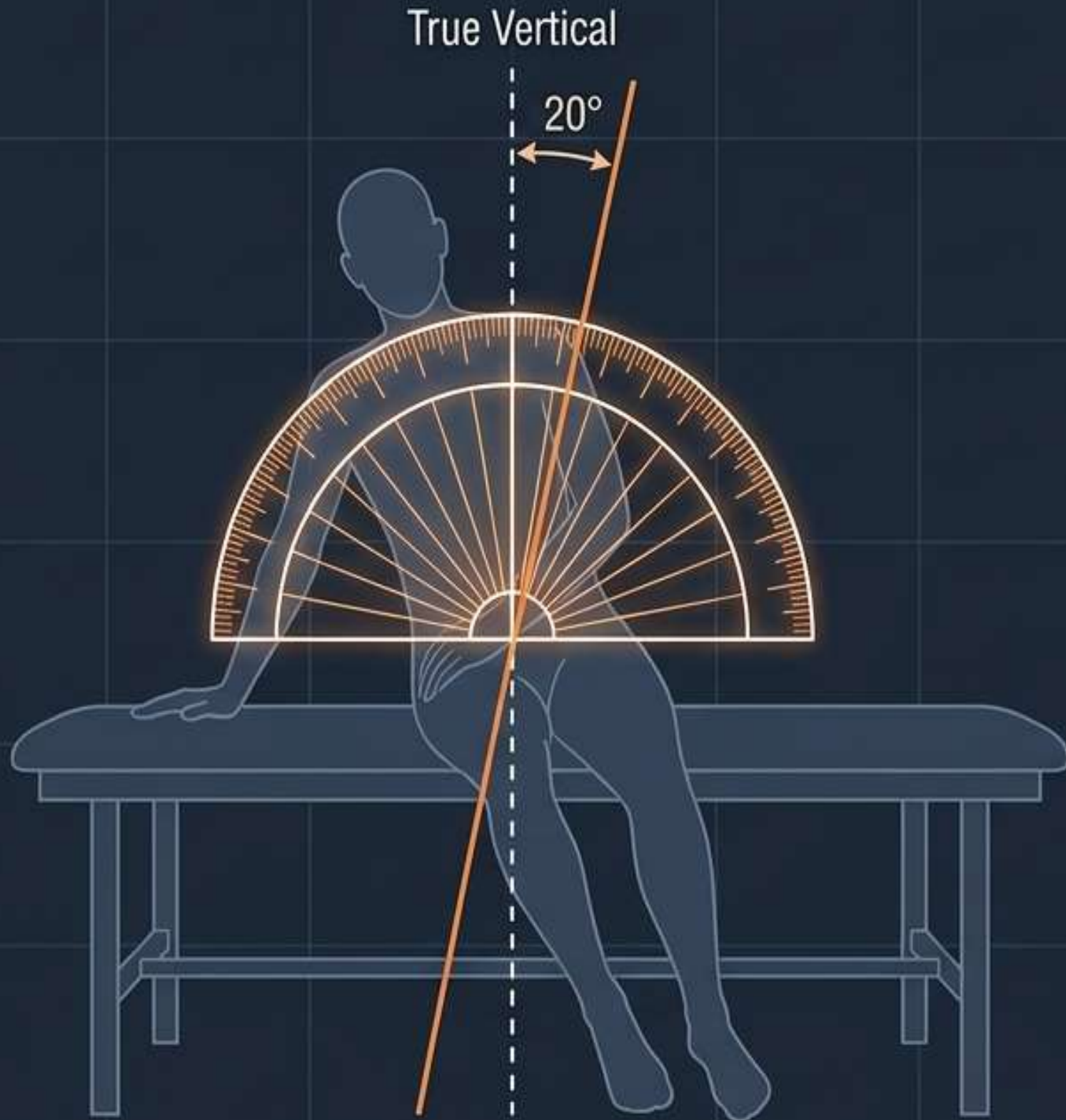
- **Fluent (Wernicke's):** Temporal lobe lesion. Smooth, melodic speech but impaired auditory comprehension (word salad).
- **Nonfluent (Broca's):** Frontal lobe lesion. Slow, hesitant, labored speech with limited vocabulary, but good comprehension.



