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Are Variations in the Use of Carotid Endarterectomy Explained by Population Need? A Study of Health Service Utilisation in Two English Health Regions

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Objectives: *to describe variation in utilisation of carotid endarterectomy (CEA) within two English health regions and explore relationships between use, need and proximity to services.*
Design: *consecutive case series of operations. Comparison at a population level with district stroke mortality, hospital admissions and material deprivation.*
Main outcome measures: *standardised utilisation rates for CEA and measures of inter-district variability. Spearman's rank correlation coefficients for associations between variables.*
Results: *variation in utilisation rates was considerable (14-fold difference across district populations). More individuals had bilateral surgery in the Yorkshire region than in the Northern (11.7% vs. 5.5%, $p=0.002$). There was no association between utilisation rates for CEA and district stroke mortality ($r=-0.06$, 95% CI -0.41 to 0.30) or admission rates for stroke ($r=0.17$, 95% CI -0.2 to 0.49). There was a strong relationship between residence in districts where services were located and higher utilisation. Rates of CEA were lowest in the regions' most affluent wards.*
Conclusion: *use of CEA varies widely, depending on area of residence. Variation is not a consequence of differences in need, but reflects clinical practice and supply of services. There is evidence to suggest unmet need for CEA.*

Key Words: Endarterectomy, carotid; Health services needs and demands; Health services accessibility; Socioeconomic factors.

Introduction

Variations in the use and outcome of health care can provide insights into the effectiveness, efficiency and equity of health services.[1] Such variations also generate questions about clinical practice and decision making, and about the quality of service.[2]

International variations in the use of carotid endarterectomy (CEA) are well recognised; in 1991 the rate of surgery in the U.S.A. was fifteen times higher than in the U.K.[3] Differences in operation rates have also been reported between and within regions in North America,[4,5] Scandinavia,[6,7] and the U.K.[8,9] However, few studies in the U.K. have explored the reasons for such variations.

Population-based utilisation rates of CEA in two neighbouring NHS administrative regions in England (combined population approximately 6.5 million) were assessed against measures of stroke mortality and morbidity, material deprivation and proximity to services in order to identify factors associated with differing access. The study did not aim to assess the impact of surgical rates on population morbidity or mortality from stroke, but to explore the association between surgical intervention rates and proxy measures of population need.

Methods

Determining district utilisation rates

A consecutive case series of residents of the Northern and Yorkshire regions, who underwent CEA (OPCS operation codes L29.4–L29.5)[10] in NHS hospitals between January 1992 and October 1995, was identified from Hospital Episode Statistics. This included all

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Table 1. Variation in operation rates for carotid endarterectomy in the Northern and Yorkshire regions.

Region	No. of districts	No. of procedures	No. of individuals	No. with bilateral surgery (%)	Standardised annual operation rate (per million over 35 yr)	Median (range) district standardised annual operation rates (per million over 35 yr)	Systematic component of variation
Northern	15	363	344	19 (5.5)	57.9	47.1 (21.6–130.1)	23.5
Yorkshire	16	869	778	91 (11.8)	112.8	103.5 (14.3–215.3)	18.7
Combined	31	1232	1122	110 (9.8)	88.1	59.1 (14.3–215.3)	–

operations on residents performed both within and outside the regional boundaries. To ensure ascertainment of all cases further sources were also searched, including surgical audit records, clinical computing systems and theatre registers. Patient age, sex, postcode of residence and the hospital where surgery was performed were recorded. Repeat admissions for bilateral surgery were identified.

Population denominators based on the 1991 census, corrected for under-enumeration,[11] were derived for each of 31 District Health Authorities (DHAs) within the regions. District population-based utilisation rates for both procedures and individuals, directly standardised for age and sex, were calculated using the European standard population.[12]

Determining measures of need and supply

Standardised death rates from cerebrovascular disease (ICD 430–438) for men and women aged 45–74 years for the time period 1993–1995 were calculated for each DHA. Standardised hospital admission rates of the resident populations for cerebrovascular disease, for men and women aged 45–74 years, were calculated using Hospital Episode Statistics from 1993–1995.

