Stroke

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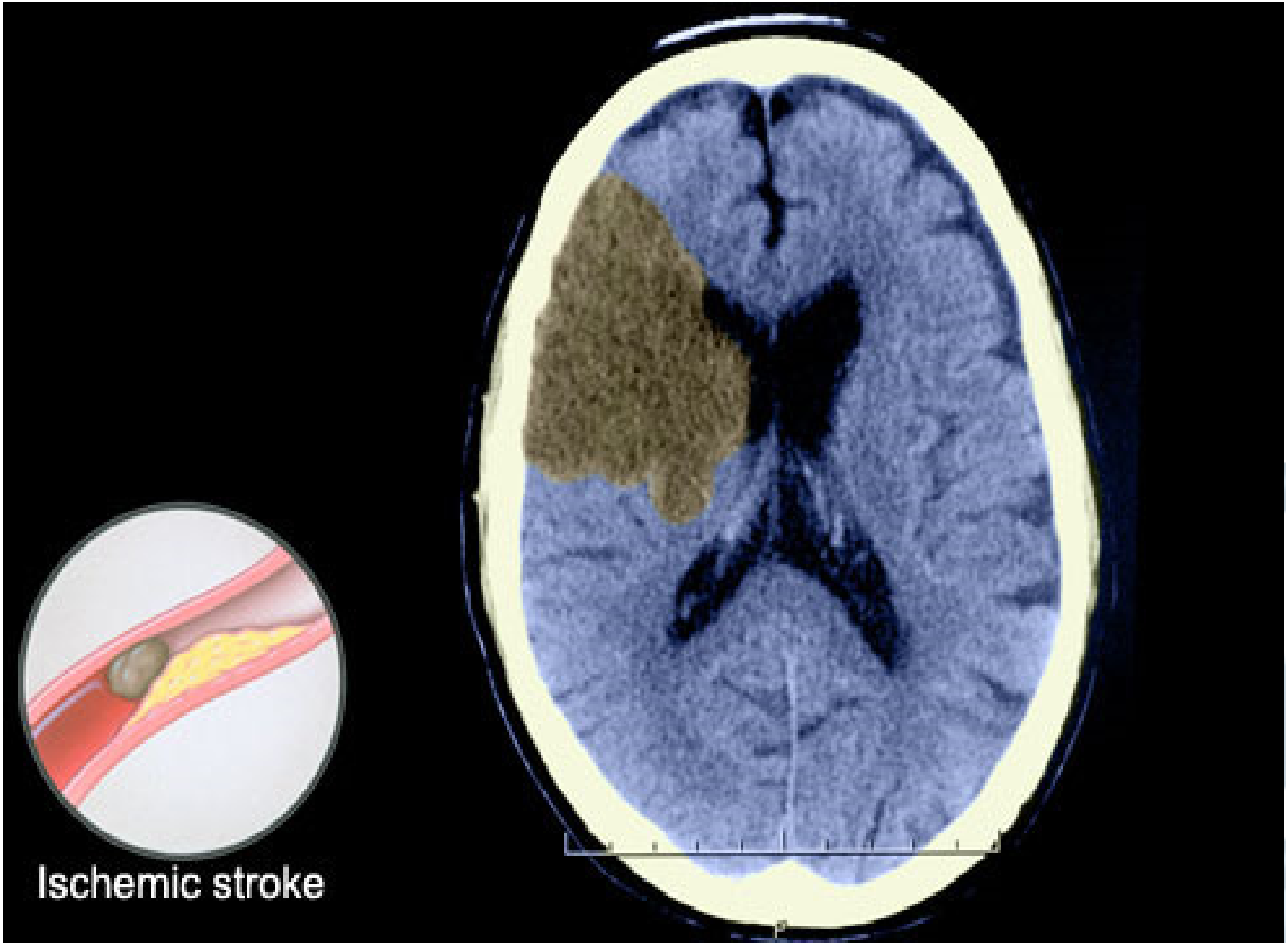
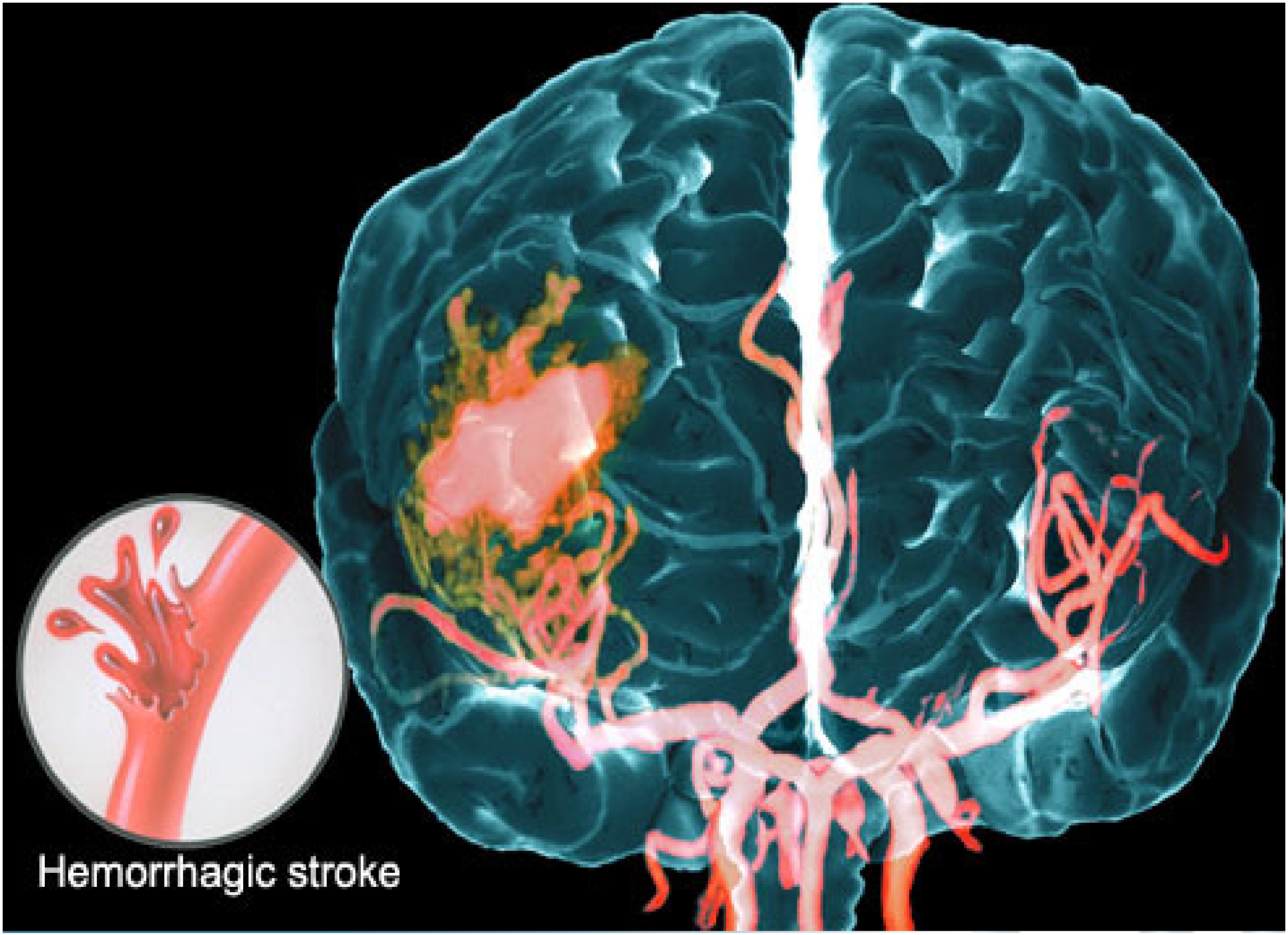
Learning Objectives

