

## Management of Acute Stroke & Understanding Diagnostic Imaging

**Acute Stroke Best Practices Workshop**  
"Advancing Best Practices in Stroke Care"

February 23, 2016

**Dr. A. Hassan MD, Neurologist**

Medical Lead- Neurology and Stroke TBRHSC



healthy  
together

## Faculty/Presenter Disclosure Slide 1



- **Faculty: Ayman Hassan**
- **Relationships with commercial interests:**
  - **Grants/Research Support:** site PI for Astra Zeneca SOCRATIS, BIOGEN IDEC ESTEEM, BAYER NAVIGATE.
  - **Other:** Employee of TBRHSC



healthy  
together

## Disclosure of Commercial Support Slide 2



- This presentation has not received any financial support or in-kind support from anyone.
- **Potential for conflict(s) of interest:**
  - I haven't received any payment/funding from any organization supporting this program and no product of AstraZeneca, Bayer or Biogen Idec will be discussed in this program.



healthy  
together

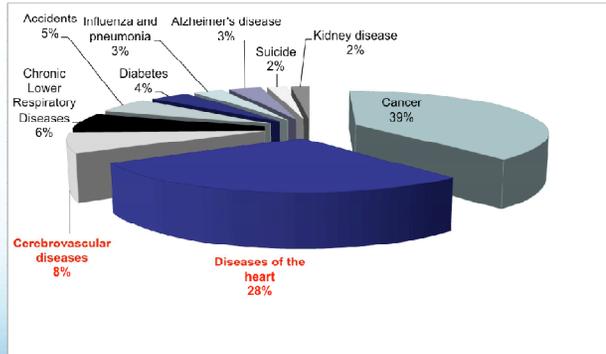
## Objectives

- Describe the types of stroke
- Brief overview of cerebral circulation
- Brief overview of neuroanatomy
- Explain diagnostic imaging pertaining to stroke
- Provide an overview of Intracerebral hemorrhage (ICH)
- Provide an overview Ischemic Stroke
- Describe the various clinical stroke presentations based on anatomy



healthy  
together

## Leading causes of death, Canada, 2007, males and females combined



Adapted from: Ten leading causes of death, Canada, 2007. Statistics Canada



<http://www5.statcan.gc.ca/bsolc/olc-ccc/olc-ccc?catno=84-214-X-0100-0001&lang=eng>



healthy together

## Canada Stats



- Every year, patients with stroke spend more than 639,000 days in acute care in Canadian hospitals and 4.5 million days in residential care facilities (CSN, 2011b).
- Stroke costs the Canadian economy \$3.6 billion a year in physician services, hospital costs, lost wages, and decreased productivity (PHAC, 2009)
- **For every minute delay in treating a stroke, the average patient loses 1.9 million brain cells, 13.8 billion synapses, and 12 km of axonal fibers (Saver, 2006).**
- Each hour in which treatment does not occur, the brain loses as many neurons as it does in almost 3.6 years of normal aging (Saver, 2006).



healthy together

## Ontario Stroke Network: Stroke Report 2014

- Fewer Canadians are dying from stroke, thanks to advances in prevention, care and treatment....but still challenges ahead
- Today's stroke patient is sicker with two-thirds having one or more chronic conditions, making treatment more complex
- The population is aging and stroke is age-related – most common age 70 +
- Younger patients are having strokes and this trend is expected to continue – alarming escalation among those under 70. Over the past decade, strokes in people in their 50's have increased by 24 %, those in their 60's by 13%
- Coordinated systems are the best way to ensure the "right resources, in the right place at the right time".
- **For every symptomatic stroke there are 9 silent strokes causing cognitive impairment "tsunami" [www.ontariostrokenetwork.ca](http://www.ontariostrokenetwork.ca)**



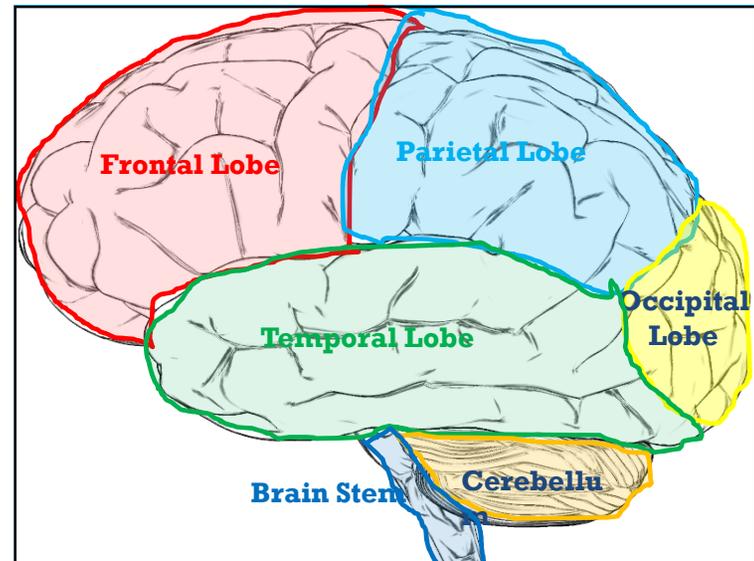
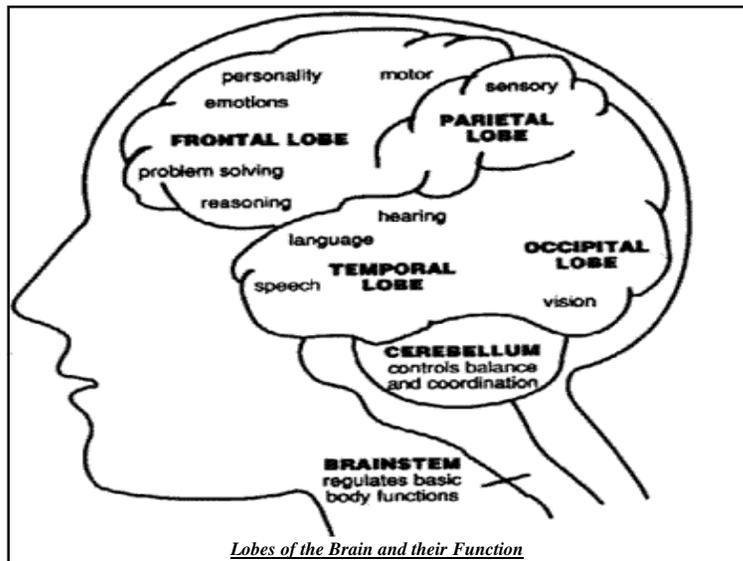
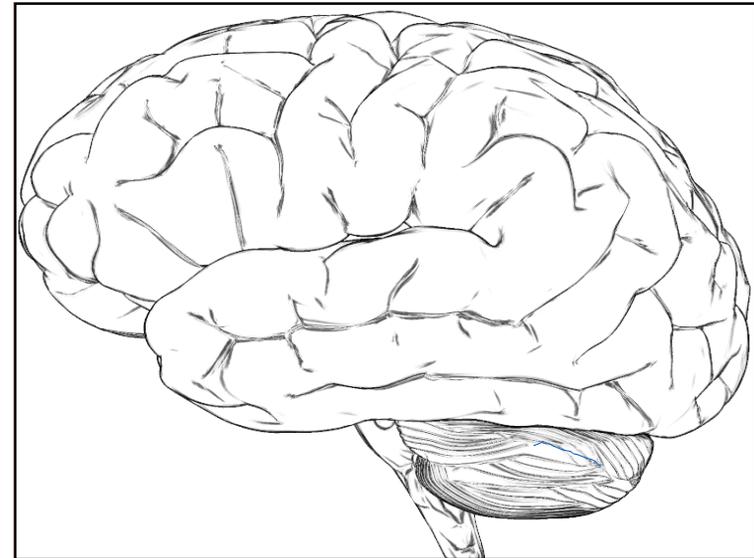
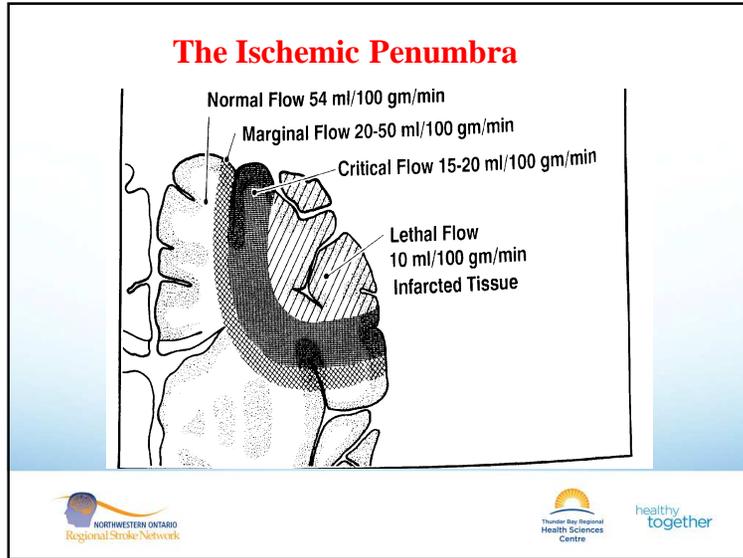
healthy together