The 1150 electoral wards in the study area were ranked from most to least deprived using the Townsend deprivation score for the ward, calculated from the 1991 census,[13] and grouped into five quintiles. Directly-standardised utilisation rates were calculated for each ward deprivation quintile.

As a simple measure of proximity to surgical services, districts were categorised by whether CEA was performed in hospitals within their boundaries. In addition, districts were further classified by the workload carried out within their boundaries: high workload (>24 operations per year), moderate (12–24 per year), low (1–12 per year) and zero workload.

Data analysis

Variation in utilisation rates between districts was assessed using the systematic component of variation (SCV).[14] This takes into account differences in the mean regional rate and differences in the size of district populations, both of which influence the amount of random variation in utilisation rates. The relationship between district CEA utilisation rates and stroke mortality and morbidity was assessed using Spearman's rank correlation coefficient.

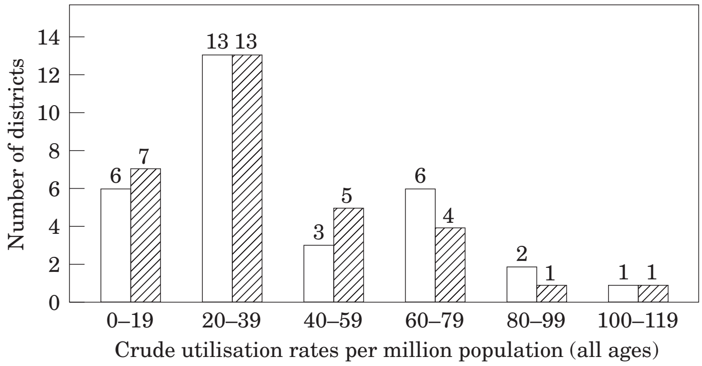

Fig. 1. Distribution of crude district population operation rates of carotid endarterectomy for procedures and individuals ($n=31$). (□) Procedures; (▨) individuals.

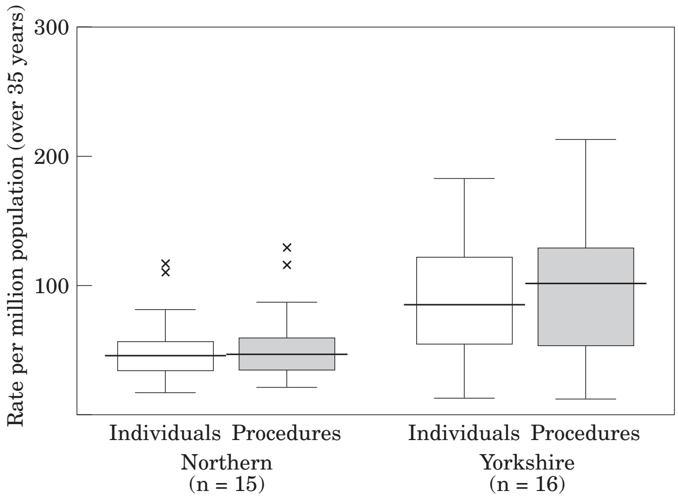

Fig. 2. Box-plot of directly standardised procedure and individual rates for carotid endarterectomy in district populations of the Northern and Yorkshire regions ($n=31$). Bar = median; box = interquartile range (IQR); whiskers = range of values within one IQR from box; × = values outside one IQR from box.

Table 2. Standardised carotid endarterectomy operation rates by ward deprivation and district workload grouping.

	No. of operations	Population mid-year 1991 (over 35 yr)	Standardised annual operation rate (per million over 35 yr)
Ward deprivation quintile			
Most deprived quintile	353	862 650	97.2
2nd quintile	282	784 137	87.5
3rd quintile	265	683 319	94.6
4th quintile	211	602 054	87.8
Most affluent quintile	114	443 362	65.4
Total	1225*	3 375 522	–
District workload group			
High workload districts ($n=3$) >24 procedures per year	448	638 931	163.5
Moderate workload districts ($n=5$) 12–24 procedures per year	244	526 264	114.9
Low workload districts ($n=6$) <12 procedures per year	152	686 271	55.6
Zero workload districts ($n=17$)	381	1 524 056	62.3
Total	1225*	3 375 522	–

*Data on age or sex of patient was missing for 7 operations.