- Update stroke prevalence and incidence
- Review risk factors
- Define neuroprotection/neurorestoration and know current works
- Understand stroke candidacy , recovery and prognosis
- Review depression and stroke

Stroke

- Destruction of brain tissue through a loss of blood supply leading to a functional impairment of the affected area
- Multiple etiologies including thrombus, embolus and hemorrhage


Ischemic stroke


Hemorrhagic stroke

Stroke

- Incidence 795,000/year
- Prevalence 6.8 million
- 4th leading cause of death
- Leading cause of disability

Stroke

- 50% of stroke survivors have residual motor deficits
- 35% unable to work at 1 year
- 26% >65 years dependent for ADLs
- 30% ambulate with assistance
- 19% aphasia
- 26% in nursing homes

Stroke

- Direct cost $28.3 billion
- Indirect cost $25.6 billion
- Total cost $53.9 billion

Uncontrollable Stroke Risk Factors

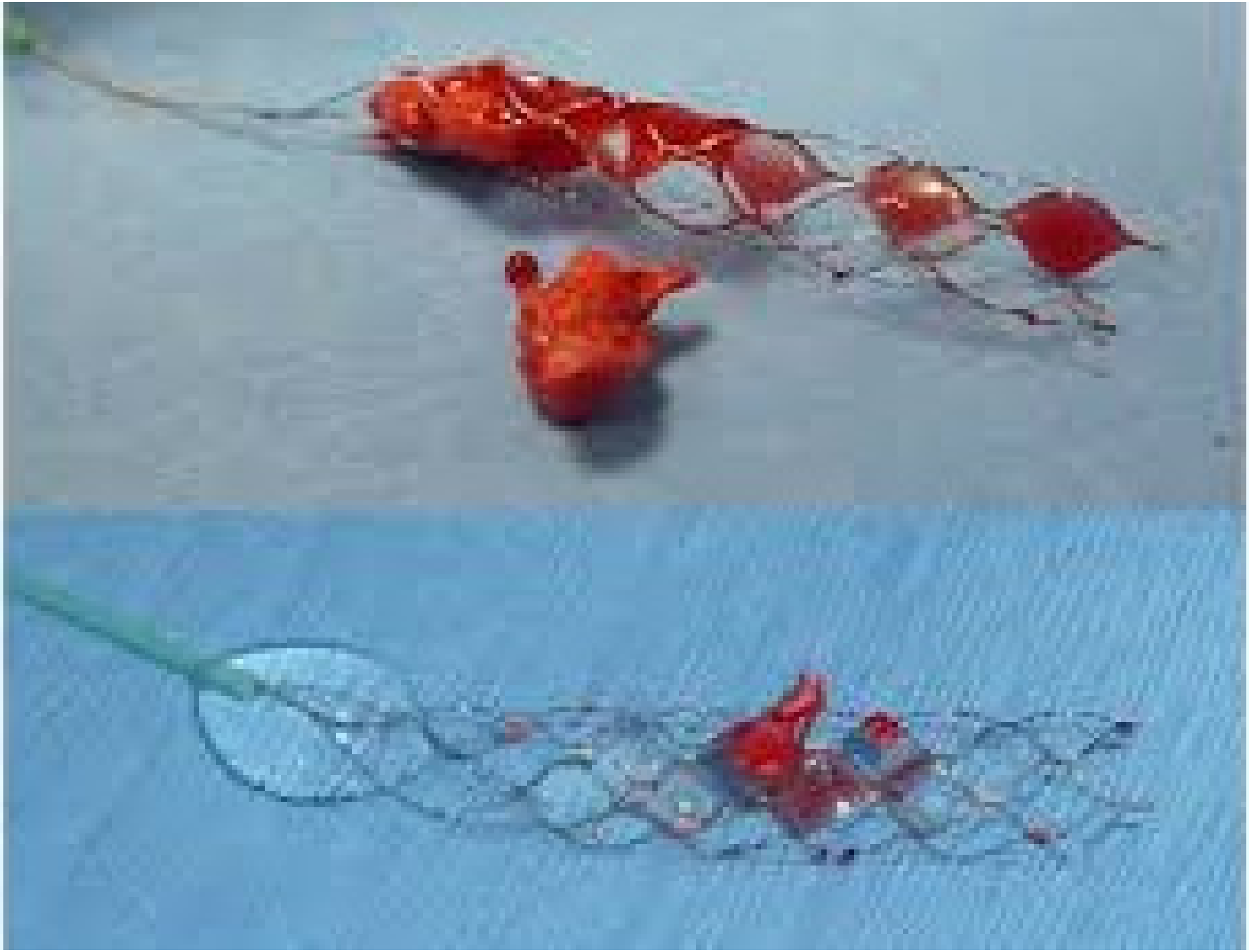
- Age
- Gender
- Race
- Family history
- Previous stroke
- Fibromuscular dysplasia
- PFO

Controllable Stroke Risk Factors

- Hypertension
- Atrial fibrillation
- Other cardiac CHF, cardiomyopathy, valve disease
- High cholesterol
- Diabetes
- Atherosclerosis
- Tobacco use
- Sickle cell
- Obesity
- Physical inactivity
- Poor diet

Stroke

- Early medical techniques are used to prevent brain damage
- Clot lysis tPA
- Clot removal
- Craniectomy
- Hemorrhage removal
- Unfortunately even with expedient treatment patients can be left with deficits



Stroke

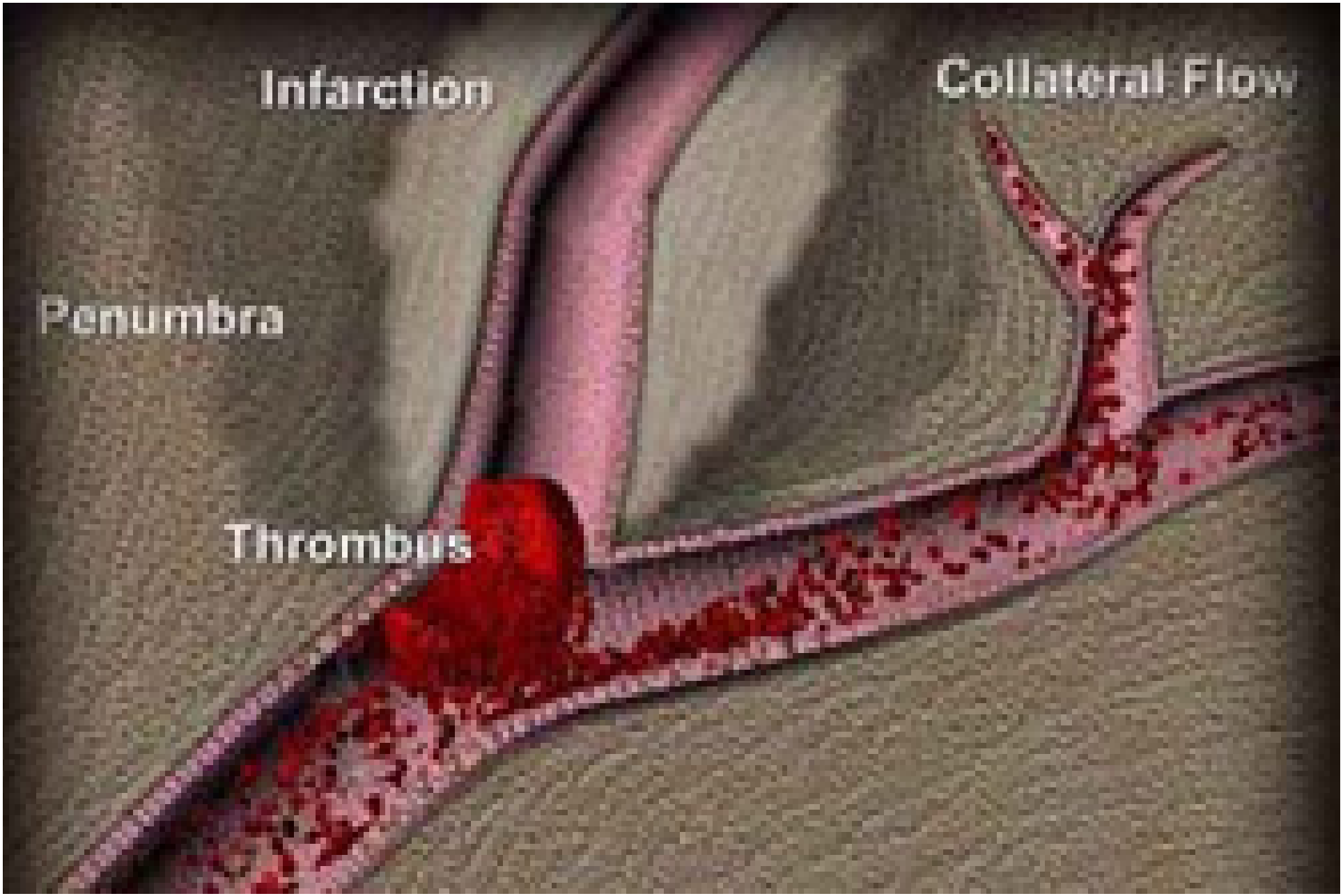
- Intensive rehabilitation has been shown to improve functional recovery
- Rehabilitation based recovery is linked to reorganization, parallel pathways and rebuilding of neural connections
- Understanding motor recovery mechanisms can provide the basis for rehabilitation strategies