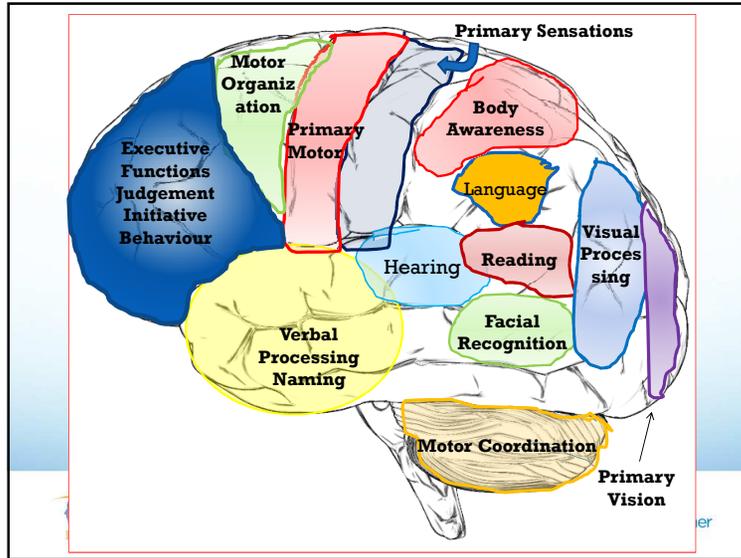
## Goals of Acute Ischemic Stroke Management

- reduce or minimize ischemic damage
- reduce cerebral edema
- prevent secondary complications
- determine etiology of stroke
- prevent recurrent stroke
- facilitate access to rehabilitation and community reintegration



healthy together





### Lobes of the Brain and their Function

**Frontal Lobe**

- Responsible for voluntary motor function.
- Memory for habits and motor activities.
- Executive Functions: task initiation, motivation, planning and self-monitoring
- The ability to concentrate and attend, elaboration of thought, learning and behaviour including: intellect, abstract reasoning, problem solving, judgment, sequencing, planning, concentration
- Controls emotional response, expressive language, word associations and memory for habits and motor activities

**Parietal Lobe**

- Location for visual attention, touch perception, goal directed voluntary movements, manipulation of objects.
- Integration of different sensory input.
- Ability to sense the position, location, orientation and movement of the body and its parts.

**Temporal Lobe**

- Hearing ability, receptive language (Wernicke's Area), some visual perceptions, visual memory
- Integration of visual, auditory and somatic information.
- Sense of identity, behaviour and emotions.
- Memory (storage, retrieval of words, experiences)

**Occipital Lobe**

- Primary visual reception area.
- Spatial organization and interpretation of visual information.
- Visual reflexes.

**Brain Stem**

- Breathing, heart rate, swallowing, reflexes to seeing and hearing, startle response, controls sweating, blood pressure, digestion, temperature.
- Affects level of alertness, ability to sleep and sense of balance.

**Cerebellum**

- Regulation and coordination of voluntary movement, posture, muscle tone, balance and equilibrium.
- Control of fine motor movements.

### The Human Brain

- 100 billion nerve cells (neurons)
  - All in grey matter
  - Highly organized into functional regions
- Prolonged processes of the neuron (axons) surrounded by myelin (insulation)
  - White matter

Logos: Northwestern Ontario Regional Stroke Network, Thunder Bay Regional Health Sciences Centre, healthy together

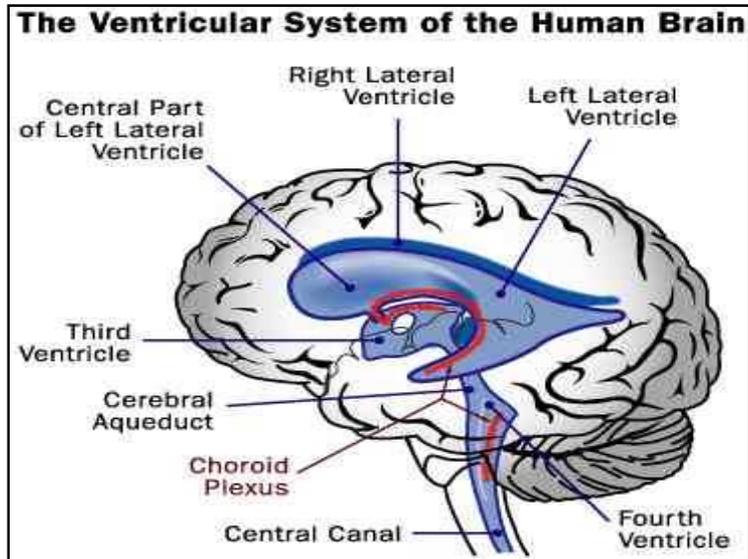
### The Brain Stem and Cerebellum

**Brain Stem**

- midbrain
- pons
- medulla

**Cerebellum**

Logos: Northwestern Ontario Regional Stroke Network, Thunder Bay Regional Health Sciences Centre, healthy together

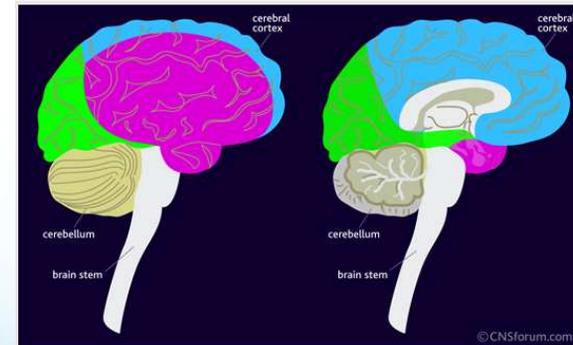
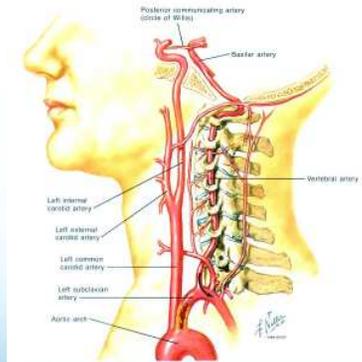


### Cerebral Circulation

- 4 vessels
  - 2 carotid ==> internal carotid (anterior circulation)
  - 2 vertebral ==> basilar artery (posterior circulation)
- Circle of Willis
  - connects carotids to vertebral-basilar
  - inconsistent in humans - too bad!