Disorders of Swallowing (Dysphagia)

- Occurs in ~51% of strokes (up to 81% in brainstem strokes).
- Caused by Cranial Nerve impairment (V, VII, IX, X, XII) altering oral and pharyngeal control.
- **Clinical Risk:** Delayed swallow reflex and reduced peristalsis lead to high risk of aspiration, resulting in acute respiratory distress or fatal aspiration pneumonia.

Ipsilateral Pushing (Pusher Syndrome)



Ipsilateral Pushing

An unusual motor behavior where the patient actively pushes with their stronger extremities toward their paralyzed (hemiparetic) side.

Pathophysiology

Caused by stroke affecting the posterolateral thalamus.

The Deficit

The brain misperceives the subjective postural vertical position, believing the body is upright when it is actually tilted $\sim 20^\circ$ toward the weak side.

Clinical Impact

- Severe lateral postural imbalance and high fall risk.
- Traditional canes are dangerous (patient uses them to push harder).
- Good prognosis; the brain compensates and the syndrome rarely lasts beyond 6 months.

Summary: The Vascular Syndrome Master Matrix

Vascular Territory	Primary Structures	Motor/Sensory Profile	Hallmark Unique Deficits
MCA	Lateral hemisphere	Face/Arm > Leg	Aphasia (Left) or Neglect (Right)
ACA	Medial hemisphere	Leg > Face/Arm	Abulia, apraxia, incontinence
PCA	Occipital / Thalamic	Contralateral hemianopsia	Memory loss, visual agnosia, central pain
Lacunar	Deep white matter	Pure motor or pure sensory	Cortex preserved (No aphasia/neglect)
Vertebrobasilar	Brainstem / Cerebellum	“Crossed signs”	Ataxia, cranial nerve palsy, Locked-in syndrome

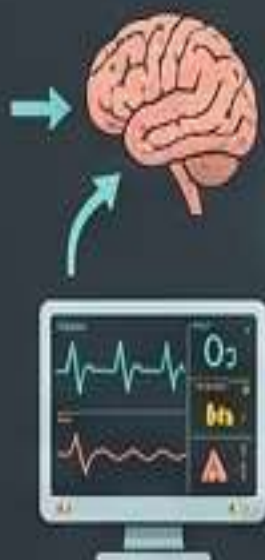


Step 1: Acute Phase

Setting: Intensive Care / Specialized Stroke Unit

Timing: Mobilization within 72 hours

Key Focus:
Prevent learned nonuse of hemiparetic extremities, position to prevent contracture, monitor vitals (O2 drops, altered consciousness).



Step 2: Subacute Phase (High Intensity)

Setting: Inpatient Rehabilitation Facility (IRF)

Threshold:
Patient tolerates 3+ hours of active rehab per day, 6 days/week



Key Focus:
Intensive functional restoration.



Step 3: Subacute Phase (Moderate Intensity)

Setting: Transitional Care Unit (TCU) / Skilled Nursing

Threshold:
Patient tolerates 60-90 minutes of therapy per day, 5 days/week



Key Focus:
Continued mobility and ADL training.



Step 4: Chronic Phase

Setting: Outpatient / Home Health

Key Focus:
Long-term community reintegration and compensatory strategies.



Decoding Post-Stroke Synergy Patterns

Following a stroke, patients often lose the ability to perform isolated joint movements, resulting in “obligatory synergies” - highly stereotyped, abnormal patterns where muscles are linked together, causing the entire limb to respond in a fixed, predictable movement.

The Flexion Synergy (The “Retracted” Pattern)



**Upper Extremity:
The “Tucked” Arm**
Characterized by scapular retraction, shoulder abduction, elbow flexion, and forearm supination.

Strongest Components:
Elbow flexion and hip flexion are typically the most dominant movements in this pattern.

**Lower Extremity:
The “Shortened” Leg**
Involves hip flexion, abduction, and external rotation, with knee flexion and ankle dorsiflexion.

Person A
(Pure Flexion)

The Extension Synergy (The “Stiff” Pattern)



**Upper Extremity:
The “Reaching” Arm**
Characterized by scapular protraction, shoulder adduction, elbow extension, and forearm pronation.

