Carotid Artery Disease Management

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Financial Disclosures

None

Conflicts of Interest

None

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Carotid Artery Disease Management

Learning Objectives:

-Understand the role of carotid artery disease in stroke

-Understand the role of ultrasound in the diagnosis of Carotid stenosis

-Understand the basics of best medical therapy for the treatment of carotid artery stenosis.

- Understand when surgery for carotid artery stenosis is indicated.

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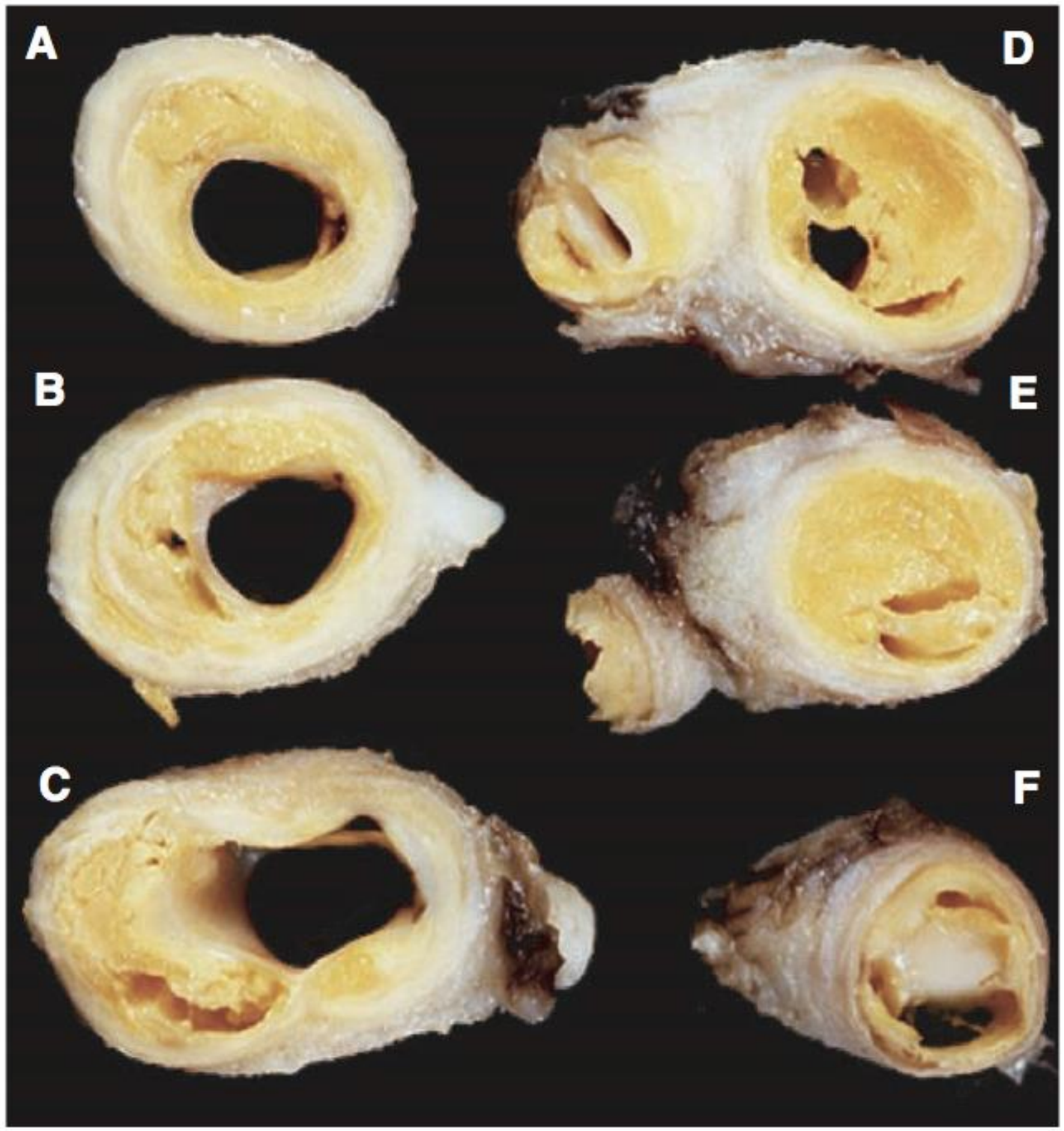
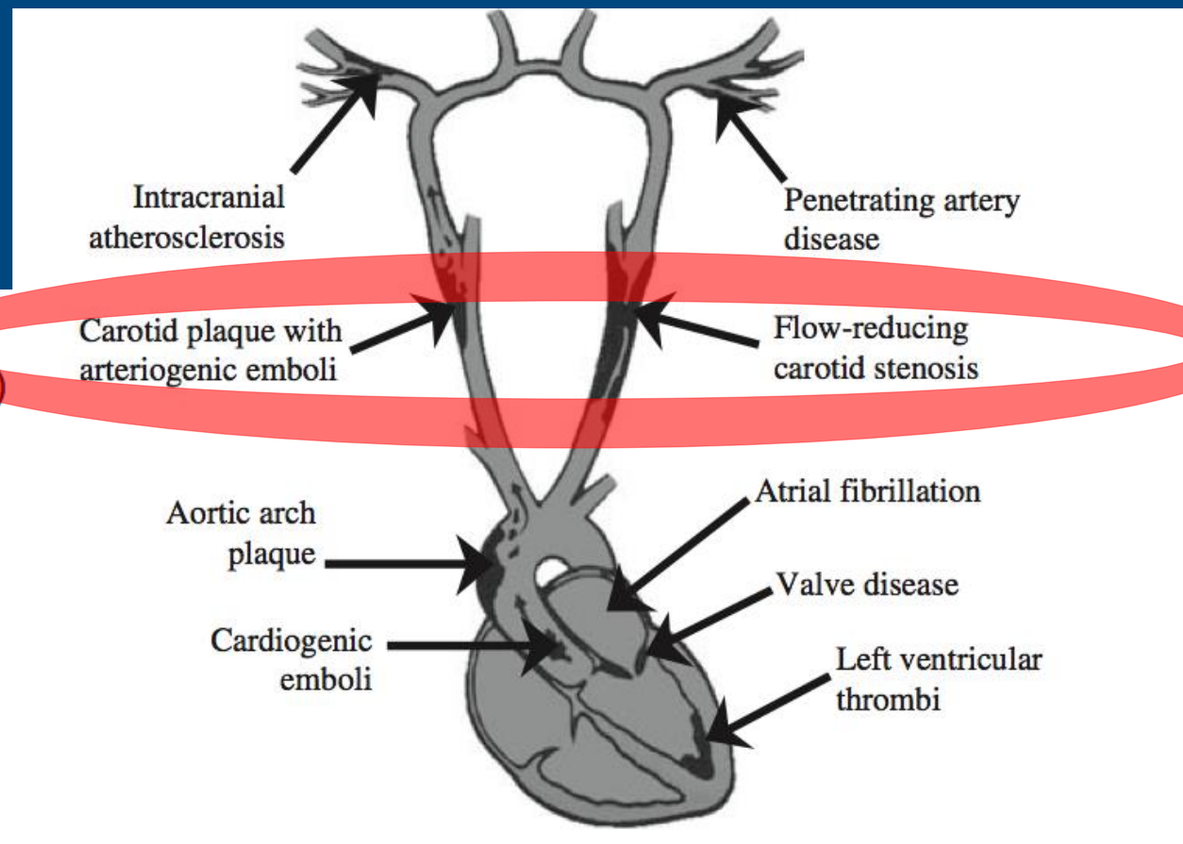
Introduction:

- Stroke 3rd leading cause of death in the USA
- More than half a million new strokes each
- The leading cause of serious long-term disability
- Direct and indirect costs at $40 billion



Causes of Stroke

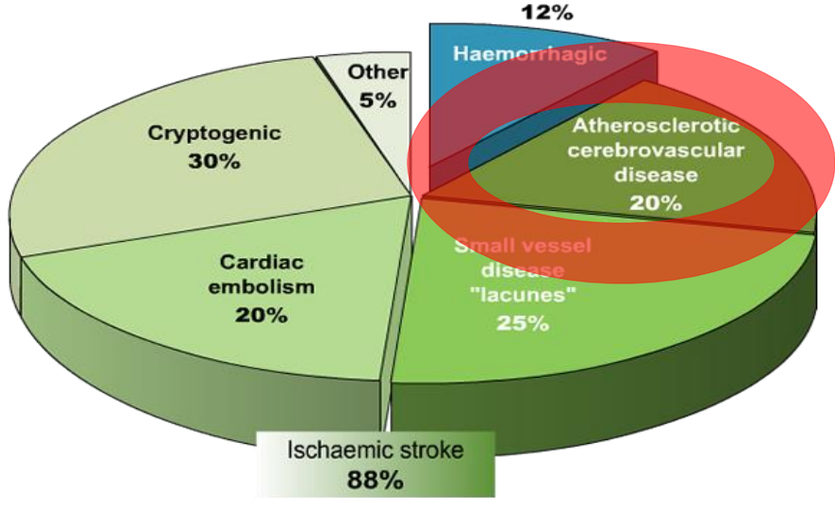


Embolism
- Arterial atheroembolism (carotid atherosclerosis)
- Cardiac
  - Atrial fibrillation
  - Myocardial infarction
  - Cardiomyopathy
  - Prosthetic valves
- Paradoxical (DVT)

Ischemic stroke

Small-vessel occlusive disease
- Lacunar
- Arteritis
- Drug induced

Large-vessel occlusive disease
- Carotid atherothrombosis
- Arteritis
- Dissection



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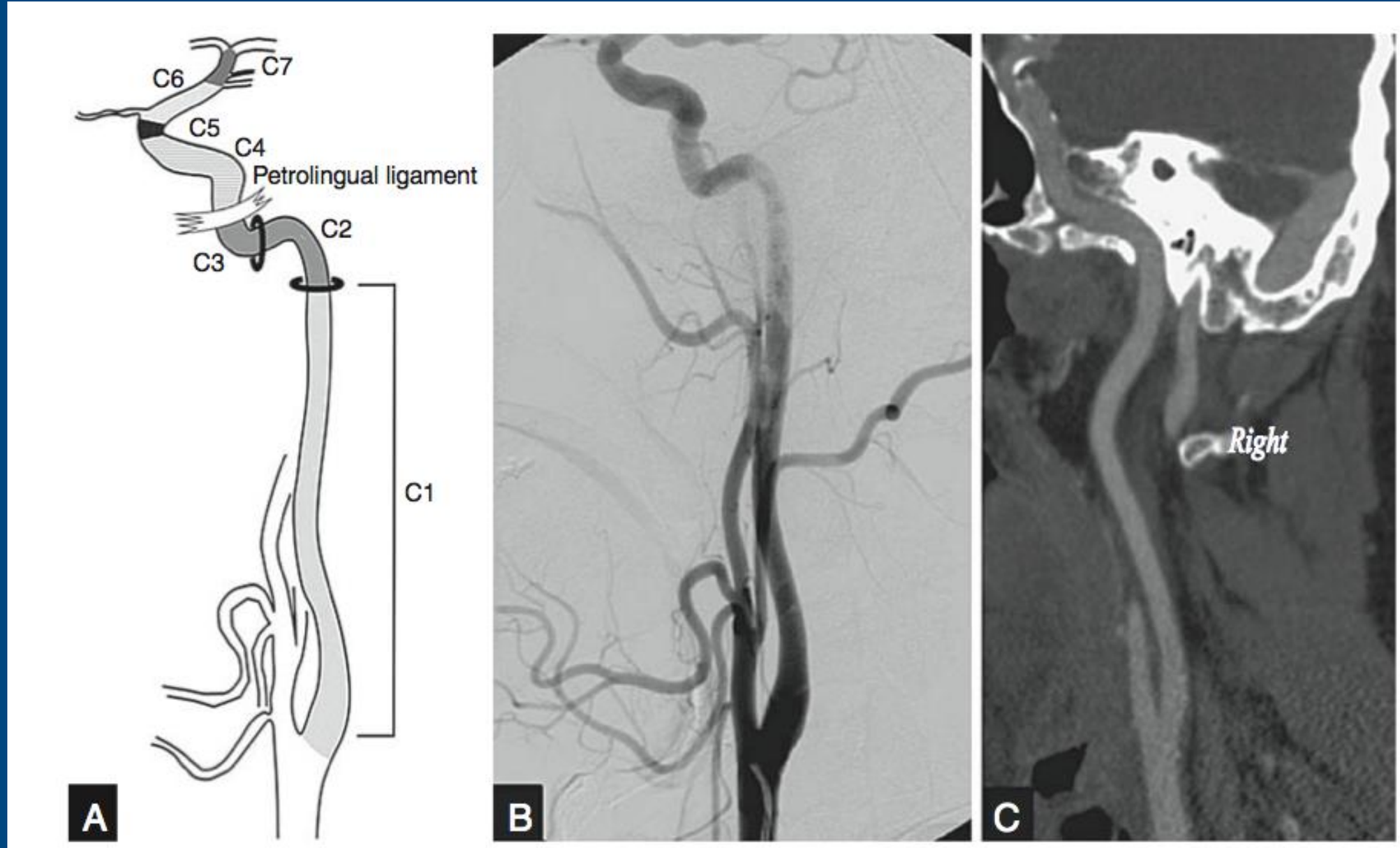
Carotid Artery Anatomy



1) cervical, 2) ascending petrous, 3) horizontal petrous, 4) ascending cavernous, 5) horizontal cavernous, 6) clinoid, 7) ophthalmic, and 8) terminal