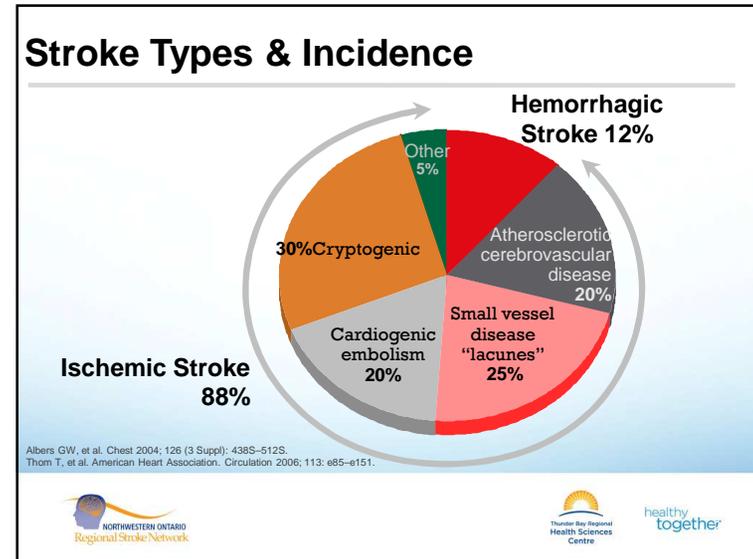
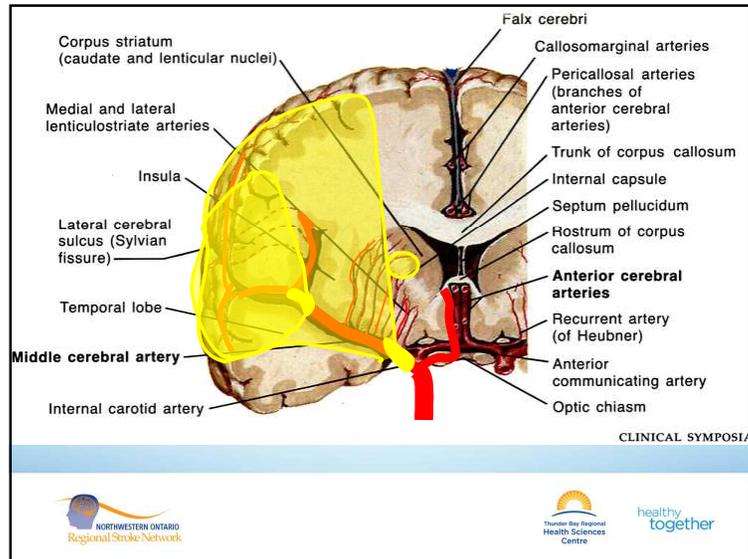
### Cerebrovascular Anatomy



References

Blood supply of the central nervous system. In: *Neuroanatomy. An illustrated colour text.* Crossman AR and Neary D. New York, USA: Churchill Livingstone, 1995: 153-160.





## Definitions

- **Ischemic stroke**
  - Clinical syndrome characterized by sudden onset of focal neurological deficits, due to a perfusion defect in a vascular territory
- **Hemorrhagic stroke**
  - Sudden onset neurological deficits secondary to intraparenchymal hemorrhage
- **Transient Ischemic Attack**
  - As above with resolution of the focal neurological deficits within 24 hours and no evidence of infarction on imaging
  - Most resolve within 1-2 hours

## Cerebrovascular Emergencies

- **Ischemic strokes ~ 87%**
- **ICH (intracranial hemorrhage) ~ 10%**
- **SAH (Subarachnoid hemorrhage) – 3%**
- **TIA (Transient Ischemic Attack)**
  - ~15 000 Canadians experience a TIA / year
  - Risk of recurrent stroke following a TIA at 90 days is 10-20%

Heart and Stroke; Go et al. Circulation 2013

## Diagnostic Tests- in Stroke Care

- Neurological Exam
- Laboratory Tests
- CT or CAT scan – Computed Tomography
- Carotid Doppler
- Echocardiogram
- MRI – Magnetic Resonance Imaging
- MRA –MR Angiography
- CTA – CT angiography
- Cardiac Rhythm monitoring



## CT

- CT scans use computers and rotating X-ray machines to create images of slices, or cross-sections, of the brain.
- CT scans are a primary method to rule out hemorrhagic stroke. Ischemic stroke is not usually apparent until 6 – 12 hrs from symptom onset
- Often the first diagnostic test when a pt presents to the ED – to determine appropriate candidate for tPA
- In many cases, the involved area of the brain does not appear abnormal for the first several hours after the onset of ischemic stroke.

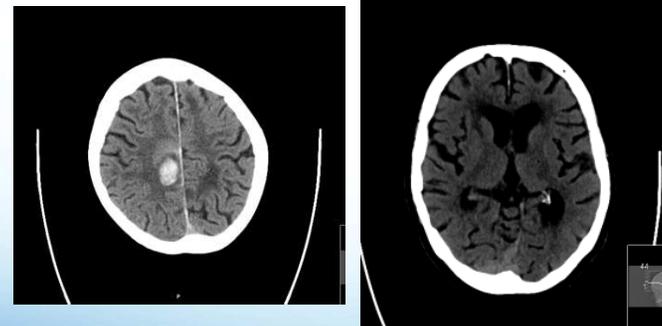


## CT of the head

- Bone absorbs the most X-rays, so the skull appears white on the image.
- Water (in the cerebral ventricles or fluid-filled cavities in the middle of the brain) absorbs little, and appears black.
- The brain has intermediate density and appears grey.
- Most ischemic strokes are less dense (darker) (hypodense) than normal brain, whereas blood in hemorrhage is denser and looks white on CT.



## CT head showing ICH Lt and small Lt Thalamic infarct



**CTA** Once you have diagnosed the infarction, if embolic you want to R/O carotid artery disease by performing a CTA.



## CTA Preparation Implications

- Contrast media can be nephrotoxic

Patient Prep:

- At TBRHSC all individual need kidney function tests within 1 month prior to test (GFR)
- Certain individuals may need additional preparation prior to the test
- If pt has diabetes, and on Metformin (glucophage), will need to hold medication day of procedure and two days following CTA and a repeat GFR is required prior to restarting Metformin.



## MR IMAGING

- Based on behavior of hydrogen protons exposed to a magnetic field and a radio wave
- T1, T2, FLAIR, Diffusion, Gadolinium enhanced, and Angiography are specific types of Neuro imaging sequences.