Results

Case series

A total of 1232 CEA operations were identified, performed on 1122 individuals, 733 (65.3%) male. Of this group, 363 procedures (29.5%) were performed on residents of the Northern region. Operations were carried out by 29 surgeons, 13 in the Northern region and 16 in the Yorkshire region. The number of operations carried out annually doubled during the study from 209 in 1992, to 445 in 1995 (based pro rata on 10 months' data). The rate of increase was similar in both regions. More older patients underwent surgery in the Yorkshire region (median age 68 years, IQR 61 to 73 years) than in the Northern (median age 64 years, IQR 57 to 70) ($\chi^2=30.4$, $p<0.00001$). There was no difference in the sex distribution of patients between the regions. Yorkshire residents were more likely to have bilateral surgery (11.7% vs. 5.5%, $p=0.002$).

Variation in district utilisation rates

The standardised rate of CEA procedures amongst Yorkshire residents was twice that of the Northern region (see Table 1). The difference between regional rates for individuals was slightly lower (1.8) as a result of the greater proportion of Yorkshire region residents who underwent bilateral surgery. Variation in procedure and individual rates was greater between district populations than between regions. Fig. 1 shows the distribution of crude utilisation rates for district populations. There was a 14-fold difference in procedure rates, and a 12-fold difference in individual rates between populations with the highest and lowest rates. This variation persisted after standardisation for the age and sex structure of the populations (see Table 1 and Fig. 2). The SCV was similar in each region, suggesting that the variability in population rates was comparable given the overall difference in average regional rates.

Relationship with need and supply

Population stroke mortality rates (45–74 yr) ranged from 59.8 to 133.8 per 100 000 across the districts (median 92.4, IQR 84.9 to 97.4) and stroke admission rates (45–74 yr) from 220.4 to 535.7 per 100 000 (median 374.3, IQR 349.3 to 446.9). There was a significant correlation between population stroke mortality and population-based admission rates ($r=0.59$, 95% CI 0.30 to 0.78). No correlation was found between population utilisation rates for CEA and stroke mortality for either individuals ($r=-0.09$, 95% CI -0.43 to 0.27), or procedures ($r=-0.06$, 95% CI -0.41 to 0.30). There was no correlation between utilisation rates and stroke admission rates for individuals ($r=0.19$, 95% CI -0.17 to 0.51), or procedures ($r=0.17$, 95% CI -0.20 to 0.49).

Standardised operation rates were similar in all but the most affluent quintile of wards, in which rates were lower (Table 2). However, there was a marked positive relationship between residence in districts which contained hospitals providing CEA and population operation rates. The annual standardised operation rate in populations surrounding a CEA performing centre was almost double that in districts in which the operation was not carried out (110.3 vs. 62.3 per million population over 35 yr). Rates were highest in those populations containing hospitals with the greatest workload (Table 2).

Discussion

Our study demonstrates large variations in the rate of CEA which are not explained by population demography or need. On the basis of our findings, there is evidence of considerable geographic inequity within the study area.

Rates of CEA have been shown to be positively correlated with stroke incidence at a regional level in the UK, although the Northern region appears to have a low rate of CEA use compared to predicted need.[9] However, this study demonstrates that this relationship does not hold at a local level. Whilst more procedures may be performed in regions with a greater burden of stroke, in this study the dominant influence on who has access to the service appears to be proximity to supply.

The SCV can be used to compare the extent of variation with other procedures: values below four indicate low variation (e.g. inguinal herniorrhaphy), 5–10 moderate variation (e.g. prostatectomy) and above 10 high variation (e.g. tonsillectomy).[15] In this study the SCV was over 18 in both regions, indicating high variation.