Strongest Components:
Forearm pronation, knee extension, and ankle plantarflexion.

**Lower Extremity:
The “Scissoring” Leg**
Involves hip extension and adduction, knee extension, and ankle plantarflexion with inversion.

Functional Impact:
Strong extension in the leg often leads to a “scissoring” gait during walking.

Person B
(Pure Extension)

Mixed Synergy (The “Variable” Presentation)



Combinational Movement
Patients often display a mix of components from both flexion and extension patterns.

Inter-Limb Variance
The upper extremity may show flexion dominance while the lower extremity shows extension.

Recovery Transition
As recovery progresses, spasticity wanes and isolated joint control begins to emerge.

Person C
(Mixed Synergy)

Synergy Component Comparison Table

Joint	Flexion Synergy	Extension Synergy
Elbow	Flexion (Strongest)	Extension
Forearm	Supination	Pronation (Strongest)
Knee	Flexion	Extension (Strongest)
Ankle	Dorsiflexion	Plantarflexion (Strongest)

The Motor Recovery Activation Curve



Stage 1:	Stage 2:	Stage 3:	Stage 4:	Stage 5:	Stage 6:
Flaccid paralysis.	Early synergy; facilitatory stimuli elicit minimal voluntary movement.	Marked spasticity; full, strong obligatory synergies.	Synergy influence declines; out-of-synergy isolated movements emerge.	Waning spasticity; relative independence from synergy.	Near-normal, isolated joint control.

Functional Assessment Matrix: Core Clinical Instruments

NIH Stroke Scale (NIHSS)

Acute Triage

11-item variable ordinal scale measuring acute impairments (consciousness, visual fields, facial palsy, motor arm/leg).

Completed in 5-8 mins.

Stroke Rehab Assessment of Movement (STREAM)

Motor Mastery

30 items across 3 subscales (upper limb, lower limb, basic mobility). Explores "out-of-synergy" voluntary control.

Max Score: 70

Function in Sitting Test (FIST)

Postural Stability

14 items examining static and dynamic sitting balance using sternal nudges and reaching tasks. Scored on a 0-4 scale.

Max Score: 56

Stroke Impact Scale (SIS)

Quality of Life

59-item self-report measure spanning strength, memory, emotions, ADLs, and participation.

Culminates in 0-100 perceived recovery rating.

Box 15.7 Examples of General Goals and Outcomes for Patients with Stroke

Impact of pathology/pathophysiology is reduced.

- Patient/client, family, and caregiver knowledge and awareness of the disease, prognosis, and plan of care are enhanced.
- Symptom management is enhanced.
- Changes associated with recovery are monitored.
- Risk of secondary impairments and recurrence of condition is reduced.
- Intensity of care is decreased.

Impact of impairments is reduced.

- Cognitive function is improved.
- Communication is improved.
- Sensory awareness and skin integrity are improved.
- Perceptual function is improved.
- Awareness and use of the hemiplegic side is improved.
- Pain is decreased.
- Joint integrity and mobility are improved.
- Motor function (motor control and motor learning) is improved.
- Muscle performance (strength, power, and endurance) is improved.
- Postural control and balance are improved.
- Gait and locomotion are improved.
- Aerobic capacity is increased.

Ability to perform physical actions, tasks, or activities is improved.

- Independence in ADL is increased.
- Tolerance of upright postures and activities is increased.

- Problem solving and decision making skills are enhanced.
- Safety of patient/client, family, and caregivers is improved.

Disability associated with chronic illness is reduced.

- Ability to assume/resume self-care and home management is improved.
- Ability to assume work (job/school/play), community, and leisure roles is improved.
- Awareness and use of community resources are improved.