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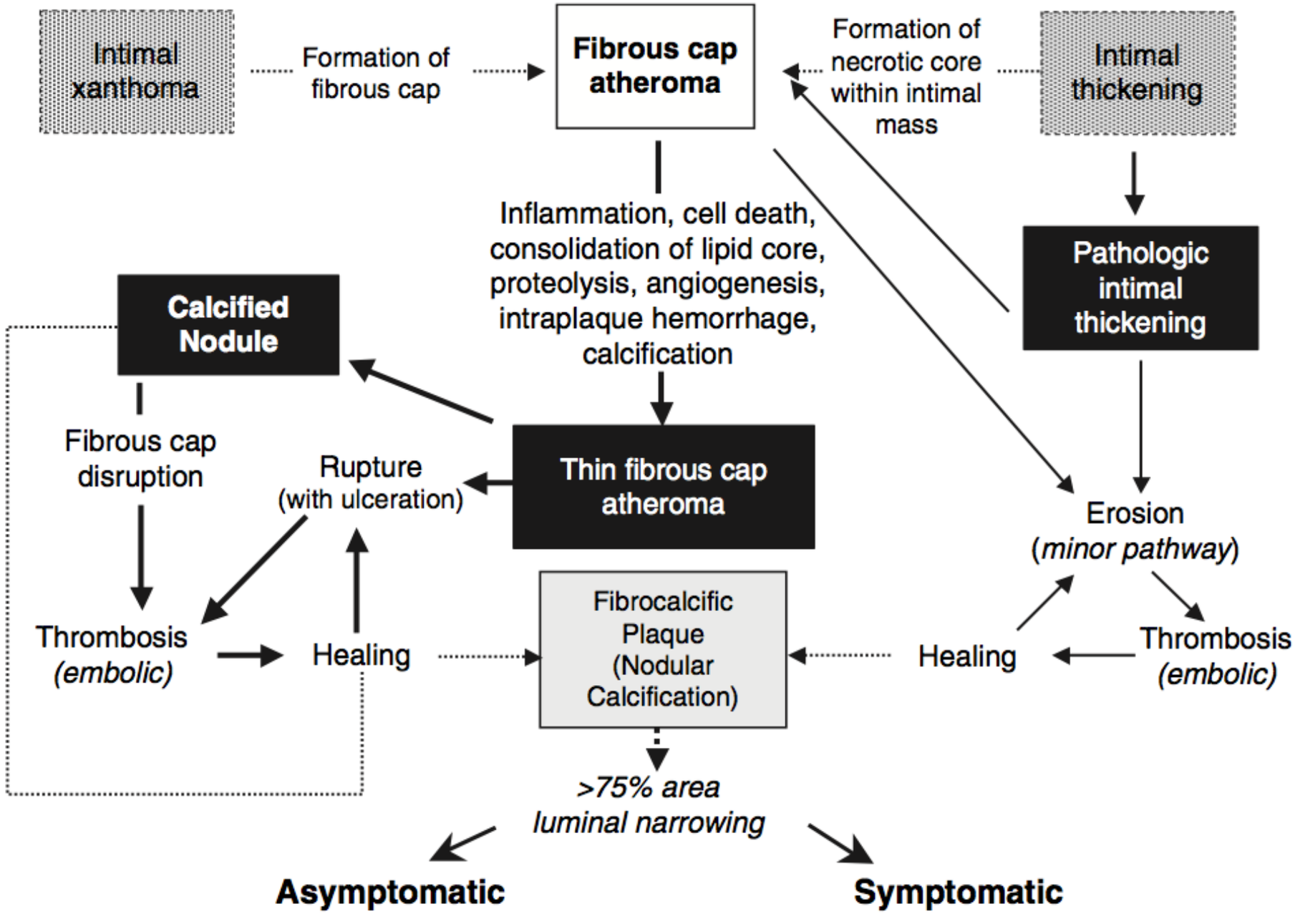
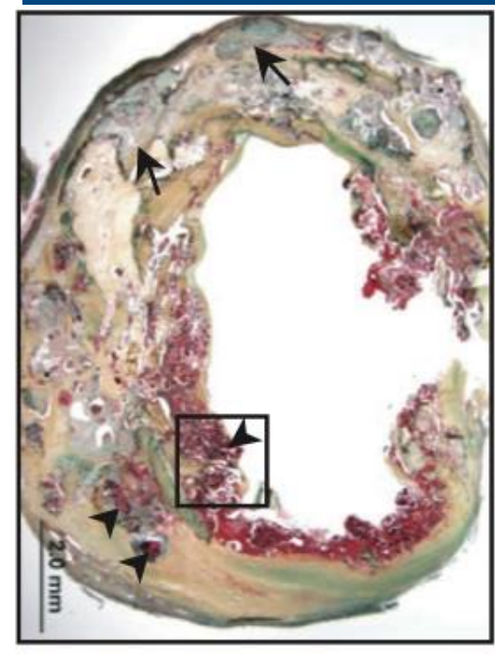
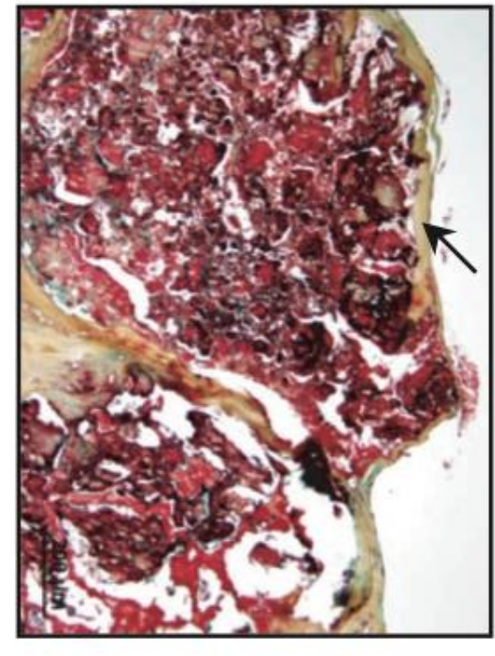
Carotid Artery Stenosis Pathology