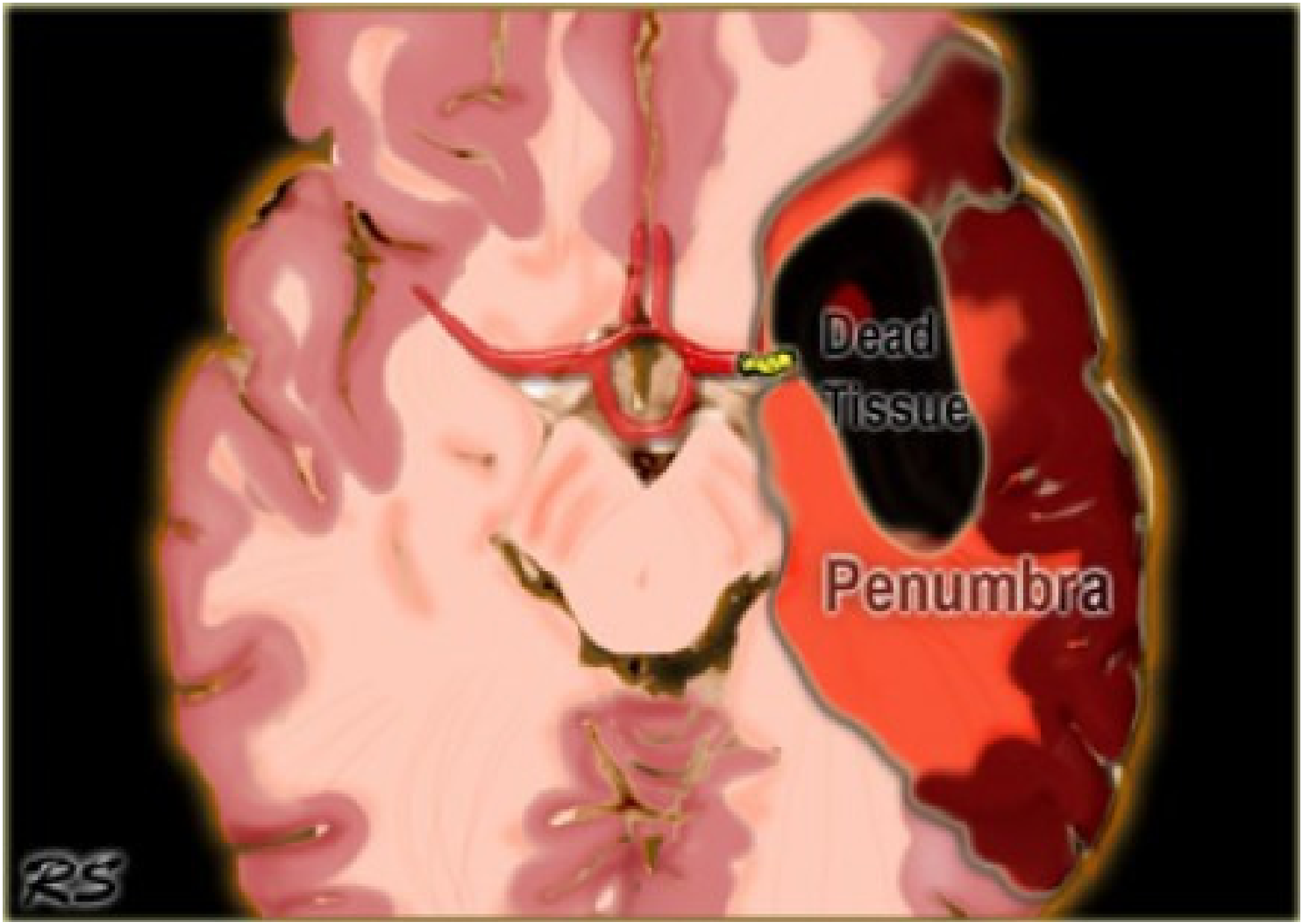
Stroke Recovery

- The recovery after a stroke involves an interplay of acute and post-acute processes

Stroke

- Interruption of blood supply to the brain leads to three pathologic areas
- Central core – cell death
- Penumbra – viable tissue area adjacent to core that may die
- Diaschisis – decreased neurologic function resultant from a sudden interruption of major input to a part of the brain remote from the site of damage


Infarction
Collateral Flow
Penumbra
Thrombus


Dead
Tissue
Penumbra

Acute Post Stroke Brain Processes

- Recovery process set in immediately and during the first few hours and days that lead to reperfusion and cessation of inflammation
- Penumbra may recover
- Diaschisis may resolve
- Subsequent active recovery is achieved through neuroplasticity