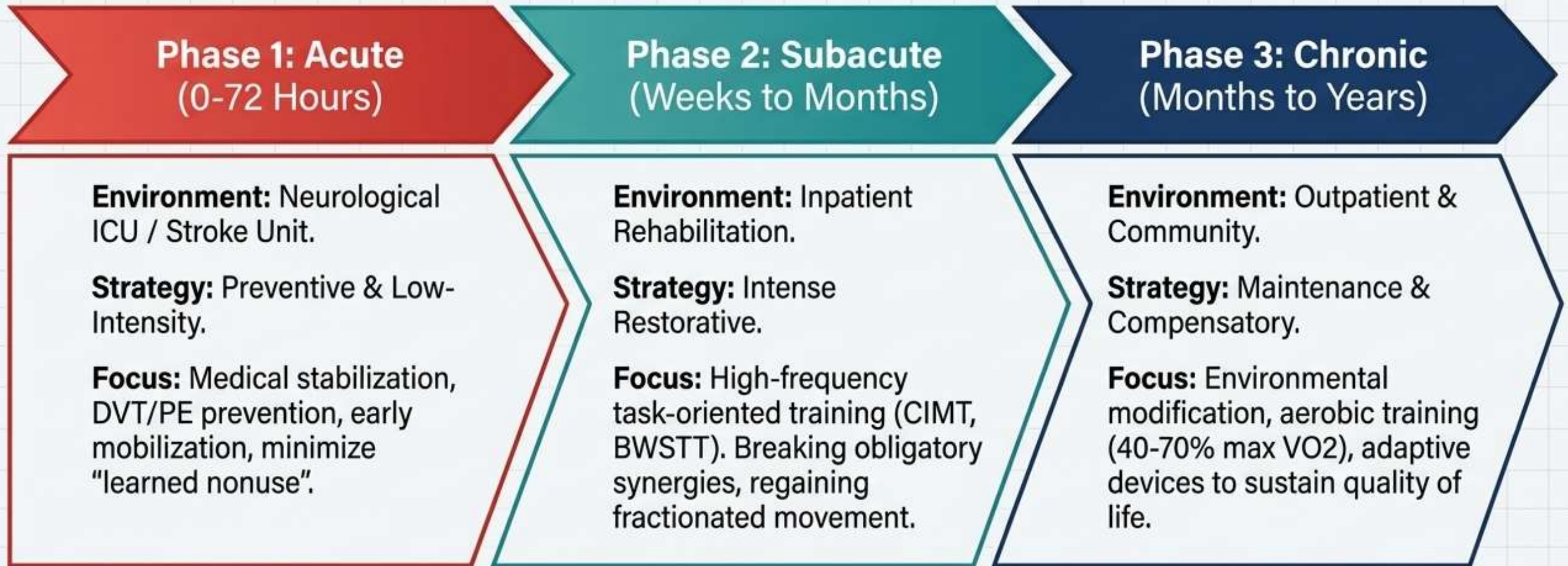
Health status and quality of life are improved.

- Sense of well-being is enhanced.
- Stressors are reduced.
- Insight, self-confidence, and self-management skills are improved.
- Health, wellness, and fitness are improved.

Patient/client satisfaction is enhanced.

- Access and availability of services are acceptable to patient/client and family.
- Quality of rehabilitation services is acceptable to patient/client and family.
- Care is coordinated with patient/client, family, caregivers, and other professionals.
- Discharge placement needs are determined.