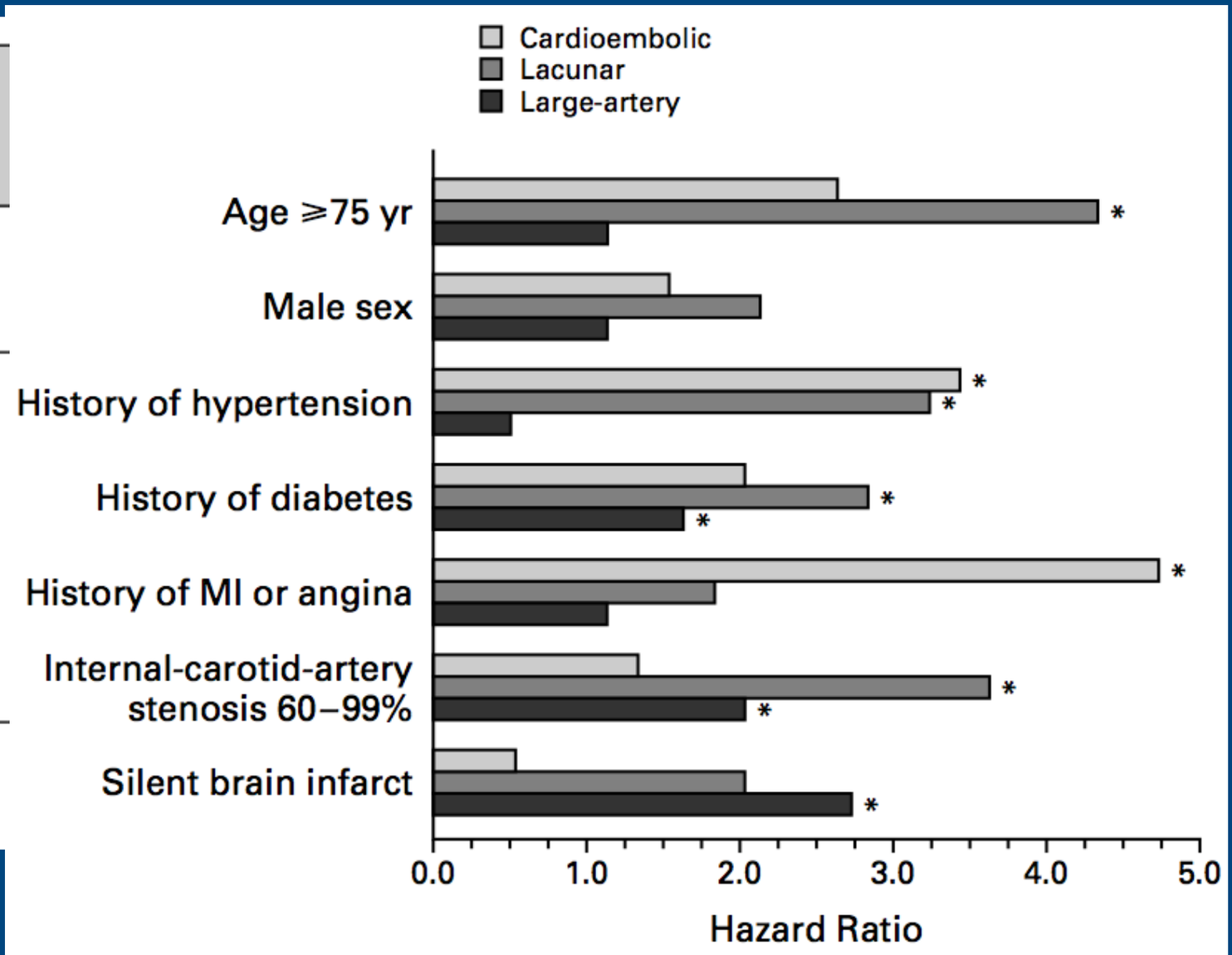


Carotid Artery Stenosis Epidemiology

Table 4.5 Multivariate determinants of asymptomatic CAS

Variable	Odds ratio (95% CI)	Risk score
Age	4.1 (2.6–6.7)	4
Sex (male)	1.4 (0.9–2.0)	NS
Current smoker	2.0 (1.2–3.5)	1
Coronary artery disease	2.4 (1.5–3.9)	2
Hypercholesterolemia	1.9 (1.2–2.9)	1

CAS, carotid artery stenosis; CI, confidence interval.
Adapted from Qureshi et al.[50]



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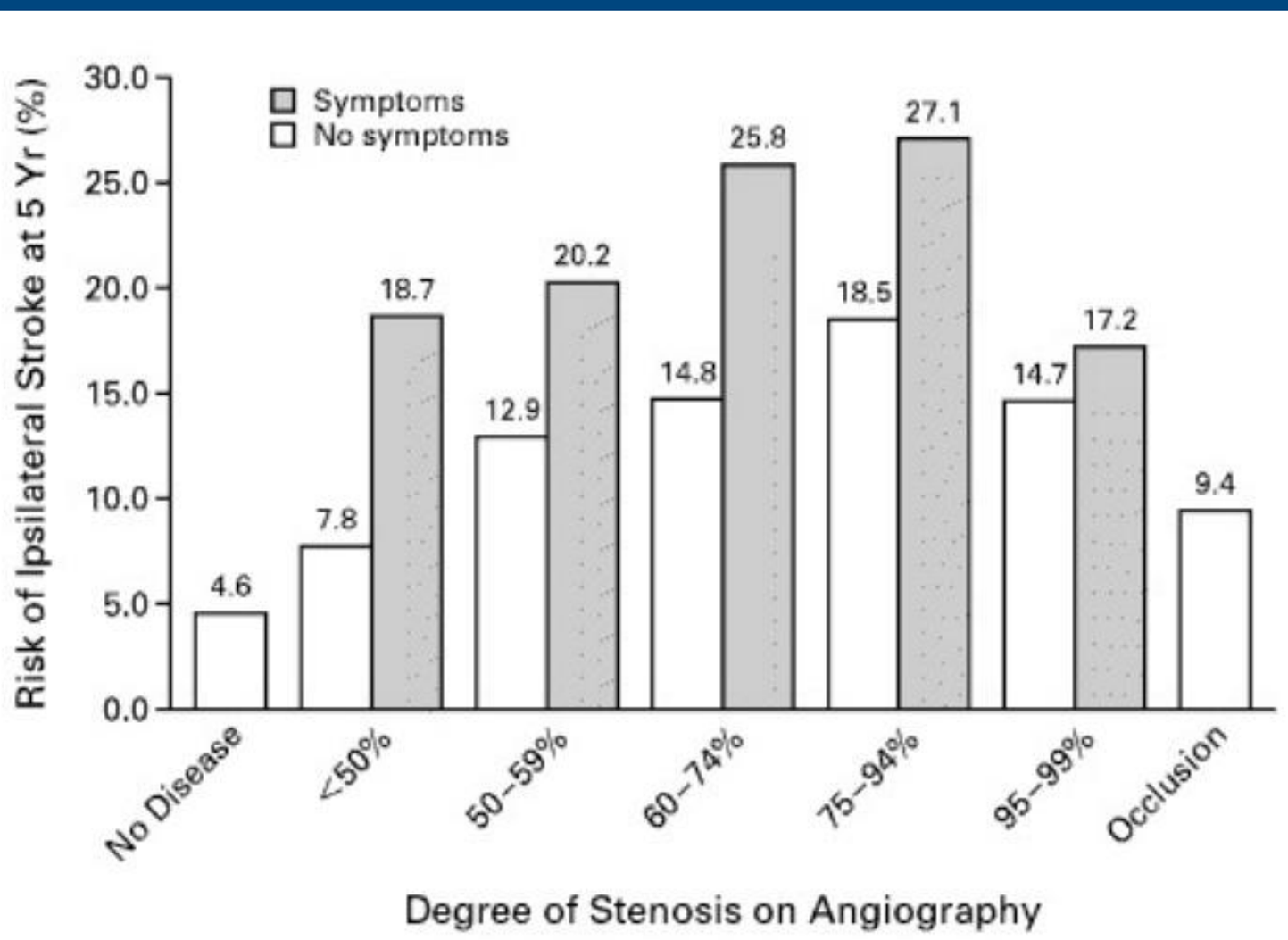
THE CAUSES AND RISK OF STROKE IN PATIENTS WITH ASYMPTOMATIC INTERNAL-CAROTID-ARTERY STENOSIS

