Journal of Epidemiology and Community Health 1997;51:132–133

Stroke mortality—secular and geographic trends: comment on papers by Maheswaran and colleagues

Shah Ebrahim

Stroke mortality rates have fallen over several decades in industrialised countries.[1] A recent analysis using the National Statistics Office historical data set for England and Wales[2] has shown a steady decline, with greater falls at younger ages, from 1901 to 1936–39. From 1940–60 rates increased in both younger and older people, and from 1961–91 rates declined again at all ages. In the USA, the rate of decline has accelerated during the century from 0.5% per year in 1900–20 to 4–5% per year since the 1970s but did not show any increase in the 1940s to 1960s.[3]

In interpreting these trends it is important to ask the following questions. Could the trends be due to:

- Changes in coding practices associated with *International Classification of Diseases* revisions?
- Changes in diagnostic fashion?
- Changes in diagnostic technology leading to greater accuracy? Or
- Real effects due to reduced case fatality or reduced incidence rates?

Coding changes associated with the 5th revision of the *International Classification of Diseases* resulted in an increase in deaths ascribed to stroke and partly explain the 1940s increase in mortality rates. Diagnostic fashion has changed resulting in far more strokes attributed to "acute, ill-defined and unspecified" categories (ICD 436, 437) than specific diagnoses. However, post mortem evidence from Manchester hospitals does suggest that the ratio of cerebral haemorrhage to cerebral thrombosis declined over the period 1877–1961.[4] Diagnostic technology, in particular use of computed tomography, might explain some of the recently reported increased incidence of stroke[5] because of greater ascertainment, but does not explain the declining mortality trend.

The reduction in mortality rates was associated with falls in incidence[6–8] and case fatality[9] during the 1970s. However, during the 1980s stroke incidence may have increased in some countries, despite continued falls in mortality and case fatality,[10] although this is not a consistent finding.[11] If a real increase in stroke incidence is occurring in the face of continued declines in mortality and case fatality, this suggests that stroke is getting less severe, perhaps because of a reduction in the ratio of haemorrhagic to thrombo-embolic stroke, or greater ascertainment of milder, formerly unrecognised cases.

Since 1973–74 the secular trend has been more rapid and explanations proposed include the use of antihypertensive treatment,[12 13] reductions in smoking,[14] secular falls in blood pressure,[15] changes in atmospheric pollution,[16] and increases in the amount of fruit and vegetables eaten.[17 18] None of these factors seems likely to explain the declining trend observed since 1901 or to be a complete explanation for the more recent trends.[19 20]

Early life influences

The "early life influences" hypothesis suggests that maternal and infant health is of importance in determining the risk of cardiovascular disease in later life[21] and that this may explain the declining trend in stroke mortality.[22] However, since declines in stroke mortality appear to have occurred at similar rates at all ages over the century, period (ie factors operating around the time of death) rather than cohort effects (ie factors determined by the generation born into) are more likely explanations for the trends.

In the article on pages 121–26 of the Journal, Maheswaran *et al* have demonstrated that the general fall in stroke mortality rates has occurred at a slower rate in Greater London than in the rest of the south east of England.[23] Furthermore, they have found that a crossover in age specific mortality rates for Greater London and the south east of England has occurred at different periods and is consistent with a cohort effect in people born around 1916–21. They have then tested the early life hypothesis by examining trends in maternal and neonatal mortality which might be expected to show a similar crossover in rates in 1916–21 if early life factors were important in explaining the cohort effect. This was not the case; if anything the trends were in the opposite direction.

An examination of data for England and Wales from 1931–85 using age-period-cohort modelling[24] has shown that period effects predominate, but also found a significant cohort effect once period effects had been allowed for. Those cohorts born from 1890 experienced declining rates whereas those born after 1920 have had an increase in mortality rates which is not consistent with an "early life influences" hypothesis. Alternative explanations for this include an increased susceptibility to stroke (eg by improved survival of people with ischaemic heart disease and diabetes) and an increase in exposure to major risk factors (eg alcohol, physical inactivity). By contrast, the US National Statistics Office data show that each successive birth cohort since 1890 has ex-

Department of Primary Care and Population Sciences, Royal Free Hospital School of Medicine, Rowland Hill Street, London NW3 2PF
S Ebrahim

Correspondence to:
Professor S Ebrahim.

