

explanation may lie in the evolution of the procedure. The operation was first described in the early 1950s by Eastcott in London, and was popularised in the United States by DeBakey in Texas. By the mid-1970s a generation of surgical trainees had emerged from the teaching centres. A decade later in the United States very many operations were being done and selection was no longer confined to symptomatic patients with appropriate carotid lesions. A study showed that 32% of a random sample of 1302 Medicare patients had surgery for inappropriate reasons and 9.8% had a serious perioperative complication.⁷ Public concern led to reduced enthusiasm, and Medicare introduced stringent guidelines for payments for endarterectomy.⁸

Present situation

In the United Kingdom and most other countries the growth of the operation has been much more restrained and 40 years after its introduction many feel that its potential for preventing stroke remains unfulfilled.⁹ Since the multicentre trials were published, interest has picked up among general practitioners, neurologists, and ophthalmologists. Disease based transient ischaemic attack clinics are being set up, and diagnostic Duplex ultrasonography is widely available. Whatever the arguments about the optimal use of resources, it is difficult to deny an effective operation for patients with repetitive transient ischaemic attacks

and high grade carotid stenosis. The operation costs the NHS about £3000 compared with an average cost of £45 000 for rehabilitation and care if the stroke is not prevented.¹⁰ Perhaps the final word should go to the neurologist in the *BMJ* 15 years ago,¹ who said that if he had a transient ischaemic attack he would choose his surgeon and anaesthetist carefully, and hope that sense would overcome apprehension, leading to a successful carotid endarterectomy.

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- 3 European Carotid Surgery Trialists' Collaborative Group. MRC European carotid surgery trial interim results for symptomatic patients with severe (70-99%) or with mild (0-29%) carotid stenosis. *Lancet* 1991;337:1235-41.
- 4 North American Symptomatic Carotid Endarterectomy Trial Collaborators. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. *N Engl J Med* 1991;325:445-53.
- 5 Magee TR, Earnshaw JJ, Cole SEA, Hayward JK, Baird RN, Horrocks M. A 5 year review of carotid endarterectomy in a vascular unit using a computerised audit system. *Ann R Coll Surg Engl* 1992;74:430-3.
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Purchasers need a broader perspective

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Stroke is one of the leading causes of premature death and disability in the United Kingdom,¹ and district health authorities have an important responsibility for purchasing appropriate services to meet this challenge. Is carotid endarterectomy such an appropriate service? To answer this question, we need to examine the benefits to the individual from the procedure and then to try to extrapolate this effect to a population.

Benefits to individuals

Two comparable multicentre randomised controlled trials have measured the outcome of carotid endarterectomy in people with severe symptomatic carotid artery stenosis. The reduction in the absolute risk of a disabling or fatal stroke (the outcome with probably the greatest public health significance) was estimated at 5% in the European trial² and 10% in the North American study.³ Both studies used experienced surgeons with a good operative record. These figures provide compelling evidence of the benefit to individuals from surgery, which should not be ignored. Of course, people in this risk group often die of other causes, but the absolute benefit of endarterectomy remains, even when such deaths are taken into account.

This measure of benefit, however, omits the morbidity experienced by the many people who have cerebral angiography. Depending on the investigation protocol used and on the experience of the person performing the angiogram, morbidity from this procedure alone can negate any benefit which might result from surgery.⁴ Morbidity might be avoided by using non-invasive diagnostic techniques, but at present even centres with the most experience have been unable to eliminate the need for angiographic studies.⁵

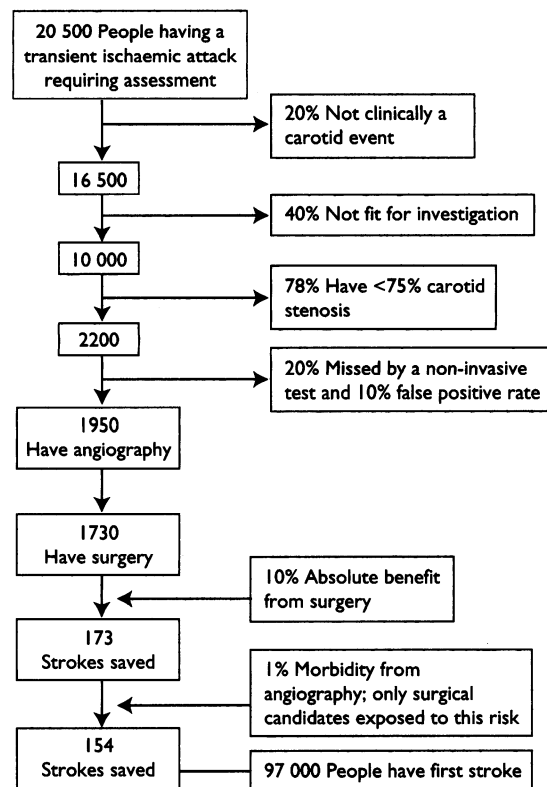
Appreciable risks are thus associated with both investigation and surgery, even under ideal conditions. Unfortunately, many procedures are being carried out under less than ideal conditions. For example, inexperienced practitioners more often produce unfavourable outcomes in vascular surgery,⁶ yet a survey in 1989 indicated that 22% of procedures were carried out by surgeons undertaking fewer than 10 operations a year.⁷ Considerable variation in the choice of investigations was also noted, and this could result either in excessive numbers of people being exposed to the risks of angiography or in inappropriate surgical referral.

