

Guy's and St Thomas' **NHS**  
NHS Foundation Trust



## Stroke Medicine

*Medico-Legal Issues in Neurosurgery & Neurological Disease*

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King's College London

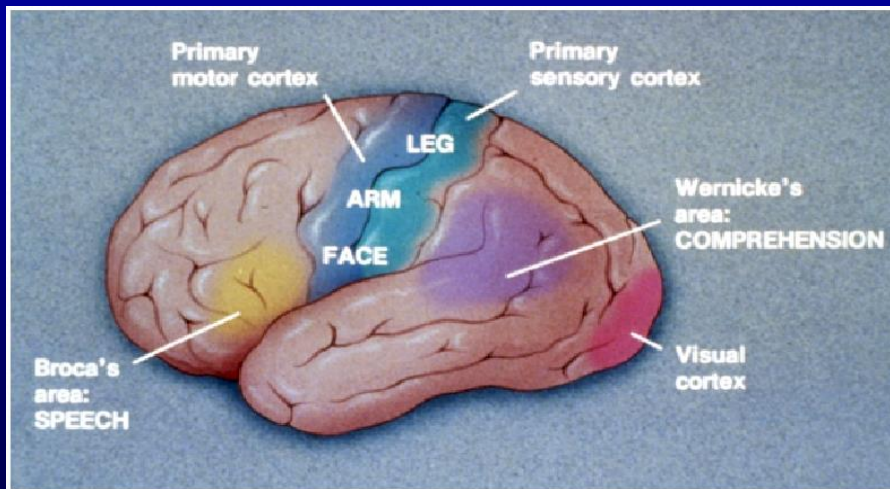


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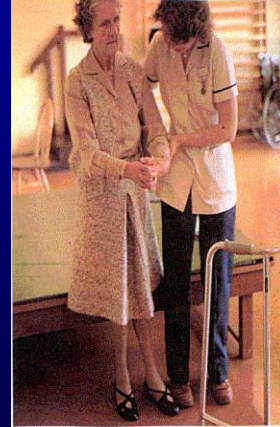
# STROKE / TIA



Focal neurological deficit of vascular origin

## The Burden of Stroke

- 110,000 people/year in England have a stroke
- Of patients who have a stroke:
  - 30% die in the first month
  - 35% are significantly disabled
  - 5% are admitted to long-term residential care
- Stroke:
  - is the 3rd most common cause of death
  - is the single largest cause of adult disability
  - costs the NHS £2.8 billion/year



## STROKE 50 years ago !!!

- HISTORY                      Stroke
- EXAMINATION                Stroke
- MANAGEMENT              Prayers  
   Will

## STROKE 20 years ago !!!

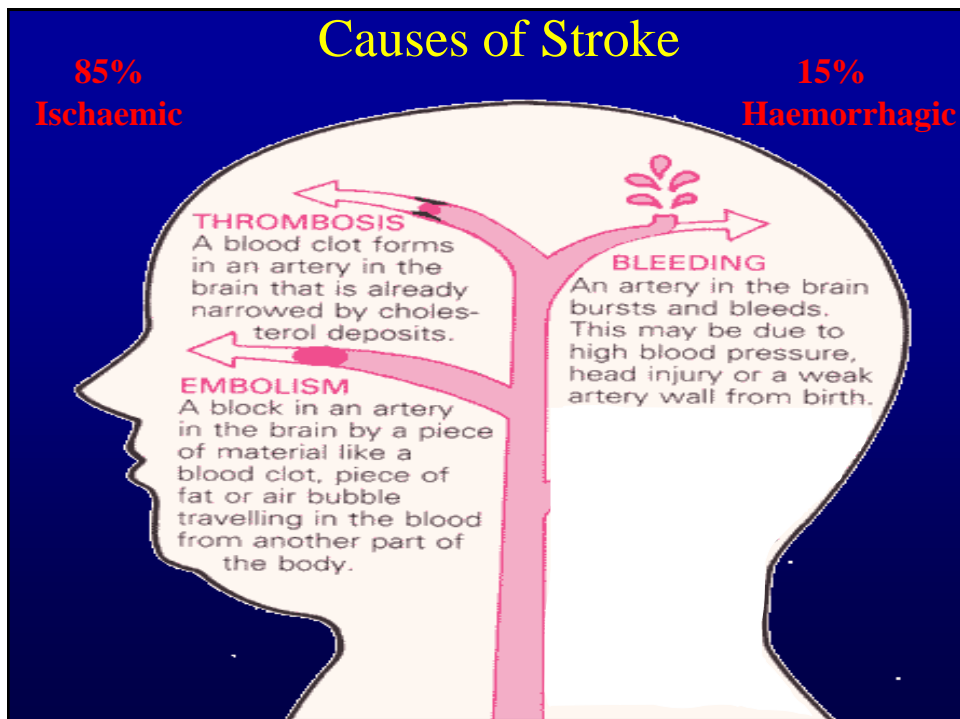
- HISTORY                      Stroke
- EXAMINATION                Stroke
- MANAGEMENT              Prayers  
   Will

## Stroke care is a national priority!!

- 1999            RCP National Clinical Guidelines for Stroke  
                    RCP National Sentinel Audit
- 2001            NSF for older people
- 2005            National Audit Office report
- 2007            National Stroke Strategy
- 2008            HfL Stroke project  
                    NICE guidelines

## Stroke is a medical emergency!

- ‘Brain attack’      ‘Time is brain’
- Faster assessment & investigations
- Acute medical treatment
- Immediate secondary prevention
- Recognition & management of complications



## Model of the TIA/Stroke diagnostic process

1. Are the neurological symptoms focal rather than non-focal?
2. Are the symptoms negative rather than positive?
3. Was the onset of the symptoms sudden?
4. Were the symptoms maximal at onset rather than progressing over a period?

If YES to all questions, the symptoms are almost certainly caused by vascular pathology (cerebral ischaemia or haemorrhage).

## Focal neurological symptoms

- Motor:
  - weakness – one side of body
- Sensory symptoms:
  - loss of sensation – one side of body
- Visual:
  - monocular; binocular
- Speech/language:
  - difficulty understanding or expressing; slurred speech

## Non-focal neurological symptoms

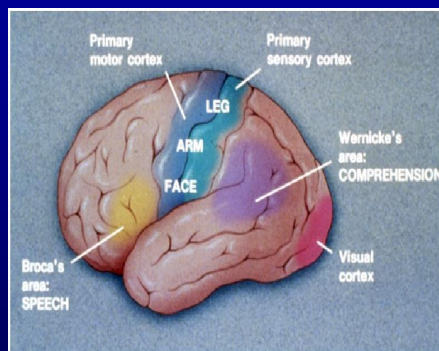
- faintness
- non-specific dizziness
- light-headedness
- confusion
- mental disorientation
- incontinence

