

### Definition of Good Lecture

- Learn one new fact
- Be entertained
- Learn management strategies that result in reduced physician regret
- Become enthusiastic, knowledgeable, therapeutically active and aggressive
- Not disturbed by office staff
  - toilets backed up
  - by spouse that car does not start

### Stroke Management Studies

Conflicting

Confusing

Less than compelling data

### What is clear about stroke data

Need to study homogeneous groups of patients

#### Poor heterogeneous

- all TIA or completed stroke patients lumped together without specific stroke subtype

#### Ideal homogeneous

- hypertensive, Afro-American male who presents with typical lacunar syndrome, without warning TIA, CT/MRI delineates lacunes, normal vascular imaging studies, no clinical evidence of PVD or CAD

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Some situations in which controlled clinical studies will never be done!

## Case 1

52 y.o. Caucasian man goes to his PCP for yearly evaluation and has no vascular symptoms

### Medical History

- mild hypertension treated with diuretic only
- mild obesity
- glucose intolerance
- dyslipidemia
- heavy smoker

### Summary

Asymptomatic, but with heavy vascular burden of risk factors

### PE

BP 160/100  
P 80 & regular  
cardiac and respiratory system normal  
left neck noise

### Characteristics of this neck sound

louder in neck than upper mediastinum  
no change in sound intensity with patient supine

### Also

left Hollenhorst plaque visualized on fundoscopic examination

### Laboratory

CBC – normal  
ESR – 42  
CRP – elevated  
Lipid profile  
    Total cholesterol – 300  
    LDL – 270  
    HDL – 30  
Homocysteine – 14  
EKG - normal  
Chest x-ray - mild cardiomegaly  
EBT – no calcification

### Significance and Source of neck noise

- Carotid artery
- Jugular vein
- Cardiac system

This sound indicates carotid bruit

- Turbulent flow
- Does not imply carotid stenosis of any degree

Since the patient is asymptomatic, what brain and vascular imaging studies are indicated?

- Carotid duplex ultrasound
- MRA
- MRA with gadolinium
- CT angiogram
- Conventional catheter angiogram

What is the role of brain imaging studies in this patient?

CT

MRI

- DWI (diffusion weighted imaging)
- PWI (perfusion weighted imaging)

What is the likely pathological basis of the carotid bruit?

- Multifocal atherosclerotic plaque
  - Concentric
  - Eccentric
- Stenosis
- Plaque rupture
- Thrombosis
- Fibrosis
- Calcification

Conclusion

Atherosclerosis is disorder of arterial wall and not lumen

What is the appropriate therapy if carotid ultrasound shows 60% extracranial carotid stenosis and this is confirmed by angiogram?

- Surgical
  - CEA
  - Angioplasty and stent

- Maximal medical management  
(Discussed later)

Vascular protection strategies

- Maintain perfusion
- Antiplatelets
- Anticoagulation

Statin  
ACE inhibitor  
Homocysteine lowering strategy  
Antihypertensive medication  
Tight glucose control  
Alter bad habits

What is stroke risk in this patient?

Correlates with degree of stenosis  
Different from cardiac status

- (acute coronary syndromes)
- hot vessel with 40 to 50% stenosis leads to ruptured plaque and coronary thrombosis

Atherosclerosis

Multifocal disorder

Pattern of progression

Lower extremities  
ankle-brachial index  
Coronary arteries  
EBT  
Aortic arch  
TEE  
Extracranial carotid and vertebral vessels  
Angiogram  
MRA  
Intracranial vessels  
TCD  
MRA  
Angiogram  
CTA  
Arterioles  
Not visualized

Does this patient have a high vascular risk?

Locations

Peripheral vascular disease  
Coronary artery disease  
Cerebrovascular disease

Stroke risk factors

Hypertension  
Cardiac disease  
Diabetes mellitus  
Dyslipidemia

## Bad habits

- Alcohol
- Smoking
- Illicit drugs
- Obesity
- Physical inactivity

## Homocysteine

## Hypercoagulable states

## Nonmodifiable factors

- Family history
- Age
- Race
- Gender

## Virchow triad for vascular thrombosis

- Blood vessel wall abnormality
- Flow disturbances
- Blood element coagulation disturbances
  - Hypocoagulable
  - Hypercoagulable

## Examples of coagulation disorders

### Hemoglobin abnormalities

### White blood cell hyperviscosity states

### Red blood cell hyperviscosity states

### Platelet abnormalities

### Inflammatory markers

- ESR, CRP, fibrinogen

### Antiphospholipid antibody syndrome

### Procoagulation disorders

- Factor S C and anti-thrombin III

- Van Leiden factor

- Plasminogen inhibitor

## Patterns

- Arterial

- Venous

## Case 2

58 y.o. Afro-American man suddenly awakens with left sided weakness. His speech is slurred, he trips going to the bathroom and his toothbrush drops from his left hand. Exam shows pure motor left hemiparesis. BP is 210/110 mm Hg and pulse is 80 and regular. He has no carotid bruit. Funduscopy shows hypertensive retinopathy. PMH includes hypertension and diabetes mellitus. Meds include Hydro-Diuril, Atenolol, Verapamil, Accupril, insulin.