Accepted for publication October 1996

perienced a reduced risk of stroke with no upturn in rates in later birth cohorts.[25]

It is probable that early life influences, which play a part in determining the risk of cardiovascular disease in later life, interact in complex ways with risk factors operating throughout the lifespan. Simple age-period-cohort modelling is not able to detect such interactions and consequently does not test the hypothesis adequately.

Geographic trends

In a companion paper on pages 127–30 of the Journal, Maheswaran *et al* have examined the mortality rates for 1986–92 in people living in Greater London and the rest of the south east of England.[26] The findings are highly relevant for policy and practice: at younger ages (<65 years) socioeconomic deprivation and the proportion of Afro-Caribbean and Irish born men explain the relatively higher rates in inner London. Variation in risk factors such as smoking, hypertension, and the consumption of fresh fruit do not differ markedly between London and the rest of the south east but may be partial explanations for socioeconomic and ethnic differences in mortality. Medical care factors, both in terms of access and quality, may vary between London and the rest of south east England and merit further research.

Further clues to the causes of the time and place variation in stroke mortality are the marked rises in mortality rates in central and eastern European countries that have occurred in the last two decades[27]; the fact that poorer countries experience generally higher stroke mortality rates[28]; and social and geographic variation in England and Wales.[29] These trends, together with the downward trends over the century, point to the aetiological relevance of socioeconomic factors. MONICA studies comparing risk factor profiles, case fatality, mortality, and incidence rates between countries are now underway and will provide more data to test specific hypotheses, although methodological problems are considerable.[30]

Understanding the causes of secular and geographic trends in stroke mortality is fundamental to our preventive strategies. The UK *Health of the Nation* policy[31] focuses on the control of individual risk factors largely through primary care services. The work of Mahaswaran *et al* draws attention to the complexity of variation in time and place and, together with earlier analyses, highlights the need for a broader approach to health promotion involving population health protection (eg tobacco control, reducing the addition of salt in processed foods) and, more specifically, improvement of primary care (eg smoking and hypertension control, targeting of ethnic minorities) in this case in inner London.

The steady decline in stroke mortality rates since the beginning of this century and the aetiological factors responsible are probably the same as those causing the general reduction in mortality that has occurred over the same time period – namely improvements in nutrition and socioeconomic development.[32] The mechanisms by which social and economic factors influence the health of the population still require further exploration so that better methods of prevention may be found. The message for health policy is that the emphasis on primary prevention through modification of individual risk factors may achieve much less than expected. The need to maintain socioeconomic development and reduce material inequalities in the population deserve greater attention.