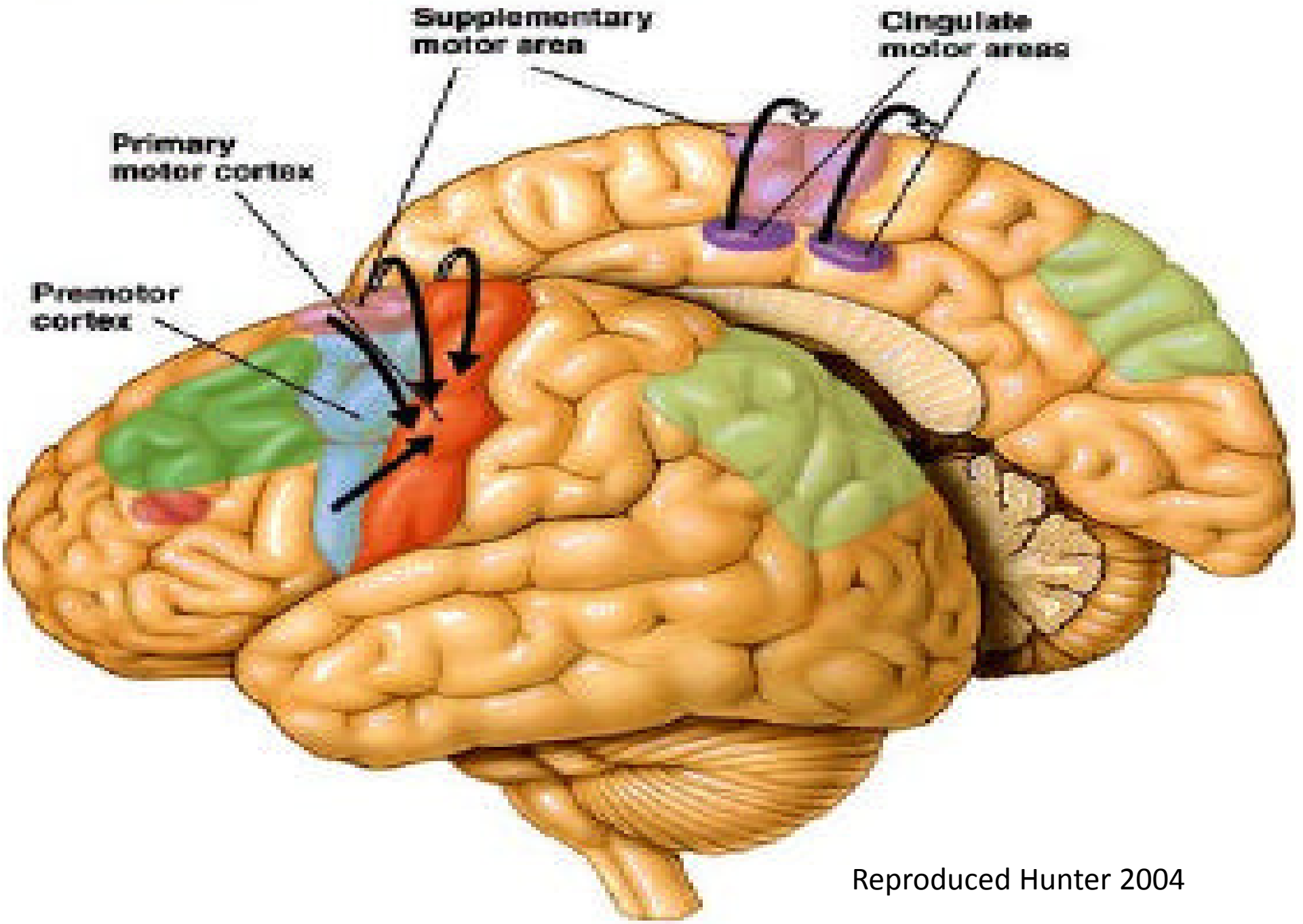
Neuroplasticity

Definition: The ability of the nervous system to respond to intrinsic and extrinsic stimuli by reorganizing its structure, function, and connections

- Can occur at many levels from molecular to cellular to systems
- Can occur during development, in response to disease, or in relation to therapy

Plasticity

- Plastic reorganization is dependent on:
  - Location of infarct
  - Size of infarct
  - Age
  - Individual variations in anatomic and functional connections
- Stroke plasticity can be within system or cross modal



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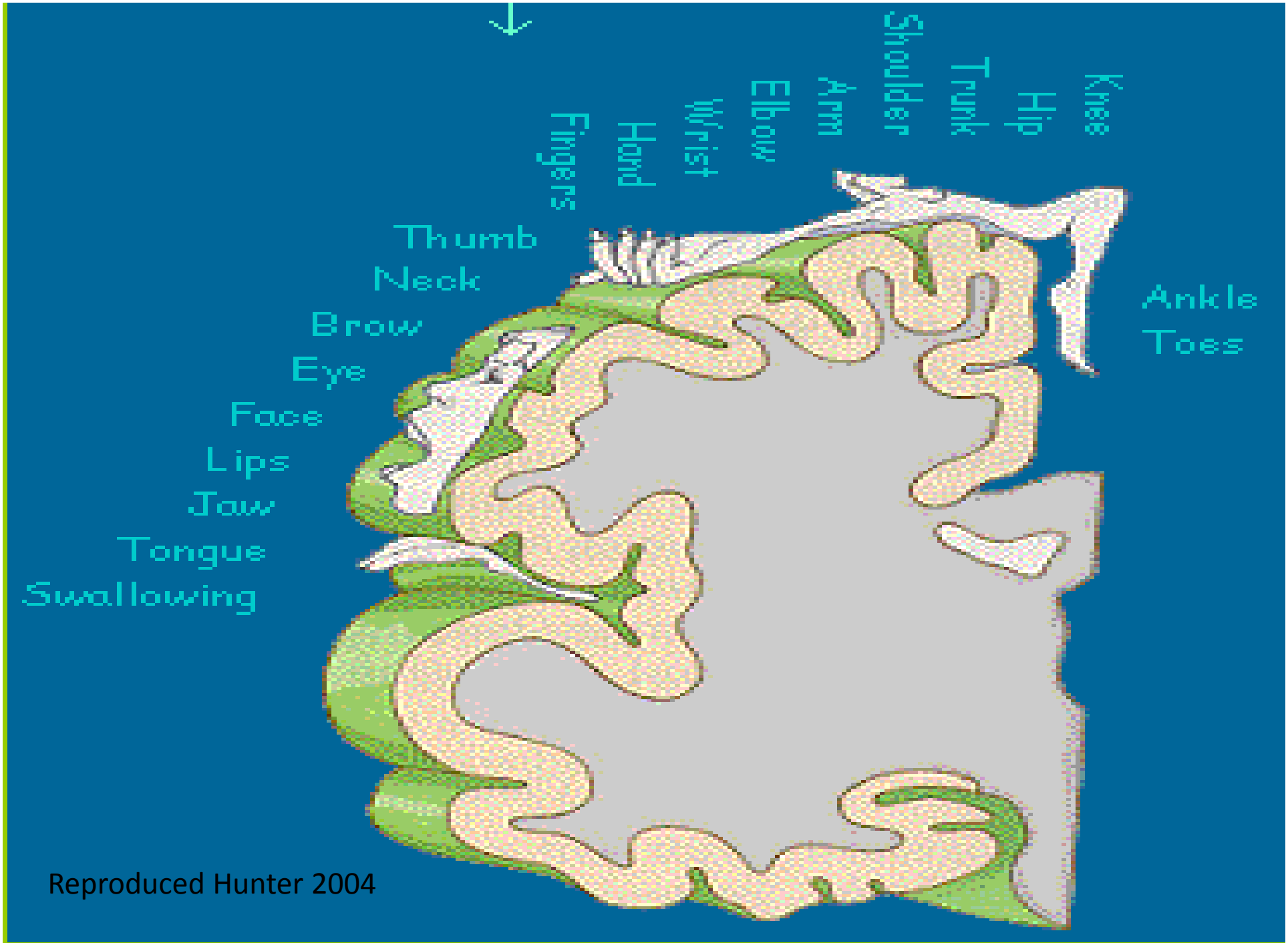

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Anatomy of Motor Cortex

- Initially felt to be a point to point representation
- Highly dynamic and adjustable
  - major subdivisions with highly distributed representation
  - different body parts overlap spatially and temporally
  - multiple separate sites for each of motor cortical organization
- Flexible organization with possible substitution and reorganization

Neuroplasticity After Stroke

- Redundancy of brain circuitry [parallel pathways]
- Unmasking/reorganization of previous existing but inactive pathways ipsi/contra
- Sprouting of new fibers from surviving neurons leading to formation of new synapses

Within Plasticity Parallel Pathways

- Primary motor cortex as well as the premotor, supplemental motor cortex and cingulate motor cortex contain somatotopic representation
- They connect to pyramidal tracts
- These parallel pathways can substitute for each other in recovery

