



Perioperative Stroke

Alex Bekker, M.D, Ph.D.
Professor and Chair,
Department of Anesthesiology
Rutgers New Jersey Medical School

"My brain, that's my second favorite organ."



Brain Injuries

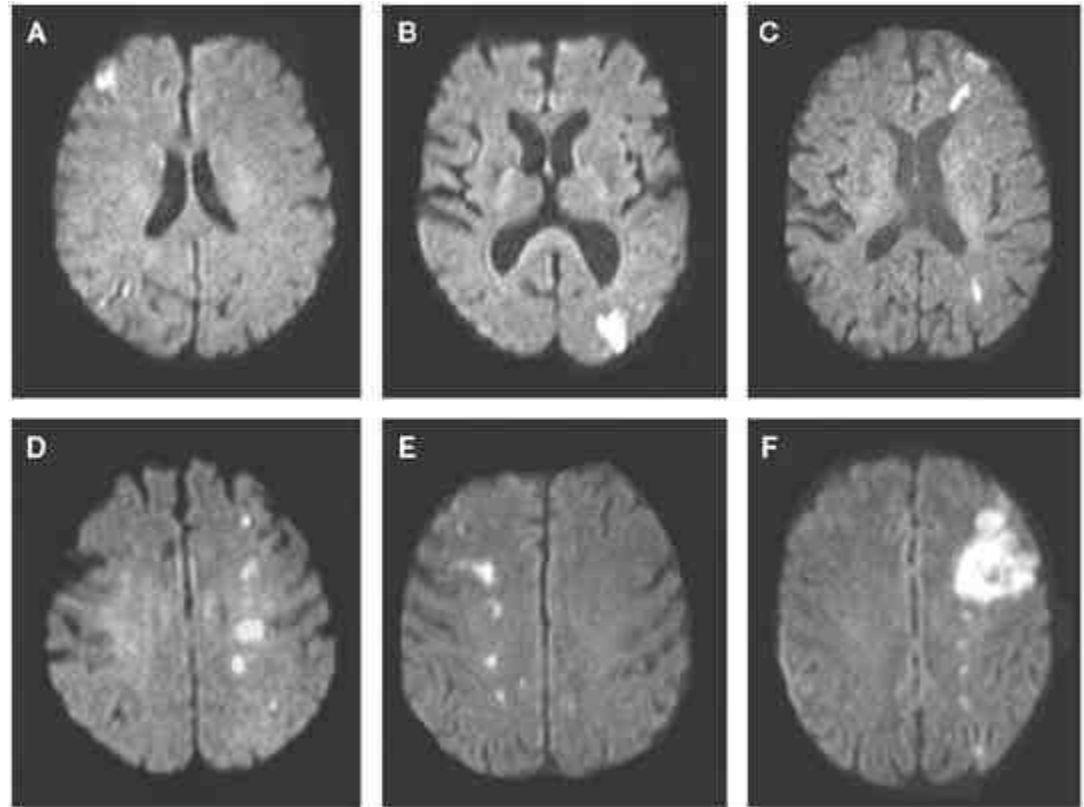
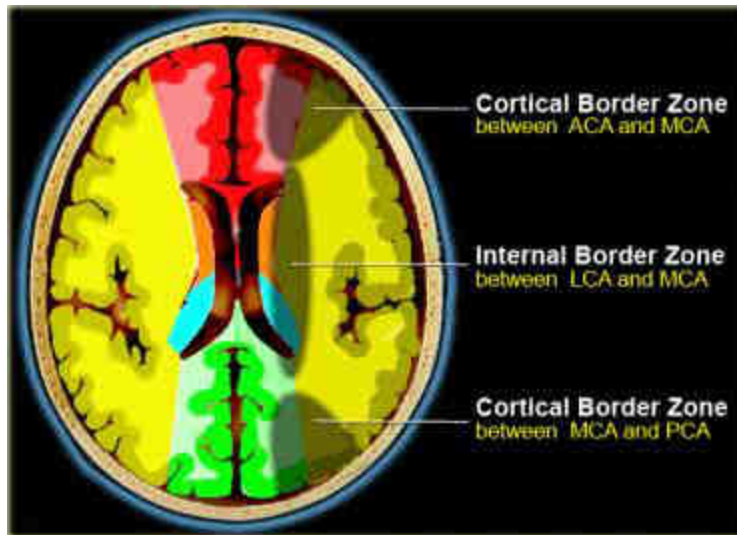