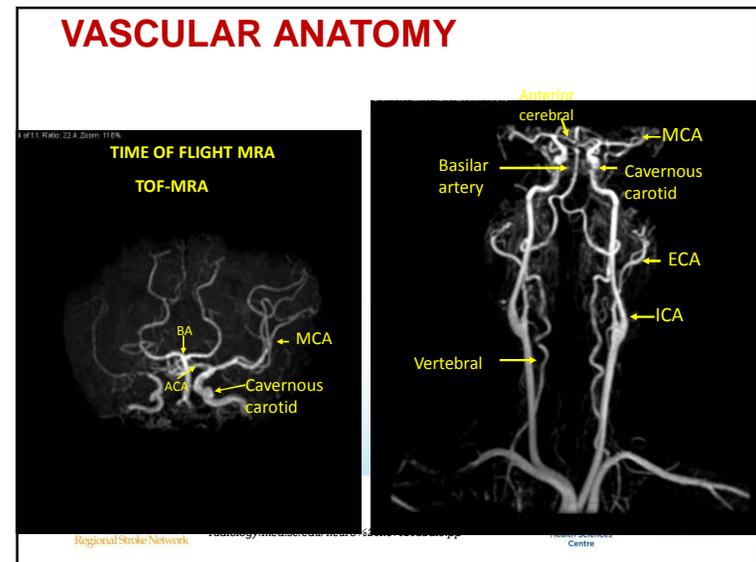
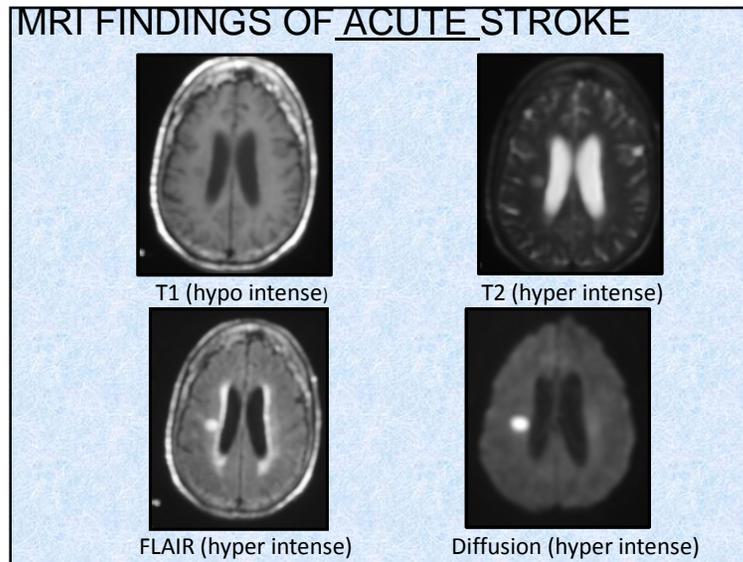
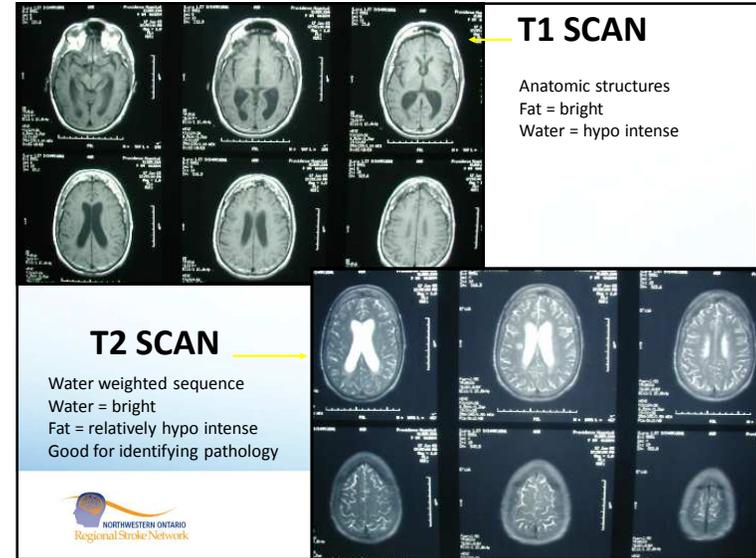
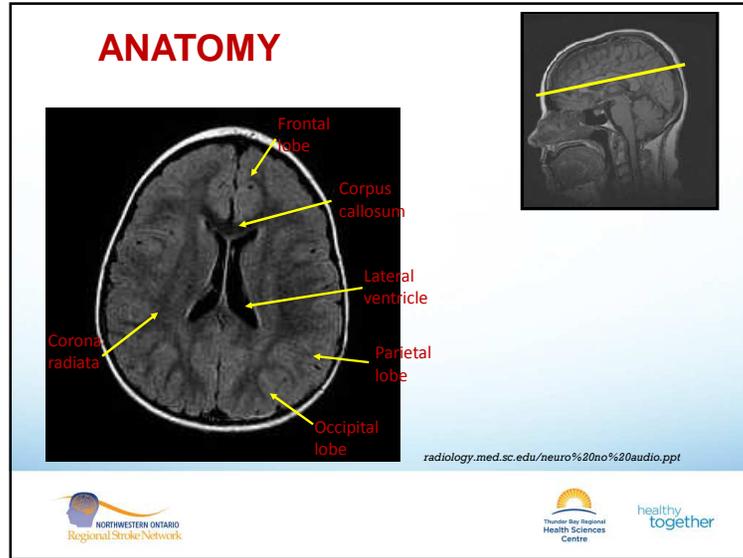


## MRI

- Unlike CT uses magnetic field to get pictures
- Shows more detail than CT for ischemic stroke patients
- Takes about 30 - 40 minutes, therefore not used in hyper acute stroke situation when tPA is considered
- Can show smaller ischemic strokes better than CT
- Can pick up ischemic stroke sooner than CT in hyper acute stage
- Does not show subarachnoid hemorrhage well
- High cost
- Can visualize in various modes. DWI (diffusion weighted imaging lets you know if it is a fresh/acute stroke
- Higher magnetic fields, bigger magnets, yield better results.

(<http://emedicine.medscape.com/article/115506-overview#1>)







## Cardiac Rhythm Monitoring

### ECG

#### Telemetry

Holter 24 or 48 hour

Loop Recorder 2 weeks

- Focus is to rule out atrial fibrillation/flutter or paroxysmal AF (5% of people over 65 have AF)
- AF most common cause of cardio-embolic stroke
- Risk for AF induced stroke increases with age
  - 1.5% risk at age 50 and 24% risk at age 80



healthy  
together

## Hemorrhagic Stroke



healthy  
together

## Hemorrhagic Strokes

- **Intracerebral hemorrhage (ICH)**
  - Bleeding within the parenchyma of the brain
- **Intraventricular hemorrhage (IVH)**
  - Bleeding into the ventricular system
- **Epidural hemorrhage**
  - Bleeding into the epidural space between the dura and the skull
- **Subdural hemorrhage (SDH)**
  - Bleeding into the subdural space (between the dura and the arachnoid layers)
- **Subarachnoid hemorrhage (SAH)**
  - Bleeding into the subarachnoid space (between the arachnoid and pia matter)



healthy  
together

## ICH

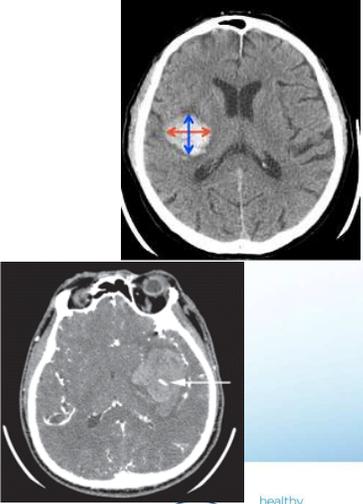
- **Presentation:**
  - Increased ICP
    - Headache
    - Nausea, vomiting
    - Decreased LOC
  - Focal neurologic deficits depend on location and may progress as the hematoma expands
  - Seizure



healthy  
together

## ICH

- Prognosis is dependent
  - Volume
    - $(A \times B \times C) / 2$ 
      - C = # of slices x slice thickness
  - Location
- “Spot Sign”
  - Active extravasation



Logos: NORTHWESTERN ONTARIO Regional Stroke Network, Thunder Bay Regional Health Sciences Centre, healthy together

## ICH

- >1/3 of patients will experience ~33% growth of their initial bleed within 24 hours
  - 26% of patients will have 33% growth in 1<sup>st</sup> hour
  - 12% of patients will have 33% growth in 1-20 hours
  - Within a few hours, can no longer talk to them...
- What can we do?
  - Stop bleeding
  - BP control
  - Transfer to an ICU with Neuro-ICU trained MDs and RNs
  - Glycemic control
  - Consult neurosurgery



## ICH – Acute Treatment

- Correct the INR if patient is on Warfarin
  - FFP
  - Vitamin K 10-20 mg IV - Class I, Level C
  - PCC – Prothrombin Complex Concentrate - Class IIa, Level B
    - Faster and less side effects
    - Octaplex - Factors II, VII, IX, and X and Proteins C and S
  - Factor VIIa is not enough - Class III, Level C
- Patients on NOACs – Limited data



## ICH – Acute Treatment

- Patients who are not coagulopathic
  - Studies have been done looking at FVIIa
    - Class III, Level A ... Not safe...so not a good idea
  - Pilot level trials ongoing considering patients who have active bleeding – using the “Spot sign”
- Correct thrombocytopenia
  - Class I, Level C
- Patients on antiplatelet agents
  - Class IIb, Level B



## ICH – Acute Treatment

- **Blood Pressure**
  - New evidence (INTERACT-2, NEJM, 2013)
    - For SBP 150-220, Acutely lowering to a SBP <140mmHg was safe and associated with better outcomes based on mRS
    - Class IIa, Level B