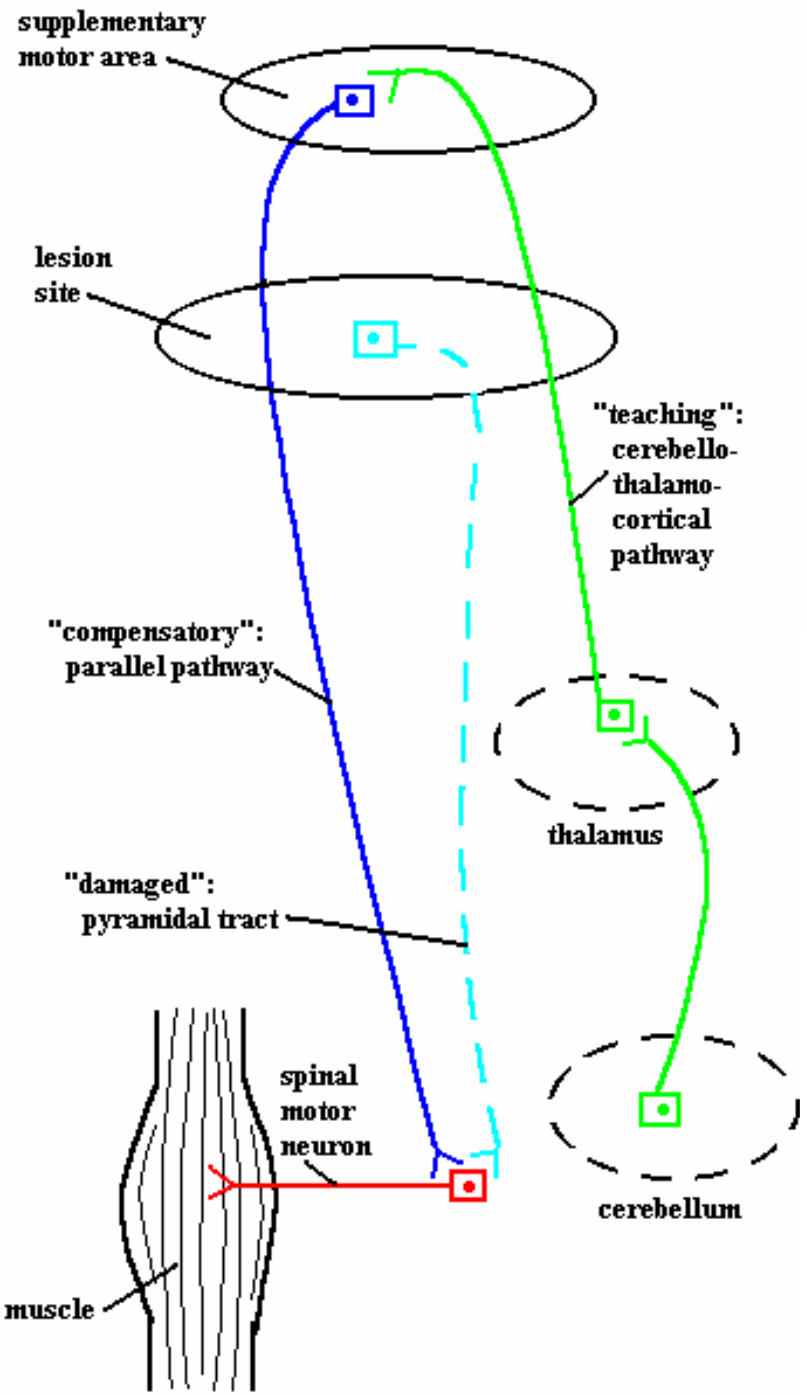

Figure 9: The brain of a recovered stroke patient relies on a compensatory neural pathway (dark blue) as substitution for the damaged neural pathway (blue dashed). The cerebello-thalamo - cortical pathway (green) is “teaching” the supplementary motor area its new function, which is indicated by abnormal activity in the cerebellum and thalamus. (Freely adapted from Azari & Seitz, 2000)

Within Plasticity Cortex Unmasking/ Reorganization

- Undamaged motor cortex adjacent to or in the contralateral hemisphere reorganizes and takes over the function of the damaged cortex
- Swallow has a bilateral asymmetric interhemispheric representation with the motor/premotor cortex

Within Plasticity Cortex Reorganization/Unmasking

- Recovery has been noted by fMRI from activation of the smaller contralateral undamaged hemisphere and from ipsilateral rim
- Ipsilateral plastic changes are usually more efficient

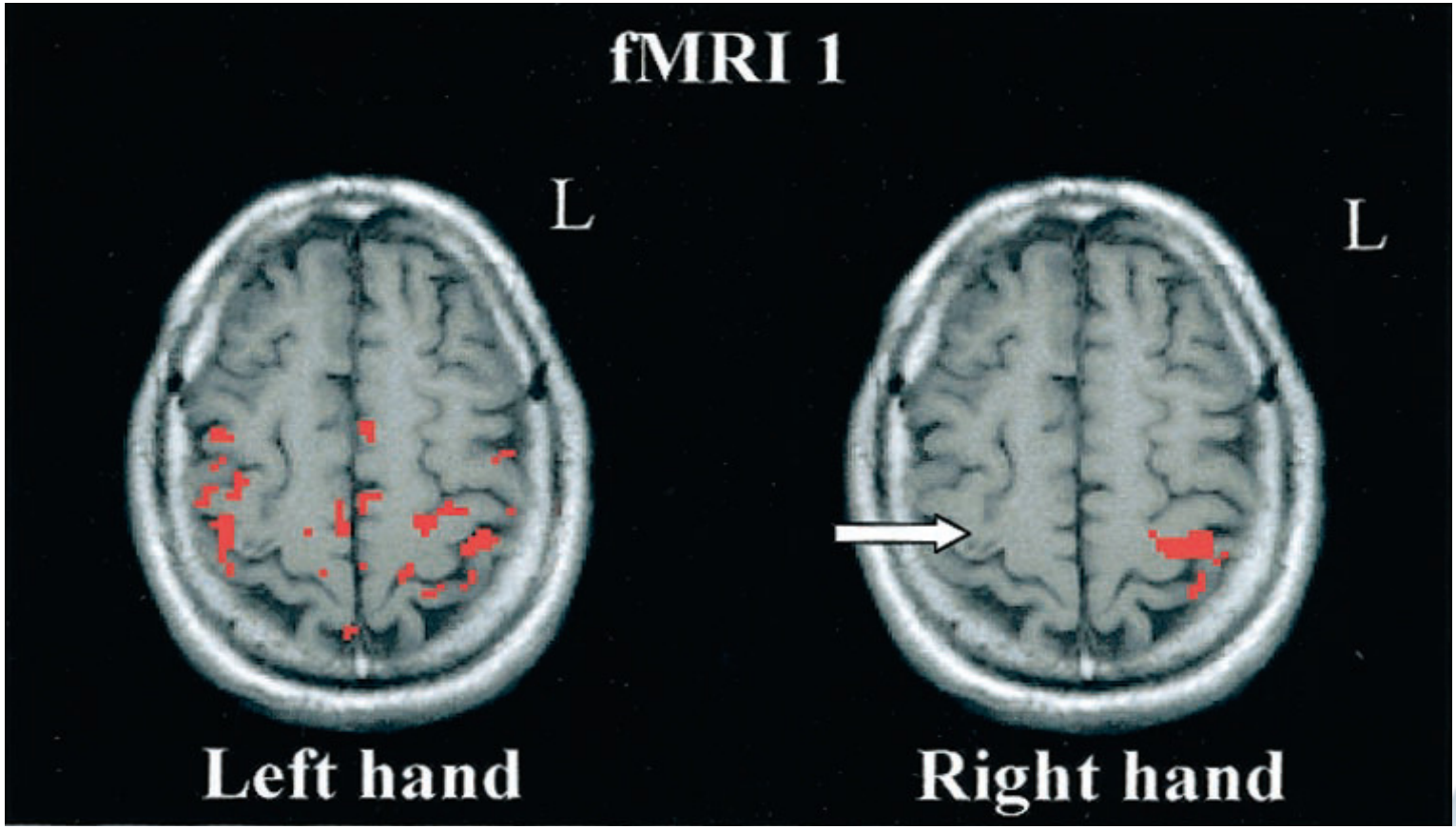

Figure 2. Comparison between the extent of fMRI activation of the unaffected right hand (focused activation on SMC; Index-HEM1.0, IndexSMC1.0) and affected left hand (recruitment of ipsilateral SMC, frontal premotor areas, and SMA; Index-HEM0.01, IndexSMC0.14) in patient 11-HEM (M1lesioned). First fMRI session was 1 month after stroke. Statistical thresholds are the same for both hands (**P**0.0001). White arrow shows small lesion involving the M1 hand representation