*do not suggest Stroke/TIA*

*unless accompanied by focal neurological symptoms*

## How do Strokes/TIAs present?

- Presentation depends on which part of the brain is affected

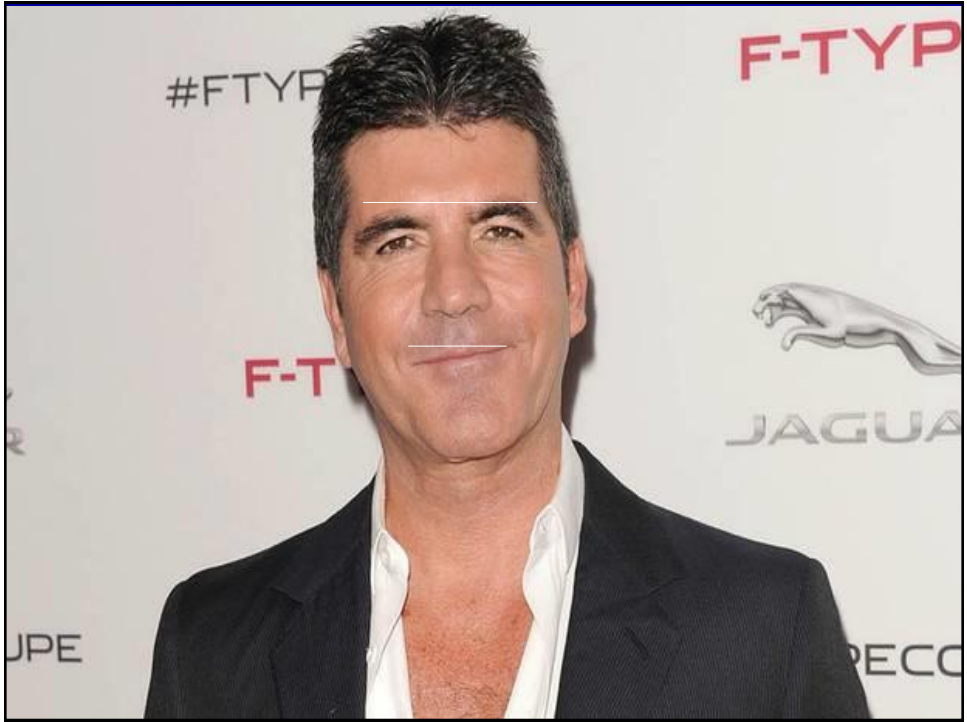
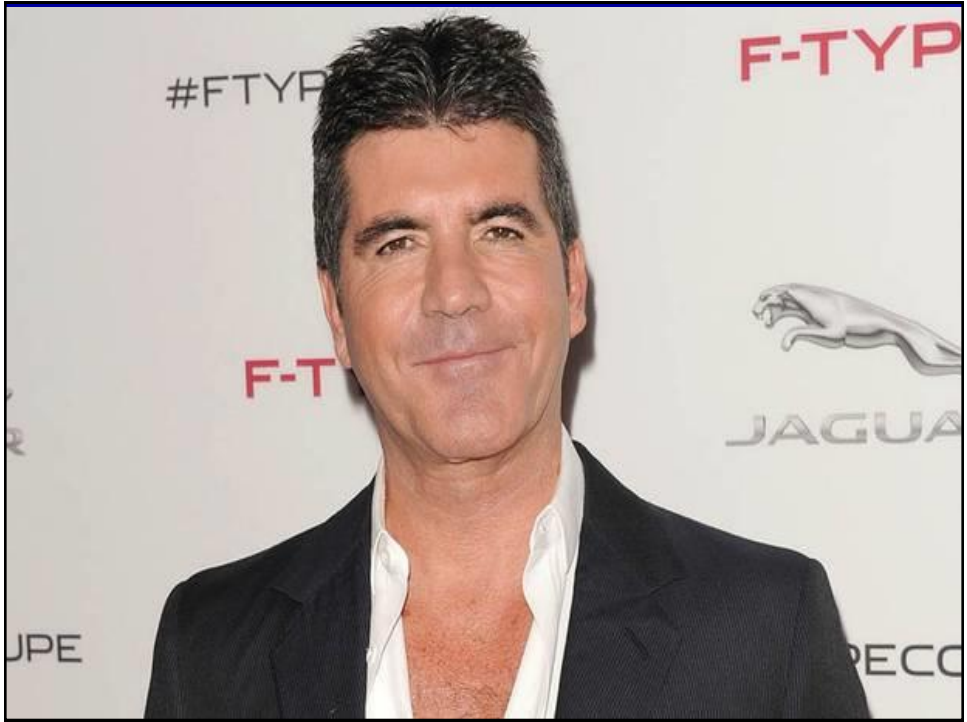


- Diagnosis not easy!
- Stroke mimic exists



**"I CAN'T UNDERSTAND THE LEEDS PLAYERS."**







## A study of the workload and effectiveness of a comprehensive acute stroke service

N U Weir, A M Buchan

*J Neurol Neurosurg Psychiatry* 2005;76:863-865

**Objective:** To study the workload of and use of acute intervention within an established acute stroke service, the Calgary Stroke Programme (CSP).

**Methods:** Prospective record of all acute referrals, diagnoses, and management decisions over a 4 month period.

**Results:** The CSP received 572 referrals (median: 32 per week), 88% of which were made between 7 am and midnight. Of the 427 patients seen in person, 29% had not had an acute stroke or transient ischaemic attack (TIA). Fifty percent of patients with suspected acute stroke were referred within 3 h of symptom onset and 11% with acute ischaemic stroke (equating to 35% of those referred within 3 h of onset and seen in person) were treated with thrombolysis.

## A study of the workload and effectiveness of a comprehensive acute stroke service

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*J Neurol Neurosurg Psychiatry* 2005;76:863-865

**Table 1** Diagnosis in the 125 patients who did not have an acute stroke or TIA

Diagnosis	%
Seizure/post-ictal	19
Migraine	15
Functional disorder	14
Metabolic disturbance	8
Syncope/pre-syncope	6
Infection	6
Cerebral mass: tumour or subdural haematoma	5
Peripheral vestibular disturbance	3
Multiple sclerosis related	3
Spinal/radicular/peripheral nerve problem	3
Confusion: various or undefined causes	6
Miscellaneous other diagnoses/not recorded	12

**STROKE/TIA MIMICS**

## Case history

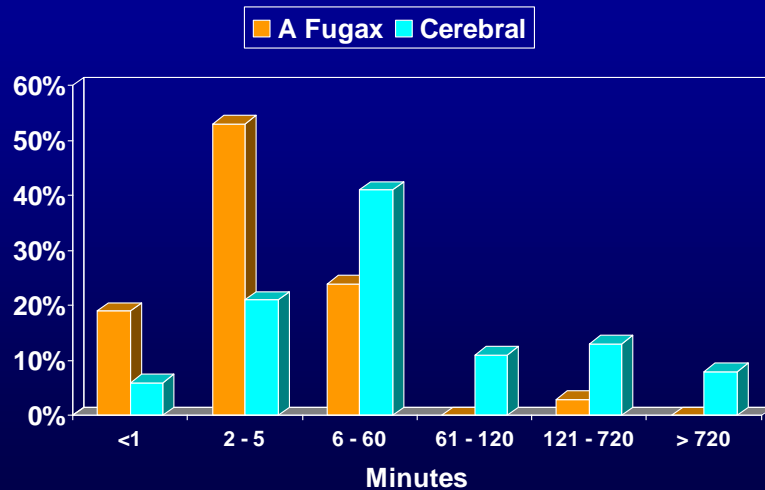
- 52 year old woman contacts her GP immediately after recovering from a 30 minute episode of sudden weakness of her right arm and slurring of her speech. Her medical history is unremarkable other than a history of high blood pressure. Examination is normal.
- What action should be undertaken for this lady?

## Model of the TIA/Stroke diagnostic process

1. Are the neurological symptoms **focal** rather than non-focal?
2. Are the symptoms **negative** rather than positive?
3. Was the **onset** of the symptoms **sudden**?
4. Were the symptoms **maximal at onset** rather than progressing over a period?

If **YES** to all questions, the symptoms are almost certainly caused by vascular pathology (cerebral ischaemia or haemorrhage).

## Duration of TIA



## TIA GP referral behaviour varies!

‘ I refer when I have time to write a letter’

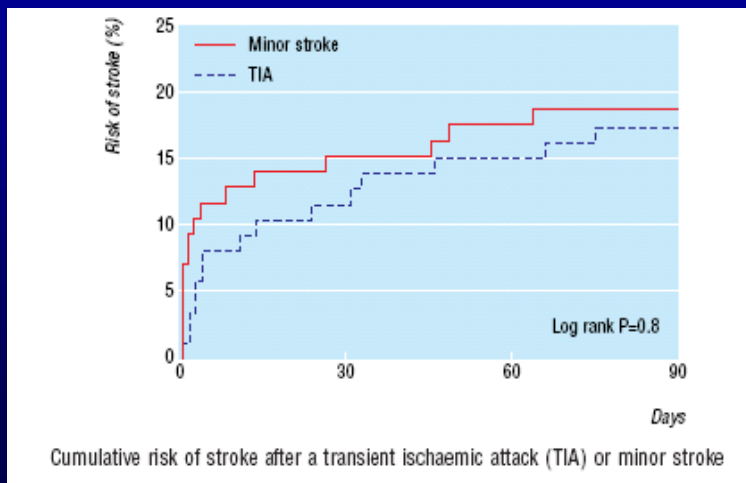
‘ I would not refer the first TIA’

‘ It varies depending on the severity of symptoms’

‘Just a TIA, no lasting damage’

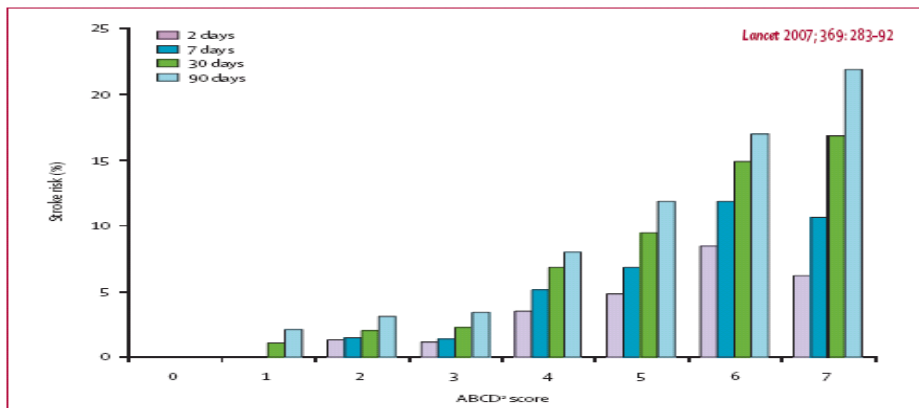
# Risk of stroke after TIA

8.0% at 7 days  
11.5% at 30 days  
17.3% at 90 days

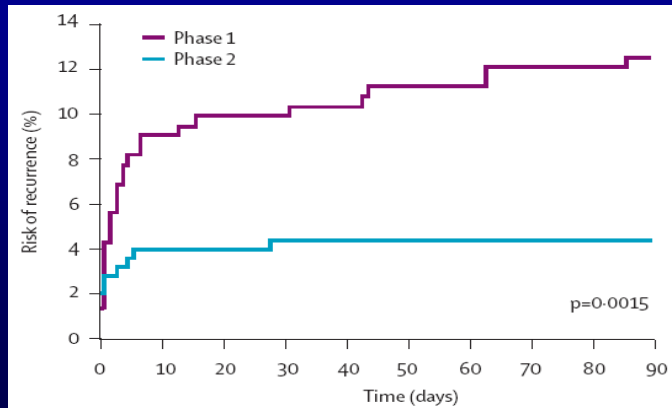


Coull et al., BMJ 2004

Age	≥ 60 yrs	1 point
	<60 yrs	0 points
Blood pressure	≥ 140/90	1 point
	<140/90	0 points
Clinical Features	Speech impairment without weakness	1 point
	Unilateral weakness	2 points
Duration of symptoms	10-59 mins	1 point
	≥ 60 mins	2 points
Diabetes	Yes	1 point