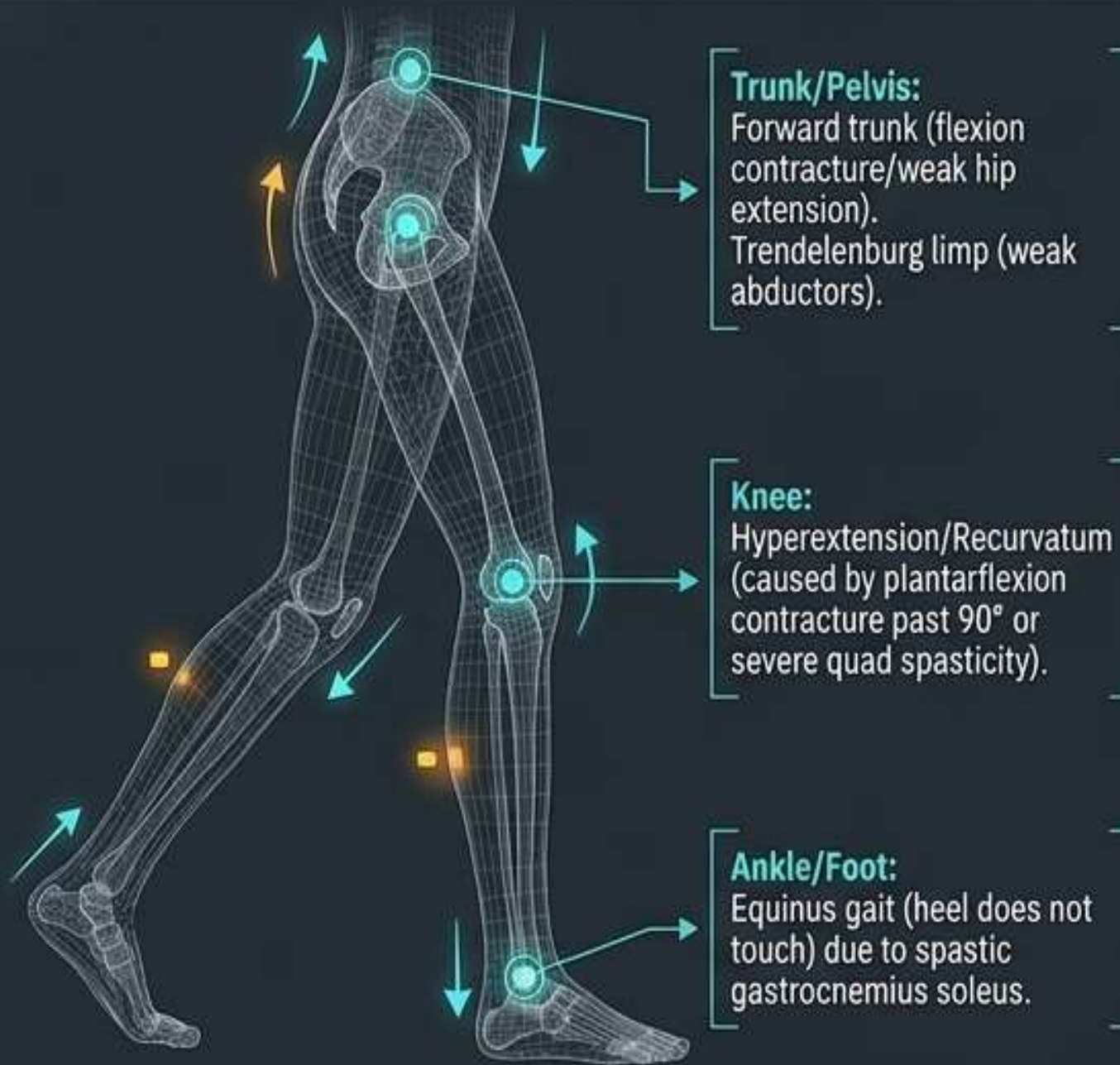
Synthesis: The Stroke Recovery Continuum of Care