Anderson, C. S., Heeley, E., Huang, Y., Wang, J., Stapf, C., Delcourt, C., ... & Chalmers, J. (2013). Rapid blood-pressure lowering in patients with acute intracerebral hemorrhage. *New England Journal of Medicine*



## Case #1

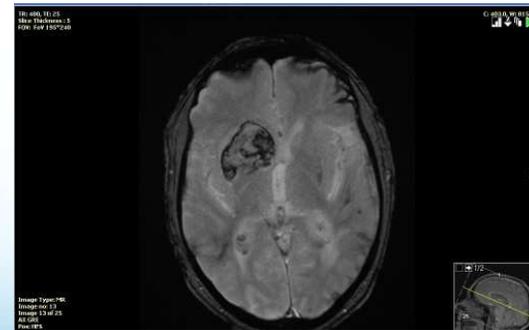
- 78 y/o R.H male, c/o of headache while driving and wife noticed that he was drifting over and crossing the midline. She drove him to hospital and en-route he became weak on Lt. Side and lethargic.
- PMH: HTN, CLL/BM transplant, Prostate CA, Basal cell CA, E.Tremors, Celiac, repeated Shingles, pneumonia, ch bronchitis.
- O/E: BP 217/112, stuporous, Lt. facial droop, Lt arm>leg weakness.



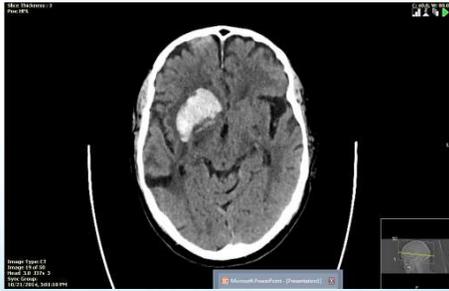
## CT Head



## MRI Head GRE



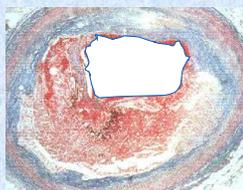
## Follow Up CT Head 2 days later



## Ischemic Stroke

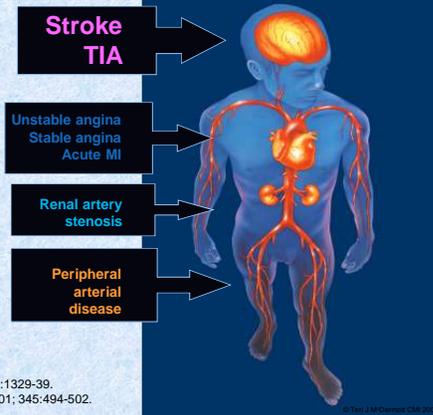


## Atherothrombosis

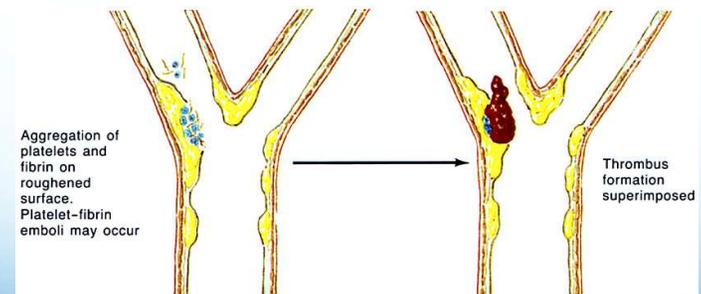


- Atherothrombosis**
- sudden (unpredictable) plaque disruption
  - (rupture or erosion)
  - platelet activation
  - thrombus formation

CAPRIE Steering Committee. Lancet 1996; 348:1329-39.  
The CURE Trial Investigators. N Engl J Med 2001; 345:494-502.



## Atherosclerosis - Thromboembolism



## Thrombus Formation

Embolization of plaque contents (cholesterol) and/or platelet-fibrin aggregates. Occlusion of blood vessels distally in arterial tree

Thrombus causes total arterial occlusion

*F. Netter M.D.*  
© CIBA-GEIGY

**NORTHWESTERN ONTARIO**  
Regional Stroke Network

**Thunder Bay Regional**  
Health Sciences Centre

healthy together

Medial

Lateral

**NORTHWESTERN ONTARIO**  
Regional Stroke Network

**Thunder Bay Regional**  
Health Sciences Centre

healthy together

## Atherothrombotic Ischemic Stroke -Major Risk Factors

- Hypertension
- Diabetes
- Dyslipidemia
- Cigarette use
- Alcohol abuse
- Family history

**NORTHWESTERN ONTARIO**  
Regional Stroke Network

**Thunder Bay Regional**  
Health Sciences Centre

healthy together

## Hyper Acute Ischemic Stroke

- t PA - window of time < 4 ½ hours
- Thrombectomy – window of time < 6 hrs

**NORTHWESTERN ONTARIO**  
Regional Stroke Network

**Thunder Bay Regional**  
Health Sciences Centre

healthy together



**TIME IS BRAIN**

<http://www.brainandspine.com.hk/images/ice/thumb/1175x465/75/images/slides/time.jpg>

NORTHWESTERN ONTARIO Regional Stroke Network

Thunder Bay Regional Health Sciences Centre

healthy together

## “Time is Brain”

### ■ NINDS Recommendations for Timeline of Care:

- ED physician sees patient within 10 mins
- Stroke physician notified within 15 mins
- CT scan is completed within 25 mins
- CT interpretation is obtained within 45 mins
- IV rtPA should be initiated within 60 mins

### ■ Some centers in Europe are door to needle in 25 mins

### ■ Strategies to increase speed of treatment:

- Activate stroke team prior to CT scan
- Glucose only lab to worry about
- Store rtPA in ED
- Mix rtPA early (once CT shows no blood)



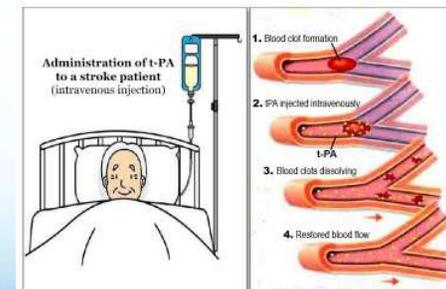
## rtPA

- Tissue plasminogen activator (abbreviated tPA) is a protein involved in the breakdown of blood clots. It is a serine protease found on endothelial cells, the cells that line the blood vessels.
- As an enzyme, it catalyzes the conversion of plasminogen to plasmin, the major enzyme responsible for clot breakdown.
- Because it works on the clotting system, tPA is used in clinical medicine to treat embolic or thrombotic stroke. Use is contraindicated in hemorrhagic stroke and head trauma.
- tPA is manufactured using recombinant biotechnology techniques. tPA created this way may be referred to as recombinant tissue plasminogen activator (rtPA).



## Intravenous t-PA a.k.a. the “clot buster”

- Can be given within 4.5 hours of onset of signs of stroke.



<http://www.pyroenergen.com/articles13/images/tpa-intravenous-therapy.jpg>



**rtPA < 3hours exclusion criteria:**

- Stroke or significant head trauma within 3 months
- Major surgery or serious trauma within 14 days
- Gastrointestinal and urinary hemorrhage within 21 days
- Arterial puncture at a noncompressible site within 7 days
- History of intracranial hemorrhage
- Intracranial neoplasm, arteriovenous malformation, or aneurysm
- Symptoms of subarachnoid hemorrhage
- Active internal bleeding
- Pretreatment blood pressure with systolic >185 or diastolic >110
- Clear and large hypodensity on CT scan
- Current bleeding diathesis including
  - INR>1.7
  - Heparin within 48 hours resulting in abnormal PTT
  - Platelets <100,000/mm3
  - Direct thrombin or factor Xa inhibitor (NOAC) use within 48 hours

Jauch, E. C., et al, (2013). Guidelines for the Early Management of Patients With Acute Ischemic Stroke A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke, 44(3), 870-947.