Focal infarction



Hemorrhagic stroke

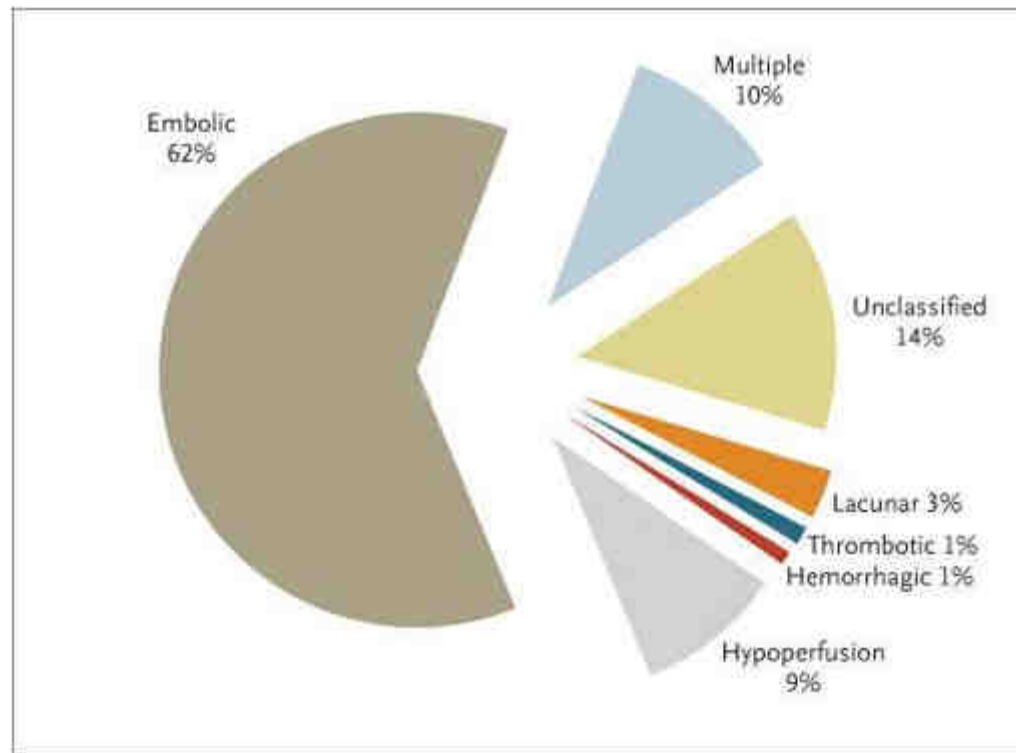
Brain Injuries: Hypoperfusion



Incidence of Stroke after Various Surgical Procedures

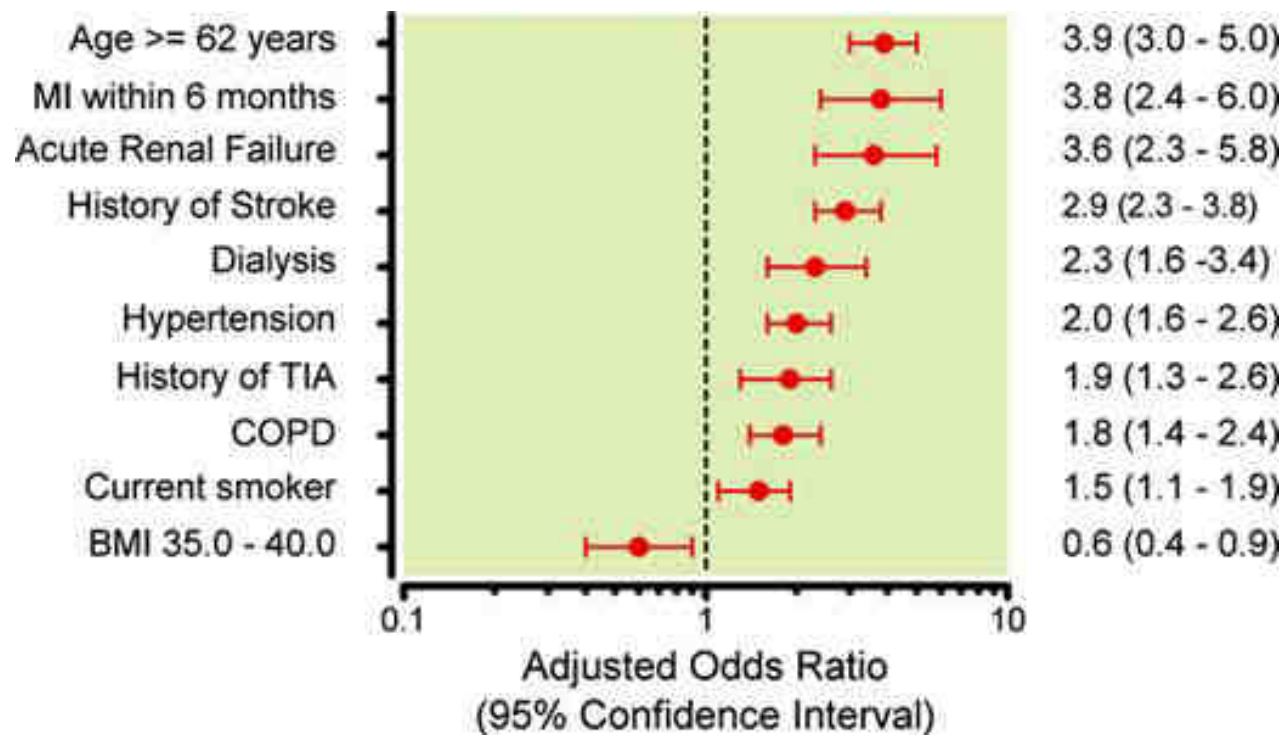
Procedure	Risk of Stroke (%)
General surgery	0.08-0.7
Peripheral vascular surgery	0.8-3.0
Head and neck surgery	4.8
Carotid endarterectomy	5.5-6.1
Isolated CABG	1.4-3.8
Isolated valve surgery	4.8-8.8
Combined CABG and valve surgery	7.4
Aortic repair	8.7


Mechanism of Perioperative Stroke



Selim M, *NEJM* 2007

Predictors of Perioperative Stroke





75 y.o. man was admitted for partial thyroidectomy. During the last year, he experienced two episodes of reversible ischemic neurologic deficits involving the right eye and left arm and leg. He also had chronic atrial fibrillation, and NIDDM. During the procedure, he developed an episode of rapid atrial fibrillation at 130 bpm. On emergence from anesthesia, he had a left hemiplegia. The CT showed multiple bilateral cerebral infarcts.



Etiology of Perioperative Emboli

- Activation of the hemostatic system and reduced fibrinolysis after surgery
- Dehydration, bed rest
- Withholding of antiplatelet or anticoagulant therapy
- Atrial fibrillation

Timing of Surgery in Relation to Stroke

How long should general surgery be delayed after stroke?

- Autoregulation is impaired after stroke for approximately two weeks
- Allow at least 1 month to elapse between a moderately large ischemic stroke and surgery

Bond R, *Cerebrovasc Dis* 2004
McKhann G, *Stroke* 2006

Large artery stenosis and surgery

- Asymptomatic carotid stenosis does not increase the stroke risk
- Patients with symptomatic carotid artery stenosis should undergo CEA or CAS
- In patients having both coronary and carotid artery stenosis, the symptomatic lesion should be treated first with a staged procedures