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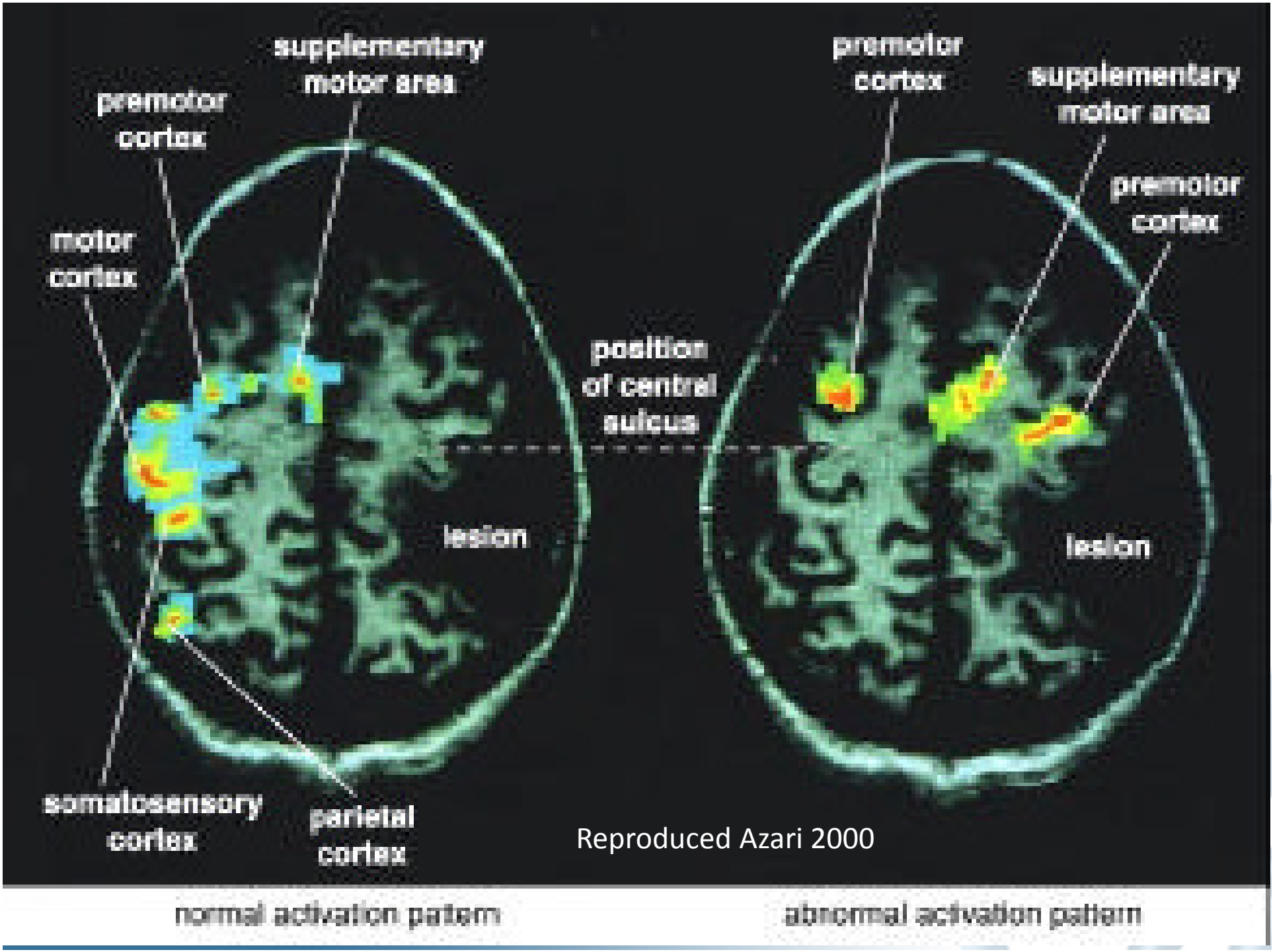

supplementary
motor area
premotor
cortex
motor
cortex
position
of central
sulcus
lesion
somatosensory
cortex
parietal
cortex
premotor
cortex
supplementary
motor area
premotor
cortex
lesion
Reproduced Azari 2000
normal activation patern
abnormal activation pattern

Within Plasticity Sprouting

- Sprouting consist of synapse formation, synapse unmasking, synapse excitability, and axonal/dendritic branches
- Cramer/Baiting showed increased dendritic synapses and levels of proteins related to growth

Within System Sprouting

- There is widespread gene activations in peri-infarct cortex and surroundings
- Similar genes for neuronal growth, dendritic spine development and synaptogenesis during early brain development
- Transcription analysis reveals that genes are upregulated in response to ischemia compared to nonischemic area

Sprouting Continued

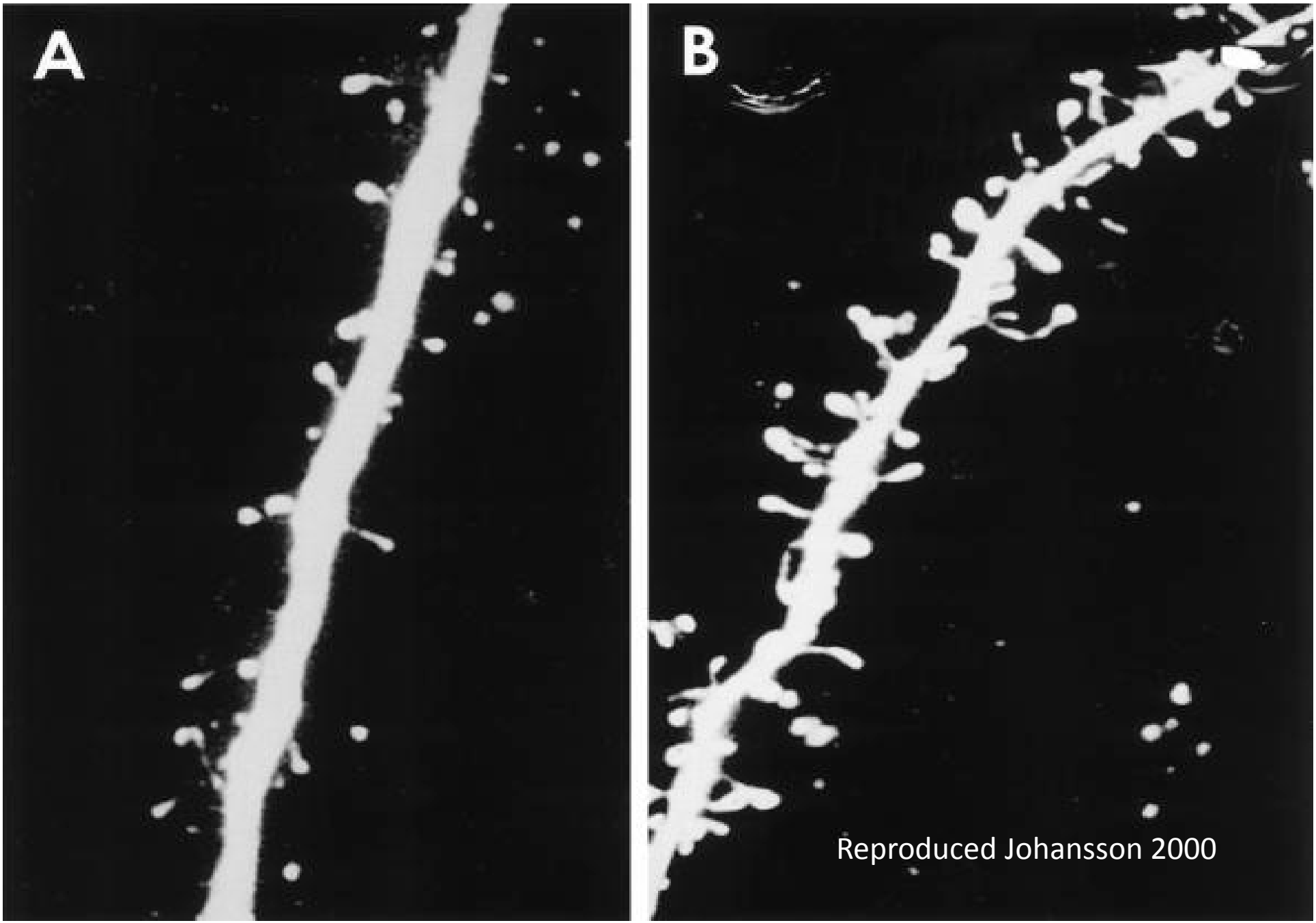
- Li et al has shown peri-infarct neurons express an age related growth associated genetic program that controls axonal sprouting and mediates the formation of new patterns of connections within the motor system
- Other factors including brain derived neurotrophic factor is upregulated with ischemia and motor learning