## ACT FAST! EXPRESS Study (Lancet 2007)



National  
Stroke  
Strategy,  
2007

## Then what?



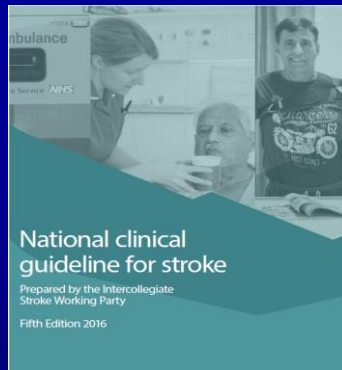
Primary  
Care  
Guidelines,  
2008

**High risk patients:**  $ABCD^2 \geq 4$  or  $\geq 2$  TIAs in 1 week

Specialist assessment/investigation within 24 hours

**Low risk patients:**  $ABCD^2 < 4$

Specialist assessment/investigation within 1 week



- Patients with acute neurological symptoms that resolve completely within 24 hours (i.e. suspected TIA) should be given aspirin 300 mg immediately and assessed urgently within 24 hours by a specialist physician in a neurovascular clinic or an acute stroke unit.

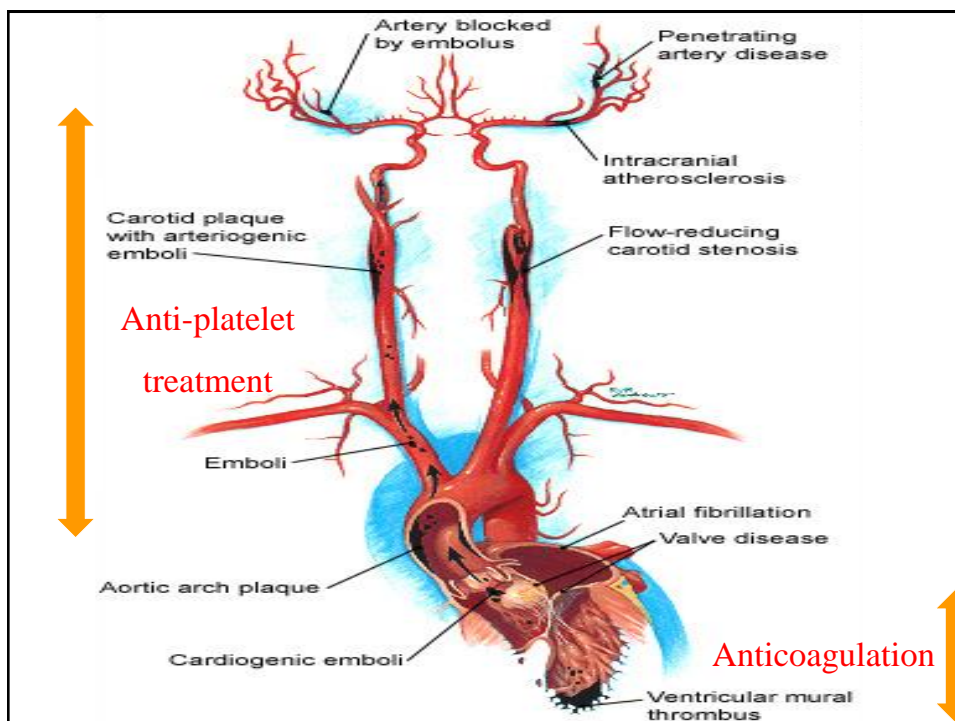
## **TIA Management**

- **Antiplatelets/Anticoagulation**
- **Carotid endarterectomy**
- **Control of vascular risk factors**
  - e.g. Blood pressure, Diabetes, Cholesterol



## TIA Management

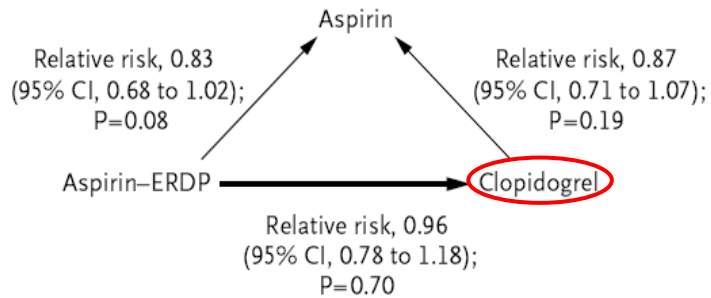
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### Stroke Prevention — Insights from Incoherence

David M. Kent, M.D., and David E. Thaler, M.D., Ph.D.

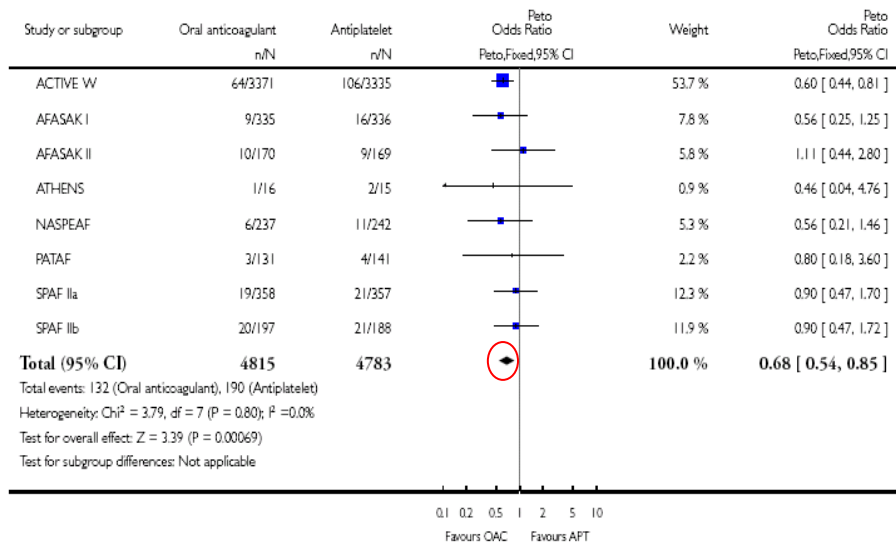
N Engl J Med. 2008 Apr 3;358(14):1519-20



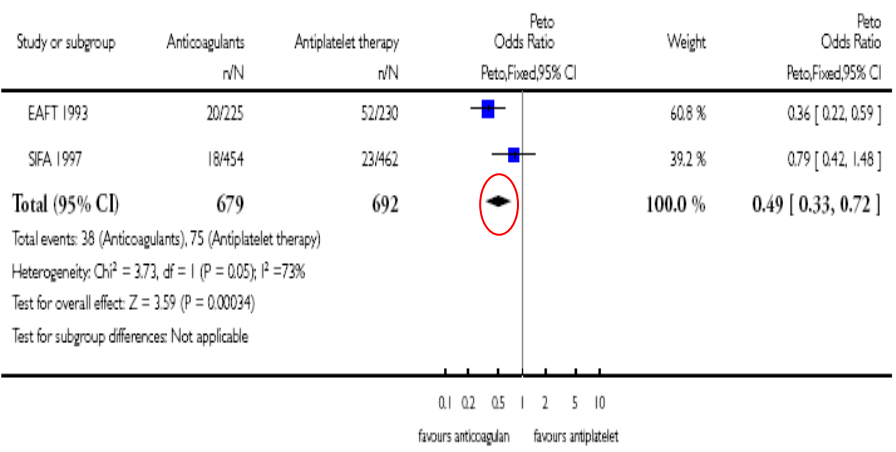
## Anticoagulation

- Warfarin
- Heparin
- DOAC
  - Dabigatran, Rivaroxaban, Apixaban, Edoxaban

### Oral anticoagulants versus antiplatelet therapy for preventing stroke in patients with non-valvular atrial fibrillation and no history of stroke or transient ischemic attacks (Review)



### Anticoagulants versus antiplatelet therapy for preventing stroke in patients with nonrheumatic atrial fibrillation and a history of stroke or transient ischemic attack (Review)