DOMENICO INZITARI, M.D., MICHAEL ELIASZIW, PH.D., PETER GATES, M.B., B.S., BRENDA L. SHARPE, B.SC.N., RICHARD K.T. CHAN, M.D., HEATHER E. MELDRUM, B.A., AND HENRY J.M. BARNETT, M.D., FOR THE NORTH AMERICAN SYMPTOMATIC CAROTID ENDARTERECTOMY TRIAL COLLABORATORS

The New England Journal of Medicine

Volume 342 Number 23 · 1693



Contributing metabolic factors to stroke risk

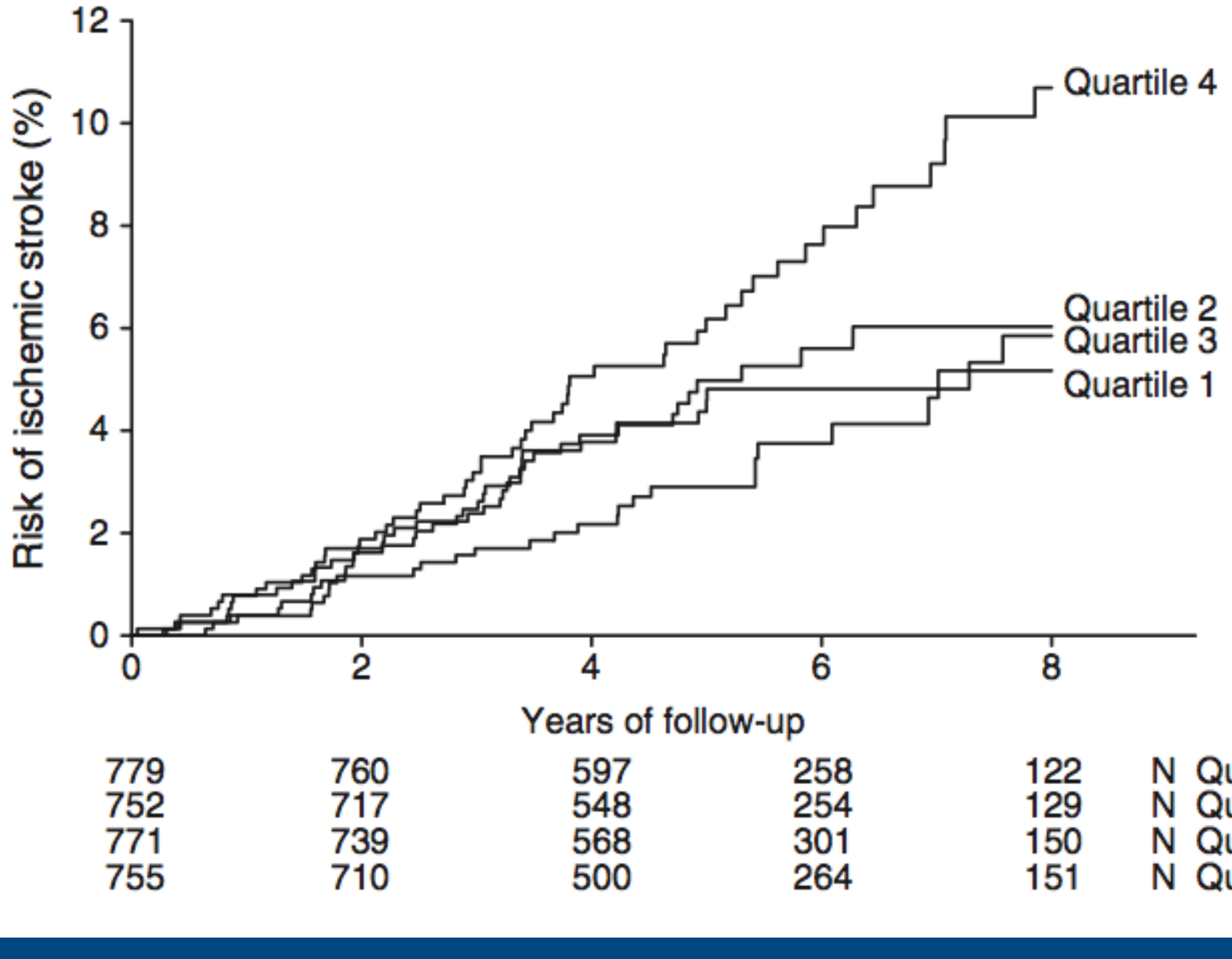


Figure 11.1 Kaplan–Meier estimate of risk of ischemic stroke according to quartile of baseline leukocyte count, from the Northern Manhattan Study. Quartile 1: $\leq 4.8 \times 10^3$ cells/L. Quartile 2: 4.9–6.2 $\times 10^3$ cells/L. Quartile 3: 6.3–7.2 $\times 10^3$ cells/L. Quartile 4: $\geq 7.3 \times 10^3$ cells/L. (Adapted from Elkind MS, Sciacca R, Boden-Albala B et al. Relative elevation in leukocyte count predicts first cerebral infarction. Neurology 2005; 64: 2121–5, with permission from Lippincott, Williams & Wilkins.)

Increasing risk of stroke with progressive

Table 1.7 Rate of carotid disease progression in patients with asymptomatic CAS

Study	No. of patients	Mean FU period (months)	Initial stenosis severity (%)	Progression to a higher category (%)	
				Total	Annual
Roederer[65]	167	36	<50	–	8
			50–79	–	20
			80–99	–	50
Mansour[66]	142	20	50–79	17	8.5
The Asymptomatic Cervical Bruit Study; Lewis[67]	715	38	None	3.25	1.5
			<50	19.5	9.5
			50–79	22.2	11.1
			80–99	9.7	6.5
Muluk[68]	1004	28	None	11.5	3
			<50	38.2	10.9
			50–79	43.5	12.2
			80–99	26.6	7.7
Cina[60]	399	6–9	<50	–	13.5
			50–79	–	3.8
			80–99	–	7.7
Martin-Conejero[69*]	180	26	<30	7	–
			30–70	27	–
Sabeti[70]	1013	8	0–99	9.2	–

CAS, carotid artery stenosis; FU, follow-up.
*Patients with prior contralateral carotid endarterectomy.