## Low numbers of Stroke Patients receiving Tpa

**WHY?**

- 'Wake up' stroke
- Arrive at hospital too late
- Major surgery within 2 weeks
- On blood thinners (elevated PTT/INR)
- Low platelet count
- Too high blood pressure
- Too low to too high blood sugar
- Symptoms improving

## New Acute Stroke Therapy Stent Retrievers

New studies - halted early due to overwhelming success

**MR CLEAN**

"Multicenter Randomized Clinical trial of Endovascular Treatment for Acute Ischemic Stroke in the Netherlands"

**ESCAPE**

"Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion with Emphasis on Minimizing CT-to-Recanalization Times"

**MERC**

**PENUMBRA**

**SOLITAIRE**

**TREVO**

### Comparisons of endovasc study design

	MR CLEAN	EXTEND IA	SWIFT PTIME	ESCAPE
Design	PROBE	PROBE	PROBE	PROBE
Center	Netherlands	Australia	US/Europe	Global/Canada
Patient #	500	70	196	316
Inclusion/ Selection	Age>18 NIHSS>2 Onset<6hrs Confirmed LVO + extracranial ICA lesions	Age>18 NIHSS Any Onset<6hrs Confirmed LVO 100% IV-tPA Mismatch on CTP with core<70cc	Age 18-80 NIHSS 8-29 Onset<6hrs Confirmed LVO 100% IV-tPA ASPECT>5 or Core<50cc or Penumbra>15 cc	Age>18 NIHSS Any Onset<12hrs Confirmed LVO ASPECT>5 and mod-good collaterals + extracranial ICA lesions
Intervention	+/- IV-tPA (89%) + IAT (81.5% stent retrievers)	IV-tPA + Solitaire	IV-tPA + Solitaire	+/- IV-tPA (72.7%) + IAT (86% stent retrievers)

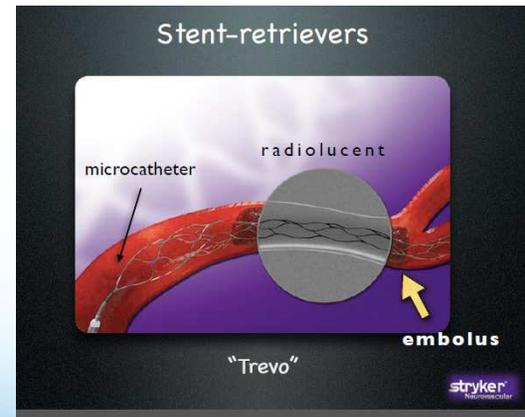


### Stent Retrieval Pilot study at TBRHSC- summary

- 4 mega RCT support new strategy for reducing stroke impact by stent retriever
- 6 month pilot in 2015 at TBRHSC to see if feasible to manage here.
- Early CT angiogram (CTA) to see if stroke patient appropriate to have treatment by stent retriever
- On call stroke doctor contacts neurosurgeon
- Time window 6 hours



<https://www.youtube.com/watch?v=uG9eDdOEC4U>





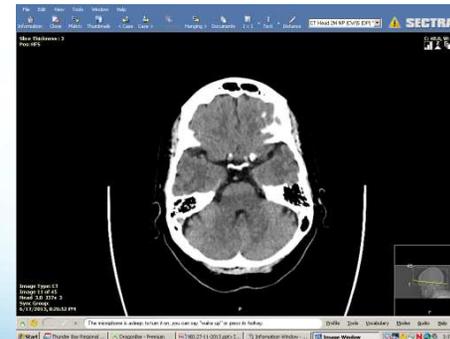
## Case # 2

- Rt. Handed 65 yrs old woman.
- While feeding her dog developed sudden dizziness, nausea and vomiting associated with neck pain on Rt side.
- Clinical exam at ED was consistent with BPPV and CT head was negative for acute intracranial pathology, she was subsequently discharged home and MRI head was booked as outpatient.

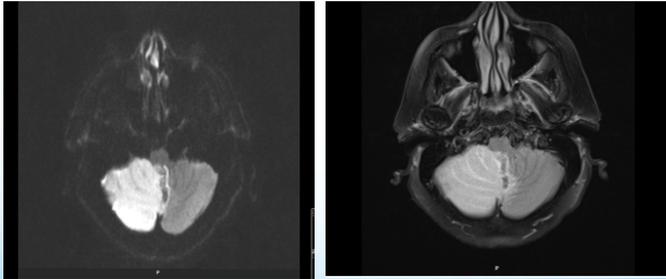
## Case # 2

- **PH:**
  - HTN
  - Dyslipidemia
  - CAD
- **O/E:**
  - Rt. Horizontal gaze nystagmus
  - Rt. Arm hypotonia and ataxia
  - Unsteady gait with tendency to fall to the Rt. Side
- **ECG showed recent onset A.Fib with rapid ventricular response, heart rate 160/min.**

## CT Head in ED



## MRI Head 4 days later



## MRA



## Case # 3

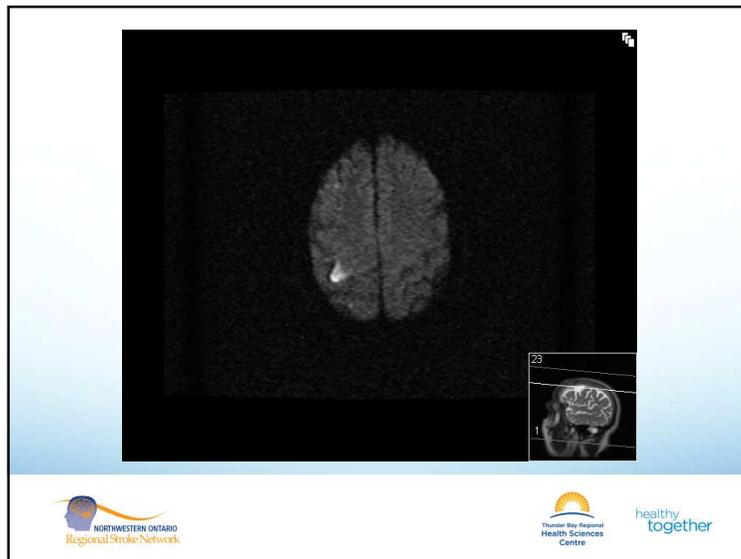
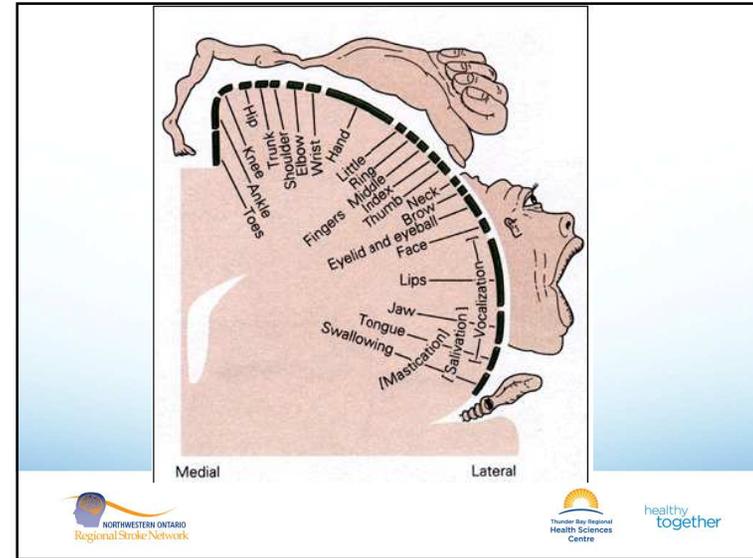
- Rt. handed 62 yrs white man,
- 8 attacks of curtain coming down over his vision on the Rt. Eye lasting for 10 min. over the last year.
- 9 months ago his speech slurred and his Lt. hand was weak for 5 min.
- 7 months prior to ED he awakened with Rt. Frontal headache , neck pain and Lt. arm heaviness and hand weakness.
- He came to the hospital because his Lt. hand remained weak.