# Stroke Prevention in Atrial Fibrillation

## DELICATE BALANCE

Prevention of thromboembolic events



Risk of haemorrhage

### Scoring Differences Between CHADS<sub>2</sub> and CHA<sub>2</sub>DS<sub>2</sub>-VASc

Risk Factor	CHADS <sub>2</sub>	CHA <sub>2</sub> DS <sub>2</sub> -VASc
	(Maximum score, 6)	(Maximum score, 9)
Congestive heart failure	1	1
Hypertension	1	1
Diabetes	1	1
Vascular disease	N/A	1
Age 65-74	N/A	1
Age ≥75	1	2
Female sex	N/A	1
Previous stroke/TIA	2	2

N/A – not applicable



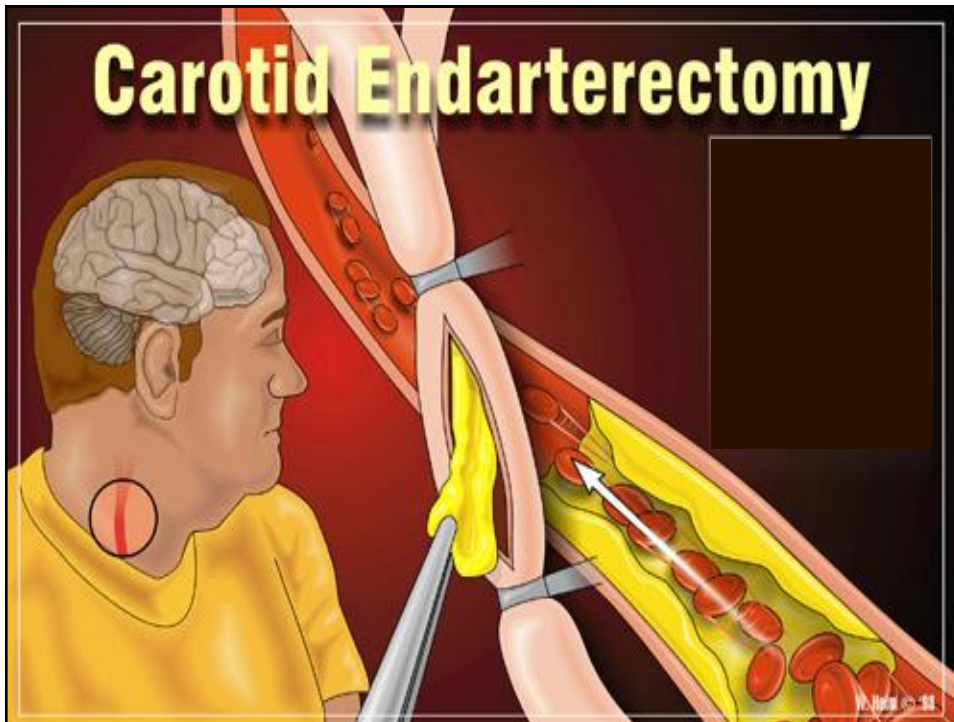
**HAS-BLED = Hypertension, Abnormal renal/liver function, Stroke, Bleeding history or predisposition, Labile INR, Elderly (> 65 years), Drugs/alcohol concomitantly** (*Pisters et al., 2010*)

<i>Letter</i>	<i>Clinical Characteristic</i>	<i>Points Awarded</i>
<b>H</b>	Hypertension	1
<b>A</b>	Abnormal renal and liver function (1 point each)	1 or 2
<b>S</b>	Stroke	1
<b>B</b>	Bleeding	1
<b>L</b>	Labile INRs	1
<b>E</b>	Elderly	1
<b>D</b>	Drugs or alcohol (1 point each)	1 or 2

**HASBLED  $\geq 3$  = High risk of bleeding** (*Camm et al. 2010*)

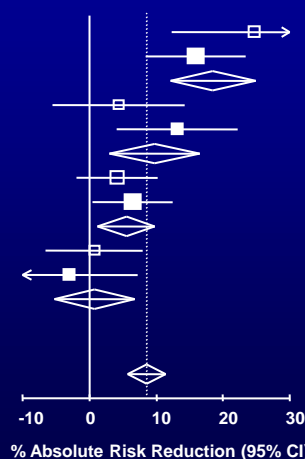
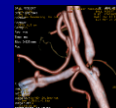
## TIA Management

- **Antiplatelets/Anticoagulation**
- **Carotid endarterectomy**
- **Control of vascular risk factors**
  - e.g. Blood pressure, Diabetes, Cholesterol



**Ipsilateral ischaemic stroke or operative stroke / death  
50-99% stenosis**

	Events / Patients		ARR (%)	95% CI
	Surgical	Medical		
<b>TIME SINCE LAST EVENT</b>				
< 2 weeks	13 / 112	26 / 75	24.7	12.3-37.1
	27 / 213	62 / 224	15.9	8.3-23.5
2-4 weeks	40 / 325	88 / 299	18.5	12.1-24.9
	17 / 136	13 / 81	4.4	-5.5-14.2
4-12 weeks	31 / 268	44 / 215	9.8	3.0-16.5
	29 / 271	31 / 216	4.1	-2.0-10.2
> 12 weeks	34 / 289	50 / 282	6.4	0.4-12.5
	63 / 560	81 / 498	5.5	1.2-9.8
TOTAL	20 / 196	12 / 113	0.7	-6.5-8.0
	21 / 125	19 / 119	-3.1	-13.3-7.2
	41 / 321	31 / 232	0.8	-5.2-6.8
<b>TOTAL</b>	<b>175 / 1474</b>	<b>244 / 1244</b>	<b>8.5</b>	<b>5.6-11.3</b>



□ ECST  
■ NASCET  
◇ TOTAL

Rothwell et al 2003



## TIA Management

- **Antiplatelets/Anticoagulation**
- **Carotid endarterectomy**
- **Control of vascular risk factors**
  - e.g. **Blood pressure, Diabetes, Cholesterol**

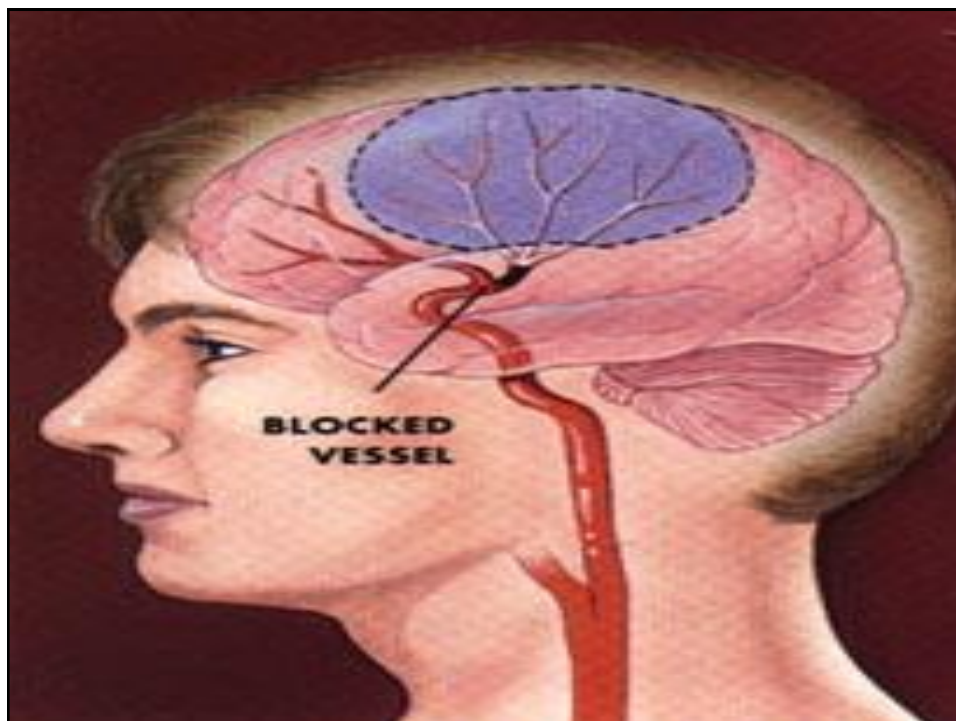
## Case History

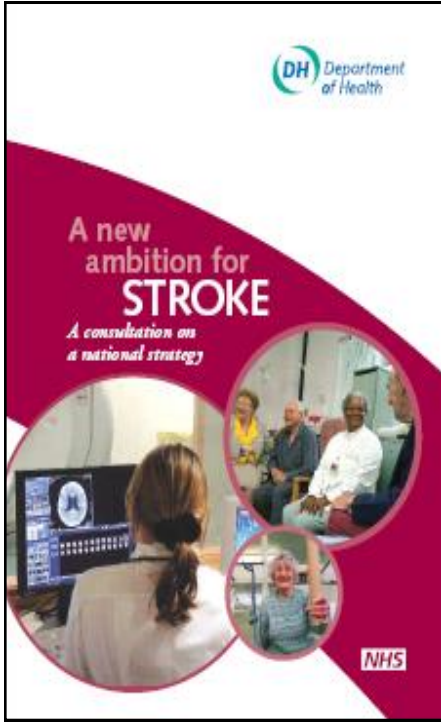
- 65-year old man
- History of high cholesterol and cigarette smoking
- Presented with left-sided weakness and numbness of sudden onset 2 hours previously
- Left-sided weakness, sensory deficit, visual deficit and neglect on examination