Evans B, *Neurology*, 2001


Naylor A, *Eur J Vasc Endovasc Surg* 2002

Perioperative Management of Antiplatelet and Anticoagulant Medications

- Bridging anticoagulant therapy with heparin or LMWH should be considered for the majority of patients who require temporary interruption of warfarin therapy
- Aspirin therapy should be continued throughout the perioperative period (CEA, low risk of hemorrhagic complications)
- Clopidogrel is usually stopped for at least 1 week because of the risk of perioperative hemorrhage

Taylor D, *Lancet* 1999

Weber A *Br J Clin Pharmacol* 2001



A 55 y.o. woman underwent arthroscopic shoulder surgery in the beach chair position. She received an interscalene block and general anesthesia. On emergence from anesthesia the patient was unable to follow commands and had left hemiplegia. CT scan revealed a large right-sided anterior cerebral and middle cerebral infarct. The CT angiography and MRI imaging of the carotid arteries did not demonstrate any pre-existing condition of those vessels.

Drugs	Amount	Monitors	Monitors	FLUID	AIRWAY	LINE	Other	PACU
Propofol Sufentanil Bac Pantone Fentanyl	1.7 1.7 1.0 2.3 1.3 2.4 2.4 2.5	ECG PICO SPO2 ETCO2 CVP BIPAP TEMP FACE CVP PA SVO2: O	150 100 50	WFI (ml) WRI (ml) FRL Urine Position	Brand: MAC 2.5 ET Tubed at 22 ET Tube: SE Equal Airway: Draft/Asa Eyes: taped Ant. Numb: P Circuit: Se La	20g PIV @ AC 22g @ wrist	<input checked="" type="checkbox"/> Risk factor and status noted <input checked="" type="checkbox"/> Anesthesia administered <input checked="" type="checkbox"/> Anticipated in PACU <input checked="" type="checkbox"/> Fully positioned in PACU <input checked="" type="checkbox"/> Monitored at all times <input type="checkbox"/> Immediately available theologist QB 1 Day Provider Signature: <i>[Signature]</i> (Spencer)	Pre-up Meds: Midazolam 2mg Fentanyl 50mcg Acet 1g iv SpO2 @ 2.50 HR BP RR Temp

Anesthesia Time
 Surgical Time
 Equipments Checked
 IS block
 30cc 0.5% bupivacaine
 injected under VIS guidance
 see cis note

125 suction tips
 on staff
 available
 If id, patient monitors
 placed, IV induction
 started, but at least
 10 minutes was applied
 to have it in place.
 Negative VEG 2.5
 - was IV induction
 time
 ET ok
 Good Airway

PACU ORDERS (check all that apply) No PACU Orders

ADULTS:
 Morphine 1-3 mg IV q 10 min PRN pain, with a maximum of 20 mg per hour (usual dose range 0.02-0.05 mg/kg per dose)
 Oxycodone 5mg IV q 10 min PRN pain, with a max of 20 mg per hour (usual dose range 0.2-0.5 mg/kg per dose)
 Fentanyl 25 mcg IV q 5 min PRN pain, with a maximum of 150 mcg per hour (usual dose range 0.15-0.5 mg/kg per dose)
 Propofol 0.5 mg IV q 10 min PRN sedation/ventilation, usual dose range 0.1-1.0 mg per dose

CHILDREN:
 Morphine 0.1-0.2 mg IV q 10 min PRN pain, with a maximum of 1 mg per hour (usual dose range 0.02-0.05 mg/kg per dose)
 Oxycodone 0.1 mg IV q 10 min PRN pain, with a maximum of 1 mg per hour (usual dose range 0.25-0.5 mg/kg per dose)
 Fentanyl 1 mcg IV q 5 min PRN pain, with a maximum of 10 mcg per hour (usual dose range 0.1-0.5 mcg/kg per dose)

Call anesthesia for non-recovery 70% Discharge from PACU with O2 by nurse at 2-4 L/min at 90% O2 SAT 90%

OTHER: Zofran 4mg IV prn nausea Prescribed by *[Signature]* (Killoan) Bumper 3030