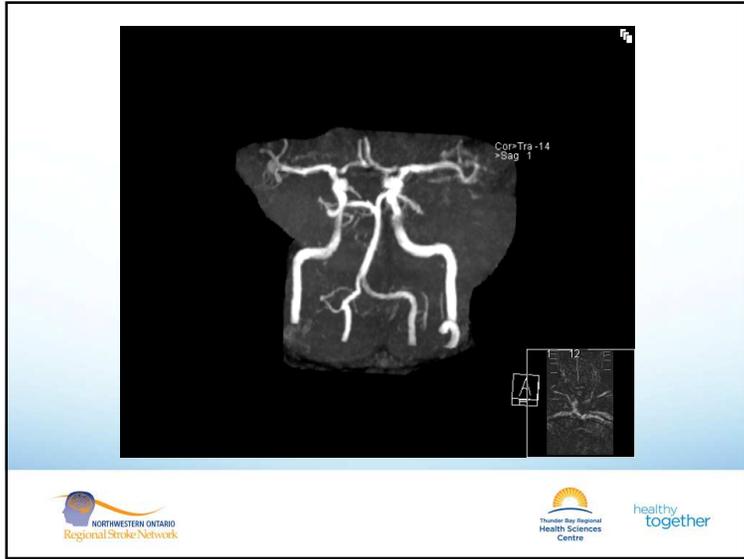
## Case # 3

- **Past history**
  - Smoked cigarettes 1 1/2 PPD for 35 years
  - Angina/CABG 3 yrs before.
  - Slight, well-controlled HTN.
  - Cervical disc disease
- **Family history**
  - Father had stroke and died at 69 yrs
- **Examination**
  - BP 130/85, pulse regular, no bruits, Lt hand marked weakness, no coordination or sensory disturbance.

### What is the most likely diagnosis?

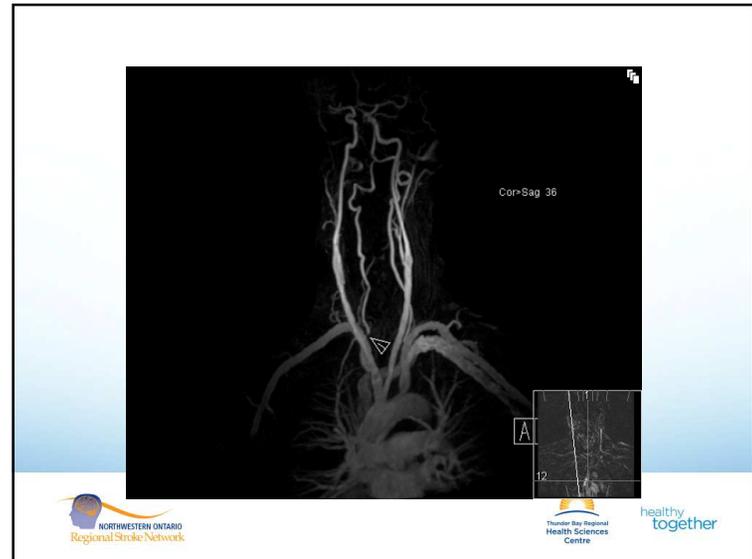
- A- Cervical disc with Rt radiculopathy?
- B- Occlusive disease of the Rt. MCA?
- C- Occlusive disease of the Rt. ICA?
- D- Occlusive disease of the VB system?
- E- Occlusive disease of the Rt. ACA?





### Case # 3

- He had a successful Rt. Carotid endarterectomy and during follow up in SPC he was found to have marked difference (> 20 mm Hg) between the 2 arms systolic B.P.



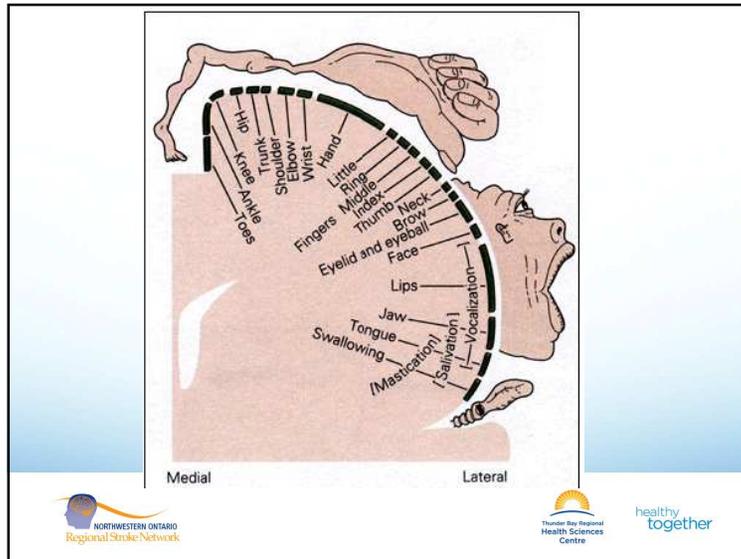
## Case # 4

- 63 yrs old Rt. Handed white man, previously healthy, presented to ER with a sudden onset aphasia after 75 min of onset.
- Past history
  - Hyperlipidemia
  - Drinking 3 beer/ 1 glass of wine daily
- Examination
  - BP135/90
  - Mixed aphasia more receptive



## What is the most likely diagnosis?

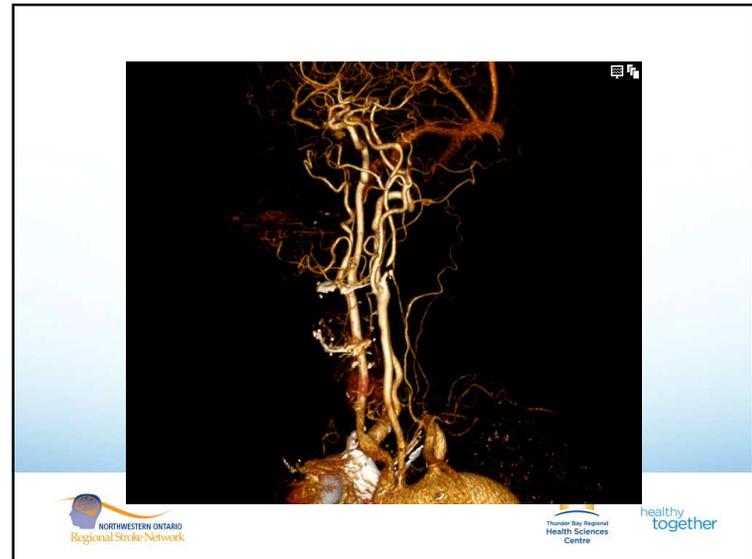
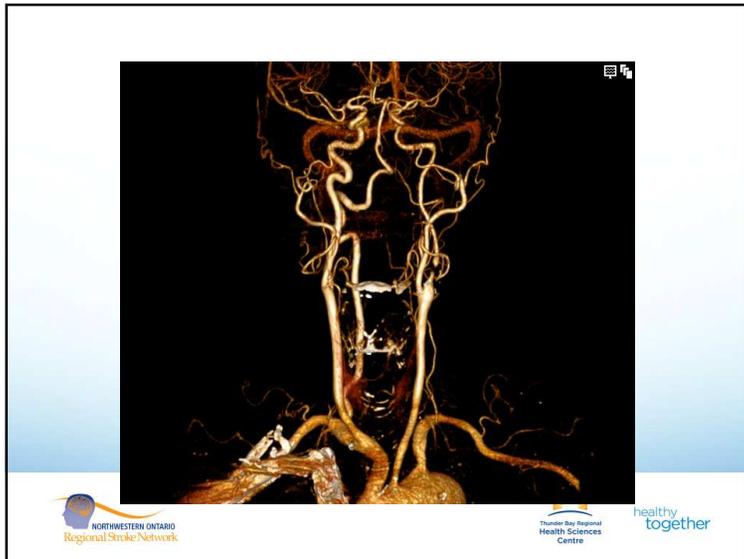
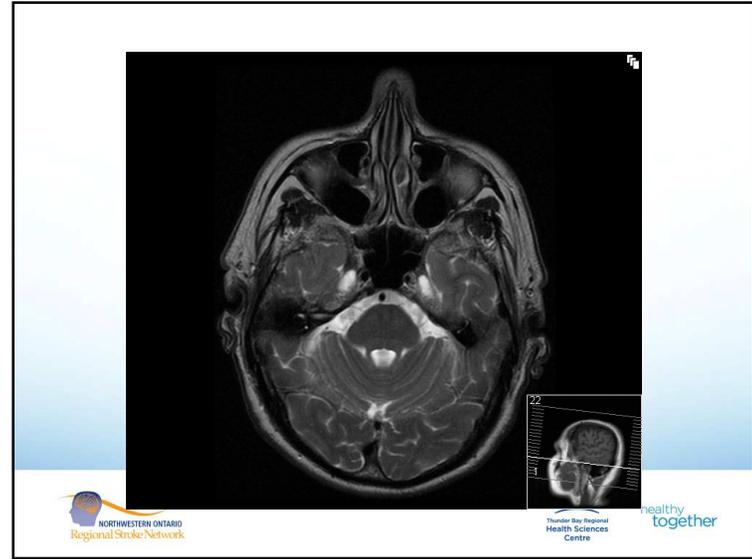
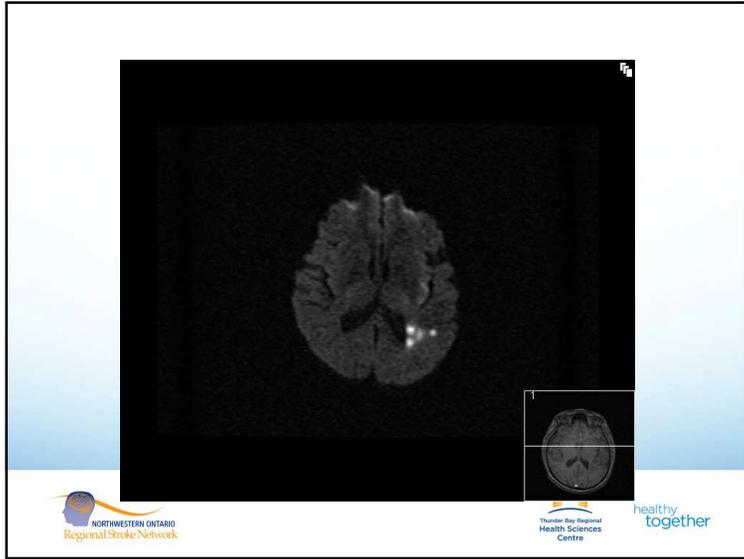
- A- Occlusive disease of the Lt. ACA?
- B- Occlusive disease of the Lt. MCA?
- C- Occlusive disease of the Lt. ICA?
- D- Occlusive disease of the VB system?