The number of individuals who might benefit from CEA annually in the UK has been estimated at 160 per million.[16] In a region where mortality from stroke is higher than the national average,[17] the crude annual operation rate for individuals exceeded 80 per million in only two out of 31 districts. A similar pattern has been reported elsewhere in the U.K., with a three-fold variation in district uptake of CEA within the Wessex region, and an overall ratio of use to predicted need of less than 0.5.[8]

The lower rate of CEA in the most affluent population may have arisen in several ways. Absence of data from private hospitals could have led to undercounting of procedures in more affluent areas. However, discussion with local surgeons suggests that private sector activity for CEA is low and could not explain this difference. Alternatively, cerebrovascular disease has a strong relationship with socio-economic status,[17] and the observed pattern of use may truly reflect underlying need. However, CEA-performing hospitals are often situated in deprived inner-city areas and it may be that the apparent inverse relationship with deprivation results from the confounding effect of proximity to services.[15]

Some authors have identified the level of uncertainty surrounding indicators for an intervention as an important source of variation in its use.[18] Robust evidence of the effectiveness of CEA only became available shortly before the study period;[19,20] additional information on its role in asymptomatic patients was published during the study.[21] There is evidence of differences in surgical practice within our study, with Yorkshire residents more likely to undergo bilateral surgery and be operated on at a greater age. Variations in the extent of bilateral surgery probably reflect differences in surgical practice for asymptomatic carotid disease. The Asymptomatic Carotid Surgery Trial (ACST)[22] was recruiting during the study period and some of this surgery may have been performed as part of the trial.

Guidelines for CEA have been published in the U.K.[23] and U.S.A.,[24] but the extent of their use in the study area is not known. It is likely that uncertainty about the use of the procedure was a factor in promoting variation and, as has been seen with other innovations such as coronary angioplasty, this may diminish as its use increases.[25]

Reliance on hospital data means that important aspects of the pathway to surgery cannot be included in the study. The influence of referral practice from primary care or of differences in access to diagnostic services such as Doppler ultrasound remain unexplored.

Differential accuracy of data capture by different hospitals could cause spurious differences between areas, but is unlikely to explain the variation observed, given its extent and the use of multiple data sources for case ascertainment. More importantly, the "appropriateness" of surgery was not assessed. Studies in the early 1980s from North America suggested that only a third of all CEAs performed were "appropriate".[26,27] More recent work in Canada reported that surgical intentions were appropriate in 33% of cases, uncertain in 49% and inappropriate in 18%.[28]

The role of clinical audit in monitoring carotid surgery has been highlighted, chiefly in relation to perioperative morbidity.[23] We suggest that it is important to incorporate standards for the indications for surgery, as population benefits will only be realised if surgery is directed at those at highest risk. There is need for clearer consensus on the management of asymptomatic carotid stenosis. Whilst the ACAS study has demonstrated a statistically significant advantage for surgery in asymptomatic patients,[21] the low baseline risk of such individuals makes its clinical significance dubious and the implications for case identification are considerable.[29]

In summary, whilst this study relies on proxy measures of need, it strongly suggests that the existing pattern of use of CEA is largely driven by its supply, with wide differences in access to services depending on where you live and local clinical practice. While some purchasers of health care have questioned the role of CEA in stroke prevention at the population level,[30] it seems unlikely that the existing pattern of use is a result of planned contracting decisions.

This study was conducted at a time when practice in carotid surgery is changing and variation in practice may diminish with time. However, it reinforces the message that there is still a significant gap between a need and supply-driven health service and that combined approaches by providers and planners will be required if equitable access is to be achieved.

Key Messages

- There is evidence for the effectiveness of CEA in preventing stroke in high risk groups.
- Use of CEA varies widely at a district and regional level within the UK.
- Variation is not due to differences in underlying need.
- Variation reflects differences in clinical practice and the supply of services.
- There is evidence of unmet need for CEA.

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