## Model of the TIA/Stroke diagnostic process

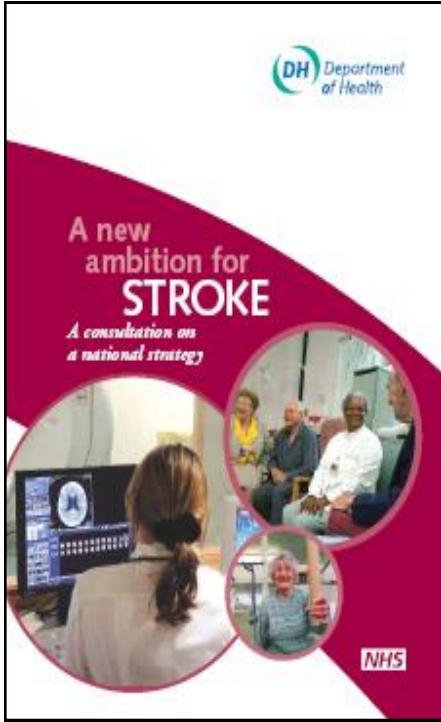
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2. Are the symptoms **negative** rather than positive?
3. Was the **onset** of the symptoms **sudden**?
4. Were the symptoms **maximal at onset** rather than progressing over a period?

If **YES** to all questions, the symptoms are almost certainly caused by vascular pathology (cerebral ischaemia or haemorrhage).





Typically,  
..... neurons  
are lost to the brain  
each minute  
a stroke  
goes untreated.



Typically,  
1.9 million neurons  
are lost to the brain  
each minute  
a stroke  
goes untreated.

**WHEN STROKE STRIKES, ACT F.A.S.T.**

Suspect a stroke? Act FAST. Call 999.

**F** Facial weakness  
Can the person smile? Has the mouth drooped?  
**A** Arm weakness  
Can the person raise both arms?  
**S** Speech problems  
Can the person read, write or understand what is said?  
**T** Test these symptoms

Stroke is a medical emergency. If you suspect a stroke, call 999 immediately.

Accident & Emergency

Facial weakness

Arm & leg weakness

Speech problems

Time to call 999

## Potential to reverse neurologic impairment with thrombolytic reperfusion

brain tissue destined to die

salvageable brain area

The average stroke patient loses 32,000 brain cells every second<sup>1</sup>

Reperfusion offers the potential to reduce the extent of ischemic injury<sup>2,3</sup>

References: 1. AHA Stroke Journal Report. December 9, 2005. 2. González. *Am J Neuroradiol.* 2006;27:728-735. 3. Donnan. *Lancet Neurol.* 2002;1:417-425.

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## Common ‘medicolegal’ questions

- *Is it a supportable clinical judgement that thrombolysis may have been considered but may not have been given?*
- *Do we agree with the contention that thrombolysis is not without risk and if given in this particular case it is more likely than not to have made no material difference to the outcome?*
- *Do we consider that had thrombolysis been attempted, on the balance of probabilities, that is to say considering whether something is more probable than not, the damage suffered by the pursuer in consequence of his stroke would have been prevented?*

### The New England Journal of Medicine

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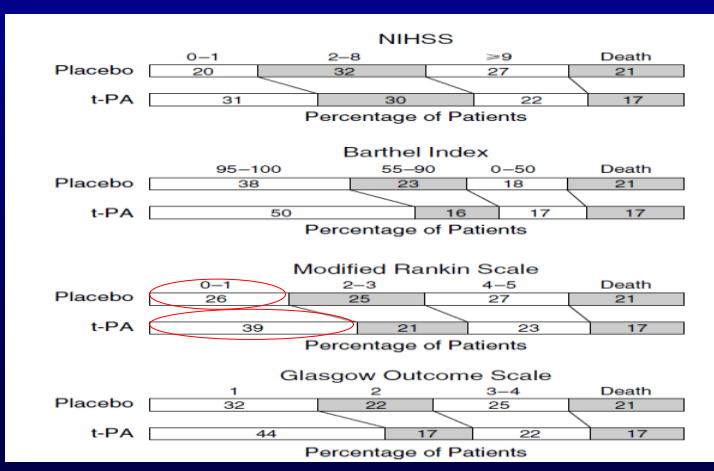
Volume 333

DECEMBER 14, 1995

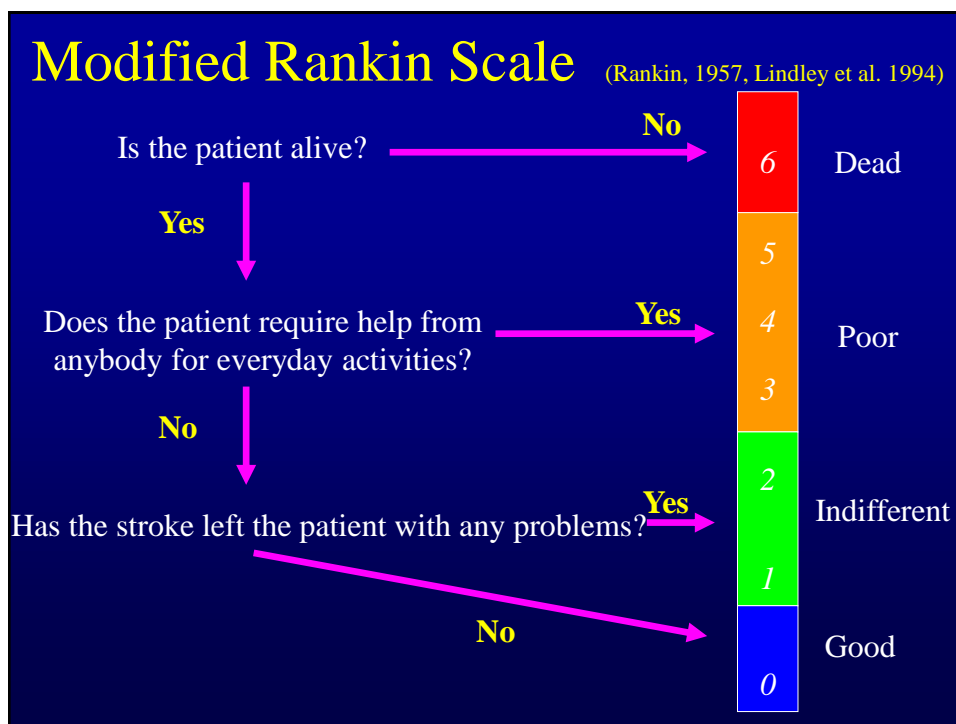
Number 24

#### TISSUE PLASMINOGEN ACTIVATOR FOR ACUTE ISCHEMIC STROKE

THE NATIONAL INSTITUTE OF NEUROLOGICAL DISORDERS AND STROKE t-PA STROKE STUDY GROUP\*







## Modified Rankin Scale

0 - **No symptoms.**

1 - **No significant disability.**

Able to carry out all usual activities, despite some symptoms.

2 - **Slight disability.**

Able to look after own affairs without assistance, but unable to carry out all previous activities.

3 - **Moderate disability.**

Requires some help, but able to walk unassisted.

4 - **Moderately severe disability.**

Unable to attend to own bodily needs without assistance, and unable to walk unassisted.

5 - **Severe disability.**

Requires constant nursing care and attention, bedridden, incontinent.

6 - **Dead.**



## The New England Journal of Medicine

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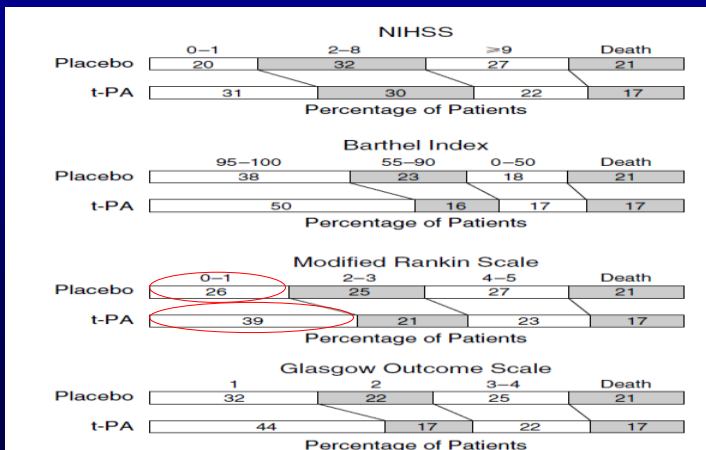
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THE NATIONAL INSTITUTE OF NEUROLOGICAL DISORDERS AND STROKE t-PA STROKE STUDY GROUP\*