### Diagnostic investigations

- Chest radiogram – cardiomegaly
- EKG – left ventricular strain pattern
- BUN – 32
- Creatinine – 2.6
- Urinalysis – 2+ proteinuria

### Neuroimaging

- CT – right capsular hypodense lesion
- MRI – multiple bilateral capsular hyperintense lesions
- Carotid ultrasound – nl
- MRA – nl
- Transcranial Doppler – nl
- Conventional angiogram – nl

### Immediate Potential Strategies

- Parenteral or sublingual BP lowering with medication
  - Anticoagulation
  - Antiplatelet medication
  - Anti-edema strategy
    - Cytotoxic
    - Vasogenic
    - Interstitial
  - Vascular protection
  - Neuroprotection

### Conclusion

#### Vascular Imaging Studies

Most likely represents arteriolar disease which is below resolving capability of angiography

### Pathology

- Vascular
  - Lipohyalinosis
  - Fibrinoid degeneration
  - Microatheroma
  - Charcot-Bouchard aneurysm
- Brain
  - Lacune
  - Hemorrhage

### Case 3

78 y.o. Caucasian male develops palpitations and chest pain. He has dyslipidemia and essential hypertension. Meds include Lipitor, Hydro-Diuril, ASA, Plavix, Atenolol. He had prior myocardial infarction one decade ago. He has no neurological dysfunction, however, he develops headache and dizziness when he takes his NTG for chest pain. He drinks a six-pack of beer daily.

#### Investigations

EKG  
atrial fibrillation  
CT (brain)  
no abnormalities  
MRI (brain)  
periventricular white matter disease

#### Evaluate stroke risk and potential stroke mechanisms in this patient

Cardiac  
– red clot formation (thrombin rich)  
Cerebrovascular atherosclerotic carotid stenosis – white clot formation (platelet-fibrin rich)

#### Further diagnostic investigations

ECHO  
TTE  
TEE  
Carotid ultrasound  
MRA  
CTA

#### Treatment Options

ASA  
Dipyridamole  
Clopidogrel  
Ticlopidine  
Aggrenox  
Coumadin

Treating MD believes patient is “too old” and “non-compliant” to take Coumadin. He is started on ASA 325 mgm daily. Three months later he awakens with left-sided headache and appears confused. Exam shows Wernicke aphasia and right homonymous hemianopsia. Pulse rate is 82 but irregular

## Diagnostic Evaluation

- CBC and platelet count – normal
- EKG – atrial fibrillation
- CT – left temporal-parietal nonhemorrhagic infarct
- MRI – left temporal-parietal hyperintense lesion
- MRI with diffusion weighted imaging – multiple lesions in both hemispheres

## DWI finding significance

- Recent lesion(s) within 10 to 14 days
- Most sensitive and earliest to detect ischemic lesion
- Based upon principle of Brownian motion
- With embolization would expect multiple lesions to be visualized with MRI

Anticoagulation is initiated with intravenous heparin to maintain PTT of 80. Three days later, he becomes lethargic and develops right hemiparesis.

## What are potential mechanisms of neurological worsening?

Hemorrhagic transformation

Re-embolization

Edema→mass effect→hydrocephalus→herniation

Seizure with prolonged postictal state

Complicating medical condition

## Management

### Avoid

Hyperthermia

Hyperglycemia

Hypoxia

Hypercarbia

Hyperviscosity

Blood pressure extremes

Hypertension

Hypotension

### Anticoagulation

Heparin

Coumadin

## Case 4

63 y.o. woman experiences an episode of sudden loss of vision in her left eye. She says this is similar to a shade being pulled down over the eye. Vision returns in 15 minutes.

She has no headache.

She has 3 similar episodes over 2 week period.

When she closes the involved eye, vision is normal in the opposite eye.

She goes to the eye doctor and he notes slightly elevated intraocular pressure and suggests she schedule "routine" appointment with PCP, and be followed as "glaucoma suspect".

She has high blood pressure, dyslipidemia, on no hormonal replacement.