1 Bonita R, Beaglehole R. Explaining stroke mortality trends. *Lancet* 1993;**341**:1510–11.
2 Charlton J, Murphy M, Khaw K-T, Ebrahim S, Davey Smith G. Cardiovascular diseases. In: *Health of adult Britain*. London: National Statistics Office, HMSO (in press).
3 Ostfeld AM. A review of stroke epidemiology. *Epidemiol Rev* 1980;**2**:136–52.
4 Yates PO. A change in the pattern of cerebrovascular disease. *Lancet* 1964;i:65–9.
5 Broderick JP, Phillips SJ, Whisnant JP, O'Fallon WM, Bergstralh EJ. Incidence of stroke in the eighties: the end of the decline in stroke? *Stroke* 1989;**20**:577–82.
6 Garraway WM, Whisnant JP, Furlan AJ *et al*. The declining incidence of stroke. *N Engl J Med* 1979;**300**:449–52.
7 Tanaka H, Udea Y, Date C *et al*. Incidence of stroke in Shibata, Japan: 1976–1978. *Stroke* 1981;**12**:460–6.
8 Ueda K, Omae T, Hiroat Y *et al*. Decreasing trend in incidence and mortality from stroke in Hisayama residents, Japan. *Stroke* 1981;**12**:154–60.
9 Garraway WM, Whisnant JP, Drury I. The changing pattern of survival following stroke. *Stroke* 1983;**14**:699–703.
10 Harmsen P, Tsipogianni A, Wilhelmsen L. Stroke incidence rates were unchanged, while fatality rates declined, during 1971–1987 in Goteborg, Sweden. *Stroke* 1992;**23**:1410–15.
11 Sarti C, Tuomilehto J, Sivenius J *et al*. Declining trends in incidence, case-fatality and mortality of stroke in three geographic areas of Finland during 1983–1989. Results from the FINMONICA stroke register. *J Clin Epidemiol* 1994;**47**:1259–69.
12 Tuomilehto J, Nissinen A, Wold E *et al*. Effectiveness of treatment with antihypertensive drugs and trends in mortality from stroke in the community. *BMJ* 1985;**291**: 857–60.
13 Whisnant JP. The decline of stroke. *Stroke*, 1984;**15**:160–8.
14 Bonita R, Scragg R, Stewart A, Jackson R, Beaglehole R. Cigarette smoking and risk of premature stroke in men and women. *BMJ* 1986;**293**:6–8.
15 Joosens JV, Kestelloot H, Amery A. Salt intake and mortality from stroke. *N Eng J Med* 1979;**300**:1396–8.
16 Know EG. Meterological associations of cerebrovascular disease mortality in England and Wales. *J Epidemiol Community Health* 1981;**35**:220–3.
17 Gillman MW, Cupples LA, Gagnon D, Posner BM, Ellison RC *et al*. Protective effect of fruit and vegetables on development of stroke in men. *JAMA* 1995;**273**:1113–7.
18 Gale CR, Martyn CR, Winter PD, Cooper C. Vitamin C and risk of death from stroke and coronary heart disease in a cohort of elderly people. *BMJ* 1995;**310**:1563–6.
19 Tuomilehto J, Bonita R, Stewart A, Nissinen A, Salonen JT. Hypertension, cigarette smoking, and the decline in stroke incidence in eastern Finland. *Stroke* 1991;**22**:7–11.
20 Bonita R, Beaglehole R. Does treatment of hypertension explain the decline in mortality from stroke? *BMJ* 1986; **292**:191–92.
21 Barker DJP. *Fetal and infant origins of disease in adult life*. London. British Medical Journal Group, 1992.
22 Anonymous. Infant nutrition and cardiovascular disease. Editorial. *Lancet* 1988;i:568–9.
23 Maheswaran R, Strachan DP, Elliott P, Shipley MJ. Trends in stroke mortality in Greater London and south east England – evidence for a cohort effect? *J Epidemiol Community Health* 1997;**51**:121–26.
24 Wolfe C, Burney P. Is stroke mortality on the decline in England? *Am J Epidemiology* 1992;**136**:558–65.
25 Feinleib M, Ingster L, Rosenberg H *et al*. Time trends, cohort effects and geographic patterns in stroke mortality – United States. *Ann Epidemiology* 1993;**3**:458–65.
26 Mahaswaran R, Elliott P, Strachan DP. Socioeconomic deprivation, ethnicity and stroke mortality in Greater London and south east England. *J Epidemiol Community Health* 1997;**51**:127–31.
27 Bonita R, Stewart AW. International trends in stroke mortality: 1970–1985. *Stroke* 1990;**21**:989–92.
28 Kalache A, Aboderin I. Stroke: the global burden. *Health Policy & Planning* 1995;**10**:1–21.
29 Acheson R, Sanderson C. Strokes: social class and geography. *Pop Trends* 1978;**12**:13–17.
30 Asplund K, Bonita R, Kuulasmaa K *et al*. Multinational comparisons of stroke epidemiology. Evaluation of case ascertainment in the WHO MONICA stroke study. World Health Organization monitoring trends and determinants in cardiovascular disease. *Stroke* 1995;**26**:355–60.
31 Secretary of State for Health. *Health of the nation*. London, HMSO, 1992.
32 McKeown T, Record RG, Turner RD. An interpretation of the decline in mortality in England and Wales during the 20th century. *Popul Studies* 1975;**29**:391–422.