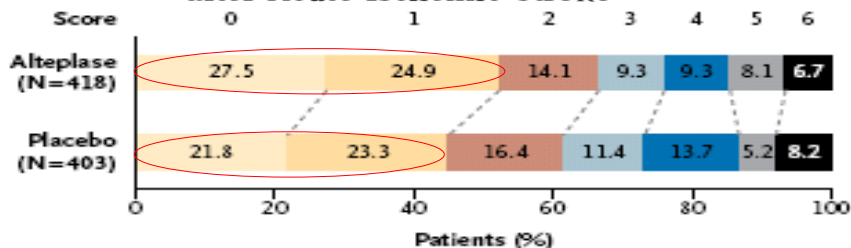
## The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812

SEPTEMBER 25, 2008

VOL. 359 NO. 13

### Thrombolysis with Alteplase 3 to 4.5 Hours after Acute Ischemic Stroke

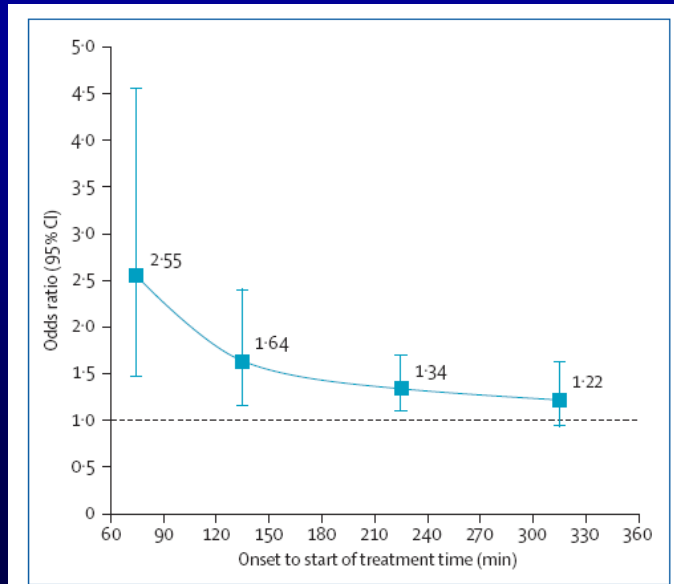


#### CONCLUSIONS

As compared with placebo, intravenous alteplase administered between 3 and 4.5 hours after the onset of symptoms significantly improved clinical outcomes in patients with acute ischemic stroke; alteplase was more frequently associated with symptomatic intracranial hemorrhage. (ClinicalTrials.gov number, NCT00153036.)

## Alteplase for ischaemic stroke—much sooner is much better

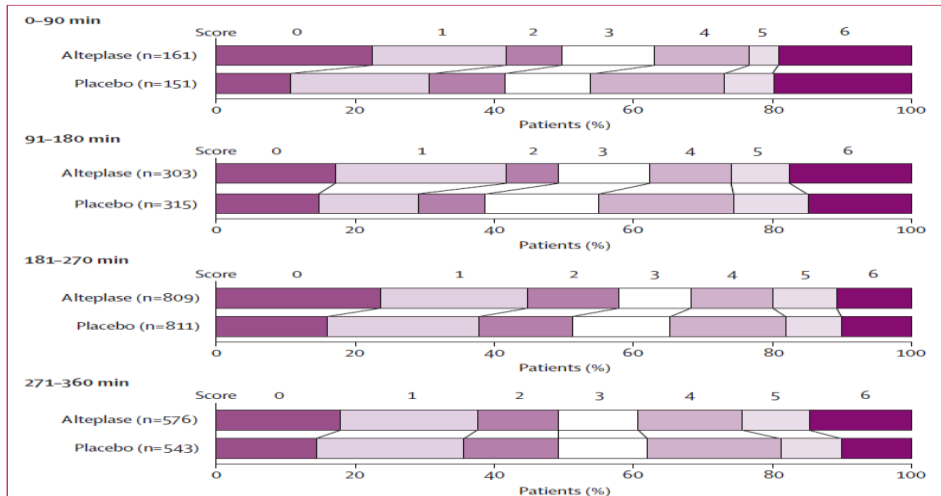
www.thelancet.com Vol 375 May 15, 2010



## Time to treatment with intravenous alteplase and outcome in stroke: an updated pooled analysis of ECASS, ATLANTIS, NINDS, and EPITHET trials

Lancet 2010; 375:1695-703

Kennedy R Lees, Erich Bluhmki, Rüdiger von Kummer, Thomas G Brott, Danilo Toni, James C Grotta, Gregory W Albers, Markku Kaste, John R Marler, Scott A Hamilton, Barbara C Tilley, Stephen M Davis, Geoffrey A Donnan, Werner Hacke, for the ECASS, ATLANTIS, NINDS, and EPITHET rt-PA Study Group Investigators\*



## Bleeding risk

- 1% natural risk in ischaemic stroke
- 3% with thrombolytic treatment within 3 hours
- Increases with delay from time of onset
- 7% with thrombolytic treatment within 6 hours

## British Association of Stroke Physician Stroke Service Standards

- *An established thrombolysis pathway should be in operation 24/7*
- *Time from hospital arrival to treatment within 30 minutes of arrival during office hours*
- *Time from hospital arrival to treatment no more than 60 minutes outside office hours*

## Intra-arterial thrombolysis

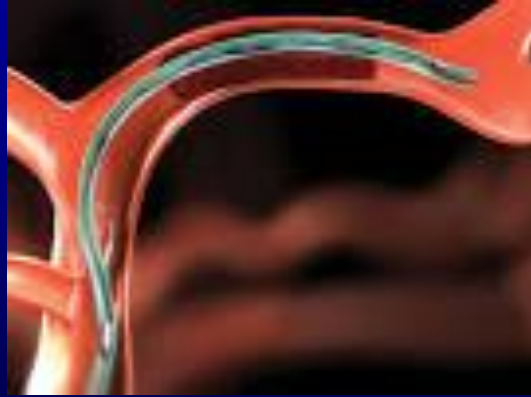
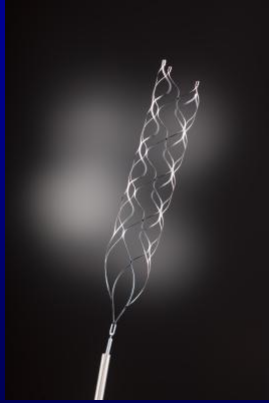
- Requires specially trained personnel and facilities
- Delays administration of thrombolysis
- Thrombolysis delivered directly
- Allows extension of time-window for thrombolysis
- Trend to better outcome than iv rt-PA, particularly for proximal large vessel occlusion



## Mechanical thrombectomy devices

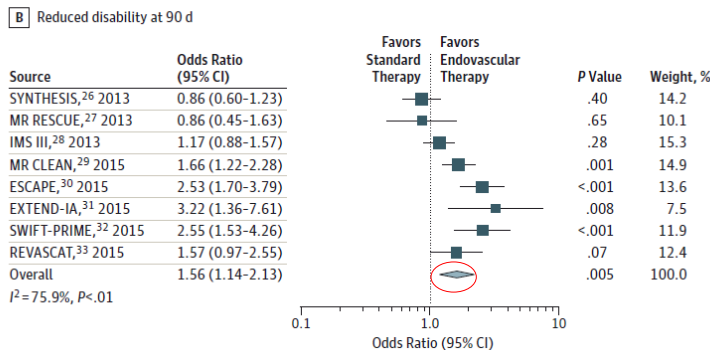
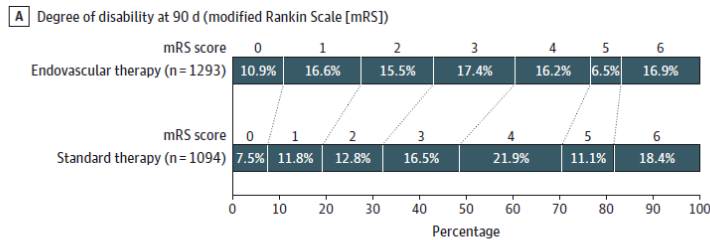


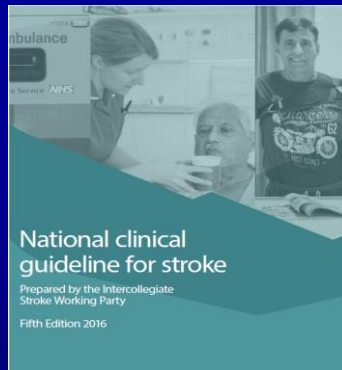
# Stent-retriever devices



## Endovascular Thrombectomy for Acute Ischemic Stroke A Meta-analysis

JAMA. 2015;314(17):1832-1843





Patients with acute ischaemic stroke should be considered for combination intravenous thrombolysis and intra-arterial clot extraction (using stent retriever and/or aspiration techniques) if they have a proximal intracranial large vessel occlusion causing a disabling neurological deficit (National Institutes of Health Stroke Scale [NIHSS] score of 6 or more) and the procedure can begin (arterial puncture) within 5 hours of known onset.