Beach Chair Position

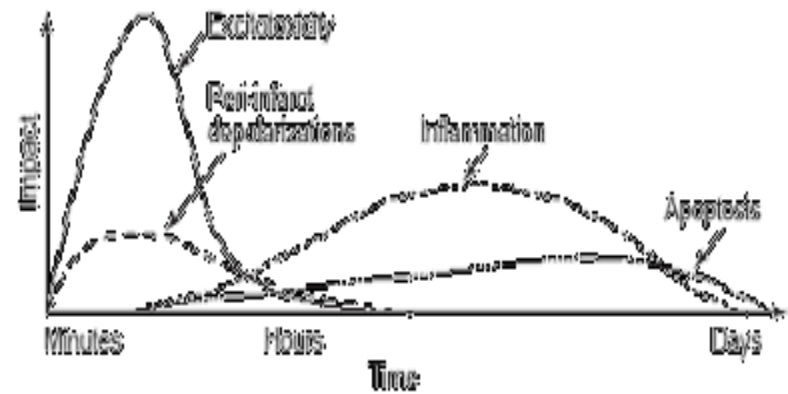
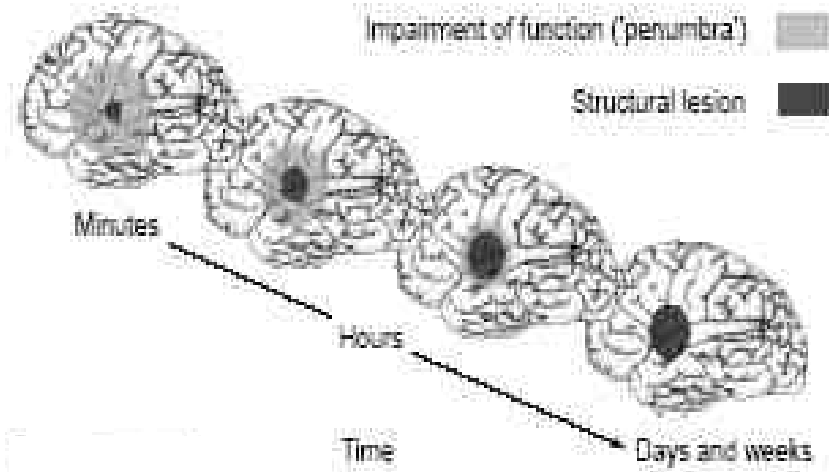




Mechanisms of Ischemia

- **Supply Demand Imbalance**
- **Excess Neurotoxic Factors**
- **Lack of Neurotrophic Factors**
- **Delayed Processes (i.e. inflammation, apoptosis)**

Putative Cascade of Events in Cerebral Ischemia





Cerebral Protection: Definitions

- Prevention
Methods to reduce injury
- Neuroprotection
Therapy initiated before the injury
- Neuroresuscitation
Treatment instituted after the insult
- Neurorestoration
Brain remodeling which improves a functional outcome

Potential Interventions

- Increase CBF in the ischemic territory
- Reduce cerebral metabolism
- Reduce intracranial pressure
- Suppress seizures and sympathetic discharge
- Inhibit excitatory neurotransmitter activity
- Prevent Ca and Na influx
- Inhibit lipid peroxidation
- Scavenge free radicals
- Promote antiapoptotic proteins
- Inhibit apoptotic enzymes