### What are potential mechanisms?

Vascular

Transient ischemia

Hemorrhage

Electrical

Focal seizure

Migraine equivalent

Spreading cortical depression

Demyelination of MS type

### Why not due to these mechanisms?

Metabolic

Hyper - or hypoglycemic electrolyte disorder does not cause focal impairments

Mass lesion does not cause sudden impairment of function

Medications – toxin, alcohol – do not cause focal impairments

Three days later she experiences an episode in which she loses the ability to speak and her right side becomes useless and paralyzed for 30 minutes. This resolves completely. The episode occurred after dinner at which she had 3 glasses of wine.

### Potential Mechanisms of visual disorder

Primary eye disease

Optic nerve vascular disease

Arteritis

Giant cell

Nonarteritic

Carotid disease

Optic nerve demyelination

Optic neuritis – multiple sclerosis

Ocular migraine

Medical condition

Coagulation disorder  
– CRAO, CRV thrombosis  
APLA syndrome

Define these terms

Transient ischemic attack  
Reversible ischemic neurological deficit  
Cerebral infarct with transient signs  
Minor stroke  
Major disabling stroke

What is goal of cerebrovascular disease management?

Vascular protection  
Neuro protection

Goal of cerebrovascular management -

Prevent major disabling stroke

Do not consider prevention of reversible deficits as goal of therapeutic intervention.

Remember - Concept of ischemic tolerance

Neuroimaging results

CT – nl

MRI – nl

Carotid duplex – occlusion of left internal extracranial) carotid artery

Severe 99% stenosis of left ICA with ulcerated plaque

Angiogram

Management – reperfusion strategies

Intravenous heparin

Thrombolytics

Antiplatelets

CEA

Angioplasty - stent

## Case 5

49 y.o. Afro-American hypertensive man develops occipital headache and dizziness. He is confused, disoriented and has brief episodes of transient blindness. Exam shows quiet inattentive state, left pronator drift, bilateral Babinski signs. Funduscopy shows hypertensive retinopathy. BP 250/145, P = 90 reg, R 18. Neck is supple.

## PMH

Hypertension for 5 years. Meds include OH-diuril, atenolol, accupril and clonidine. Patient has several periods where he suddenly stopped his medication due to financial issues. This time he stopped meds 3 days ago. He has dyslipidemia for which he takes pravachol. Also has a diagnosis of "migraine" characterized by episodes of bilateral occipital headaches and dizziness; these are most intense upon awakening and disappear by noon.

## Labs

CBC and platelet count – nl

BUN 38

Creatinine 2.8

Chest radiogram – cardiomegaly

EKG – left ventricular hypertrophy

ECHO – concentric hypertrophy with ejection fraction of 60%

## Neuroimaging

CT – hypodense lesions in bilateral posterior parietal-occipital regions

MRI – hyperintense regions in both parietal-occipital regions

## Differential diagnosis

Ischemic stroke

Hemorrhagic stroke

    Intracerebral

    Subarachnoid

Venous sinus thrombosis

Intracranial mass

    Subdural hematoma

    Neoplasm

## Definition of Stroke

    Sudden

    Onset

    Focal

    Neurological impairment

        (negative symptoms)

### Course

Stabilize  
Deteriorate rapidly and die  
Progress over 24 to 48 hours  
Recurrence

### Acute hypertensive vascular crisis

Rapid BP increase  
Systolic > 240  
Diastolic > 140

May occur:    With encephalopathy  
                                 Without encephalopathy

### End-organ signs of damage

Funduscopy - Hypertensive retinopathy  
Cardiac -        Congestive heart failure  
                                 Chest pain due to CAD  
                                 Dissecting aneurysm  
Renal -         Deteriorating renal function  
Brain - Ischemic stroke  
                                 Large vessel  
                                 Arteriole  
                                 Hemorrhage

### Hypertensive encephalopathy

Diffuse > focal signs  
Altered mental state  
Generalized seizures  
Bilateral Babinski signs  
Visual disturbances

### Signs and symptoms

Effect posterior brain region: Due to cerebral autoregulation breakthrough at high level

### Management

Rapid lowering of BP utilizing parenteral and controllable agent  
Medical emergency that requires immediate therapy

### Goal of therapy

Prevent or correct medical complications  
Lower BP        Diastolic by 1/3, but not below 95  
                                 Systolic by 1/3

## Medications

Labetalol –

Effective if CAD prominent

Esmolol –

Rapid onset beta blocker useful if aortic dissection occurring or for post-operative crisis

Nicardipine (Cardene)

Calcium channel blocker

Diazoxide (Hyperstat)

Hydralazine –

Avoid with dissection or CAD

Nitroprusside (Nipride)

May ICP due to vasodilation

Required arterial line

## Case 7

Dr. R.J. is a 64 year-old surgeon. He awakens one morning and feels entirely well. While eating breakfast, he notes precipitous development of left-sided weakness. His speech becomes slurred, and he drops his fork. He feels dizzy and sees double. This persists for ten minutes and all symptoms rapidly and completely resolve. He does not seek medical care as he believes the symptoms are due to “low blood sugar” before breakfast as they resolve with food intake.