## Case History

- 65-year old man
- History of high blood pressure and cigarette smoking
- Presented *at 11:30pm to his local hospital* with left-sided weakness and numbness of sudden onset 2 hours previously
- Left-sided weakness, sensory deficit, visual deficit and neglect on examination



## Common 'medicolegal' questions

- *Do we consider that the employees of the health board were negligent in failing to provide stroke specialist care in this case?*
- *Do we consider that the employees of the health board were negligent in failing to consider thrombolysis in this case?*

## National clinical guideline for stroke

Prepared by the Intercollegiate Stroke Working Party

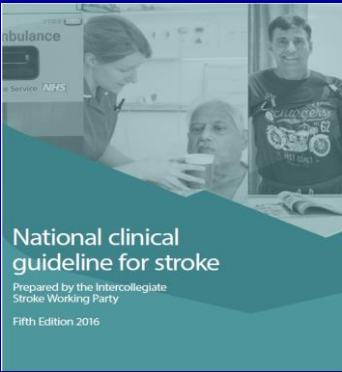
July 2008

All patients seen within three hours of an acute neurological syndrome suspected to be a stroke should be transferred directly to a specialised hyperacute stroke unit that will assess for thrombolysis and deliver it if clinically indicated.

Alteplase should only be administered within a well organised stroke service with:

- staff trained in delivering thrombolysis and in monitoring for any associated complications

Protocols should be in place for the delivery and management of thrombolysis, including post-thrombolysis complications.



National clinical guideline for stroke  
Prepared by the Intercollegiate Stroke Working Party  
Fifth Edition 2016

People with an acute neurological presentation suspected to be a stroke should be admitted directly to a hyperacute stroke unit which cares predominantly for stroke patients. Acute hospitals receiving medical admissions that include people with suspected stroke should have arrangements to admit them directly to a hyperacute stroke unit on site or at a neighbouring hospital, to monitor and regulate basic physiological functions such as neurological status, blood glucose, oxygenation, and blood pressure.

## Specialist care in an acute stroke unit



Specialist  
Stroke Unit Care



Early Imaging



Pharmacological  
Interventions

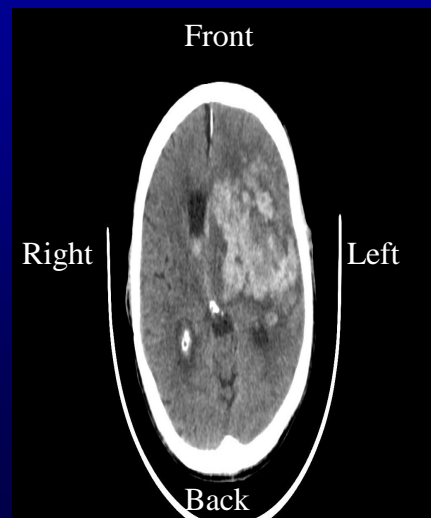
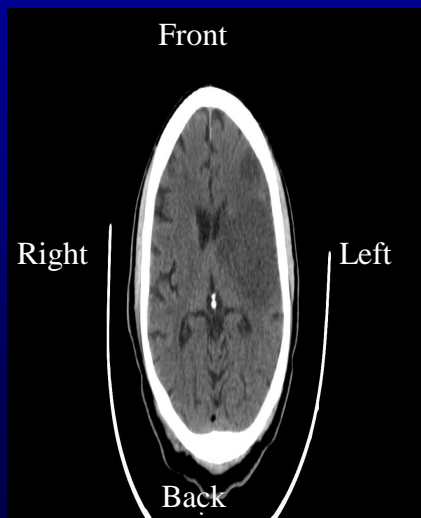
**A stroke unit is:**  
A discrete area within the hospital  
Staffed by specialist MDT  
Access to monitoring and rehabilitation equipment  
Regular MDM for goal setting

## Why a stroke unit?

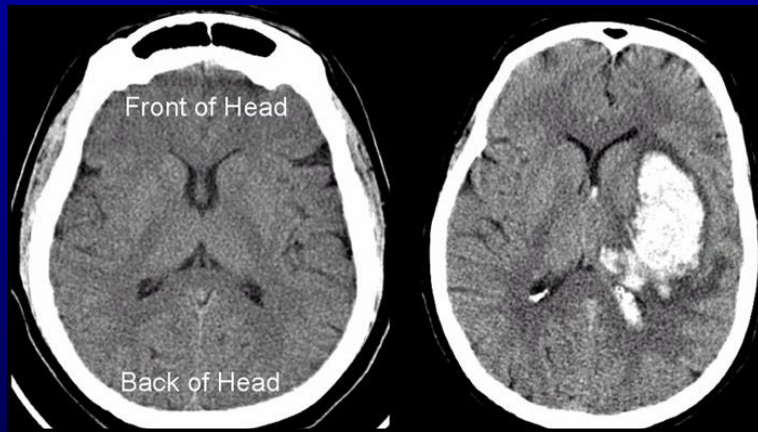
### Stroke Unit Trialists' Collaboration

- Reduced Mortality (17%)
- Reduced Death or Institutionalisation (25%)
- Reduced Death or Dependency (31%)

## Imaging the brain is an essential investigation of suspected stroke



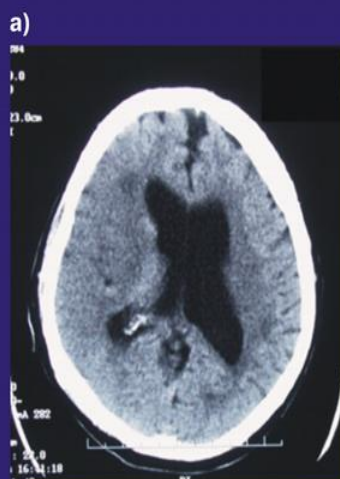
## Hyperacute brain imaging



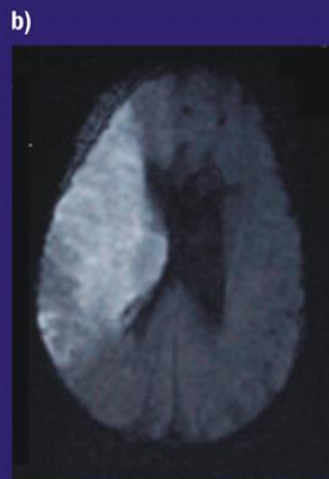
Hyperacute ischaemic  
left MCA territory stroke