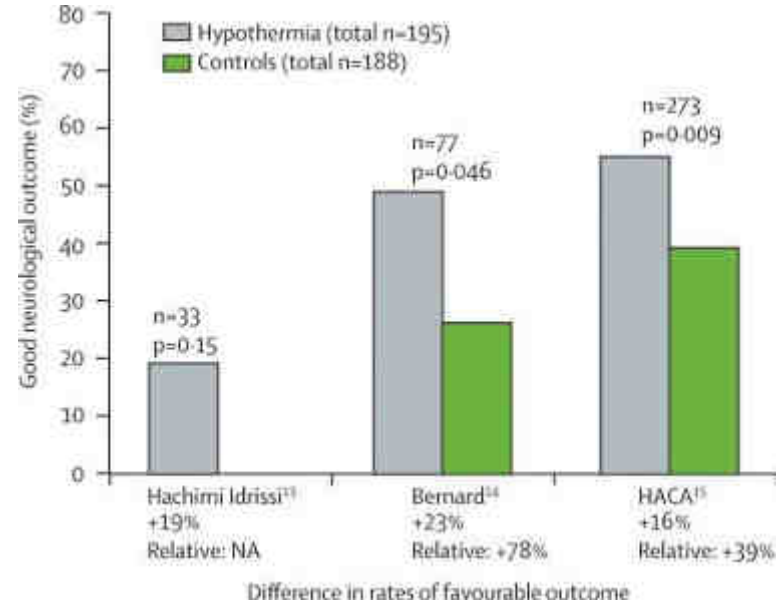
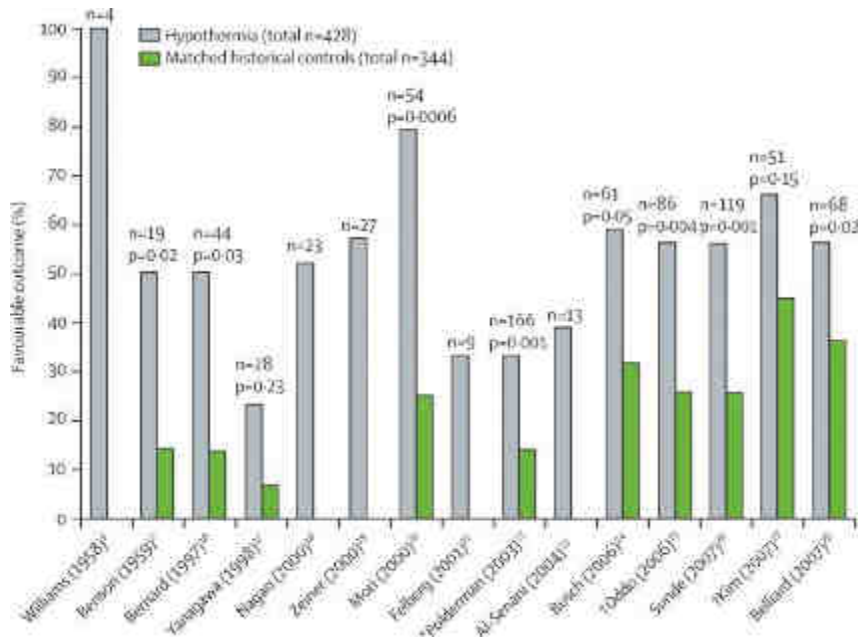
Is Neuroprotective Therapy Just a Fantasy Invented by Basic Scientists?

- **Timing**
- **Age and associated illness**
- **Morphological and functional differences between the brain of humans and animals**
- **Discrepancies on the outcome measures and functional outcomes**
- **Plasma concentration of drugs and side effect**

Hypothermia

- Cerebral metabolism is reduced by 5-7%/1° C
- Suppresses excitotoxins and oxygen radicals
- Reduction in edema and inflammatory responses
- Perioperative hypothermia triples the incidence of adverse myocardial events
- Impairs immune function
- Decreases collagen synthesis
- Reduces platelet function
- Decreases activation of the coagulation cascade

Hypothermia and Cardiac Arrest



Barnard SA, *NEJM*, 2002

The HACA Group, *NEJM*, 2002



Statins After Ischemic Stroke and Transient Ischemic Attack

An Advisory Statement From the Stroke Council, American Heart Association and American Stroke Association

“Based on results of numerous large-scale randomized trials, the vast majority of patients with a history of ischemic stroke or transient ischemic attack could benefit from statin use”

Stroke 2004; 35:1023



Physiologic Modifiers of Ischemic Outcome

- Cerebral perfusion pressure
- Blood glucose
- PaCO₂
- Seizure prophylaxis
- Body temperature



Final Thought

If the human brain were simple enough for us to understand it, we would be too simple to understand it