Table 8.2
stenosis

Initial car
severity

<50%
<80%

carotid

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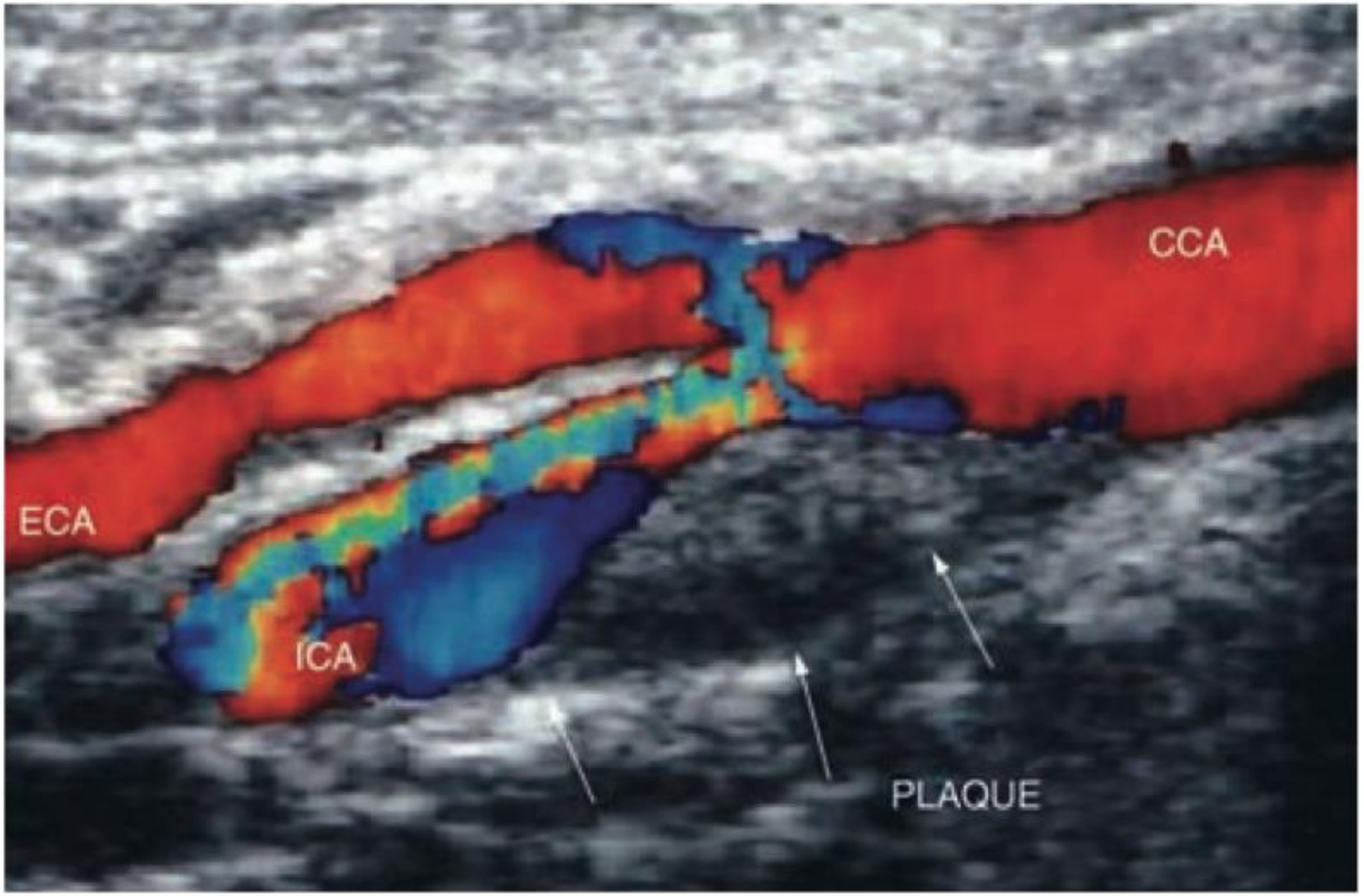
Carotid Artery Stenosis Diagnosis



Carotid Artery Stenosis

Screening Carotid Ultrasound:

- Considered for asymptomatic patients who have
  - PAD
  - CAD
  - AAA
  - At least two risk factors for stroke including:
    - high blood pressure
    - high cholesterol
    - tobacco smoking
    - a first-degree relative with atherosclerosis that developed before age 60
    - a family history of ischemic stroke

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STRANDNESS CRITERIA		ZWIEBEL CRITERIA	
Stenosis, %	Characteristics	Stenosis, %	Characteristics
Normal	PSV < 125 cm/sec No SB Flow reversal in bulb	0	PSV < 110 cm/sec EDV < 40 cm/sec PSV ICA/CCA < 1.8 EDV ICA/CCA < 2.4 SB < 30 cm/sec
1-15	PSV < 125 cm/sec No or minimal SB Flow reversal in bulb absent	1-39	PSV < 110 cm/sec EDV < 40 cm/sec PSV ICA/CCA < 1.8 EDV ICA/CCA < 2.4 SB < 40 cm/sec
16-49	PSV > 125 cm/sec Marked SB	40-59	PSV < 130 cm/sec EDV < 40 cm/sec PSV ICA/CCA < 1.8 EDV ICA/CCA < 2.4 SB < 40 cm/sec
50-79	PSV > 125 cm/sec EDV < 140 cm/sec	60-79	PSV > 130 cm/sec EDV > 40 cm/sec PSV ICA/CCA > 1.8 EDV ICA/CCA > 2.4 SB > 40 cm/sec
80-99	PSV > 125 cm/sec EDV > 140 cm/sec	80-99	PSV > 250 cm/sec EDV > 100 cm/sec PSV ICA/CCA > 3.7 EDV ICA/CCA > 5.5 SB > 80 cm/sec

Carotid Artery Stenosis

Medical Management for all patients with carotid stenosis

- Medical regimen including:
  - Statin therapy
  - 75-150 mg/day aspirin
  -Antihypertensive medications
-Risk factor modification including:
  - Smoking cessation
-Routine Surveillance Ultrasound once stenosis is identified

EVIDENCE SUMMARY

Peter F. Lawrence, MD, Section Editor

Best evidence for medical therapy for carotid artery stenosis

Jason Constantinou, MD, FRCS, Parveen Jayia, MRCS, and **George Hamilton, MD, FRCS,**
London, United Kingdom

Carotid atheromatous disease is an important cause of stroke and represents a key target in stroke prevention. Randomized trials have shown the efficacy of carotid endarterectomy in secondary stroke prevention. Carotid stenting presents a less invasive alternative to surgical intervention. Advances in medical management, if compliance can be ensured, are leading to improvement in outcomes when implemented as sole therapy in the treatment of atherosclerotic carotid stenosis. This includes lifestyle modification, blood pressure control, and antiplatelet and statin therapy. Over the last 20 years, the annual rate of ipsilateral stroke associated with asymptomatic carotid stenosis has decreased from 2% to 4% to less than 1%. This is largely due to improvements in medical therapy. However, despite numerous trials and years of clinical research, the optimal management of symptomatic and asymptomatic carotid disease remains controversial. This article presents and summarizes the evidence supporting best medical treatment for carotid artery stenosis. (J Vasc Surg 2013;58:1129-39.)