Hyperacute haemorrhagic  
left MCA territory stroke

## Right Hyperacute Middle Cerebral Artery Infarct

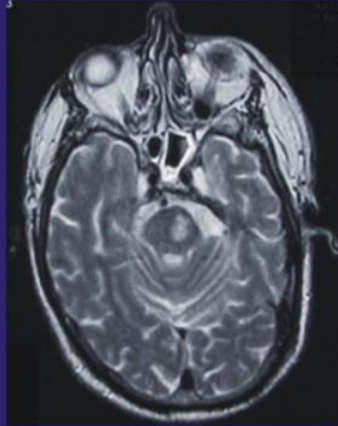


CT

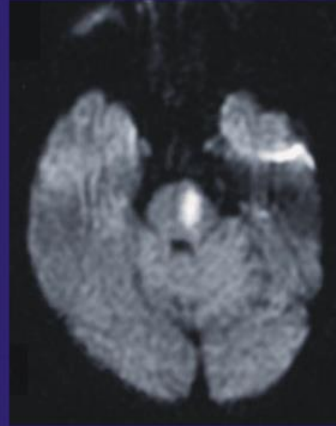


MRI

## Pontine infarction

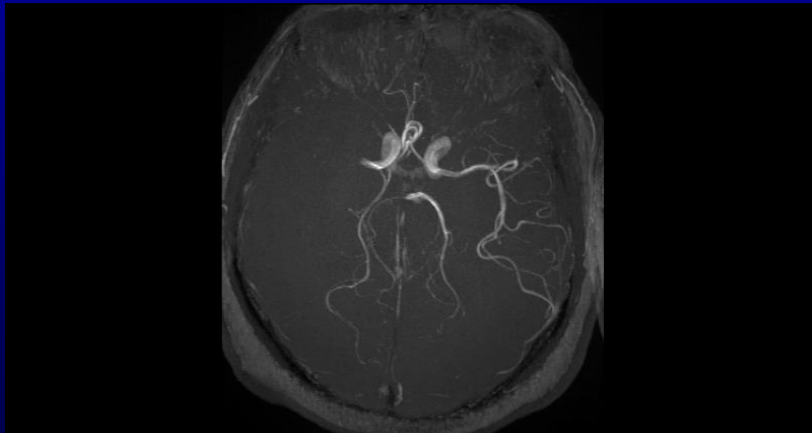


T2

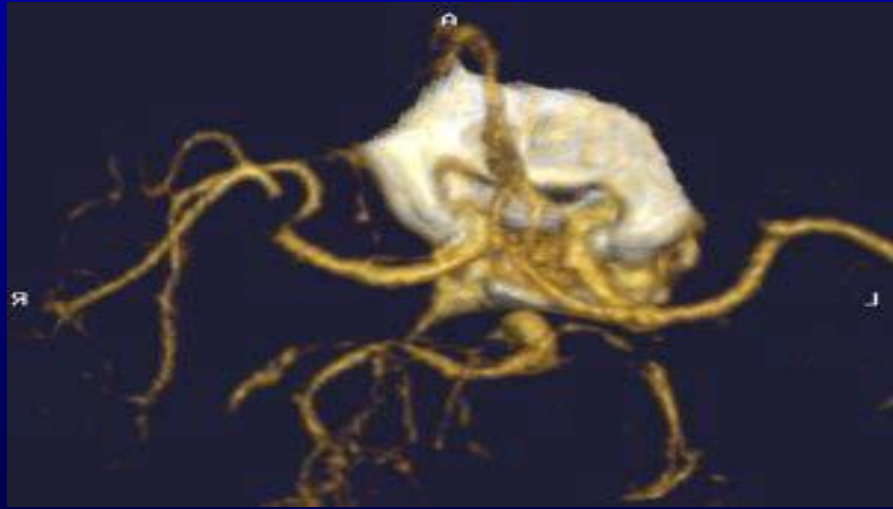


DWI

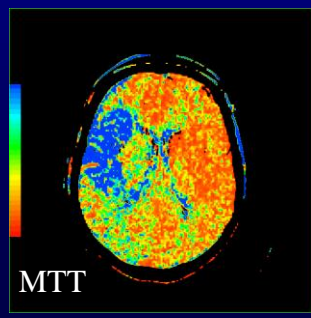
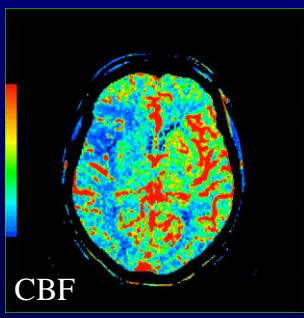
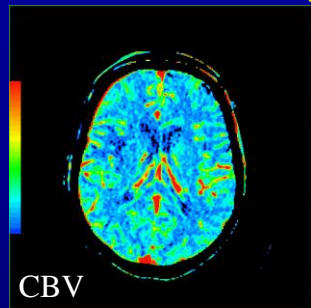
## Magnetic Resonance Angiography



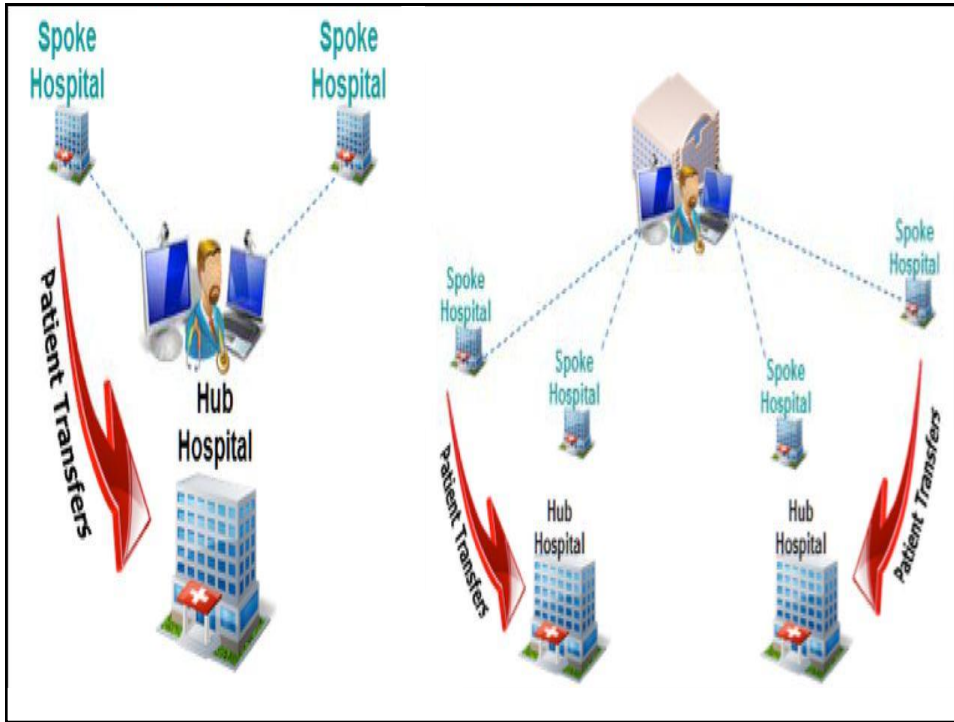
## CT Angiography with 3D Reconstruction



## CT perfusion brain scanning







## 30-minute blue light ambulance travel time from the hyper-acute stroke units (HASUs)



The green area shows the areas that are within 30 minutes travel time (under ambulance blue light conditions) of a HASU




## “Telestroke”


### The Application of Telemedicine for Stroke

Steven R. Levine, MD; Mark Gorman, MD  
(*Stroke*. 1999;30:464-469.)


A




B



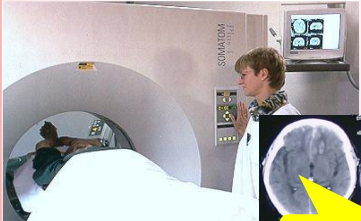
C




● Remote Hospital● Stroke Centre





Regional stroke ward



CT/MRI




DICOM-Data



Up to 2 Mb/sec

*One spring Sunday afternoon:*




**15:20**  
63 year old father of the bride collapsed at the wedding with right sided weakness and dysphasia

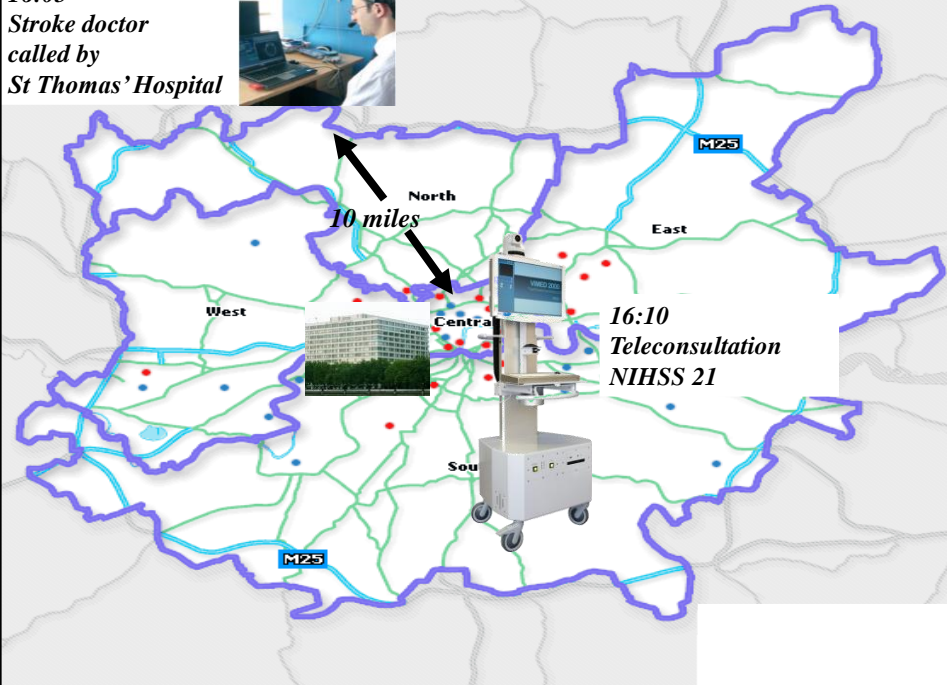


**16:09 Arrival at St Thomas' Hospital**

**16:05**  
Stroke doctor called by St Thomas' Hospital



**10 miles**



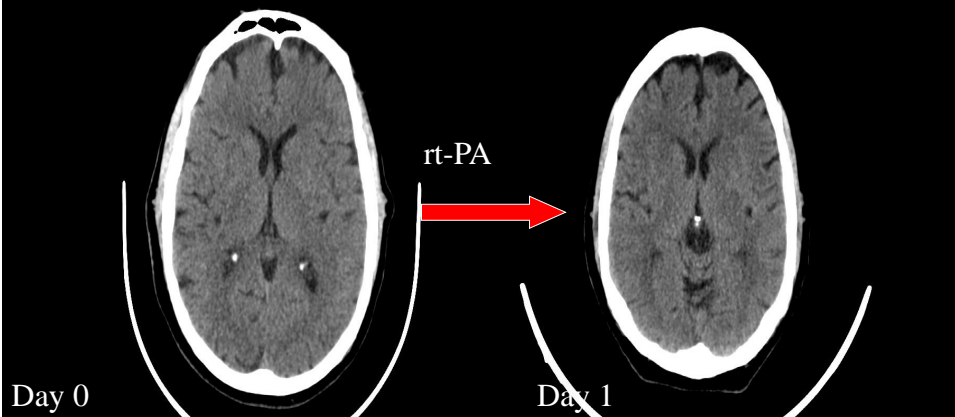
**16:10**  
Teleconsultation  
NIHSS 21

CT Brain at 16:14



→ Thrombolysis at 16:25 (16 minute door to needle time)

## Pre and post-thrombolysis CT brain scans



## Mobile CT scanning



## ? Stroke-mobile