### Past Medical History

He has hypertension for which he takes baby aspirin, hydrochlorothiazide and Metoprolol. He is relatively noncompliant with medication. He has had a prior myocardial infarction and still has occasional angina. He has intermittent claudication of legs and has been diagnosed with peripheral arterial vascular disease, but refuses vascular or cardiac surgery. (“All my friends are cardiac or vascular surgeons and all they want to do is operate, whether necessary or not.”) He is obese, smokes one pack of cigarettes per day and has elevated blood cholesterol levels. He has no history of diabetes mellitus.

### Subsequent course

He proceeds to his office to carry out his schedule for the day. He is fine until 30 minutes before his lunch break, when he suddenly develops a severe occipital headache and becomes dizzy with diplopia. He collapses and can not move his left side and can not speak.

### Physical examination

BP 190/104 mm Hg (right arm, sitting)  
P 80 regular  
R 12, regular  
Neck – supple, no neck vein distension  
Heart & Lungs – normal  
Pulse – symmetrical, no bruits

### Neurological examination

#### Mental state

Awake, eyes open but does not follow examiner commands, can not verbalize -  
phonate

#### Gait

Cannot stand due to severe weakness

#### Motor

Quadriplegic with no motor response, motor tone reduced in all extremities

#### Reflexes

Areflexic with extensor Babinski responses bilaterally

### Sensory

No withdrawal response to pin prick

### Cranial nerves

Pupils equal and respond to light; no horizontal eye movements with preserved vertical eye movements, bilateral facial weakness with preserved blink response; gag and palate movements preserved; aphonic

### Laboratory studies

CBC – normal

Urinalysis – normal

Chest x-ray – enlarged heart

EKG – old anterior wall myocardial infarction

### Imaging investigations

CT - Hypodense pons and cerebellum

MRI - Hyperintense pons, cerebellum, thalamus, and occipital cortex

MRA - High grade midbasilar stenosis

### Treatment options

Thrombolytics

Intravenous  
Intra-arterial

Anticoagulant

Unfractionated heparin  
LMWH

Mechanical  
Angioplasty  
Stent

## Case 8

52 year-old hypertensive man awakens with left throbbing headache and vomits. When he gets out of bed, he is unsteady, dizzy and has horizontal double vision when he looks across the room.

PMH indicates hypertension controlled with diuretic and ACE inhibitor.

### Examination findings

MS - alert and attentive

Gait - broad-based ataxic with disequilibrium

Motor- no drift or hemiparesis

Reflex - symmetrical and plantar flexor response

Coordination - impaired heel-to-shin and normal finger-to-nose

CN - bilateral abducens paresis and left central facial weakness

PE - BP 220/120; P 52; R 10;

neck – limitation of flexion

### Hypertensive vascular complications

Hypertensive crisis with encephalopathy

Lipohyalinosis

Fibrinoid degeneration

Lacunae

Intracerebral hemorrhage

Accelerated atherosclerosis

### Lacunar syndromes

Pure motor hemiparesis

Pure sensory stroke

Hemiparesis – hemianesthesia

Dysarthria – clumsy hand syndrome

Ataxic – hemiparesis

### Hypertensive hemorrhages

Putaminal

Caudate

Thalamic

Pontine

Mesencephalic

Cerebellar

Supratentorial

White matter

## Management of cerebellar hemorrhages

HA

Vomiting

Elevated blood pressure

Treat and prevent seizures

Vasogenic edema – herniation

Hematoma evacuation

Hydrocephalus correction

## Pitfalls of management

Avoid medications with these effects

- Increase bleeding

- Reduce consciousness

- Reduce respiratory drive

- Impair neurological function

- Cause GI bleeding

- Impair renal function

- Increase intracranial pressure

Watch cerebral perfusion pressure with neuro checks every 30 minutes

Discontinue or reverse any anticoagulant or antiplatelet medication

## Hematoma Enlargement

Continued bleeding

- stretch-tear contiguous vessels

Edema formation

- vasogenic

Ischemia development

- cytotoxic

Rebleeding