Carotid Artery Stenosis

Medical Management

Statin therapy (conclusions based upon results of numerous RTC's):

-All patients with carotid artery stenosis should be treated with statin medications as tolerated (multiple RCT's)

-Each 10% reduction in LDL cholesterol was estimated to reduce the risk of stroke by 15.6%.

(Paraskevas KI, Hamilton G, Mikhailidis DP. Statins: an essential component in the management of carotid artery disease. J Vasc Surg 2007;46:373-86.

Carotid Artery Stenosis

Medical Management

Antiplatelet therapy (Aspirin):

-Has been shown to reduce incidence of stroke by 25%

(Antithrombotic Trialists Collaboration. Collaborative meta-analysis of randomised trials of anti-platelet therapy for prevention of death, myocardial infarction and stroke in high risk patients. BMJ 2002;324: 71-86.)

-Meta-analysis of 21 trials supports the us of aspirin of 75 mg- 150 mg per day

(Antithrombotic Trialists Collaboration. Collaborative meta-analysis of randomised trials of anti-platelet therapy for prevention of death, myocardial infarction and stroke in high risk patients. BMJ 2002;324: 71-86.)

- Plavix can be used in patients who cannot take Aspirin.

-No evidence to support DAPT

Carotid Artery Stenosis

Medical Management

Anticoagulation:

-Offers no greater benefit than aspirin but did have a significantly increased risk of causing intracranial hemorrhage.

(Berge E, Sandercock P. Anticoagulants versus antiplatelet agents for acute ischaemic stroke. Cochrane Database Syst Rev 2002;(4): CD003242.)

Carotid Artery Stenosis

Medical Management

Blood pressure control:

-Control of blood pressure can lead to a 30% to 40% reduction in stroke and is one of the most modifiable risk factors for carotid artery disease

(Sillesen H. What does ‘best medical therapy’ really mean? Eur J Vas Endovasc Surg 2008;35:139-44.)

-The use of low dose thiazides (bendrofluazide) and ACE inhibitors (captopril, ramipril) decrease stroke risk

(Wright JM, Musini VM. First-line drugs for hypertension. Cochrane Database Syst Rev 2009;(3):CD001841. , Yusuf S, Sleight P, Pogue J, Bosch J, Davies R, Dagenais G. The Heart Outcomes Prevention Evaluation Study Investigators. Effects of an angiotensin converting enzyme inhibitor, Ramipril, on cardiovascular events in high-risk patients. N Engl J Med 2000;342:145-53. , Hanson L, Lindholm L, Niskanen L, Lanke J, Hedner T, Niklason A, et al. Effect of angiotensin-converting-enzyme inhibition compared with conventional therapy on cardiovascular morbidity and mortality in hypertension: the Captopril Prevention Project (CAPP) randomised trial. Lancet 1999;353:611-6.)

Carotid Artery Stenosis

Surgical Management (CEA)

Asymptomatic Carotid Artery Stenosis:

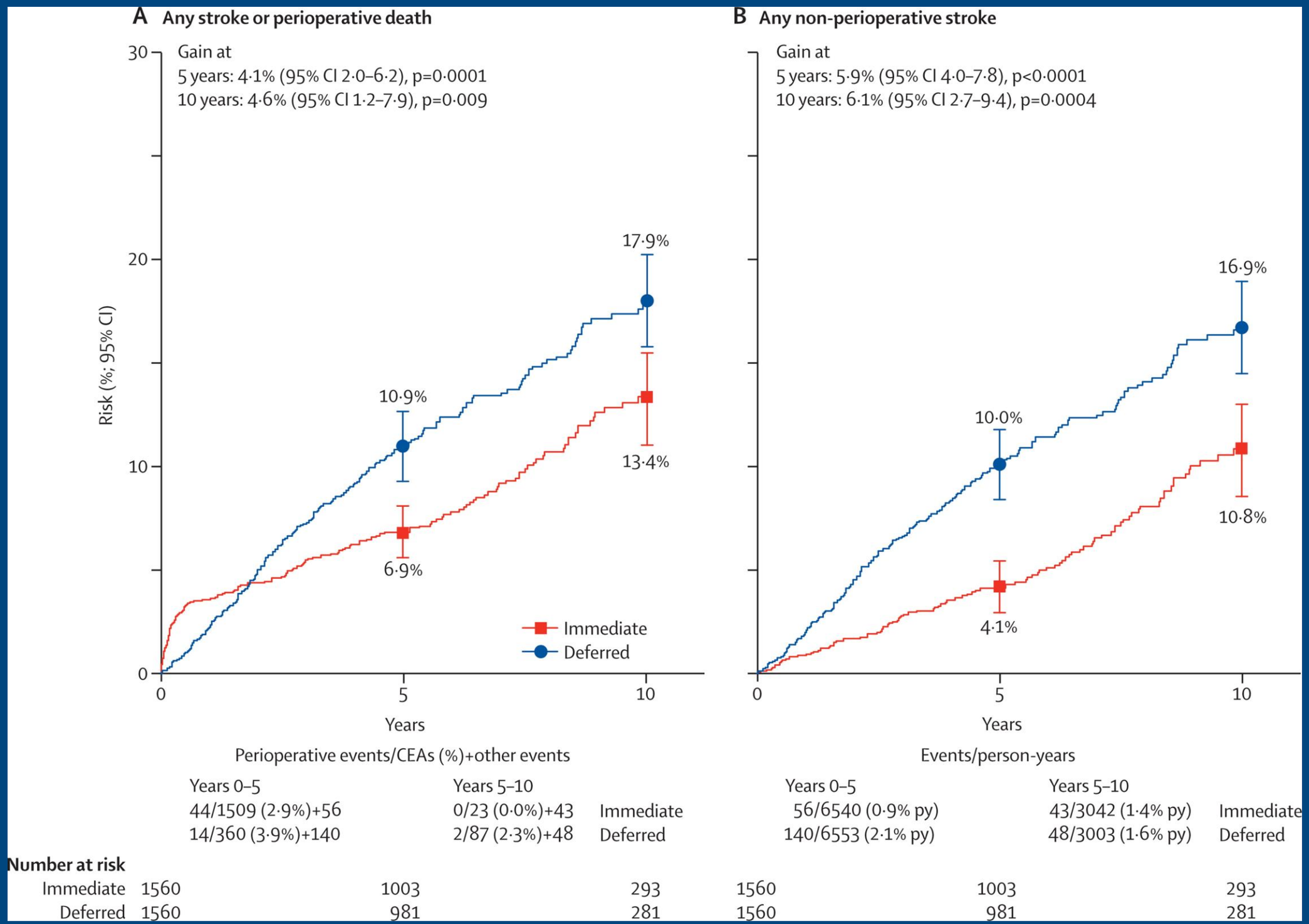
- Several trials comparing CEA to BMT with long term f/u
- Several trials to compare CEA to CAS
- Ongoing trials comparing CEA, CAS, and BMT