The Association of British Neurologists has recently produced guidelines for the management of people who have had a transient ischaemic attack or uncompleted ischaemic stroke.⁸ In principle, this advice should increase the number of patients being managed under ideal conditions. However, the history of guidelines suggests that not all surgeons will change their practice.

Population benefits

How could the benefits for the individual translate into improvements in the health of a community? If all those with severe carotid artery stenosis who had had a transient ischaemic attack underwent surgery the overall reduction in the incidence of first stroke has been estimated to be 0.5%.⁹ This is based on the premise that a quarter of people who have had a transient ischaemic attack have arterial disease amenable to surgery and that the absolute reduction in the risk of stroke from surgery is 10%. This estimate of the number of suitable operative candidates is rather generous. Epidemiological survey suggests that 80% of

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Annual effects of carotid endarterectomy service on incidence of stroke in England

transient ischaemic attacks occur in the territory of the carotid artery,¹⁰ and one case series suggests that 61% of such patients will be fit for investigation and that 22% of them will have severe (over 75%) carotid artery stenosis.⁴ This means that the proportion fit for surgery is nearer a tenth (figure).

Furthermore, if we assume that the guidelines proposed by the Association of British Neurologists are being followed, some cases will be missed by a non-invasive test, hence fewer may benefit from surgery. A generous estimate of the accuracy of carotid Doppler examinations, from the results of a multicentre trial,¹¹ would be a sensitivity of 80% at a positive predictive value (which determines the number of false positive results) of 90%. This loss of surgical candidates will, however, be offset by the fact that only those about to have surgery will be exposed to the risks of angiography.¹²

Commentary: valuable in selected patients

Two well conducted clinical trials have shown that carotid endarterectomy can prevent strokes in people presenting with transient ischaemic attacks in the carotid territory. The financial and human costs of a stroke must mean that carotid endarterectomy should be purchased. However, the clinical and financial benefits will outweigh the risks only if certain important criteria are met. Firstly, the risk of stroke or death after a transient ischaemic attack is highest in the first six months so speed of investigation and intervention is important. Secondly, the patient should be medically fit for surgery. Thirdly, only those people with a stenosis greater than 70% should have been shown definitely to benefit from endarterectomy. Finally, and perhaps most importantly, the procedure must be carried out by a surgical team that has an acceptably low rate of vascular complications. Necessary requirements to meet these aims include the following: a transient ischaemic attack protocol enabling general practitioners to identify who should be referred; a fast track transient ischaemic attack clinic and rapid access to appropriate investigations; and information for the purchaser on complication rates achieved by individual surgeons.—PETER C RUBIN, *professor of therapeutics, University of Nottingham*

After all these factors are taken into account the maximum achievable reduction in the incidence of first stroke falls below 0.2% (figure). This does not allow for any benefit which may accrue to those who have had an uncompleted stroke, as any improvement in the outcome for these patients would not contribute to changes in the incidence of first stroke. In other words, the most optimistic estimate of the effect of the procedure in England is that 154 first strokes could be prevented out of the 97 000 which occur every year.¹³ This assumes that all those 154 patients can be readily identified and promptly referred to a high quality centre.

This assumption is immediately challenged by the observation that nearly a quarter of these procedures might be carried out by surgeons who do the operation only occasionally. This is of great concern since the potential reduction in stroke incidence is so small that practice need not vary greatly from the ideal for the benefits to vanish altogether.

Value for money

If one is still prepared to accept an estimate of the effect of the service, which includes the assumption of best practice throughout, what action should be recommended to a health authority charged with "ensuring... effective services for the prevention and control of diseases and the promotion of health?"¹⁴ Carotid endarterectomy would be unlikely to have a measurable effect on stroke incidence in any one district and would exclude other opportunities for providing healthcare. Other primary and secondary preventive measures for stroke may prove a better investment.¹⁵

What services are purchased will, of course, depend on what each health authority regards as its main purpose: if the short term reduction in costs without making any politically uncomfortable decisions is most important then the vanishingly small benefits from carotid endarterectomy are an appropriate investment, as many of the costs relating to people and capital will remain. If, however, the goal is improving the health of the population, carotid endarterectomy should not be purchased.

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