Within Systems Electrophysiologic Changes

- Poststoke investigations have demonstrated an increase in excitation or a decrease in inhibition in the peri-infact cortex
- Happens within days and resolves outside of the “sensitive period”
- The increase in the E/I ratio may recreate an environment similar to that during development or unmask a latent cortico-cortico connection

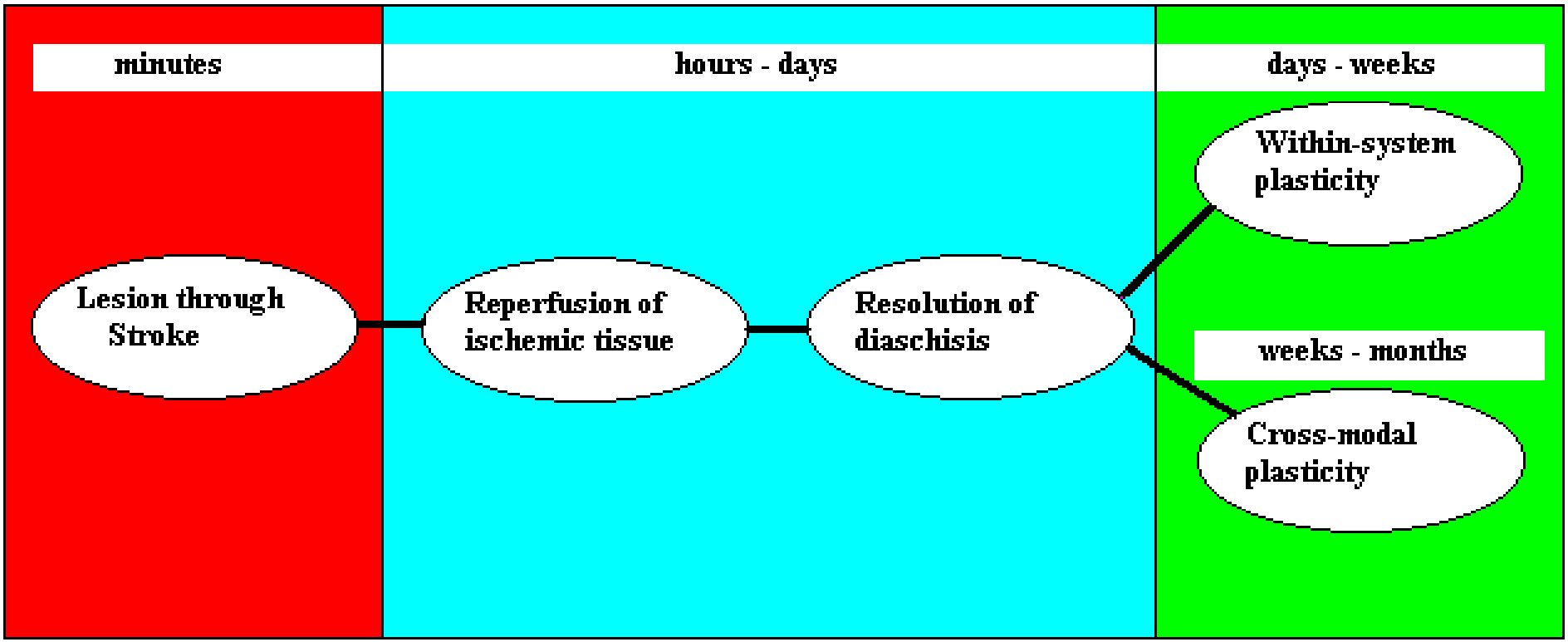
Within System Structural Changes

- Immediately after ischemia peri-infarct dendritic spine numbers are decreased
- Within days there is a dramatic increase in the rate of spine formation that is maximal at 1-2 weeks and still seen at 1 month
- This leads to new axonal growth and path finding which is associated with remapping of both local and long distance connections linked to the region of injury


A
B
Reproduced Johansson 2000

Cross Modal Plasticity

- When the motor cortex is extensively damaged networks are recruited that are not normally involved in a particular motor task
- Zari Seitz noted with sequential finger manipulation task the visual cortex showed neural activity [blindfolded]
- Cross modal plasticity is usually noted late in the recovery phase



1.) Loss of blood supply through stroke leads to permanent brain damage within minutes

2.) Passive tissue response sets in during the first few hours after sroke, whereby somestill intact neural pathways within the damaged area may be saved

3.) Active recovery processes through adaptive plasticity can take place ranging from days up to months after stroke

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Evidence Based Review of Stroke Rehabilitation Executive Summary 14th Edition

- Robert Teasell et al
- 1171 randomized controlled studies
- Original publication 4/02 with 11 revisions

- Combined acute and rehabilitation stroke units are associated with:
  - A reduction in death/dependency;
  - Need for institutionalization;
  - Length of hospitalization.

(strong evidence)

- Patients with severe or moderately severe strokes who receive acute stroke rehabilitation have decreased:
  - risk of being dependent;
  - risk of poor outcome (death/dependency)

(moderate evidence)

- Very early mobilization :
  - Reduces medical complications;
  - Improves function;
  - Decreases time to achieve functional ambulation

(moderate evidence)

- Greater functional improvement made by patients on specialized stroke units are maintained over the short and long term (strong evidence)

- The Evidence Based Review of Stroke Rehabilitation Executive Summary suggests that stroke patients who: are treated in acute care specialized stroke units; receive very early mobilization; and treated in acute rehabilitation units have better outcomes with less mortality

Patterns of Neurologic Recovery

- 95% of patients reach best neurologic function within 11 weeks
- Milder strokes recover more quickly
- Only minor recovery occurs after 6 months

Prognostication

- Initial prognostic accuracy is limited by:
  - Cerebrovascular disease is heterogeneous (type, location, size)
  - Transient symptoms (edema, bleed, penumbra)
  - Medical comorbidities

Ambulatory Prognosis

- 85% of 285 stroke patients treated with inpatient rehabilitation were ambulatory at discharge.
- Patients reached Brunnstrom stage 3 (active flexion and extension synergy throughout range)

  Feigenson J. Stroke 1977;8:651-656
- Cohort report indicated that 80% of long term stroke survivors were independent in mobility

  Gresham G. N Engl J Med 1975;293:954-956

Recovery of Arm Function

- Poor prognosis for useful hand function
  - Complete arm plegia at onset
  - No measurable grip strength at 4 weeks
- 11% gain good hand control with initial severe weakness
- 70% of patients will make a full or good recovery who have some finger motor recovery at 4 weeks

Aphasia Recovery

- 33% of stroke patients have language impairments
- At 6 months only 12%-18% have identifiable aphasia
- Language impairments can improve beyond 1 year
- Poor prognosis is seen with global aphasia and larger lesions

Dysphagia Recovery

- Dysphagia rapidly improves in patients with unilateral strokes
- By one month post onset only 2% of patients still have difficulty
- Brainstem or bilateral hemispheric strokes progress more slowly