Systematic Review of Guidelines for the Management of Asymptomatic and Symptomatic Carotid Stenosis *Stroke. 2015;46:3288-3301*

10-year stroke prevention after successful carotid endarterectomy for asymptomatic stenosis (ACST-1): a multicentre randomised trial

Prof Alison Halliday, FRCS, Prof Michael Harrison, FRCP, Elizabeth Hayter, BMus, Xiangling Kong, MSc, Prof Averil Mansfield, FRCS, Joanna Marro, MSc, Hongchao Pan, PhD, Prof Richard Peto, FRS, Prof John Potter, FRCP, Kazem Rahimi, DM, Angela Rau, MBBS, Steven Robertson, BA, Jonathan Streifler, MD, Prof Dafydd Thomas, FRCP

The Lancet
Volume 376, Issue 9746, Pages 1074-1084 (September 2010)
DOI: 10.1016/S0140-6736(10)61197-X



Perioperative events/CEAs (%)+other events			
Years 0–5	Years 5–10		
44/1509 (2·9%)+56	0/23 (0·0%)+43	Immediate	
14/360 (3·9%)+140	2/87 (2·3%)+48	Deferred	

Events/person-years		
Years 0–5	Years 5–10	
56/6540 (0·9% py)	43/3042 (1·4% py)	Immediate
140/6553 (2·1% py)	48/3003 (1·6% py)	Deferred

Number at risk

Immediate	1560	1003	293	1560	1003	293
Deferred	1560	981	281	1560	981	281

The Lancet 2010 376, 1074-1084DOI: (10.1016/S0140-6736(10)61197-X)

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Table 2. Primary End Point, Components of the Primary End Point, and Other Events, According to Treatment Group.*

End Point	Periprocedural Period				
	CAS (N=1262)	CEA (N=1240)	Absolute Treatment Effect of CAS vs. CEA (95% CI)	Hazard Ratio for CAS vs. CEA (95% CI)	P Value
	no. of patients (% ±SE)		*percentage points*		
Death	9 (0.7±0.2)	4 (0.3±0.2)	0.4 (–0.2 to 1.0)	2.25 (0.69 to 7.30)†	0.18†
Stroke					
Any	52 (4.1±0.6)	29 (2.3±0.4)	1.8 (0.4 to 3.2)	1.79 (1.14 to 2.82)	0.01
Major ipsilateral	11 (0.9±0.3)	4 (0.3±0.2)	0.5 (–0.1 to 1.2)	2.67 (0.85 to 8.40)	0.09
Major nonipsilateral‡	0	4 (0.3±0.2)	NA	NA	NA
Minor ipsilateral	37 (2.9±0.5)	17 (1.4±0.3)	1.6 (0.4 to 2.7)	2.16 (1.22 to 3.83)	0.009
Minor nonipsilateral	4 (0.3±0.2)	4 (0.3±0.2)	0.0 (–0.4 to 0.4)	1.02 (0.25 to 4.07)	0.98†
Myocardial infarction	14 (1.1±0.3)	28 (2.3±0.4)	–1.1 (–2.2 to –0.1)	0.50 (0.26 to 0.94)	0.03
Any periprocedural stroke or postprocedural ipsilateral stroke	52 (4.1±0.6)	29 (2.3±0.4)	1.8 (0.4 to 3.2)	1.79 (1.14 to 2.82)	0.01
Major stroke	11 (0.9±0.3)	8 (0.6±0.2)	0.2 (–0.5 to 0.9)	1.35 (0.54 to 3.36)	0.52
Minor stroke	41 (3.2±0.5)	21 (1.7±0.4)	1.6 (0.3 to 2.8)	1.95 (1.15 to 3.30)	0.01
Any periprocedural stroke or death or postprocedural ipsilateral stroke	55 (4.4±0.6)	29 (2.3±0.4)	2.0 (0.6 to 3.4)	1.90 (1.21 to 2.98)	0.005
Primary end point (any periprocedural stroke, myocardial infarction, or death or postprocedural ipsilateral stroke)	66 (5.2±0.6)	56 (4.5±0.6)	0.7 (–1.0 to 2.4)	1.18 (0.82 to 1.68)	0.38

Brott TG, et al. Stenting versus Endarterectomy for Treatment of Carotid artery stenosis. N Engl J Med 2010. ;363:11-23.

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Carotid Artery Stenosis

Surgical Management (CEA)

Asymptomatic Carotid Artery Stenosis:

- Greater than 80% stenosis
- Good functional/cognitive status
- Life expectancy > 5 years
- <1 percent surgical risk (physiological)
- Surgeon with < 1 percent stroke risk
- Absence of ESRD

Systematic Review of Guidelines for the Management of Asymptomatic and Symptomatic Carotid Stenosis *Stroke. 2015;46:3288-3301*

Carotid Artery Stenosis

Surgical Management (CEA)

Symptomatic Carotid Artery Stenosis:

- CEA for patients with 50-79% stenosis and symptoms while on BMT or lesions deemed high risk for stroke (symptoms while not on BMT) at average to moderate risk for surgery (physiological or anatomic).
- CEA for patients with >80% stenosis and symptoms at average to moderate risk for surgery (physiological or anatomic)

% Stenosis	NASCET absolute risk reduction of any stroke or death @ 5 years	ECST absolute risk reduction of any death or stroke @ 2 years
50 - 69%	8.4% (1.4 - 15.4)	5.7% (-0.8 – 12.2)
70 - 99%	15.0% (7.4 - 22.6)	21.2% (12.9 – 29.4)

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Carotid Artery Stenosis

Surgical Management (CAS)

Symptomatic Carotid Artery Stenosis:

- CAS for patients with 50-99% stenosis and symptoms while on BMT at prohibitive risk for CEA

Systematic Review of Guidelines for the Management of Asymptomatic and Symptomatic Carotid Stenosis *Stroke. 2015;46:3288-3301*

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Carotid Artery Disease Management

Conclusions:

-Carotid artery stenosis is a significant cause of preventable stroke
-Diagnosed and surveillance is performed by duplex ultrasound
-Screen ultrasound should be performed on all patients with risk factors for carotid disease
-Medical therapy has a large role in prevention of stroke related to carotid artery stenosis
-CEA is indicated for low risk asymptomatic patients with >80% stenosis and low-moderate risk patients with 50-99% symptomatic stenosis
-CAS is rarely indicated

Systematic Review of Guidelines for the Management of Asymptomatic and Symptomatic Carotid Stenosis *Stroke. 2015;46:3288-3301*

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