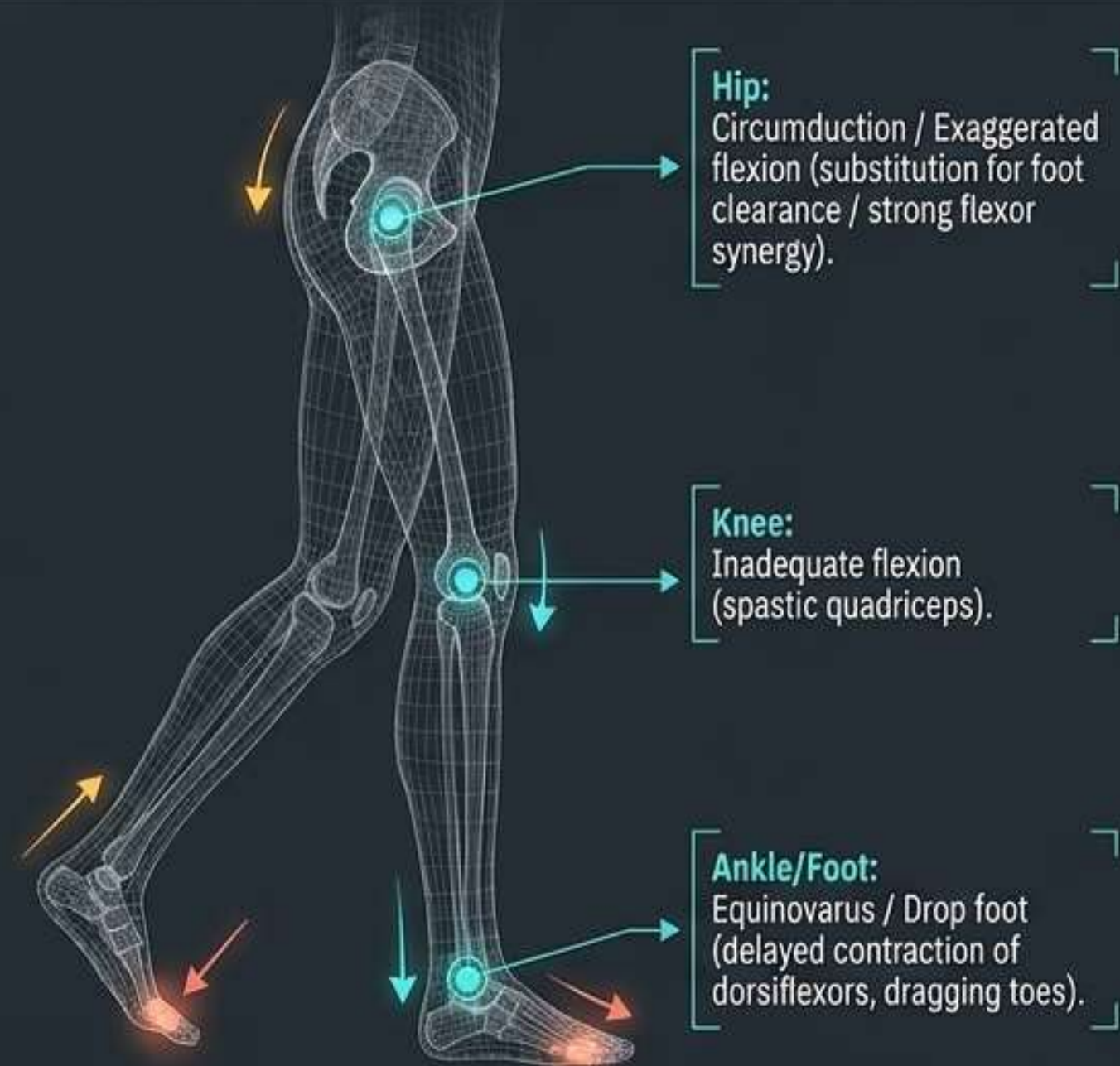
Rehabilitation is a continuous, evolving science.