## Case # 4

- He received tPA with marked improvement of his speech over 4 weeks.





## Case # 4

- Blood pressure target is < 140/90 unless DM <130/80 with high grade stenosis blood pressure should be on the upper limit of target.
- Watershed infarction is indicative of a large artery disease.



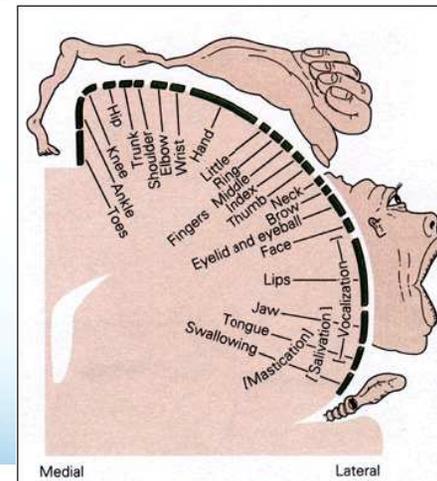
## Case # 5

- 49 yrs Rt handed woman, At 01:00 Rt leg>arm weakness and numbness.
- P.H:
  - DM
  - dyslipidemia
  - hypothyroidism
  - MVR (mechanical valve)
  - A.Fib (warfarin D/C 5 days before and started lovenox in preparation for cardiac angio)
- O/E:
  - Rt facial droop
  - Slurred speech
  - Rt arm 3/5 weakness
  - Rt leg 0/5 weakness and hypoesthesia



## What is the most likely diagnosis?

- A- Occlusive disease of the Lt. ACA?
- B- Occlusive disease of the Lt. MCA?
- C- Occlusive disease of the Lt. ICA?
- D- Occlusive disease of the VB system?





## Optimal Stroke Management With tPA: tPA Target Times

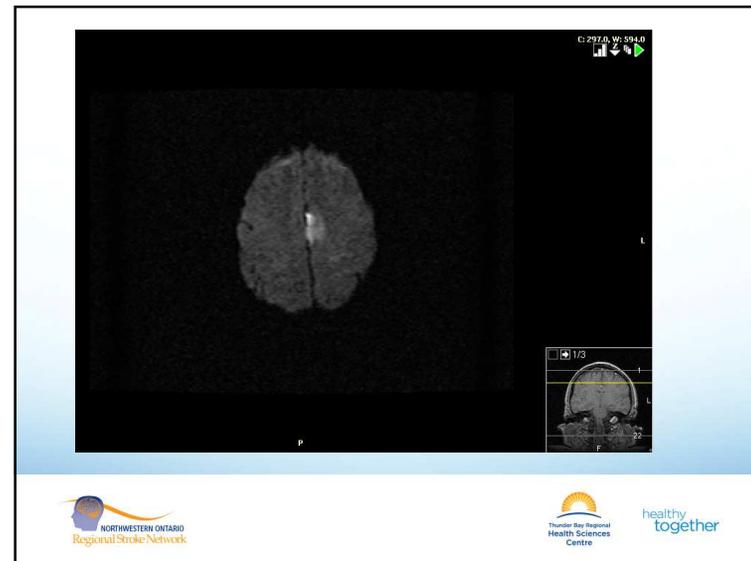
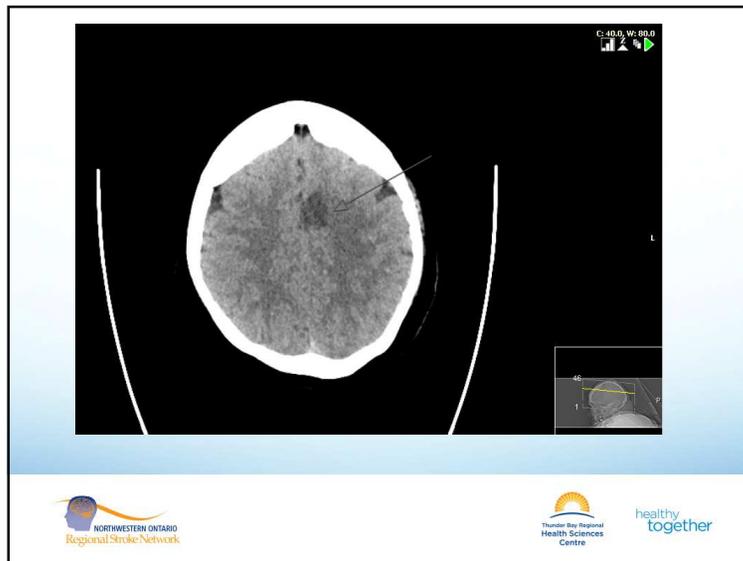
### ■ rapid coordinated emergency response facilitates early diagnosis and treatment

- door-to-triage 1 minute
- door-to-stroke team notification 15 minute
- stroke team-to-bedside 30 minute\*
- door-to-CT scan 25 minute
- door-to-needle 60 minute

\*(occurring concurrently)



healthy together



**QUESTIONS**



The illustration shows a person with a large head and a small body, looking at a document that has a large question mark on it. The background is a light blue gradient.

 NORTHWESTERN ONTARIO  
Regional Stroke Network

 Thunder Bay Regional  
Health Sciences  
Centre

healthy  
together