Visual Field Recovery

- 20% of stroke patients have visual field cuts
- Recovery usually not as impressive as motor or sensory recovery
- If field cut persists without noticeable recovery beyond 2-3 weeks late recovery is less likely

Factors Predicting Poor Outcome

- Advanced age
- Medical comorbidities
  - Myocardial infarction
  - Congestive heart failure
  - Diabetes

Factors Predicting Poor Outcome continued

- Severity of the stroke
  - Severe weakness
  - Poor sitting balance
  - Visual spatial deficits
  - Cognitive change
  - Incontinence
  - Low initial ADL scores
- Longer time interval to onset of rehabilitation/therapy

Post-Stroke Depression

- Mood disorder due to a general medical condition
- Associated with increased disability, increased cognitive impairment, increased mortality, increased falls and worse outcomes
- Two forms of PSD
  - Major endogenous depression
  - Minor reactive depression

Major Endogenous Depression

- 10-50 percent of stroke patients
- Monoamine pathways are disrupted
- Depletion of norepinephrine/serotonin or receptor sites
- Generally full recovery in 1-2 years

Minor Dysthymic Reactive Depression

- 15-40 percent of stroke patients
- Varying recovery over 2 years
- Can become a major depressive disorder

Risk Factors of PSD

- Female
- Previous history of depression
- Functional limitations
- Cognitive impairment
- Assistance needed for ADL
- Location of stroke (Bilateral frontal, temporal, and caudate)

Treatment of PSD

- Strong evidence that transcranial magnetic stimulation is effective
- Moderate evidence for brief psychosocial intervention with antidepressants is more effective than antidepressants alone
- No benefit from speech therapy, physical activity or music therapy

Treatment cont.

- Strong evidence that treatment of PSD is associated with improved function
- Moderate evidence that early treatment is associated with increased long term survival
- Strong evidence that heterocyclic antidepressants improve depression yet side effects are more frequent
- Strong evidence that SSRI are effective
- Moderate evidence that SNRI are effective
- Absence of evidence for SSRI/SNRI regarding the effectiveness as a treatment for PSD

Treatment cont.

- Moderate evidence that methylphenidate is more effective than placebo for PSD and acts more quickly than traditional antidepressants
- Treatment duration is recommended for 6 months

Prevention of PSD

- Strong evidence that initiation of antidepressant therapy in non-depressed stroke patients is associated with a reduced risk for development of PSD
- Ongoing individualized contact and support is associated with less PSD

Right MCA Brain Stroke

- Left sided weakness
- Left sided sensory loss
- Left visual field cut/hemianopsia
- Attention span deficit
- Denial of deficits
- Neglect/Ignore left side
- Agnosia do not recognize faces, pictures or objects
- Emotional lability

Right Brain Stroke cont.

- Impulsivity act without plan
- Visual/Spatial deficit problem judging distance, size, position, rate of movement and how parts relate to the whole

Right Brain Stroke cont.

- Can be very deceptive in cognition/safety
- Keep environment safe
- Scan to left
- Handle task in tandem
- Place objects on right
- Minimize distractions
- Minimize clutter

Left Brain MCA Stroke

- Right weakness
- Right sensory loss
- Aphasia – verbal expression, auditory comprehension, reading comprehension, graphic expression

Left Brain Stroke cont.

- Slow, deliberate and easily frustrated
- Comfortable pace
- Be patient
- Identify strengths of communication and check them
- Normal voice
- Use gestures pictures, if needed
- Use yes/no

Posterior Stroke

- Brainstem, cerebellar or occipital
- Occipital – visual loss
- Cerebellar/brainstem – ataxia, diplopia, vertigo, dysphagia and dysarthria

Dysphagia Signs/Symptoms

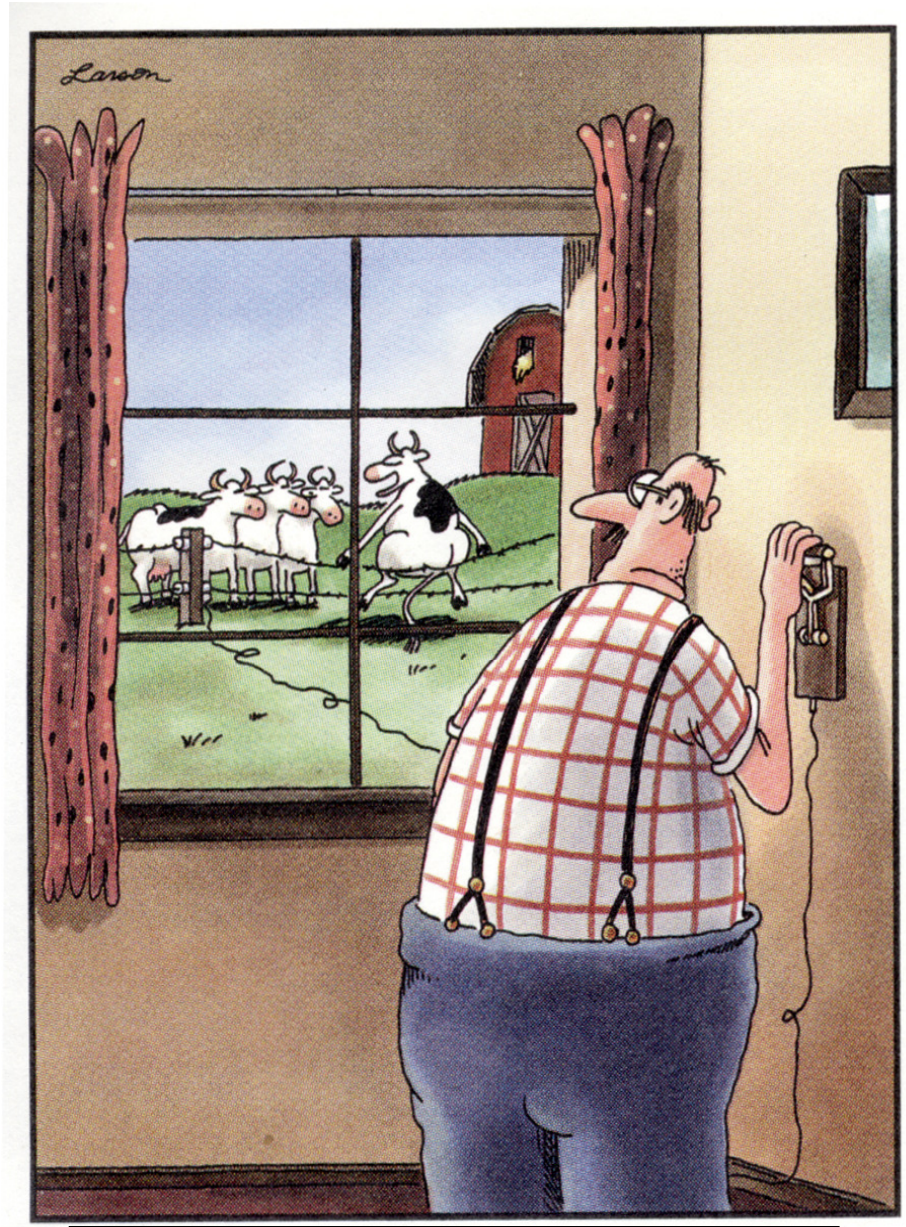
- Wet vocal quality
- Tearing of eyes when eating/drinking
- Coughing when eating/drinking
- Cough
- Rattle of lungs
- Fever

Dysphagia Treatment/Prevention

- Speech Pathology evaluation
- Change texture solids – pureed, soft
- Change consistency fluids – thicken
- Position upright
- Chin tuck or head turn

Summary

- Stroke is a prevalent lethal/disabling condition
- Combined acute and rehabilitation stroke units have better outcomes
- Early onset intensive therapy results in better outcomes
- Depression should be recognized and treated



"Look, if it was electric, could I do this?"