Kinematic Gait Analysis: Deviations and Mechanics

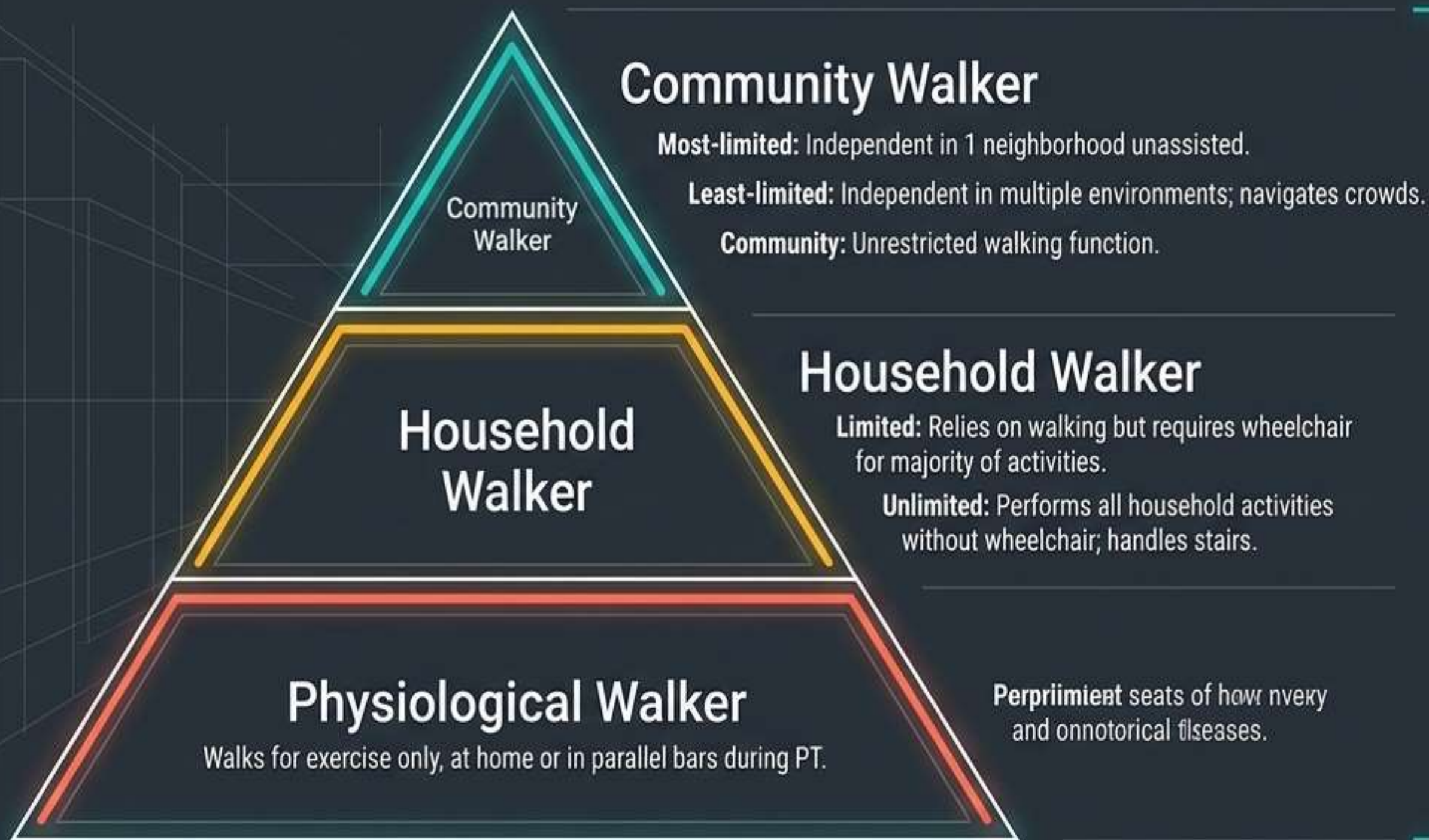
Stance Phase



Swing Phase



Functional Walking Categories (Perry's Classification)



Diagnostic Differentiators

Physiological factors dictating progression up the pyramid:

- Strength
- Proprioception
- Isolated Knee Control (flexion/extension)
- Gait Velocity

Synthesis: From Diagnostic Data to Intervention Planning



Treatment Protocol Card: CIMT

Constraint-Induced Movement Therapy (mCIMT)

Target Modality: Upper Extremity Functional Recovery

Active Practice:

30 minutes of functional task practice and behavioral shaping 3 days per

Restraint Protocol:

Mitt worn on the less affected Upper Extremity for up to 5 hours per day.

Duration:

10-week extended outpatient protocol.



Mechanism of Action

Overcomes “learned nonuse.” Capitalizes on neuroplasticity by forcing the brain to reorganize cortical maps to utilize the hemiparetic limb through intense, repetitive, task-specific practice.

Treatment Protocol Card: Lower Extremity & Posture

Static Control: Modified Plantigrade



Setup: Patient standing, leaning forward with the hemiparetic Upper Extremity extended and weight-bearing.

Biomechanical Benefit: Forces an 'out-of-synergy' posture. Extends the elbow and wrist while creating an extension moment at the knee to assist weak knee extensors. Provides a stable, four-limb Base of Support.

Dynamic Control: BWSTT



Protocol: Body Weight Supported Treadmill Training.

Prescription: 4-5 sessions per week, 20-30 minutes per session. Integrates variable speeds (slow 0.22 m/sec to fast > 0.89 m/sec).

Mechanism: Promotes early overground walking mechanics, safely breaks lower extremity synergy patterns, and builds aerobic capacity.